November 2012

FINAL REPORT

SYSTEM WIDE WATER AUDITS

IN SUPPORT
OF
REGIONAL WATER CONSERVATION PLANNING

FOR THE

SOUTHEASTERN COLORADO
Water Conservancy District
"Your investment in water"

Prepared by:

GREAT WESTERN INSTITUTE

Table of Contents

Appendices

Table of Contents (continued)

List of Figures

List of Tables

System Wide Water Audits to Support the Regional Water Conservation Planning Effort

Southeastern Colorado Water Conservancy District

Background

The District is in the process of developing a Regional Water Conservation Plan (hereafter "RWC Plan" or "Plan") that will support its permitting efforts to complete the Arkansas Valley Conduit (AVC), and help create a regional partnership between the District and the AVC project partners. Work had begun on developing the Plan; however, after interviewing a great majority of the Plan participants (aka, the project partners located in the Lower Arkansas River Valley below Pueblo that are participating in the development and implementation of the RWC Plan), it became increasingly clear that the management and tracking of non-revenue water[1] is a vital issue for all entities involved in the AVC, and that the effective reduction of real and apparent losses would be the key yardstick for measuring future success of the RWC Plan[2].

Data characterizing current practices for tracking and measuring real and apparent system losses are not consistently documented by the various Plan participants (see Table 1). Estimates of system wide losses, especially of treated water, are needed from all the Plan participants using a consistent tracking and reporting mechanism to support Plan development and implementation. To this end, a system wide audit of each Plan participant's water supply system was conducted to understand and characterize those key data collection methods and water distribution characteristics that may influence water loss and tracking of non-revenue water. The focus of this project was therefore to help develop an understanding of the water loss and management from a regional perspective that would help local water suppliers with infrastructure management and improvements, as well as improve overall cash flow and water use efficiency – thus supporting long-term sustainability of the various organizations.

To support the needs of the District in its regional planning role, the system wide audits were designed and conducted to collect data and characterize non-revenue water and water loss management for each of the Plan participants in a manner that facilitates regional water conservation planning efforts. To this end, the data which was collected through the audit process was used to:

- Support development of specific, measureable water conservation goals;
- Design water conservation programs that can be implemented on a regional basis; and
- Define future data collection requirements that may be conducted consistently by all Plan participants during RWC Plan implementation.

[1] Non-revenue water is a term that has been developed by the American Water Works Association (AWWA) to describe the water that a water company or utility produces by does not sell. The components of non-revenue water include real losses (due to leaks, etc.) and apparent losses (due to inaccurate meters, etc.). Non-revenue water also includes unbilled authorized uses such as hydrant flushing, filter backwash, etc. This report will use the term non-revenue water in place of the less accurate term unaccounted for water. (see footnote 21)

[2] Although other measures and programs would be included in the Plan, the reduction of real and apparent losses is expected to provide for a significant portion of the realized future demand reductions resulting from implementation of the Plan.

Table 1 - Summary of Reported Pre-System Wide Audit Unaccounted and Unbilled Water

County		Participant	Water unaccounted (%)[1]	Water unbilled (%)[1]
Bent	1	Hasty Water Company	6	-
	2	Las Animas, City of	1	3
	3	McClave Water Assoc.	15	15
Crowley	4-7	Crowley County Commissioners (includes #1 96 Pipeline Company, #8 Crowley County Water Association, #9 Town of Crowley, and #29 Town of Ordway)[2]	8.4	8.4
	8	Olney Springs, Town of	7.5	5
	9	Sugar City, Town of	-	10
Kiowa	10	Eads, Town of	5	-
Otero	11	Beehive Water Assn	-	-
	12	Bents Fort Water Co.	10	10
	13	Cheraw, Town of	-	-
	14	East End Water Assn.	5	5
	15	Eureka Water Co.	18	18
	16	Fayette Water Assn.	-	-
	17	Fowler, Town of (potable only)	5	35
	18	Hancock Inc.	6	-
	19	Hilltop Water Co.	-	15
	20	Holbrook Center Soft Water	5	5
	21	Homestead Improvement Assn.	5	5
	22	La Junta, City of	7	1
	23	Manzanola, Town of	17.5	-
	24	Newdale-Grand Valley Water Co.	-	16
	25	North Holbrook Water	-	-
	26	Patterson Valley Water Co.	11	11
	27	Rocky Ford, City of	-	-
	28	South Side Water Assoc.	-	-
	29	South Swink Water Co.	14	14
	30	Valley Water Co.	17	17
	31	Vroman	-	-
	32	West Grand Valley Water Inc.	-	10
	33	West Holbrook Water	-	-
Prowers	34	Lamar, City of	17.5	17.5
	35	May Valley Water Assoc.	15	-
	36	Wiley, Town of	5	-
Pueblo	37	Boone, Town of	-	-
	38	St. Charles Mesa Water District	17	17

[1] From the "Merrick Participant Surveys," prepared for the SECWCD 2010.
[2] Weighted based on population data provided in the "Merrick Participant Surveys"

Overview of Work Performed

The system wide audits were conducted using a modification of the methodology contained in Manual-36 – Water Audits and Loss Control Programs – prepared by the American Water Works Association (AWWA). This manual of water supply practices defines a water audit program that "is an effective tool available to utilities to quantify consumption and losses that occur in the distribution system and the management of these processes." The manual provides step-by-step instructions on how to compile the information and calculate performance factors for water distributors.

The scope of the AWWA's methodology is admittedly grander than what is needed for many of the AVC Plan participants; however, the themes and the concepts remain the same regardless of the size or sophistication of the distributer. Therefore, slight modifications to the M-36 methodology were incorporated to address the needs of the project without creating undue hardship on the Plan participants.

Objectives

The overall objective of the system wide audits was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key components of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Estimate and characterize non-revenue water (aka, water loss) within each local water supply system; and
- Identify best management practices (BMPs) which would improve local water use efficiency by addressing current and future water loss.

In addition, these data collected through the audit process were used to support evaluations of potential performance guidelines and assessments of costs related to planning for and implementing regional water efficiency programs.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with each Plan participant to inform them of the nature and intent of the water audit; and to request that specific data be made available (in any format that was easy) for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected and reported; and
- Setting the units of measure.

Based on this request, the Plan participants were asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Data was typically made available in hard copy format – based on files maintained in either electronic and/or handwritten formats.

The specific data request included:

- List of all the meters serviced by size (preferably in table format).
- When each meter, by size category, was last tested/replaced (including master meters).
- For small systems: A map showing locations of well head(s) and other source water, master meter and service area.
- For larger systems: A map showing locations of water treatment plant(s), master meter(s) and service area.
- Estimates of master meter accuracy (and what regular adjustments are used).
- Monthly master meter data for two years, with date read.
- For smaller systems: Monthly water delivery data for all customers for two years (including unbilled, billed, and date billed).
- For larger systems: Monthly water delivery data for all customers, by customer category, for two years (including unbilled and billed, and date billed).
- Listing of metered, unbilled accounts, if they exist (for example City Parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Noteworthy is that the majority of the Plan participants were able to compile the requested data; however, as expected, the form and the completeness of the data was not consistent from organization to organization. In addition, some of the data collected was anecdotal in nature such that the results of the analyses performed must be tempered based on the known limitations of the available data.

Notwithstanding the limitations in the data and the data collection process, the system wide audits succeeded in determining the nature of water loss management for each of the Plan participants and the characteristics of data collection and management related to overall water production and delivery tracking to the extent needed to support regional water conservation planning and the District's permitting requirements.

Conducting the Audit

The in-the-field audit team performed the audits over the five week period from August 29th to September 30th[3]. During this time, 37 of the 38 Plan participants were visited individually in face-to-face meetings with staff, operators, and/or board members. The meetings were used to update the Plan participants regarding the ongoing development of the RWC Plan, and to conduct the business of the audit. In particular, the following tasks were completed in conducting the audit:

- Water production and distribution information were collected (including a map of the system and production records);
- Water billing information were collected; and
- Other key water distribution system information and policies information were collected (e.g., system wide pressure, length of pipelines, piping material, number of customer tie-ins, history of

[3] With the exception of the City of Fowler, which was conducted in March 2012.

recent leaks, leak detection and repair policies, meter testing and replacement policies, quantity and nature of unbilled and unmetered uses).

These data were used by the audit team to determine the key characteristics of each of the Plan participant systems; to estimate non-revenue water; and characterize real and apparent system losses for each operating system. These data were also crucial in helping to identify ongoing best management practices that are in use within current operational programs.

Developing the Database and Calculations

The audit team organized the data collected from each of the Plan participants into an Excel database associated with each of the key attributes of the data collected including:

- Meter sizes and age (including whether or not automated meter reading devices (AMR) have been installed);
- Distribution system pipe diameter, length, and materials;
- Water treatment plant/system characteristics; and
- Comparison of produced water to water sold (including accounting for unbilled, unmetered and unbilled, metered water uses).

The calculations for non-revenue water were developed based on these data using methodologies discussed in the M-36 Manual including:

- Total water supplied (including cross connects with other water sources (e.g., water supplied by the Crowley County)) per period
- Total billed authorized consumption per period
- Calculated non-revenue water per period
- Estimated unbilled consumption per period
- Estimated total water losses per period

Develop Project Summary and Data Compilations

The audit team prepared this report to summarize the results of the audit for each Plan participant, which includes a data compilation and the results of the calculations for each organization that participated in the system wide audit. This report will be used to inform the RWC Plan such that information regarding the scope of and need for water loss control programs can be ascertained and cost benefit calculations can be developed.

In addition, a data compilation (AKA, white paper) was produced for each Plan participant based on the information collected during the audit. The individual white papers include a summary of the data collected by each Plan participant, as well as a list of recommendations that each participating organization may wish to consider to manage and reduce current system wide water loss – including both real and apparent losses. A copy of each of the white papers prepared for the individual Plan participant is included in Appendix A.

Summary of Data Collection Efforts

The Plan participants provided substantial data to the water audit team during the period August through September of 2011[4].

The data presented in this subsection of the report includes the following:

- Meter Information – age, size and amount of automation (i.e., radio reads) currently in place.
- Billing/General Record Keeping – nature of record keeping (i.e., electronic vs. hardcopy files), regularly of meter reading and billing including reading of master meters and customer meters
- Pipe Information – size, material, and length (age of pipe materials was discussed with all Plan participants but was not typically reported by the majority of the Plan participants)
- Water Treatment Plant Information – nature of water treatment and for those with filtration, how backwash water is managed

Qualification of the Data

The data that were provided by the Plan participants came to the audit team in various formats, for various timeframes, and in varying states of completeness. This occurred since the organizations that collect and use these data manage and oversee the operations of substantially different water systems, which differ in size and complexity, location and type of source water; and are funded through substantially different mechanisms. Nonetheless, the data provided was considered adequate in characterizing those system attributes of the various water providers to allow for the development of comparisons and evaluations on a regional basis.

However, the specific accuracy of all the data collected during the system wide audits is not entirely understood given the nature of the data collection and management systems in place[5]. Therefore, some screening and qualification of the data was deemed necessary to support a consistent and fair use of those data that were provided by the Plan participants. To this point, the data that was collected and is presented in the tables that follow were considered to be of acceptable quality and quantity to support regional planning efforts. A more rigorous use of the data may not be warranted without a better understanding of the data background and history, which was beyond the scope of this effort.

Meters

The Plan participants, in general, are fully metered, such that they are all able to measure water use at the connections with all of their customers. There are a few uses identified by various Plan participants that are not metered, such as some town facilities, an occasional church or other grandfathered user, and some hydrants or stand pipes; however the vast majority of uses are metered. Table 2 presents a summary of the unmetered uses found during the audit.

[4] With the exception of the City of Fowler, which was conducted in March 2012.

[5] For example, the length of distribution water line was estimated in some cases from scaling maps, or from anecdotal information; meter age was estimated from institutional knowledge; water line material was provided anecdotally to the audit team. These data were considered reasonably quantifiable within the limitations of the data use – that being for regional planning purposes.

Table 2 - Unmetered Water Uses Identified During Data Collection

Church	Other Water Treatment Plant Uses
Construction Water (from hydrants and/or standpipes)	Street Cleaning
Filter Backwash	Sewer Collection Cleaning
Fire Suppression	Town Hall
Firehouse	Town Shop
Hydrant and Line Flushing	Town/City Parks

Note that not all Plan participants had unmetered uses; nor were all churches, for example, unmetered. It was found that for each of the uses listed in Table 2, at least one of the Plan participants had this type of unmetered use.

A summary of the data collected to characterize the size and age of the Plan participant's meters is presented in Appendix B. As this table indicates, over 19,300 meters are owned and maintained by the Plan participants collectively in the Lower Arkansas River Valley. Of these meters, roughly 95% are 5/8 by 3/4 inch meters; which are typically used for single family residential customers based on the efficacy of the meters and the excepted volume and flow of water to a domestic tap. The vast majority of the water customers in the Lower Arkansas River Valley served by the Plan participants are in fact single family residential user. In addition, most single family residential users do not utilize their domestic supply for seasonal outdoor irrigation, per se. They do; however, utilize potable water for stock water. In fact, some of the largest water users outside of City limits in the Lower Arkansas River Valley are feedlots. Prisons, parks, schools, nursing homes, apartment buildings and other multi-user entities (e.g., trailer parks) are also large water users in this area.

Another important characteristic of meters owned and maintained by the Plan participants is their age. For instance, about two thirds of the meters currently in place are older than 10 years, and in some locations over 90% of the meters are older than 10 years. Although a residential water meter may last beyond 10 years[6], it is important that the Plan participants maintain accurate customer meters such that water sales are consistent with water use. Large diameter meters are more susceptible to under reading actual usage than are typical domestic meters; however, all meters can become inaccurate with age and use. Since all meters tend toward under reading actual use, old meters can negatively impact cash flow for operating water companies. Given the percentage of non-revenue water measured for the Plan participants (see the

[6] One of the most important best practices that will be proposed for the Plan participants involves tracking individual water meter use. Mr. Norman Noe of South Swink has collected data indicating that a water meter tends to lose reasonable accuracy after passing about 2 million gallons of water. For his systems, he therefore tracks water use for each meter and attempts to replace meters as they reach 2 million gallons. This method may not be effective for all Plan participants, depending on local conditions (e.g., corrosive water, water high in iron or manganese, etc.) which may compromise meters sooner; however, a general tracking of water use for each meter installed would be an effective method to identify and budget for appropriate meter replacement programs.

BMP

next section), it is anticipated that a portion of the non-revenue water is attributable to under reading meters[7].

An effective meter age was calculated for each of the Plan participants for comparative purposes. The calculation was developed by assuming that meters less than 5 years old average 2.5 years in place; meters between 5 and 10 years old averaged 7.5 years in place; and meters older than 10 years in place averaged 15 years old. A result of this calculation, based on these assumptions is presented in Appendix B.

Appendix B also presents a listing of the number, and related percentage, of automated meter reading (AMR) devices (aka - radio read devices) that were installed and operational at the time of the audits. This totaled to over 3,600 AMR devices, which is about 19% of all meters in the Lower Arkansas River Valley. Eight of the 38 Plan participants have AMR devices, with two organizations – the Town of Swink and Crowley County Water Authority having all of their meters connected to radio read devices[8].

Meter Reading and Billing

The vast majority of the Plan participants collect master meter data and customer meter data on a monthly basis; turning around use data within weeks to bill their customers. Most small Plan participants read customer meters in one or two days near the end of the month and bill at either the end of the month or at the first of the following month using these data. There are a few organizations that read meters over a longer period of time due to the number of customers or the geography of their customer base; and then bill on the first of the month, but these are not the typical operations. In addition, there are a few operations that read meters and bill at uneven increments; when time is available.

It is important to note that for many of the smaller water providers, meter reading (which include gaining access to the meters), meter data translations into billing software or billing files, and storage of master meter data, as well as customer water use data is managed by volunteers and unpaid (or under paid) staff. It is through the shear goodwill of numerous individuals that many small Plan participants manage to maintain cash flow. It is not clear how goodwill is to be translated into the future, as volunteers leave and staff are replaced. This is an issue for the long-term sustainability of some organizations and may need to be addressed by adopting a best practice related to staffing and training, as well as future data management.

BMP

Water Rates

Most Plan participants follow similar practices in billing for water use. These practices involve billing all customers for a fixed fee, or service fee, that typically includes a modest amount of water as part of the

[7] This kind of water loss is termed "an apparent loss" since the water company does not bill or receive revenue for this water, but has to pay to treat and distribute it.

[8] AMR devices are considered a best practice for rural water systems. Although the cost of installation is high, the ease of data collection and data management are considered to be highly desirable by rural water providers, in general, and the Plan participants, specifically.

BMP

fee[9]. Most Plan participants also use a flat rate for water varying from between $1.50 and $3.50 per thousand gallons, although some organizations have seasonal rates or inclining tiered water rates that increase with water use. Organizations are sensitive to the needs of their customers, and therefore are hesitant to raise rates due to a concern that customers may stop outdoor irrigation causing blight, or that those on fixed incomes will not be able to afford an increase.

BMP

Best practices related to water rate structures for many Plan participants may include establishing lower service fees and charging for all water used[10], perhaps even on a per gallon or per hundred gallon basis[11]. Given that many residential customers use some increment of 1,000 gallons per billing period, it may be of benefit to local water providers to obtain more accurate meters, which read in ten or hundred gallon increments. This change would carry a cost related to upgrading all customer meters; however, it would also make billing more accurate and better aligned with actual usage. It may also help characterize non-revenue water, since errors related to meter reading increment would be reduced.

Data Management

Overall data management is variable across the different Plan participants. Some organizations have sophisticated data archives; whereas others have hard copy archives which may or may not be subject to risk from flood or fire. Future data management for all Plan participants may require more uniform data

BMP

reporting and storage protocols, since it is anticipated that each organization will provide data to the District on a regular basis to support project water administration and AVC operations. No specific protocols have been identified at this time; however, it may become important for the District and the Plan participants to track various metrics in the future such as non-revenue water; total billed water; total produced water; total AVC deliveries; etc. The RWC Plan will discuss this issue further.

Distribution Piping

Perhaps the largest sunk cost related to water supply in the Lower Arkansas River Valley is distribution piping[12], which spans over about 1,000 miles, varying in sizes from 1-inch to 12-inches in diameter. Appendix C presents a summary of the pipe material and size data collected during the system wide audits. As can be seen in the table in Appendix C, a majority of the distribution piping is PVC (about 70%), followed by ABS (about 15%), steel and concrete (8%), and various other materials. A substantial portion of the PVC piping is new since 2000; however some of it dates back 40 plus years. For the smaller water supply

[9] For example, a service fee of $24 is charged to all customers and it carries 3,000 gallons of water with it. After 3,000 gallons of water is used during a single billing period, the customer is then charged a flat rate for each 1,000 gallons of water used above 3,000 gallons (e.g., if 5,000 gallons are used, then the customer is billed the service fee plus the cost of 2,000 gallons of water).

BMP

[10] Changing the service fee structure would reduce the bill of some customers that use less than the allotted amount of "free water" that comes attached to the service fee.

BMP

[11] Changing the cost for water from per thousand gallons to per gallon or per hundred gallons would have to be supported by meters that read in graduations of less than 1,000 gallons.

[12] This is the piping that delivers water from the production well and/or treatment facility to the customers, linking the water supply system to the customer service lines. Service lines, both before the customer meters and after the customer meters are not included in these quantities.

systems, PVC of appropriate thickness (dependant on system pressures) is the preferred distribution pipe material due to its availability, cost, lack of reactivity to corrosive soils, and ease of installation.

ABS is another type of plastic pipe that was used in the past for distribution piping; however, this pipe material has proven to be brittle and difficult to repair. It is known for splitting due to pressure impacts and age. Not all ABS pipe is prone to leaking, but it may be desirable for local water providers with this pipe material to plan for its replacement as soon as practical. For many Plan participants, this is not necessarily cumbersome, for most organizations with ABS pipe have implemented partial replacement efforts due to past pipeline failures and leaks. St. Charles Mesa, the Town of Ordway, South Swink Water Company and Bents Fort Water Company, which current maintain about 94% of the ABS pipe in the ground in the Lower Arkansas River Valley, are the exceptions. Even though these water providers do not exhibit unusually large amounts of non-revenue water, which would be expected if their water systems leaked, the District may still wish to consider specific programs that may be need to assist these Plan participants in replacing the ABS in their distribution systems.

BMP

Another characteristics of the small water supply systems operated by the majority of the Plan participants are that they are not looped (which is required for fire fighting and to maintain system pressures in City supplied systems) and do not have isolation valving and submetering, which are beneficial in locating and repairing leaks. One best practice that may be recommended in the RWC Plan will be the installation of isolation valving and submetering within the small water provider systems for just these purposes.

BMP

Another best practice that may be of some benefit to the small water providers would be to maintain detailed distribution system maps that would identify pipe and appurtenance locations; piping materials; and piping age. This information would be of benefit to document and pass along current institutional knowledge that may not currently be adequately archived.

BMP

Finally, leak detection testing using sonic devices have had substantial success in some rural settings in Colorado and in other locations across the country, dependant on the pipe materials and pipe accessibility (test pits may have to be dug to provide access for placement of listening devices on the buried pipe in some locations). The Plan participants have voiced an interest in having access to leak detection equipment and trained staff to support local leak detection efforts. The Colorado Rural Water Authority, among others, may be able to team with the District to help address the needs of the local water providers. To this point, leak detection programs may be considered as a BMP in the RWC Plan.

BMP

Water Production and Treatment

Most of the Plan participants utilize groundwater production wells for local water supply. Most of the wells are contained in the soft water portion of the hard rock aquifer systems that underlie the Lower Arkansas River Valley; although some operate shallow alluvial wells. Some locations, such as the City of Fowler, operate two systems – a hard water and soft water system. Groundwater production within the Lower Arkansas River Valley utilizes substantial energy to lift water from depths of dozens to hundreds of feet below the ground surface to elevated surface storage tanks which are used to maintain system head and provide peaking supplies. It is estimated that the total energy use for groundwater production by the Plan participants is in the range of 3.3 million kilowatt-hours (kWh) per year. Assuming a cost of electricity as

$0.08 per kWh[13], the total annual groundwater production cost for energy is about $270,000 (see table in Appendix D).

Water treatment also comes at a high cost for the Plan participants. To begin with, although the soft water systems are typically of higher quality than the hard water systems, both water sources may require treatment. Appendix D also presents a summary of the current potable water treatment requirements for each system as verified at the time of the audit.

Based on these data, it can be seen that 14 of the 38 Plan participants (37%) use filters to treated produced groundwater prior to distribution. Some of these water providers also use chemical additions to inhibit scale. Finally, a more energy intensity treatment process, reverse osmosis (RO), is used by three water providers. The combined energy use for water treatment by the Plan participants is estimated to be about 2 million kWh per year; or about $162,000 (see Appendix D).

BMP

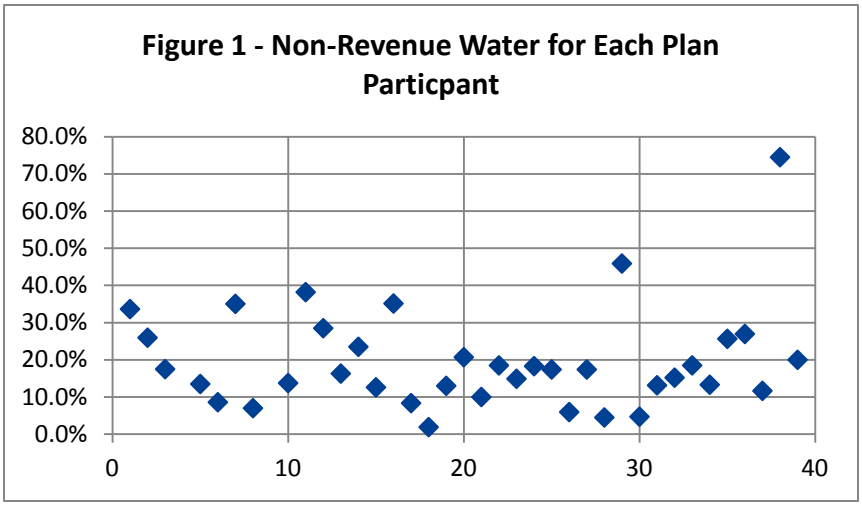
Nearly all of those Plan participants with iron filters to enhance potable water quality pump filter backwash to waste (e.g., nearby lagoons or ditches) outside of their distribution systems. These water discharges are inefficient and could be improved or eliminated with the AVC project water. Filter back wash waste accounts for about less than 1% of the total water demand by the Plan participants; however, eliminating this waste would make the individual water provider systems more efficient.

[13] State of Colorado average from the U.S. Energy Information Administration (http://www.eia.gov/cneaf/electricity/st_profiles/e_profiles_sum.html)

Characteristics of Non-Revenue Water for the AVC Plan participants

Non-revenue water was characterized and estimated using the water production and billing data provided by each of the individual Plan participants. In addition, the auditing process helped to identify and estimate quantities of unmetered and metered, unbilled water use within each individual distribution system. Based on these calculations, non-revenue water was found to vary from about 2 to 74 percent of total water produced as illustrated in Figure 1, with the average amount of non-revenue water (based on volume) for all Plan participants combined at about 20% of produced water, or about 2,000 acre-feet of water per year. This is water that is either lost from the distribution systems as leaks or is lost due to metering and/or billing inaccuracies, and/or unbilled uses (e.g., line flushing, street cleaning, filter backwash pumped to waste, etc.).

A breakdown of the amount of non-revenue water for the Plan participants is provided in Table 3. This table shows that there are five water providers with non-revenue water below 8%, which represents 14% of the Plan participants; however these five water providers produce only 3% of the total water deliveries in the AVC service area.



Noteworthy is that there are eight water providers that have non-revenue water losses of between 12 and 16%, which represents about 21% of the water providers, but about 50% of the total water deliveries. Therefore, it appears that the larger water providers in the partnership have non-revenue water losses of greater than 12%.

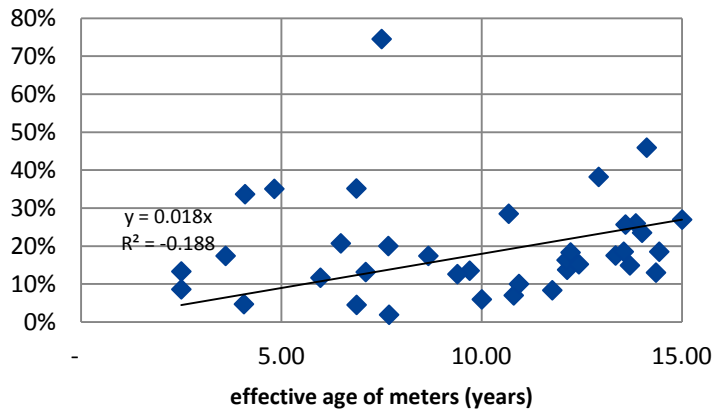
Table 3 – Categorization of Non-Revenue Water Losses for the Plan Participants

Occurrence	Number of Occurrences	% of Occurrences	Amount of Water (1000s of gallons)	% of Total Water Deliveries
< 8%	5	14%	101,115	3%
< 10%	2	5%	5,966	0%
< 12%	2	5%	163,732	5%
< 14%	6	16%	819,185	24%
< 16%	2	5%	875,826	26%
< 18%	4	11%	66,334	2%
< 20%	3	8%	85,758	3%
> or = 20%	13	35%	1,254,373	38%

Water loss was found to correlate poorly to meter age – indicating that water provider systems with older meters did not necessarily have a larger percent of non-revenue water (see Figure 2). Similarly, water loss did not correlate well to the length of distribution pipe in the ground (see Figure 3), since the systems with the most miles of pipe in the ground had some of the lowest rates of water loss observed. Water loss was also found uncorrelated to total water use for the Plan participants.

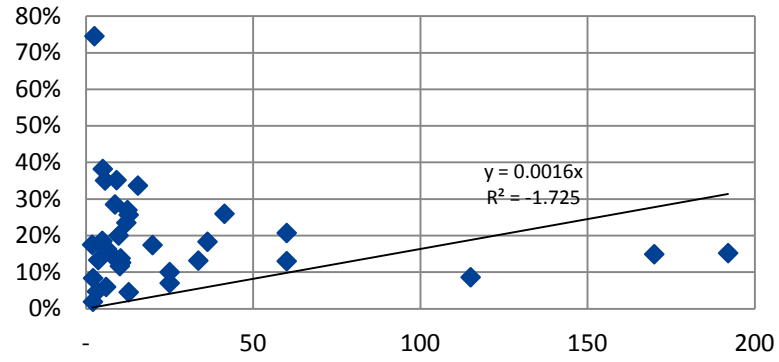
The characteristics of water loss are perhaps best characterized by a few noteworthy anecdotes. To begin with, real line loss due to leaks and breaks can be to some extent correlated to the quality of the pipe installation, more so than pipe age or material. Older pipe installed with proper bedding materials and protected from surface loads can perform at a high level for a long period of time versus newer or more robust pipe that is placed with poor craftsmanship.

Figure 2 - Non-Revenue Water vs. Meter Age



Another important characteristic related to real line loss is system pressure. For a number of smaller water systems, wintertime losses are higher (as a percentage of total water production) than in the summer. This observation may be related to increased summertime demands reducing line pressure, which in turns reduces total line losses due to small and chronic leaks[14]. ABS pipe, which can become brittle with age, can be most susceptible to pressure variations, especially in settings that have significant elevation variation where low areas can experience substantial pressure build-up.

Figure 3 - Non-Revenue Water vs. Miles of Pipe



One other noteworthy contributor to line loss relates to the existence of corrosive soils, which occur at various locations throughout the valley[15]. A number of Plan participants indicated that they experience some degree of locally extensive corrosive soils; however, a complete characterization of the location and extent of corrosive soil impacts on line losses was beyond the scope of this project.

[14] Wintertime losses can also be attributed to periods of time when snow pack can impact collecting meter readings, thereby creating apparent losses (as opposed to real line losses).

[15] Soil corrosion is a complex phenomenon, with a multitude of variables involved. Chemical reactions involving almost each of the existing elements are known to take place in soils, many of which are not yet fully understood. The relative importance of variables changes for different materials, making a universal guide to corrosion impossible. Soils with high moisture content, high electrical conductivity, high acidity, and high dissolved salts will be most corrosive. http://corrosion-doctors.org/SoilCorrosion/Introduction.htm

As previously indicated, about 70% of the pipe currently in the ground being used for water distribution by the Plan participants is PVC (varying from 1-inch to 12-inch diameter); however, over 250 miles of pipe in use is not PVC[16]. PVC pipe is not as susceptible to corrosive soils as other distribution piping material.

Apparent water losses, related to inaccurate meters, data handling errors, and unmetered water uses also are expected to influence the non-revenue water characteristics of the Plan participants. The vast majority of the meters in place are $^{5}/_{8}$ by $^{3}/_{4}$ inch meters connected to older homes (built before 1980)[17]. It is anticipated that these meters cannot accurately measure small leaks on the customer side of the meter (e.g., dripping faucets, leaking toilet flappers) which can average about 10 gallons per day per connection[18]. At this rate, inaccurate metering can attribute for 1 to 2% of observed non-revenue water on average. Unmetered water uses may contribute another 1 to 3%, as well, to the average amount of non-revenue water per Plan participant. Just controlling these two features of non-revenue water could increase overall water sales in the valley by 2 to 5%, accounting for 200 to 500 acre-feet in sales per year[19].

Overall, system wide water loss from real and apparent losses cannot be specifically correlated to meter or material age, or amount of pipe in the ground. It appears that water loss is based on a combination of variables (e.g., water pressure, elevation variability, etc.); including the manner in which water production and customer water use data is collected. Nonetheless, Plan participants will be able to reduce their non-revenue water by reducing both real and apparent losses by replacing meters, installing automated meter reading devices, improving data handling, reporting[20], and management techniques, replacing and repairing leaking pipe, and tracking unmetered water uses. Various BMPs that have been identified to support local water provider needs will be evaluated and assessed for effectiveness and cost in the RWC Plan.

Performance Guidelines

The concept of performance guidelines which would promote water use efficiency at the individual water provider level stems from the requirement of the U.S. Bureau of Reclamation (hereafter "Reclamation") that the District must ensure that Fryingpan-Arkansas Project water is used efficiently, and is put to beneficial use. To this point, performance guidelines would support more efficient water use by each Plan participant – promoting improved water use efficiency over currently observed levels, and in the process reducing non-revenue water, and therefore lost water sales receipts, for under-performing water providers.

Therefore, the policy that is explored in this report relates to developing a non-revenue water "goal" for all Plan participants including:

[16] Includes cast iron, ABS (acrylonitrile butadiene styrene), black rolled pipe, concrete, asbestos concrete
[17] roughly 95% of all meters in place are $^{5}/_{8}$ by ¾ inch meters
[18] Water Conservation Handbook, Vickers, 2003
[19] At $3.00/thousand gallons, this amounts to about $200,000 to 500,000 in currently lost revenue to the Plan participants.
[20] One key recommendation that will come out of the planning effort will be to standardize data collection methodologies, to the extent practical, such that water loss information can be assessed consistently from water provider to water provider.

- The assessment of a numerical goal
- The identification of a timeframe to achieve the goal
- The BMPs that Plan participants may choose to implement to achieve the goal
- The potential financial tools that the District can employ to encourage Plan participants to achieve the goal and support local infrastructure investments that will improve overall water use efficiency
- The reporting mechanisms that would be needed to support tracking of progress toward achieving and maintaining the goal.

Background - Developing a guideline for water loss – as a combination of real and apparent losses[21] – is challenging given the breadth of water providers that are party to the AVC and share the Fryingpan-Arkansas water resources. However, it makes sense to develop a single performance guideline for all project partners, since any losses that occur compromise the District's and Reclamation's defined mission - to ensure water is used efficiently; and is put to beneficial use by the Plan participants.

The American Water Works Association (AWWA) has developed target setting guidelines for leak management based on specific water resource, operational and financial constraints[22]. These guidelines are summarized in Table 4, noting that these values are for infrastructure leakage index, which is a measurement of real losses only.

Table 4 – Summary of Leakage Management Target-Setting Guidelines

Target Range %	Water Resources Constraints	Operational Constraints	Financial Constraints
1-3	Available resources are greatly limited and are difficult and/or environmentally unsound to develop.	Operating with system leakage above this level would require expansion of existing infrastructure and/or additional water resources to meet demand.	Water resources are costly to develop or purchase. Ability to increase revenues via water rates is greatly limited due to regulation or low rate payer affordability.
3-5	Water resources are believed to be sufficient to meet long-term needs, but demand management interventions (leakage management, water conservation) are included in long-range planning.	Existing water supply infrastructure capability is sufficient to meet long-term demand as long as reasonable leakage management controls are in place.	Water resources can be developed or purchased at reasonable cost. Periodic water rate increases can be feasible and are tolerated by the customer base.
5-8	Water resources are plentiful, reliable, and easily developed and/or produced.	Superior reliability, capacity and integrity of the water supply infrastructure make it relatively immune to supply shortages.	Costs to purchase or develop water are low, as are rates charged to customers.
>8	While operational and financial considerations may allow a long-term target greater than 8, such a level of leakage is not an effective utilization of water as a resource, such that setting a target greater than 8 is discouraged.		

An additional source of guidance that may be leveraged to assess a performance guideline is the Colorado Water Conservation Board's (CWCB) Conservation Strategy developed as a component of Statewide Water

[21] Real losses relate to distribution and service line leaks (before the customer meter) and storage tank overflows; apparent losses relate to unauthorized consumption, inaccurate customer meters and systematic data handling errors (which can include labeling unmetered uses as losses).
[22] Based on information provided in M-36, AWWA, 2009.

Supply Initiative (SWSI) 2010. This document indicated that water loss goals, for combined real and apparent losses when managed properly should be in the range of 6 to 8%. Coupling the CWCB target with the AWWA guidelines would indicate that a reasonable target for apparent losses would be in the range of 3% of total water production. Noteworthy is that Colorado water providers with water conservation plans on file with the CWCB report an average non-revenue water loss of just over 10%[23] (CWCB, 2011).

Proposed Level of Non-Revenue Water - Based on these various information sources, it would appear that a performance guideline of 6 to 10 % would be reasonable – accounting for real losses of between 4 and 7% and apparent losses accounting for the other 2 to 3%.

Timeframe - The performance guideline proposed for evaluation in the RWC Plan is suggested to be in place for each of the Plan participants at a time when each local organization is satisfied with the need, the data available to characterize water loss, and funding needed to support improved water loss management. By default, the District suggests that each Plan participant may want to consider meeting this performance guideline by 2050 (which is roughly consistent with the District's overall goal – see the following section of the Plan). However, it is the intent of the District to have each Plan participant define its own goal for water loss management, and the timeframe for reaching that goal – given that some organizations are at or below a proposed performance guideline of 6 to 10%; and others are substantially above that level. To this point, some of the Plan participants may choose to have goals that are achieved at 10-years, 20-years or 40-years into the future.

Best Management Practices and Related Costs

The Plan participants can choose from a number of tools to help them adhere to a proposed water loss guideline. The tools that the District will consider to provide to support local water loss management will include, but necessarily be limited to, the following:

- Best practices (BMPs) for:
    - Meter tracking, testing and replacement
    - Alternative meter reading increments (i.e., less than 1,000 gallon increments)
    - Meter reading and data acquisition technologies (including AMR and AMI)
    - Data management and archiving
    - Leak detection testing
    - Distribution system submetering and isolation valving
    - ABS pipe replacement
    - Alternative water rate structures and fee schedules
    - Water rate studies and assessment (which also including tracking and characterizing unmetered-unbilled uses and metered-unbilled uses)
    - System wide auditing (to characterize water loss including tracking and characterizing unmetered-unbilled uses and metered-unbilled uses)

[23] Covered entities that reported water loss in their water conservation plans reported "unaccounted for" water, rather than non-revenue water loss. There was no standard method provided to allow for a consistent comparison of reported water loss from entity to entity.

The District will develop a portfolio of financial tools that may become available to support and/or augment local water provider water conservation and water use efficiency planning and/or implementation efforts. The financial tools will include:

- Developing and maintaining an accurate listing of federal and State grant and loan programs that may be available to support local planning and/or implementation efforts;
- Developing and maintaining sample grant and loan applications that may inform local application efforts; and
- Providing grant and loan writing technical support.

Finally, the District will consider developing technical assistance programs that are either stand-alone or in partnership with selected small water system service providers (e.g., Colorado Rural Water Association). Technical assistance may include services such as:

- System wide audits
- Water rate studies
- Leak detection testing
- Meter testing
- Water conservation data tracking
- Professional training

All of these programs – maintaining and updating BMPs, developing and administering financial support, and providing technical assistance - will likely require that some funding mechanism(s) be established that can support local planning and implementation of improved water loss management practices.

Potential costs for these program components have not been fully developed to date; however, some preliminary costing has been prepared to identify infrastructure needs and technical support costs. These are summarized in Table 5.

If the infrastructure listed in Table 5, with the exception of the pipe, was scheduled to be completed over a 10 year period, the annual cost would be approximately $750,000 per year for each of the 10 years. Adding the pipe replacement using a 50-year replacement period, would add $500,000 to the annual capital costs, making the total $1,250,000.

The ongoing OM&R costs, based on the estimates presented in Table 5 are $320,000, including nearly $200,000 to pay for the operations and maintenance of new AMR/AMI infrastructure and radio transmitter systems.

Table 5 – Summary of Estimated Future Infrastructure Costs

Item		Estimated Capital Cost	Estimated OM&R Cost
Infrastructure			
	Replacement Meters	$ 3,500,000	n/a
	Submeters (for rural systems)	230,000	n/a
	Pipe Replacement [a]	25,000,000	n/a
	Automated Meter Reading Systems	3,100,000	195,000
	Automated Meter Infrastructure Systems	680,000	
Technical Assistance			
	Leak Detection Monitoring and Meter Testing	n/a	35,000
	Plan participant Outreach	n/a	10,000
	Education	n/a	10,000
	Other Technical Support (Data Collection, Audits, Water Rate Support) [b]	n/a	70,000
	Totals	32,510,000	320,000

[a] does not include piping for 5 largest utilities (Lamar, La Junta, Las Animas, Rocky Ford, St. Charles Mesa WD). These entities were excluded since they have capital improvement programs and other funding mechanisms that can support water line replacement projects.

[b] includes conducting water rate studies and audits on 5-year intervals for all small water providers

Water Use Tracking and Reporting

It will be incumbent on the District to maintain contact with all the Plan participants to track individual water provider water use, water loss, and water use efficiency once the AVC is delivering Project water. The terms of data sharing and reporting will be by necessity contained in the contract terms and conditions that will be created between the District and each of the Plan participants prior to the AVC becoming operational. The District will have to consider the data collection and reporting requirements of both Reclamation and the State with regards to the District repayment contract, as well as the District's RWC Plan in developing its requirements for Plan participant reporting. Reclamation requires an update of the RWC Plan every 5 years, whereas the State requires updates no greater than every 7 years.

Appendix A

Audit Reports for Individual Plan Participants

Appendix B

Summary of Meter Data

Appendix B
Summary of Meters Served By Plan Participants
(size, age and number with electronic read capability)

	Meter Size (inches)							Age		% by Age			Effective Meter
	5/8 to 3/4	1	1.5	2	3	4	6	< 5 yrs	> 10 years	< 5 yrs	> 10 years	Total	Age (yrs)
Beehive Water Assn	88							58	0	66%	0%	**88**	4.20
Bents Fort Water Co.	330	1						30	300	9%	91%	**331**	13.84
Boone, Town of	150			3				15	128	10%	84%	**153**	13.28
Crowley County Commissioners (includes #1 96 Pipeline Company, #8 Crowley County Water Association, #9 Town of Crowley, and #29 Town of Ordway)													
96 Pipeline	63		2	1				16	30	24%	45%	**66**	9.70
CCWA	360					2		362	0	100%	0%	**362**	2.50
Town of Crowley	110							0	110	0%	100%	**110**	15.00
Ordway	530	6		10				180	360	33%	66%	**546**	10.80
CCC													
Eads, Town of	401	1	3	7	3	3		60	298	14%	71%	**418**	12.13
East End Water Assn.	30							5	25	17%	83%	**30**	12.92
Eureka Water Co.	134							50	84	37%	63%	**134**	10.34
Fayette Water Assn.	26							6	20	23%	77%	**26**	12.12
Fowler, Town of (potable only)	687		7	4	2			35	630	5%	90%	**700**	14.00
Hasty Water Company	117	1			1			30	50	25%	42%	**119**	9.39
Hilltop Water Co.	118	1						60	30	50%	25%	**119**	6.87
Holbrook Center Soft Water	27							7	20	26%	74%	**27**	11.76
Homestead Improvement Assn.	27							11	8	41%	30%	**27**	7.69
La Junta, City of	2,907	189	47	53	6	11		100	3000	3%	93%	**3,213**	14.35
Lamar, City of	3,025	267	31	96	15			2200	1000	64%	29%	**3,434**	6.48
Las Animas, City of	1,090	54	4	17	-	1	1	250	700	21%	60%	**1,167**	10.93
Manzanola, Town of	180		4	3				14	160	7%	86%	**187**	13.54
May Valley Water Assoc.	568	8	5					30	500	5%	86%	**581**	13.70
McClave Water Assoc.	165	2						30	125	18%	75%	**167**	12.22
Newdale-Grand Valley Water Co.	191	2						60	70	31%	36%	**193**	8.67
North Holbrook Water	24							6	12	25%	50%	**24**	10.00
Olney Springs, Town of	239			3				220	21	91%	9%	**242**	3.61
Patterson Valley	40							20	10	50%	25%	**40**	6.88
Rocky Ford, City of	1,649		4	2				60	1500	4%	91%	**1,655**	14.12
South Side Water Assoc.	24							21	3	88%	13%	**24**	4.06
South Swink Water Co.	219		1					70	35	32%	16%	**220**	7.10
St. Charles Mesa Water District	3,945	104	5	7	1	1		800	3200	20%	79%	**4,063**	12.42
Sugar City, Town of	169	1	3	2				5	165	3%	94%	**175**	14.43
Swink, Town of	285	2		1				0	0	0%	0%	**288**	7.50
Valley Water Co.	115							10	100	9%	87%	**115**	13.59
Vroman	59							0	59	0%	100%	**59**	15.00
West Grand Valley Water Inc.	36							20	6	56%	17%	**36**	5.97
West Holbrook Water	12							6	4	50%	33%	**12**	7.50
Wiley, Town of	218		4	3				0	5	0%	2%	**225**	7.67
Total	**18,358**	**639**	**120**	**212**	**28**	**18**	**1**	4847	12768				
							19,376	25%	66%				

Appendix B
Summary of Meters Served By Plan Participants
(size, age and number with electronic read capability)

	Automated Meter Reading							
	Number	**%**	**Largest Meter Customer(s)**					
Beehive Water Assn	-	0%						
Bents Fort Water Co.	-	0%	State Park					
Boone, Town of	-	0%	vendor tower, school					
Crowley County Commissioners (includes #1 96 Pipeline Company, #8 Crowley County Water Association, #9 Town of Crowley, and #29 Town of Ordway)								
96 Pipeline	-	0%						
CCWA	362	100%						
Town of Crowley	-	0%	Prisons					
Ordway	40	7%	Nursing home, schools, apartments					
CCC								
Eads, Town of	-	0%	fairgrounds, football field, pool, hospital, school					
East End Water Assn.	-	0%						
Eureka Water Co.	-	0%						
Fayette Water Assn.	-	0%						
Fowler, Town of (potable only)	-	0%	School, nursing home, apartments					
Hasty Water Company	-	0%	Colorado State Parks					
Hilltop Water Co.	-	0%	Feed Lot					
Holbrook Center Soft Water	-	0%						
Homestead Improvement Assn.	-	0%						
La Junta, City of	-	0%	College, irrigation customers					
Lamar, City of	2,200	64%	Large commercial, City Pool, County Prison, Hospital College					
Las Animas, City of	50	4%	Nursing home and prison (CCA)					
Manzanola, Town of	-	0%						
May Valley Water Assoc.	-	0%	Large commercial, feed lots, school					
McClave Water Assoc.	-	0%	school, livestock					
Newdale-Grand Valley Water Co.	-	0%	feed lots					
North Holbrook Water	-	0%	2 meters are for livestock only					
Olney Springs, Town of	-	0%	ball park, trailer park, large commercial					
Patterson Valley	-	0%						
Rocky Ford, City of	50	3%	nursing home, football field					
South Side Water Assoc.	-	0%						
South Swink Water Co.	-	0%	trailer park (in the past)					
St. Charles Mesa Water District	472	12%						
Sugar City, Town of	159	91%	park, county shop, commercial					
Swink, Town of	288	100%	school, apartments					
Valley Water Co.	-	0%						
Vroman	-	0%						
West Grand Valley Water Inc.	-	0%						
West Holbrook Water	-	0%						
Wiley, Town of	-	0%	school, apartments					
Total	3621							
	19%							

Appendix C

Summary of Distribution Pipe Data

Appendix C
Summary of Pipe Materials and Sizes
(all lengths in feet unless otherwise noted)

		Material	**PVC**												
		Diameter (inches)	**1**	**1.25**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**6**	**8**	**10**	**12**	**Total**
3	Beehive Water Assn	Otero				63,360		18,480							81,840
4	Bents Fort Water Co.	Otero									18,500				18,500
5	Boone, Town of	Pueblo								7,160	2,440				9,600
7	Crowley County Commissioners (includes #1 96 Pipeline Company, #8 Crowley County Water Association, #9 Town of Crowley, and #29 Town of Ordway)	Crowley													
	96 Pipeline							31,680		15,840					47,520
	CCWA		not available												343,200
	Town of Crowley									13,200		1,800			15,000
	Ordway					21,120				21,120		52,800			95,040
	CCC											36,960	79,200		116,160
10	**Eads, Town of**	Kiowa		1,200		4,250				22,300	10,340	14,300	1,800	400	54,590
11	**East End Water Assn.**					21,120		3,960							25,080
12	Eureka Water Co.	Otero				21,120	11,352			9,240					41,712
13	Fayette Water Assn.	Otero	1,320		1,320	19,800	10,560								33,000
14	**Fowler, Town of (potable only)**	Otero													-
16	Hasty Water Company	Bent				29,040		23,760							52,800
17	Hilltop Water Co.	Otero	3,334	5,675	3,570	21,288	5,020	6,547		2,735					48,169
18	Holbrook Center Soft Water	Otero				9,768									9,768
19	Homestead Improvement Assn.	Otero				3,960				1,600	5,300				10,860
20	**La Junta, City of**	Otero	specific lengths of each not available - most distribution pipe is PVC and concrete												105,600
21	Lamar, City of	Prowers													26,400
22	**Las Animas, City of**	Bent	specific lengths of each not available - most distribution pipe is PVC												105,600
23	Manzanola, Town of	Otero				5,280					20,400				25,680
24	May Valley Water Assoc.	Prowers	52,536	63,096	143,246	229,046	105,600	156,288	23,760	122,496	1,056				897,125
25	**McClave Water Assoc.**	Bent	1,320	14,520	29,700	52,800		51,150		26,400					175,890
26	Newdale-Grand Valley Water Co.	Otero			31,900	12,480	6,000		21,000	15,600	18,000				104,980
27	North Holbrook Water	Otero				31,680									31,680
28	Olney Springs, Town of	Crowley						1,160		7,970	9,990	5,295			24,415
30	Patterson Valley	Otero			25,080	7,920		7,920		2,640					43,560
31	Rocky Ford, City of	Otero	not available												
32	**South Side Water Assoc.**	Otero			5,280	5,280		6,600							17,160
33	South Swink Water Co.	Otero				65,920		51,040		22,230	4,900				144,090
34	St. Charles Mesa Water District	Pueblo	specific lengths of each not available - most distribution pipe is PVC, ductile iron and ABS												538,560
35	Sugar City, Town of	Crowley						999		14,652	6,956	2,812			25,419
36	Swink, Town of	Otero				1,460		1,210		2,710	5,530	8,360			19,270
37	Valley Water Co.	Otero	6,336		12,672	12,672				15,840	15,840				63,360
48	Vroman	Otero		8,766	7,500	10,923	5,280	12,400		12,600					57,469
49	West Grand Valley Water Inc.	Otero		16,368		13,728				15,312	7,920				53,328
40	West Holbrook Water	Otero	5,280			6,600									11,880
41	Wiley, Town of	Prowers								5,280	21,120	25,080			51,480
		Total (miles)													**667.76**

Appendix C
Summary of Pipe Materials and Sizes
(all lengths in feet unless otherwise noted)

		Material	ABS								Steel/Concrete	Cast iron					AC	Blk Rolled	ABS	Total
		Diameter (inches)	1	1.25	1.5	2	2.5	3	4	Total	various	2	4	6	8	12	6	2	Miles	Miles
3	Beehive Water Assn	Otero								-									-	16
4	Bents Fort Water Co.	Otero				25,280		67,780	107,000	200,060									38	41
5	Boone, Town of	Pueblo								-							900		-	2
7	Crowley County Commissioners (includes #1 96 Pipeline Company, #8 Crowley County Water Association, #9 Town of Crowley, and #29 Town of Ordway)	Crowley																		-
	96 Pipeline									-									-	9
	CCWA									-									50	115
	Town of Crowley									-									-	3
	Ordway					36,960				36,960									7.0	25
	CCC									-									-	22
10	**Eads, Town of**	Kiowa								-									-	10
11	**East End Water Assn.**							1,320		1,320									0.3	5
12	Eureka Water Co.	Otero				1,320	1,320	1,320		3,960									0.8	9
13	Fayette Water Assn.	Otero								-									-	6
14	**Fowler, Town of (potable only)**	Otero								-		18,540	6,470	19,870	17,290	1,385			-	12
16	Hasty Water Company	Bent	2,640							2,640									0.5	11
17	Hilltop Water Co.	Otero								-									-	9
18	Holbrook Center Soft Water	Otero				1,320				1,320								6,600	0.3	3
19	Homestead Improvement Assn.	Otero								-									-	2
20	**La Junta, City of**	Otero								-	211,200									60
21	Lamar, City of	Prowers								-	158,400						52,800		-	45
22	**Las Animas, City of**	Bent								-	26,400									25
23	Manzanola, Town of	Otero								-									-	5
24	May Valley Water Assoc.	Prowers								-									-	170
25	**McClave Water Assoc.**	Bent								-	15,840								-	36
26	Newdale-Grand Valley Water Co.	Otero								-									-	20
27	North Holbrook Water	Otero								-									-	6
28	Olney Springs, Town of	Crowley								-									-	5
30	Patterson Valley	Otero			7,920			15,840		23,760									4.5	13
31	Rocky Ford, City of	Otero																	-	-
32	**South Side Water Assoc.**	Otero								-								5,280	-	4
33	South Swink Water Co.	Otero	3,400	2,640		15,840		6,640	4,640	33,160									6.3	34
34	St. Charles Mesa Water District	Pueblo								475,200									90	192
35	Sugar City, Town of	Crowley								-									-	5
36	Swink, Town of	Otero								-									-	4
37	Valley Water Co.	Otero	3,960							3,960									0.8	13
48	Vroman	Otero			7,920					7,920									1.5	12
49	West Grand Valley Water Inc.	Otero								-									-	10
40	West Holbrook Water	Otero	1,320							1,320									0.3	3
41	Wiley, Town of	Prowers								-									-	10
		Total (miles)								**149.92**	**78.00**					**12.04**	**10.17**	**2.25**		
																			200	**970**

Appendix C
Summary of Pipe Materials and Sizes
(all lengths in feet unless otherwise noted)

		Material	Comment
		Diameter (inches)	
3	Beehive Water Assn	Otero	All PVC from 1980s
4	Bents Fort Water Co.	Otero	Original ABS from 1960s plus new PVC main in 2005
5	Boone, Town of	Pueblo	PVC is new in 2007; AC is from years before
7	Crowley County Commissioners (includes #1 96 Pipeline Company, #8 Crowley County Water Association, #9 Town of Crowley, and #29 Town of Ordway)	Crowley	
	96 Pipeline		most from 1964
	CCWA		half is 30 yo; other replaced in 1992
	Town of Crowley		from 1981
	Ordway		8 inch from 1980, 4 inch from 2007, 2 inch various dates; all ABS is in alleys from 1980s and earlier
	CCC		All lines from 1980
10	**Eads, Town of**	Kiowa	Replaced older PVC and AC with PVC in 2000 (including 12900 8 inch, 10340 6 inch, all 12 inch and 250 4 inch, rest is older back to 1956
11	**East End Water Assn.**		3-inch PVC is 2-3 years old; rest is 10 plus yo
12	Eureka Water Co.	Otero	no good receords on past replacements
13	Fayette Water Assn.	Otero	All new between 1990 and 1997
14	**Fowler, Town of (potable only)**	Otero	Built in 1977 plus earlier
16	Hasty Water Company	Bent	All pipe from late 1980s except 2.5 miles of 2010 2 inch PVC
17	Hilltop Water Co.	Otero	some ABS but not indicated on drawings; PVC from 1980s and some 1995
18	Holbrook Center Soft Water	Otero	PVC newer, but no good records on replacement
19	Homestead Improvement Assn.	Otero	4 inch and 6 inch PVC new in 2007
20	**La Junta, City of**	Otero	half of system is 30 yo; some new in past 5 years
21	Lamar, City of	Prowers	replaced lot of old steel and cast iron in 1970s w/ AC, some new PVC
22	**Las Animas, City of**	Bent	significant new PVC being installed since 2009
23	Manzanola, Town of	Otero	most from 1972, w/ 2-3 miles since 1999
24	May Valley Water Assoc.	Prowers	limited new PVC; most is from the 1960s
25	**McClave Water Assoc.**	Bent	some new 4 inch since 2000; rest is 20 plus yo
26	Newdale-Grand Valley Water Co.	Otero	PVC from 1960s, except new PVC along Route 50
27	North Holbrook Water	Otero	all new in 1991
28	Olney Springs, Town of	Crowley	All new in 2004
30	Patterson Valley	Otero	various ages; not much new
31	Rocky Ford, City of	Otero	mainly cast iron and AC from 1970s or earlier
32	**South Side Water Assoc.**	Otero	PVC all new since 2005; black rolled pipe from 1998
33	South Swink Water Co.	Otero	continual upgrade from ABS to PVC each year
34	St. Charles Mesa Water District	Pueblo	begins in 1988, with some recent ABS replaced with PVC
35	Sugar City, Town of	Crowley	all new in 2005
36	Swink, Town of	Otero	all new in 2005
37	Valley Water Co.	Otero	
48	Vroman	Otero	no good receords on past replacements
49	West Grand Valley Water Inc.	Otero	most replaced in 2009
40	West Holbrook Water	Otero	ABS is original; PVC from mid 1990s
41	Wiley, Town of	Prowers	All new PVC in 1980-81
		Total (miles)	

Appendix D

Summary of Water Production, Treatment and Energy Cost Data

Appendix D

This appendix presents an analysis of the annual energy, greenhouse gas, and operating cost impacts of the groundwater pumping and water treatment currently conducted by the Plan participants.

Groundwater Pumping

The annual energy use required for groundwater pumping by each project partner was determined using the following equations:

$$BHP = \frac{Q \times TDH \times \text{Pump Eff.} \times \text{Drive Eff.}}{3960}$$

$$kWh = \frac{BHP * 0.746 * h}{\text{Motor Eff.}}$$

Where:

Q = flow rate in gallons per minute (GPM);

because this flow rate is used to size the pump a worst case scenario of continual pumping (1,440 minutes) to meet the Summer Maximum Demand (gallons per day)[1] was assumed

TDH = total dynamic head (feet);

depth of well[2] for each project partner plus an additional 100 feet added to account for friction losses, pumping to above ground storage, etc.

Pump Efficiency & Drive Efficiency;

a value of 80 percent was assumed for each

BHP = break horsepower;

continuous horsepower rating of the power unit

h = annual hours of pumping (hours/year);

total 2010 annual supply (acre-feet) for each project partner, converted to gallons, divided by the pump flow rate (gpm) for the respective partner converted to hours

Motor Efficiency;

quantified assuming an EPACT Standard motor and 25 percent oversizing of the motor

kWh = kilowatt hours

annual energy use of the pumping unit

---

[1] from Table 2-3. AVC Treatment Summary of STAG report

[2] State of Colorado Engineers Office (SEO) well data. Depth of pumping values were used in calculations, if available, otherwise depth of water values were used. If neither of these two values were provided, the depth of well was used.

Using the process outlined above, the annual energy use for each Plan participant was estimated. The total energy use by the Plan participants is about 3.3 million kWh/yr. Assuming an electricity rate of $0.08 per kWh[3], the total groundwater pumping annual operating costs for the combined Plan participants are $270,000. The associated greenhouse gas emissions for groundwater pumping by each project partner was calculated assuming an electricity emission factor of 1,916 lbs of carbon dioxide equivalent (CO_2e) per MWh of electricity consumption[4]. The total and average annual emissions in the district are 2,900 metric tons (MT) CO_2e and 77 MT CO_2e, respectively. This is equal to almost 160 car trips from Denver to Pueblo per day for all of the emissions generated in the Lower Arkansas River Valley.

Water Treatment

Depending on the source and use of water there are varying levels of treatment occurring in the district. As part of the Arkansas Valley Conduit pre-NEPA STAG report development, the type(s) of water treatment were collected via surveys and interviews with project partner[5]. Using this information and estimates of the energy use per flow rate for each type of treatment, the treatment energy use by Plan Participant was determined. The average annual treatment flow rate (MGD) was determined by averaging the summer and winter flow averages (GPD) from the STAG report.

The energy use for each of the treatment facilities was estimated using a standard table of energy uses for advanced water treatment plants. The analysis considered processing for both primary and secondary energy uses and was selected only for facilities located in the intermountain area of the United States[8]. A linear regression was approximated for each of the treatment types in order to estimate the energy given the average flow rate (GPD) for each Plan participant. The type of treatment conducted by each Plan participant can be found in D-2.

The total energy use within the SECWCD is 2.0 million kWh/yr with an average of 53,000 kWh/yr per Plan participant. Assuming an electricity rate of $0.08 per kWh[7], the total and average annual operating costs for groundwater pumping in the district are $160,000 and $4,400, respectively. The associated greenhouse gas emissions for water treatment by each Plan participant were calculated assuming an electricity emission factor of 1,916 lbs of carbon dioxide equivalent (CO_2e) per MWh of electricity consumption[6]. The total and average emissions in the district are 1,700 metric tons (MT) CO_2e and 46 MT CO_2e, respectively. This is equal to almost 95 trips from Denver to Pueblo per day for all of the emissions generated in the district.

---

[3] State of Colorado average from the U.S. Energy Information Administration (http://www.eia.gov/cneaf/electricity/st_profiles/e_profiles_sum.html)

[4] U.S. Environmental Protection Agency (EPA) eGrid (http://cfpub.epa.gov/egridweb/) for the WECC Rockies eGrid subregion

[5] From Table 2-3. AVC Treatment Summary of STAG report and participant surveys provided by Great Western Institute

[6] State of Colorado average from the U.S. Energy Information Administration (http://www.eia.gov/cneaf/electricity/st_profiles/e_profiles_sum.html)

[7] From the U.S. Environmental Protection Agency (EPA) eGrid (http://cfpub.epa.gov/egridweb/) for the WECC Rockies eGrid subregion

[8] E. Joe Middlebrooks, Charlotte H. Middlebrooks and Sherwood C. Reed, "Energy Requirement for Small Wastewater Treatment Systems", *Journal (Water Pollution Control Federation)* Vol. 53, No. 7 (Jul., 1981), pp. 1172-1197

Table D-1 – Groundwater Pumping and Water Treatment Impacts by Project Partner

Location	Groundwater Pumping				Water Treatment			
	Energy Use (kWh/yr)	Operating Cost ($/yr)	Operating Cost ($/AF/yr)	GHG Emissions (MT/yr)*	Energy Use (kWh/yr)	Operating Cost ($/yr)	Operating Cost ($/AF/yr)	GHG Emissions (MT/yr)*
Avondale	42,083	$3,497	$22	37	4,192	$348	$2	4
Beehive Water Assn	9,654	$802	$100	8	450	$37	$5	0
Bents Fort Water Co.	85,828	$7,132	$113	75	3,863	$321	$5	3
Boone, Town of	20,662	$1,717	$26	18	4,085	$339	$5	4
Cheraw, Town of	22,602	$1,878	$39	20	4,023	$334	$7	3
Crowley County Commissioners	219,454	$18,237	$20	191	70,559	$5,863	$7	61
Eads, Town of	56,374	$4,685	$19	49	15,615	$1,298	$5	14
East End Water Assn.	8,479	$705	$64	7	641	$53	$5	1
Eureka Water Co.	115,695	$9,614	$130	101	6,030	$501	$7	5
Fayette Water Assn.	19,877	$1,652	$138	17	2,502	$208	$17	2
Fowler, Town of (potable only)	46,495	$3,864	$18	40	13,064	$1,086	$5	11
Hancock Inc.	12,168	$1,011	$144	11	1,448	$120	$17	1
Hasty Water Company	14,547	$1,209	$38	13	1,950	$162	$5	2
Hilltop Water Co.	19,999	$1,662	$37	17	3,738	$311	$7	3
Holbrook Center Soft Water	25,908	$2,153	$120	23	1,078	$90	$5	1
Homestead Improvement Assn.	13,335	$1,108	$158	12	3,489	$290	$41	3
La Junta, City of	417,594	$34,702	$17	363	1,031,605	$85,726	$42	896
Lamar, City of	495,563	$41,098	$17	430	149,980	$12,463	$5	130
Las Animas, City of	122,377	$10,170	$18	106	288,228	$23,952	$42	250
Manzanola, Town of	21,424	$1,780	$46	19	3,200	$266	$7	3
May Valley Water Assoc.	406,709	$33,797	$82	353	33,654	$2,797	$7	29
McClave Water Assoc.	60,757	$5,049	$90	53	3,468	$288	$5	3
Newdale-Grand Valley Water Co.	24,770	$2,058	$36	22	4,844	$403	$7	4
North Holbrook Water	14,420	$1,198	$171	13	390	$32	$5	0
Olney Springs, Town of	13,184	$1,096	$27	11	2,466	$205	$5	2
Patterson Valley	11,772	$978	$65	10	1,025	$85	$6	1
Rocky Ford, City of	209,367	$17,398	$20	182	80,421	$6,683	$8	70
South Side Water Assoc.	12,729	$1,058	$151	11	390	$32	$5	0
South Swink Water Co.	96,152	7,990	$97	84	7,106	$591	$7	6

Location	Groundwater Pumping				Water Treatment			
	Energy Use (kWh/yr)	Operating Cost ($/yr)	($/AF/yr)	GHG Emissions (MT/yr)*	Energy Use (kWh/yr)	Operating Cost ($/yr)	($/AF/yr)	GHG Emissions (MT/yr)*
St. Charles Mesa Water District	389,929	$32,403	$20	339	149,680	$12,438	$7	130
Sugar City, Town of	34,784	$2,891	$35	30	5,090	$423	$5	4
Swink, Town of	29,822	$2,478	$65	26	19,952	$1,658	$44	17
Valley Water Co.	60,905	$5,061	$133	53	3,103	$258	$7	3
Vroman	69,752	$5,796	$181	61	355	$30	$1	0
West Grand Valley Water Inc.	42,740	$3,552	$142	37	28,169	$2,341	$94	24
West Holbrook Water	11,075	$920	$66	10	5,661	$470	$34	5
Wiley, Town of	13,184	$1,096	$46	11	332	$28	$1	0
TOTAL	**3,291,165**	**$273,496**	**$2,713**	**2,860**	**1,955,848**	**$162,531**	**$488**	**1,699**
AVERAGE	**88,950**	**$7,392**	**$73**	**77**	**52,861**	**$4,393**	**$13**	**46**

** MT = metric tons; greenhouse gas emissions are presented in units of carbon dioxide equivalents (CO_2e)*

Table D-2
Summary of Potable Water Treatment for Plan Participants

	Chlorination	Iron Filters	Ozone	Scale Sequestration	Nitrate Removal	Reverse Osmosis	Backwash Disposal
Beehive Water Assn	yes						
Bents Fort Water Co.	yes						
Boone, Town of	yes				yes		
Crowley County Commissioners (includes #1 96 Pipeline Company, #8 Crowley County Water Association, #9 Town of Crowley, and #29 Town of Ordway)							
96 Pipeline	yes						
Crowley County Water Authority	yes						
Town of Crowley	yes						
Ordway	yes						
Crowley County Commissioners	no						
Eads, Town of	yes						
East End Water Assn.	yes						
Eureka Water Co.	yes	yes					pumped to waste
Fayette Water Assn.	yes	yes	yes				pumped to waste
Fowler, Town of (potable only)	yes						
Hasty Water Company	yes						
Hilltop Water Co.	yes	yes					pumped to waste
Holbrook Center Soft Water	yes						
Homestead Improvement Assn.	connected to La Junta						
La Junta, City of	yes					yes	reject to WWTP
Lamar, City of	yes						
Las Animas, City of	yes					yes	reject to WWTP
Manzanola, Town of	yes	yes					pumped to waste
May Valley Water Assoc.	yes	yes		yes			pumped to waste
McClave Water Assoc.	yes						
Newdale-Grand Valley Water Co.	yes	yes					pumped to waste
North Holbrook Water	yes			yes			
Olney Springs, Town of	yes						
Patterson Valley	yes	yes					pumped to waste
Rocky Ford, City of	yes	yes (future only)					pumped to WWTP
South Side Water Assoc.	yes						
South Swink Water Co.	yes	yes					pumped to waste
St. Charles Mesa Water District	yes	yes					recycled to supply
Sugar City, Town of	yes						
Swink, Town of	yes	yes				yes	pumped to WWTP
Valley Water Co.	yes	yes					pumped to waste
Vroman	yes	yes					pumped to waste
West Grand Valley Water Inc.	yes	yes	yes				pumped to waste
West Holbrook Water	yes						
Wiley, Town of	yes	yes					Parks or fire fighting

96 Pipeline Company

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide the 96 Pipeline Company with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide the 96 Pipeline Company with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at your offices on September 6, 2011. The following text and tables summarize the data provided to the District during the audit.

Water Sources	5 Crowley County groundwater production wells	Chlorination then to distribution
Master Meter	Various County maintained master meters at County wells	No information available on master meter ages or testing efforts.
Meter Readings	Monthly (end of the month)	
Billings	Monthly (first of the month)	

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	63		16		17	30
1.5-inch	2			1	1	
2-inch	1			1		

The organization replaces meters as needed based on field observations (e.g., meter stops reading, leak in the meter or there is water in the meter pit, etc.). Note that there are 40 non-active meters currently.

Summary of Pipe

Pipe (feet)	2-inch	3-inch	4-inch	6-inch	Total
PVC			31,680	15,840	47,520

Pipe age is generally from 1964, with some new pipe since 2000.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations, based on surface expressions and/or pressure drops in system	4 leaks in the last 2 years
Leak Repair Costs		$500 per leak
Pipe Replacement	Nothing currently planned	

Water Loss Calculations

Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010 and 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

Data indicates that there are wide variations (more than 40%) in measured non-revenue water from month to month. These variations may be the result of many issues including:

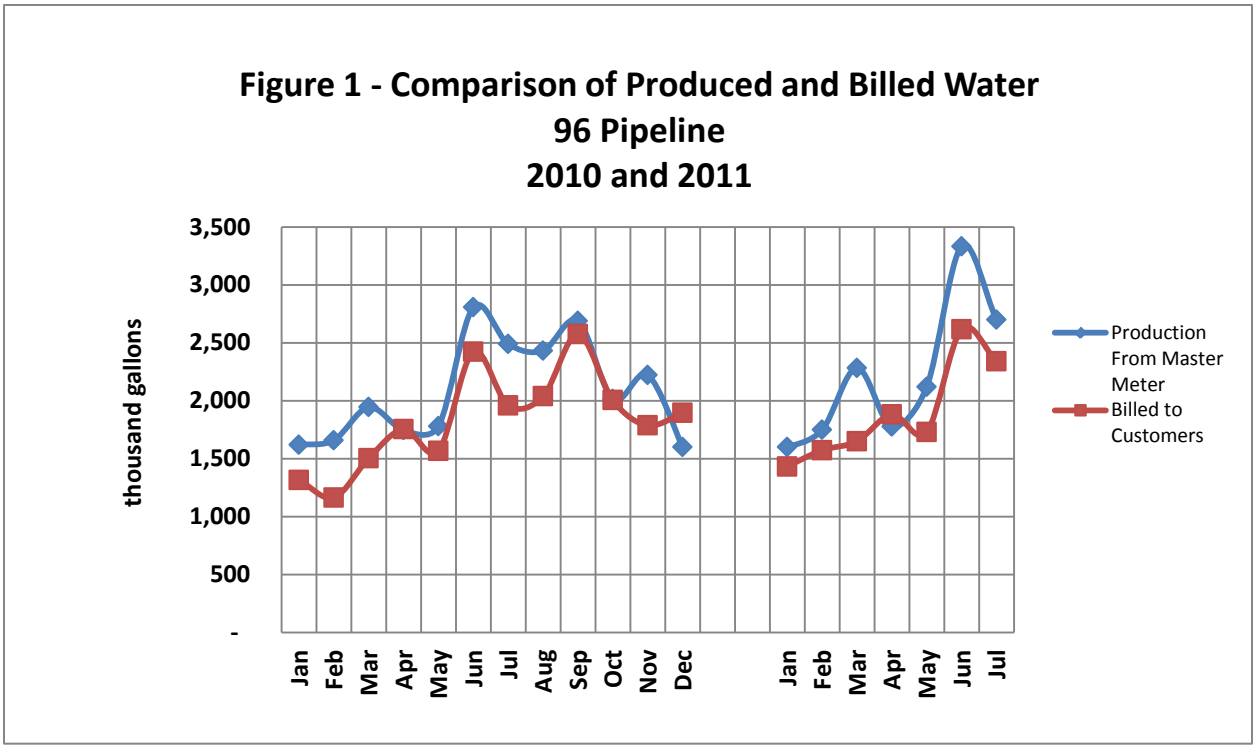
- Lack of coordination between collecting master meter and customer meter readings;
- Inaccurate master and/or customer meters;
- Variability in real loses due to leaks;
- Inconsistent data handling methods; and
- Impacts of unmetered and metered, unbilled water uses.

96 Pipeline may want to consider conducting a more rigorous system wide audit to determine why water loss data are so variable; including evaluating master meter and customer meter use records; sources of unmetered and metered, unbilled water use; testing the accuracy of master meters and

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

Table 1 – Non-Revenue Water Calculation

		Production				
		From Master Meter	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled	Non-Revenue Water
2010	Jan	1,620	1,318	0%	0%	18.6%
	Feb	1,660	1,165	0%	0%	29.8%
	Mar	1,945	1,504	0%	0%	22.7%
	Apr	1,747	1,755	0%	0%	-0.5%
	May	1,781	1,569	0%	0%	11.9%
	Jun	2,807	2,423	0%	0%	13.7%
	Jul	2,491	1,961	0%	0%	21.3%
	Aug	2,433	2,039	0%	0%	16.2%
	Sep	2,690	2,575	0%	0%	4.3%
	Oct	2,015	2,006	0%	0%	0.4%
	Nov	2,223	1,788	0%	0%	19.6%
	Dec	1,600	1,898	0%	0%	-18.6%
Total				**0%**	**0%**	**12.0%**
2011	Jan	1,600	1,434	0%	0%	10.4%
	Feb	1,749	1,574	0%	0%	10.0%
	Mar	2,284	1,651	0%	0%	27.7%
	Apr	1,777	1,883	0%	0%	-6.0%
	May	2,121	1,731	0%	0%	18.4%
	Jun	3,333	2,617	0%	0%	21.5%
	Jul	2,700	2,342	0%	0%	13.3%
	Aug	2,795				
	Sep					
	Oct					
	Nov					
	Dec					
Total				**0%**	**0%**	**15.0%**
		All volumes in thousands of gallons				



customer meters; and evaluating current data collection and handling procedures. Conducting the audit and acting on audit recommends will likely substantially stabilize the organizations water loss and subsequently its water sales revenues. Better data to characterize water loss will also allow 96 Pipeline to more effectively identify leaks and other water losses real and apparent. Finally, 96 Pipeline may want to consider a more aggressive customer meter replacement program given that about 50% of its customer meters are 10 years or older.

96 Pipeline does have a small amount of unmetered water use that could be identified. Currently they are considered to be less than 0.5% of total water deliveries. There are no known metered, unbilled water uses. Non-revenue water includes unmetered uses as losses.

Needs/Recommendations

The 96 Pipeline Company did not identify any specific areas of potential improvements that would help reduce non-revenue water in their service area; however, in general meter replacement practices could be improved. In addition, there are some best management practices which may help 96 Pipeline to better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Implement program to more aggressively replace customer meters (especially on the largest water use customers) using meters that record in 100 gallon increments for ¾-inch meters.
- Track water use through each meter over time to help prioritize future replacements.
- Improve data handling and recording of customer water use.

- Conduct a more rigorous system wide audit to identify and characterize unmetered water use and the variability of water loss; and test master and customer meters.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

Beehive Water Association

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide Beehive Water Association with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

An overview of the audit program

- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide Beehive Water Association with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at your offices on September 20, 2011. The following text and tables summarize the data provided to the District during the audit.

Water Sources	3 groundwater production wells	Water pumped to a cistern for chlorination then distribution
Master Meter	3 – one at each well	2-inch meters, tested yearly; meters are 2 to 5 years old
Meter Readings	Monthly (end of the month)	
Billings	Monthly (first of the month)	

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by ¾	88	14	14	30	30	0

Replacing meters as needed based on field observations.

Summary of Pipe

Pipe (feet)	2-inch	3-inch	4-inch	6-inch	Total
PVC	63,360	18,480			81,840

Pipe is generally from the 1980s, however some new PVC installed since then.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations, based on surface expressions and/or pressure drops in system	2 or 3 leaks in the last two years
Leak Repair Costs		$350 per leak
Pipe Replacement	Nothing currently planned	

Water Loss Calculations

Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010 and 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

Beehive has substantial water loss which may be a result of some or all of the following:

- Undetected leaks in the distribution lines or service lines (before the customer meters); and
- Unknown or unauthorized water uses (including unmetered uses).

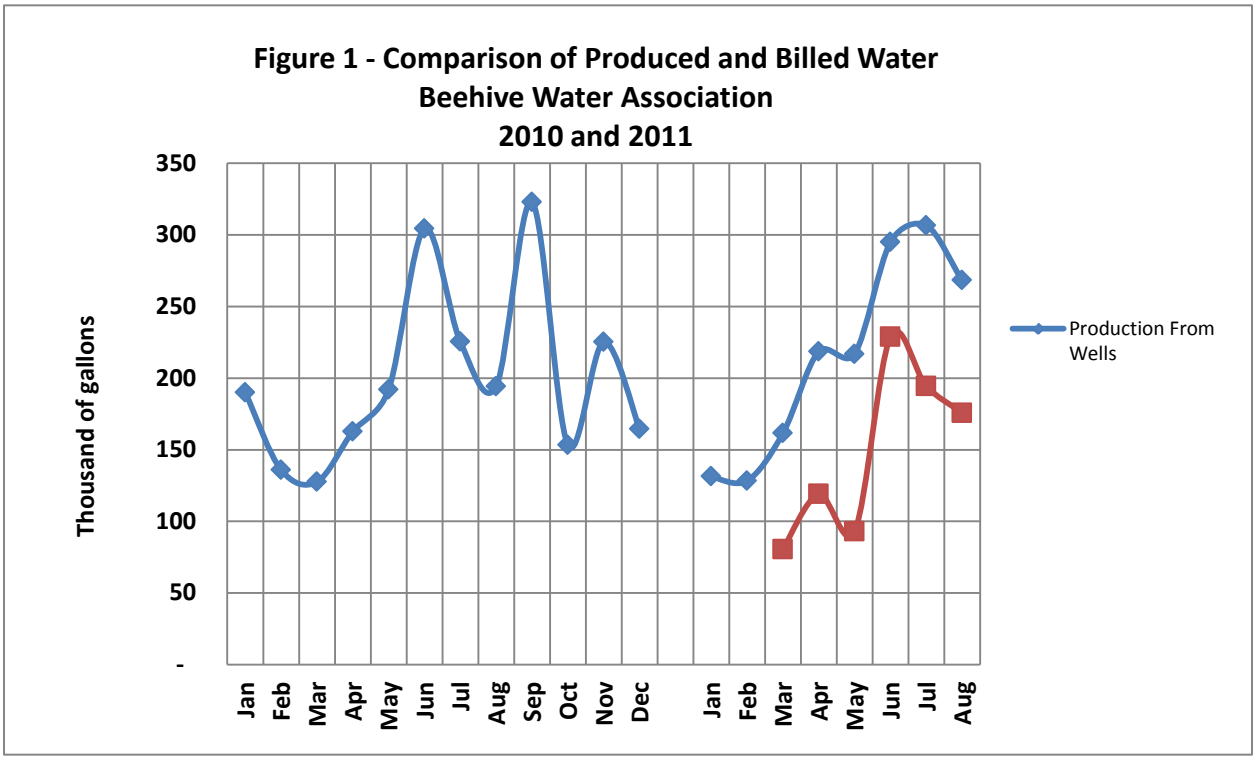
To address these issues, Beehive may consider a number of actions. To begin with, Beehive may benefit from a more rigorous system wide water audit of its record keeping, metering accuracy (both master meters and customer metering), and unmetered uses. Performing a meaningful audit may allow Beehive to improve water sales and to better track actual water use. It may also help to support any future efforts by Beehive to adjust water rates to the actual cost of service. Improved water measuring and tracking will also help the Beehive to better identify distribution leaks on a month to month basis.

To support its leak detection and repair practices, Beehive may want to consider installing sub-meters to improve leak detection; and isolation valving within the distribution system to improve the efficiency of leak repair and system maintenance.

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

Table 1 – Non-Revenue Water Calculation

		Production				
		From Wells	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled	Non-Revenue Water
2010	Jan	190				
	Feb	136				
	Mar	128				
	Apr	163				
	May	192				
	Jun	304				
	Jul	225				
	Aug	194				
	Sep	323				
	Oct	153				
	Nov	225				
	Dec	165				
Total *		**2,340**	**1,531**			**34.5%**
2011	Jan	131				
	Feb	128				
	Mar	162	80	0%	0%	50.2%
	Apr	219	119	0%	0%	45.5%
	May	217	93	0%	0%	57.1%
	Jun	295	229	0%	0%	22.4%
	Jul	307	194	0%	0%	36.6%
	Aug	268	176	0%	0%	34.5%
	Sep					
	Oct					
	Nov					
	Dec					
Total				**0%**	**0%**	**39.2%**
	* based on February 2010 to February 2011 production and billings					
		All volumes in thousands of gallons				



Beehive does not have any unmetered or metered, unbilled water use that could be identified.

Needs/Recommendations

Beehive Water Association did not identify any specific areas of potential improvements that would help reduce non-revenue water in their service area. However, there are some best management practices which may help Beehive to better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Replace customer meters using meters that record in 100 gallon increments for ¾-inch meters.
- Track water use through each meter over time to help prioritize future replacements.
- Install sub-meters and isolation valving in the pipeline system to improve leak detection and system management during leak repairs and other maintenance activities.
- Improve data handling and recording of customer water use, including coordinating the reading of customer meters with the master meters.
- Continuing annual system wide audits to identify and characterize unmetered water use.
- Conducting water rate studies to allow for rates set at cost of service (including water line replacement, etc.).

Bents Fort Water Company

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide Bents Fort Water Company with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide Bents Fort Water Company with an overview of the Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at your offices on September 20, 2011. The following text and tables summarize the data provided to the District during the audit.

Water Sources	1 groundwater production well	
Master Meter	1 at the well (plus one in the City)	2-inch meter, tested yearly; meter is 1 to 2 years old
Meter Readings	Monthly (21st or 22nd of the month)	
Billings	Monthly (27th of the month)	

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by ¾	330	4	26			300
1-inch	1				1	

Replacing meters as needed based on field observations.

Summary of Pipe

Pipe (feet)	2-inch	3-inch	4-inch	6-inch	Total
PVC				18,500	18,500
ABS	25,280	67,780	107,000		200,060

Pipe is generally 50 years old, however some new PVC installed in last 5 years.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations, but difficult to detect given sandy soil conditions that do not always promote surface expressions	5 or 6 leaks in the last two years
Leak Detection Costs	Large given prevalence of ABS pipe in the ground (which is difficult to repair) and some of the water mains are below the water table	$200 – $3,500 annually
Pipe Replacement	Currently working to replace some large diameter ABS with PVC in system	

Water Loss Calculations

Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010 and 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

Bents Fort has substantial water loss which may be a result of some or all of the following:

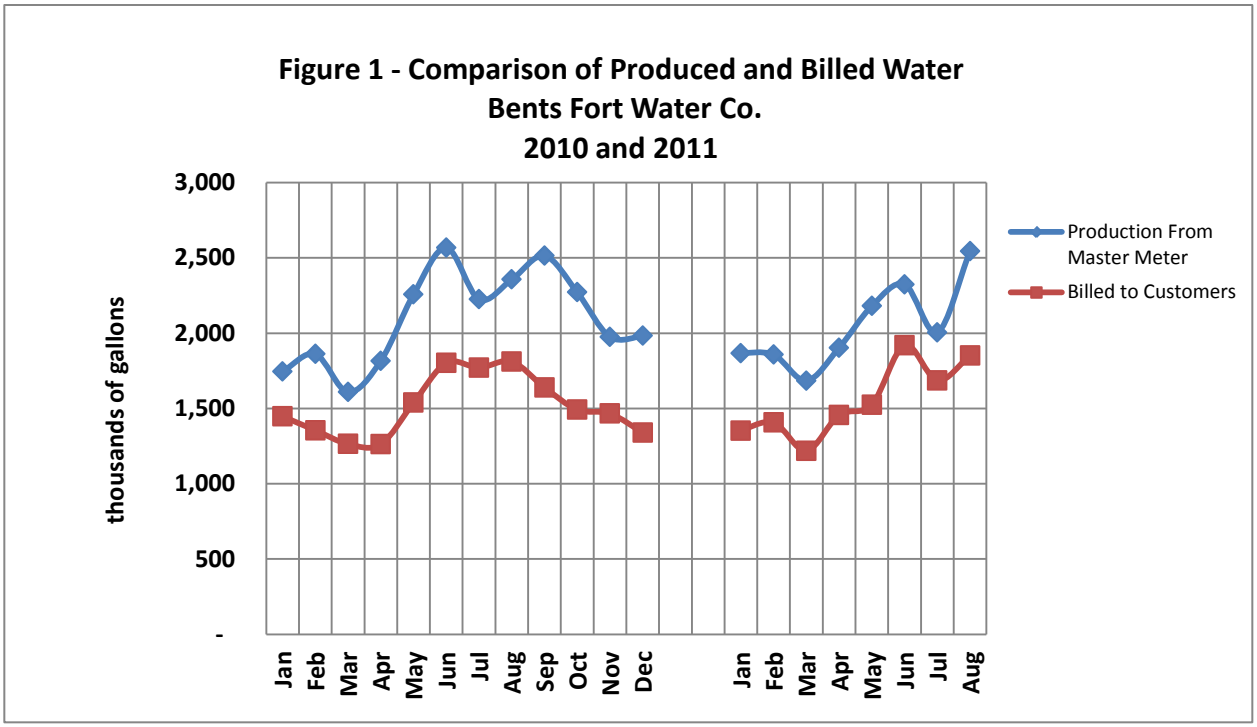
- Inaccurate customer meters;
- Undetected leaks in the distribution lines or service lines (before the customer meters); and
- Unknown or unauthorized water uses (including unmetered uses).

To address these issues, Bents Fort may consider a number of actions. To begin with, Bents Fort may benefit from a more rigorous system wide water audit of its record keeping, metering accuracy (both master meters and customer metering), and unmetered uses. Performing a meaningful audit may allow

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

Table 1 – Non-Revenue Water Calculation

		Production				
		From Master Meter	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled	Non-Revenue Water
2010	Jan	1,746	1,447	0%	0%	17.1%
	Feb	1,861	1,355	0%	0%	27.2%
	Mar	1,608	1,264	0%	0%	21.4%
	Apr	1,816	1,262	0%	0%	30.5%
	May	2,257	1,538	0%	0%	31.9%
	Jun	2,567	1,802	0%	0%	29.8%
	Jul	2,225	1,771	0%	0%	20.4%
	Aug	2,356	1,811	0%	0%	23.1%
	Sep	2,514	1,639	0%	0%	34.8%
	Oct	2,271	1,492	0%	0%	34.3%
	Nov	1,975	1,466	0%	0%	25.8%
	Dec	1,984	1,339	0%	0%	32.5%
Total				**0%**	**0%**	**27.8%**
2011	Jan	1,867	1,351	0%	0%	27.6%
	Feb	1,857	1,407	0%	0%	24.2%
	Mar	1,684	1,219	0%	0%	27.6%
	Apr	1,903	1,457	0%	0%	23.4%
	May	2,180	1,525	0%	0%	30.0%
	Jun	2,324	1,920	0%	0%	17.4%
	Jul	2,005	1,686	0%	0%	15.9%
	Aug	2,545	1,851	0%	0%	27.3%
	Sep					
	Oct					
	Nov					
	Dec					
Total				**0%**	**0%**	**24.1%**
		All volumes in thousands of gallons				



Bents Fort to improve water sales and to better track actual water use. It may also help to support any future efforts by Bents Fort to adjust water rates to the actual cost of service. Improved water measuring and tracking will also help Bents Fort to better identify distribution leaks on a month to month basis.

In addition, Bents Fort may consider implementing a more aggressive customer meter replacement program to improve the accuracy of current water use measurement, since over 90% of Bents Fort's customer meters are 10 years or older. To support its leak detection and repair practices, Bents Fort may want to consider installing sub-meters to improve leak detection; and isolation valving within the distribution system to improve the efficiency of leak repair and system maintenance.

Bents Fort has some unmetered water use related to line flushing; however, some valves have not been exercised for years limiting the amount of flushing that occurs. No estimate was made for line flushing and water use during construction. Bents Fort does not have any known metered, unbilled uses. Non-revenue water calculations included the unmetered uses in the water loss calculations.

Needs/Recommendations

Bents Fort Water Company identified a few areas of potential improvements that would help reduce non-revenue water in their service area. In addition, there are some best management practices which may help Bents Fort to better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Install more isolation valves to allow system maintenance at all tees and junctions.

- Replace existing valves which may be inoperable.
- Replace old ABS pipe which can be brittle when being repaired and parts are no longer available commercially.
- Implement program to more aggressively replace customer meters (especially on the largest water use customers) using meters that record in 100 gallon increments for ¾-inch meters.
- Track water use through each meter over time to help prioritize future replacements.
- Improve data handling and recording of customer water use, including coordinating the reading of customer meters with the master meters.
- Continuing annual system wide audits to identify and characterize unmetered water use.
- Conducting water rate studies to allow for rates set at cost of service (including water line replacement, etc.).

Town of Boone

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide the Town of Boone with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide the Town of Boone with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: Town Parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at your offices on September 7, 2011. The following text and tables summarize the data provided to the District during the audit.

Water Sources	1 groundwater production well and 1 spring (Filmore Spring[1])	Water pumped to a tank for nitrate treatment and chlorination then to distribution
Master Meter	1 master meter at the well; and 1 after treatment	6-inch master meter after treatment; not tested regularly; meter is 5 to 10 years old (replaced in 2008)
Meter Readings	Monthly (end of the month)	
Billings	Monthly (first of the month)	

[1] Filmore Spring may be required to be a water source even if the AVC is in operation.

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	150	3	5	7	10	125
2-inch	3 (includes overflow meter)					3

The Town replaces meters as needed based on field observations. Note that the spring and well water transported to the Town for treatment is stored in a tank that can overflow if production exceeds demand. The overflow meter is used to measure the excess.

Summary of Pipe

Pipe (feet)	2-inch	3-inch	4-inch	6-inch	Total
PVC			7,160	2,440	9,600
AC				900	900

Pipe age is generally unspecified, however about 50% is new PVC installed in 2007.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations, based on surface expressions and/or pressure drops in system	No leaks indicated in last 2 years
Leak Repair Costs		$500 to $1,000 (if AC) per leak
Pipe Replacement	Nothing currently planned	

Water Loss Calculations

Water loss, calculated as non-revenue water[2], was developed based on water production and water billings for 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

The water loss associated with overflow from the cistern prior to treatment has been included in the calculation of non-revenue water since this loss comes after water is collected for the Town's distribution. Additional losses are expected in the Town's distribution system including both real and apparent losses.

Water loss in the Town's water system is highly variable from month to month; however, it appears that losses are greatest, as a percentage of total water deliveries, in the winter as compared to the summer time. This observation may relate to larger water overflows occurring from the cistern in the winter, continuous undetected leaks occurring within the Town's distribution system, and/or issues with meter reading and meter accuracy that impact winter time non-revenue water.

[2] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

To address these issues, the Town may consider a number of actions. To begin with, the Town may benefit from a more rigorous system wide water audit of its record keeping, metering accuracy (both master meters and customer metering), and unmetered uses. Performing a meaningful audit may allow the Town to improve water sales and to better track actual water use. It may also help to support any future efforts by the Town to adjust water rates to the actual cost of service. Improved water measuring and tracking will also help the Town to better identify distribution leaks on a month to month basis.

In addition, the Town may consider implementing a more aggressive customer meter replacement program to improve the accuracy of current water use measurement, since over 80% of the Town's customer meters are 10 years or older.

The Town does have a number of unmetered water uses that could be identified, and these are listed in Table 1; although this may be an incomplete listing dependant on the outcome of a more rigorous water audit. The Town does not have any known metered, unbilled water uses. Non-revenue water includes losses related to unmetered water use.

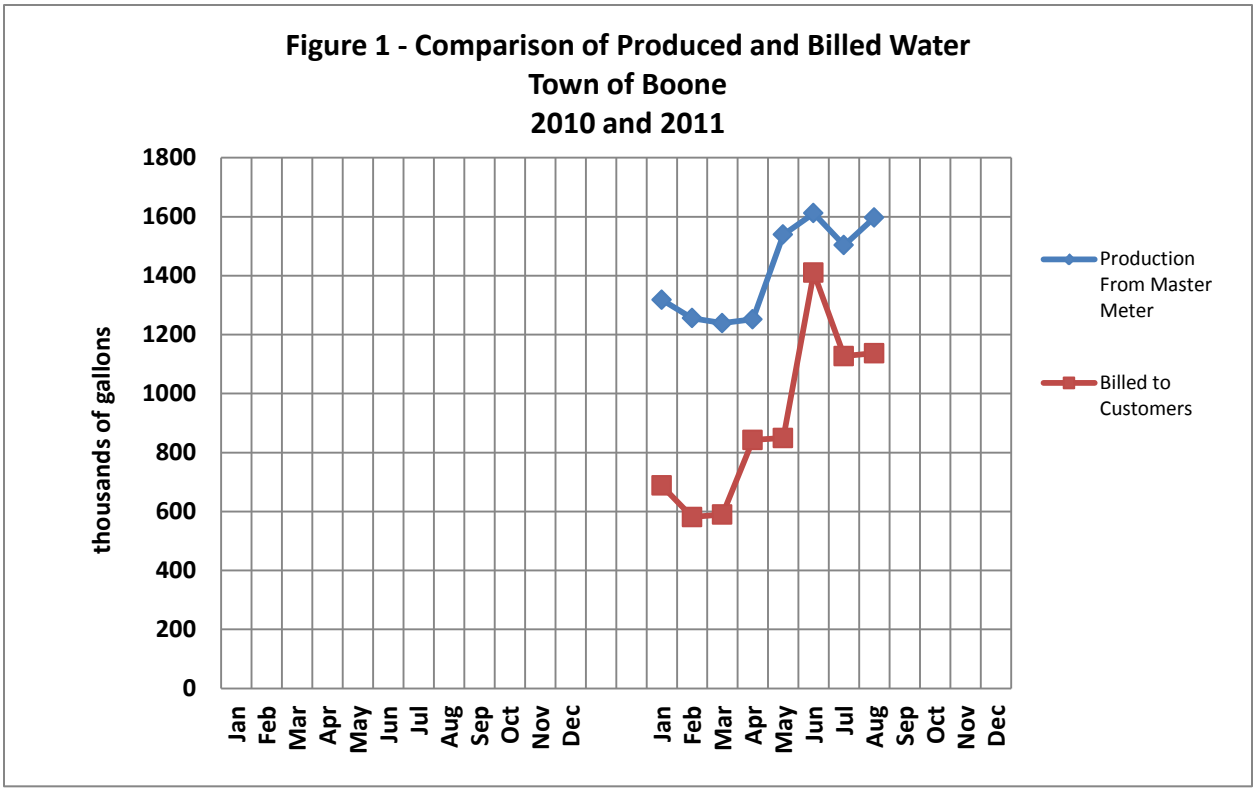


Table 1 – Non-Revenue Water Calculation

		Production						
		From Master Meter	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled*	Non-Revenue Water		
2010	Jan							
	Feb	1,058						
	Mar	1,441						
	Apr	1,550						
	May	1,905						
	Jun	2,197						
	Jul	2,019						
	Aug	1,699						
	Sep	1,662						
	Oct	1,163						
	Nov	1,014						
	Dec	875						
Total								
2011	Jan	1,761**	688	0%	0.3%	47.8%		
	Feb	1,256	581	0%	0.3%	53.7%		
	Mar	1,239	590	0%	0.3%	52.4%		
	Apr	1,252	843	0%	0.3%	32.7%		
	May	1,539	849	0%	1.7%	44.8%		
	Jun	1,612	1,410	0%	1.6%	12.5%		
	Jul	1,503	1,127	0%	1.7%	25.0%		
	Aug	1,597	1,137	0%	1.6%	28.8%		
	Sep							
	Oct							
	Nov							
	Dec							
Total				**0%**	**1.1%**	**36.1%**		
	* includes estimated water use for local church, fire suppression, town shop and town park; excludes other real and apparent losses and cistern overflow							
	** includes 10 days in December 2010; water loss calculation adjusted for pro-rated share of December							
		All volumes in thousands of gallons						

Needs/Recommendations

The Town of Boone did not identify any specific areas of potential improvements that would help reduce non-revenue water in their service area; however, in general meter replacement practices could be improved. In addition, there are some best management practices which may help the Town to better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Implement program to more aggressively replace customer meters (especially on the largest water use customers) using meters that record in 100 gallon increments for ¾-inch meters.
- Track water use through each meter over time to help prioritize future replacements.
- Install sub-meters and isolation valving in the pipeline system to improve leak detection and system management during leak repairs and other maintenance activities.
- Test the accuracy of the County and Town master meters; and replace and repair as needed.
- Improve data handling and recording of customer water use, including coordinating the reading of customer meters with the master meters.
- Conduct a more rigorous system wide audit to identify and characterize unmetered and metered, unbilled water use over time; and conduct meter testing.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

Crowley County Water Authority (CCWA)

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide the Crowley County Water Authority (CCWA) with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide the CCWA with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at your offices on September 8, 2011. The following text and tables summarize the data provided to the District during the audit.

Water Sources	5 Crowley County groundwater production wells plus one CCWA well	Chlorination then to distribution
Master Meter	1 master meter maintained by Crowley County and 1 maintained by CCWA	8-inch master meters which are 5 to 10 years old and are tested every four years
Meter Readings	Monthly (~25th of the month)	
Billings	Monthly (first of the month)	

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	360	360				
4-inch	2	2				

All meters were recently replaced with new meters and automatic meter reading (AMR) devices (which has reduced the time in the field to collect water use data by a factor of 2).

Summary of Pipe

Pipe (feet)	2-inch	3-inch	4-inch	8-inch	Total
PVC	X		X	X	343,200
ABS	x		x	X	246,000

Pipe age is generally from the early 1980s, with about 50 plus miles of original ABS replaced by PVC in 1992. Exact length of pipe for each diameter was not available.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations, but sandy soils in area limit surface expressions. Corrosive soils and copper service lines are an issue	40 leaks in the last 2 years
Leak Repair Costs		$4,000-$5,000 per leak
Pipe Replacement	Nothing currently planned	

Water Loss Calculations

Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

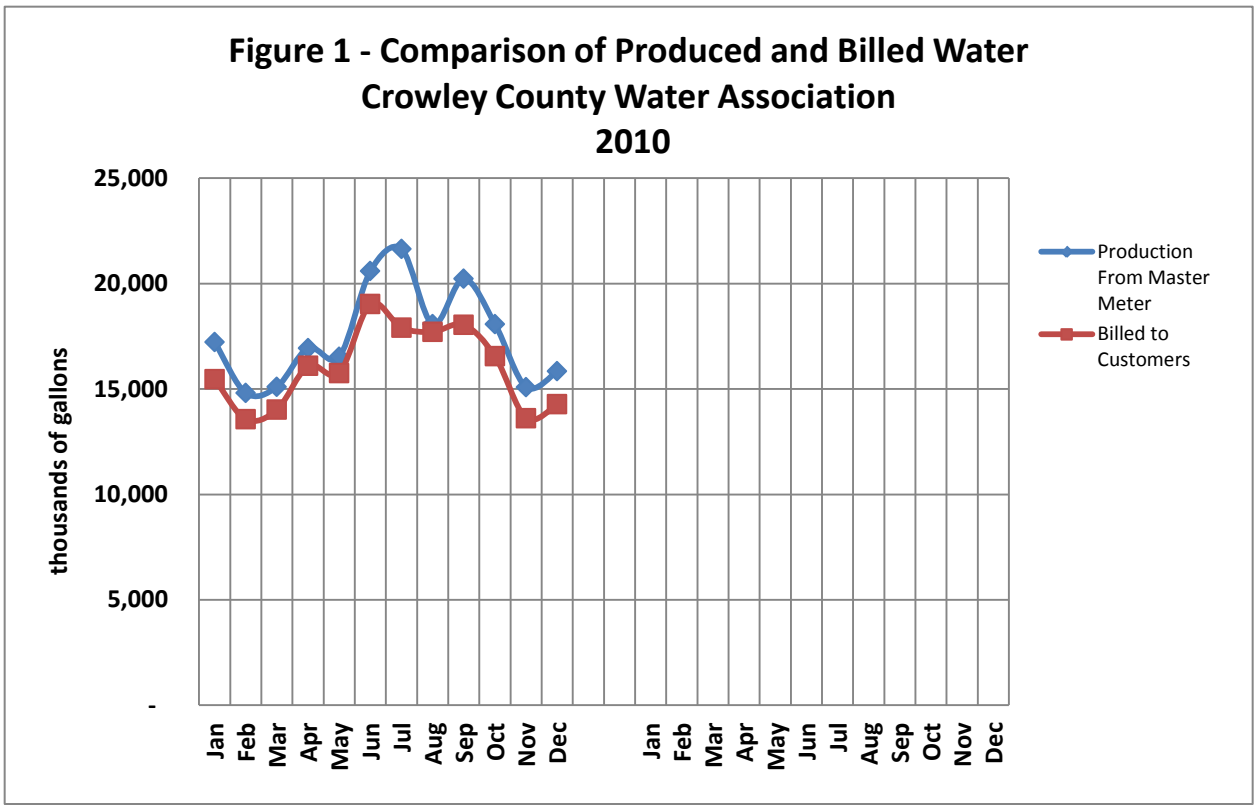
The CCWA appears to experience its greatest water loss during high demand periods – i.e., in the summertime when system pressures are lowest. It is therefore likely that a significant portion of CCWA's non-revenue water is lost due to meter inaccuracies that occurred before CCWA installed new radio read meters. Note that no data was made available to the District for water use or production in 2011 after the new meters were installed.

The CCWA has some unmetered uses related to line flushing, but has not been able to quantify these. The unmetered uses, which have been estimated for purposes of this analysis, are considered to be less than 0.5% of total water deliveries. The CCWA does not have any known metered, unbilled water use. Non-revenue water calculations included unmetered water use.

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

Table 1 – Non-Revenue Water Calculation

		Production				
		From Master Meter	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled*	Non-Revenue Water
2010	Jan	17,220	15,459	0%	0%	10.2%
	Feb	14,813	13,568	0%	0%	8.4%
	Mar	15,103	14,018	0%	0%	7.2%
	Apr	16,942	16,095	0%	1%	5.0%
	May	16,526	15,754	0%	1%	4.7%
	Jun	20,591	19,026	0%	0%	7.6%
	Jul	21,641	17,912	0%	0%	17.2%
	Aug	18,071	17,712	0%	0%	2.0%
	Sep	20,227	18,037	0%	0%	10.8%
	Oct	18,080	16,553	0%	0%	8.4%
	Nov	15,092	13,619	0%	0%	9.8%
	Dec	15,846	14,275	0%	0%	9.9%
Total				**0%**	**0%**	**8.6%**
2011	Jan					
	Feb					
	Mar					
	Apr					
	May					
	Jun					
	Jul					
	Aug					
	Sep					
	Oct					
	Nov					
	Dec					
Total				**0%**	**0%**	
	* includes line flushing					
		All volumes in thousands of gallons				



Needs/Recommendations

The CCWA identify the need for improved metering and data collection in 2010 and as a result they installed new meters in 2011. In addition, there are some best management practices which may help CCWA to better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Track water use through each meter over time to help prioritize future replacements.
- Improve data handling and recording of customer water use.
- Install sub-meters and isolation valving in the pipeline system to improve leak detection and system management during leak repairs and other maintenance activities.
- Replace ABS pipe as resources allow.
- Continue annual system wide audits to identify and characterize unmetered and metered, unbilled water use over time.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

East End Water Company

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide the East End Water Company with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide the East End Water Company with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at your offices on September 20, 2011. The following text and tables summarize the data provided to the District during the audit.

Water Sources	2 groundwater production wells (one shared with South Side)	Chlorination then to distribution
Master Meter	2 master meters plus one on the sump	2-inch master meters tested every other year, not more than 5-years old; new meter on sump
Meter Readings	Monthly (~ 27th day of the month)	
Billings	Monthly (same day as reading)	

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	30	1	2	2		25

Replacement of meters occurs as needed (typically rust shut or break), which is 1 or 2 per year. Most meters date from mid-1990s.

Summary of Pipe

Pipe (feet)	2-inch	3-inch	4-inch	6-inch	Total
PVC	21,120	3,960			25,080
ABS		1,320			1,320

ABS pipe dates back into the 1950s. PVC pipe is 10-15 years old, except 3-inch which is 2-3 years old.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations based on surface expressions, sump running dry, chemical use, and on customer calls	No recent leaks
Leak Repair Costs		$50 per leak in materials (Town has its own staff to repair leaks)
Pipe Replacement	Nothing currently planned	

Water Loss Calculations

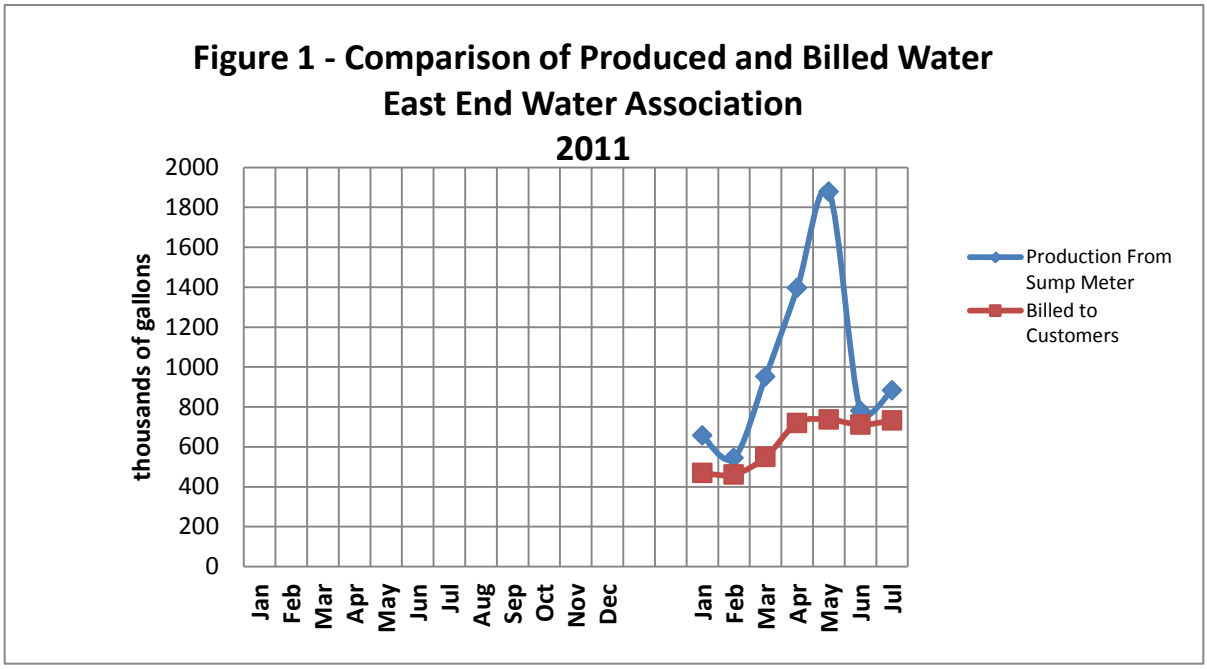
Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

Since the data shows that there are wide variations (more than 50%) in non-revenue water from month to month, which are not associated with leaks that have been identified and repaired, it may be that non-revenue water relates to data collection and handling procedures, and inaccurate meters for selected customers, more so than for real water losses. For example, month to month variations in water loss may be related to not synchronizing reading of customer meters with the master meter (i.e., master meters are read at different intervals than customer meters). The lack of consistency in meter reading can create large variability in month to month water loss. Another source of water loss may be that East Ends customer meters are not accurate given that more than 80% of these meters are 10 years or older. Therefore the organization may want to consider a more aggressive meter replacement program to improve the accuracy of its billings. Finally, Eureka may consider conducting a more rigorous assessment of unmetered and unauthorized water uses, given that measured customer water use does not vary as much as water production in periods of high demand.

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

Table 1 – Non-Revenue Water Calculation

		Production				
		From Sump Meter	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled	Non-Revenue Water
2010	Jan					
	Feb					
	Mar					
	Apr					
	May					
	Jun					
	Jul					
	Aug					
	Sep					
	Oct					
	Nov					
	Dec					
Total						
2011	Jan	657	469	0%	0%	28.6%
	Feb	544	462	0%	0%	15.1%
	Mar	952	549	0%	0%	42.3%
	Apr	1,395	720	0%	0%	48.4%
	May	1,879	737	0%	0%	60.8%
	Jun	781	711	0%	0%	9.0%
	Jul	883	732	0%	0%	17.1%
	Aug					
	Sep					
	Oct					
	Nov					
	Dec					
Total				**0%**	**0%**	**38.2%**
		All volumes in thousands of gallons				



East End has some known unmetered water use associated with line flushing, but it occurs irregularly and has not been quantified. Currently, unmetered water use is considered to be less than 0.5% of total water deliveries; however it may be that Eureka has much higher unmetered uses. Eureka does not have any known metered, unbilled uses. Non-revenue water includes those losses associated with unmetered water use.

Needs/Recommendations

The East End Water Company has not identified any specific improvements that are needed to improve water loss management. However, there are some best management practices which may help the East End Water Company better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Implement program to more aggressively replace customer meters (especially on the largest water use customers) using meters that record in 100 gallon increments for ¾-inch meters.
- Track water use through each meter over time to help prioritize future replacements.
- Install sub-meters and isolation valving in the pipeline system to improve leak detection and system management during leak repairs and other maintenance activities.
- Conduct a more rigorous system wide audit to identify and characterize unmetered and metered, unbilled water use over time, with particular attention on unauthorized uses.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

Eureka Water Company

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide the Eureka Water Company with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide the Eureka Water Company with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at your offices on September 1, 2011. The following text and tables summarize the data provided to the District during the audit.

Water Sources	3 groundwater production wells	Filtration and chlorination then to distribution
Master Meter	3 master meters at the wells plus one at the treatment plant	1-inch master meter on treatment plant tested every 4 years; new meter in 2008
Meter Readings	Monthly (15-25th day of the month)	
Billings	Monthly (1st day of the month)	

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	134	13	12	25		84

Replacement of meters has been occurring at 12-13 per year starting in 2008.

Summary of Pipe

Pipe (feet)	2-inch	2.5-inch	3-inch	4-inch	Total
PVC	21,120	11,352		9,240	41,712
ABS	1,320	1,320	1,320		3,960

No good records on past pipe replacement efforts.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations based on surface expressions, or loss of storage, and on customer calls when water service lost although leaks often do not surface due to rocky soils.	26 in the last 2 years
Leak Repair Costs		$500 per leak in materials
Pipe Replacement	Nothing currently planned	

Water Loss Calculations

Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

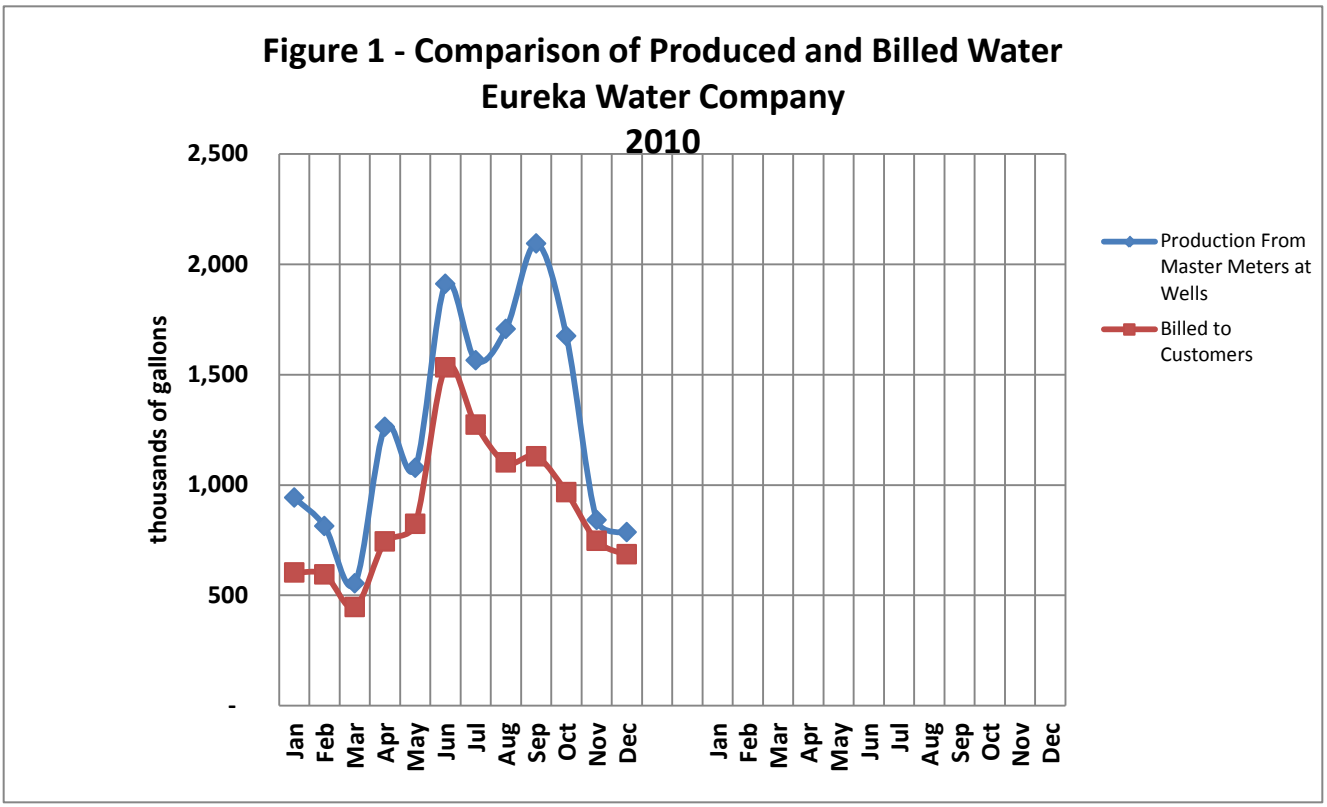
Since the data shows that there are wide variations (about 35%) in non-revenue water from month to month, it appears that non-revenue water is associated with leaks that have been identified and repaired, as well as data collection and handling procedures, and inaccurate meters for selected customers. Other undetected and/or unrepaired leaks may also exist given the total amount of water loss. To help resolve the water losses, Eureka may consider implementing a more aggressive customer meter replacement program since over 60% of its customer meters are greater than 10 years old. In addition, Eureka may also consider installing submeters (to help detect and locate leaks); and isolation valving (to improve the efficiency of leak repair and water line maintenance).

Eureka has known unmetered water use associated with filter backwashing and line flushing, which constitute between 1 and 2% of total water use. Eureka does not have any known metered, unbilled uses. Non-revenue water calculations include unmetered uses as losses.

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

Table 1 – Non-revenue Water Calculation

		Production				
		From Master Meters at Wells	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled*	Non-Revenue Water
2010	Jan	943	603	0%	2.1%	36.0%
	Feb	813	594	0%	2.5%	26.9%
	Mar	553	446	0%	3.6%	19.4%
	Apr	1,262	744	0%	1.6%	41.1%
	May	1,077	823	0%	1.9%	23.6%
	Jun	1,910	1,532	0%	1.0%	19.8%
	Jul	1,565	1,273	0%	1.3%	18.6%
	Aug	1,705	1,101	0%	1.2%	35.4%
	Sep	2,094	1,129	0%	1.0%	46.1%
	Oct	1,674	967	0%	1.2%	42.2%
	Nov	841	747	0%	2.4%	11.2%
	Dec	785	685	0%	2.5%	12.7%
Total				**0%**	**1.6%**	**30.1%**
2011	Jan					
	Feb					
	Mar					
	Apr					
	May					
	Jun					
	Jul					
	Aug					
	Sep					
	Oct					
	Nov					
	Dec					
Total						
	* includes filter backwash and annual line flushing					
		All volumes in thousands of gallons				



Needs/Recommendations

The Eureka Water Company has not identified any specific improvements that are needed to improve water loss management, except installing a automated meter on the treatment plant which would help to identify leaks and other system issues. In addition, there is a number of best management practices which may help the Eureka Water Company better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Automate meter on treatment plant
- Implement program to more aggressively replace customer meters (especially on the largest water use customers) using meters that record in 100 gallon increments for ¾-inch meters.
- Track water use through each meter over time to help prioritize future replacements.
- Install sub-meters and isolation valving in the pipeline system to improve leak detection and system management during leak repairs and other maintenance activities.
- Continue annual system wide audits to identify and characterize unmetered and metered, unbilled water use over time.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

Fayette Water Company

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide the Fayette Water Company with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide the Fayette Water Company with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at your offices on August 29, 2011. The following text and tables summarize the data provided to the District during the audit.

Water Sources	1 groundwater production well	Filtration and ozonation then to distribution
Master Meter	1 master meters at the well	2-inch master meter tested every 2 years; new meter in 2010
Meter Readings	Monthly (~1st day of the month)	
Billings	Monthly (~1st day of the month)	

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	26			6		20

Replacement of meters has been occurring as needed based on field observations.

Summary of Pipe

Pipe (feet)	1-inch	1.5-inch	2-inch	2.5-inch	Total
PVC	1,320	1,320	19,800	10,560	33,000

All pipe replaced between 1990 and 1997.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations based on surface expressions, or meter balance calculations; also leak finder equipment	No records on how many leaks in past 2 years
Leak Repair Costs		$140 -300 per leak
Pipe Replacement	Nothing currently planned	

Water Loss Calculations

Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010 and 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

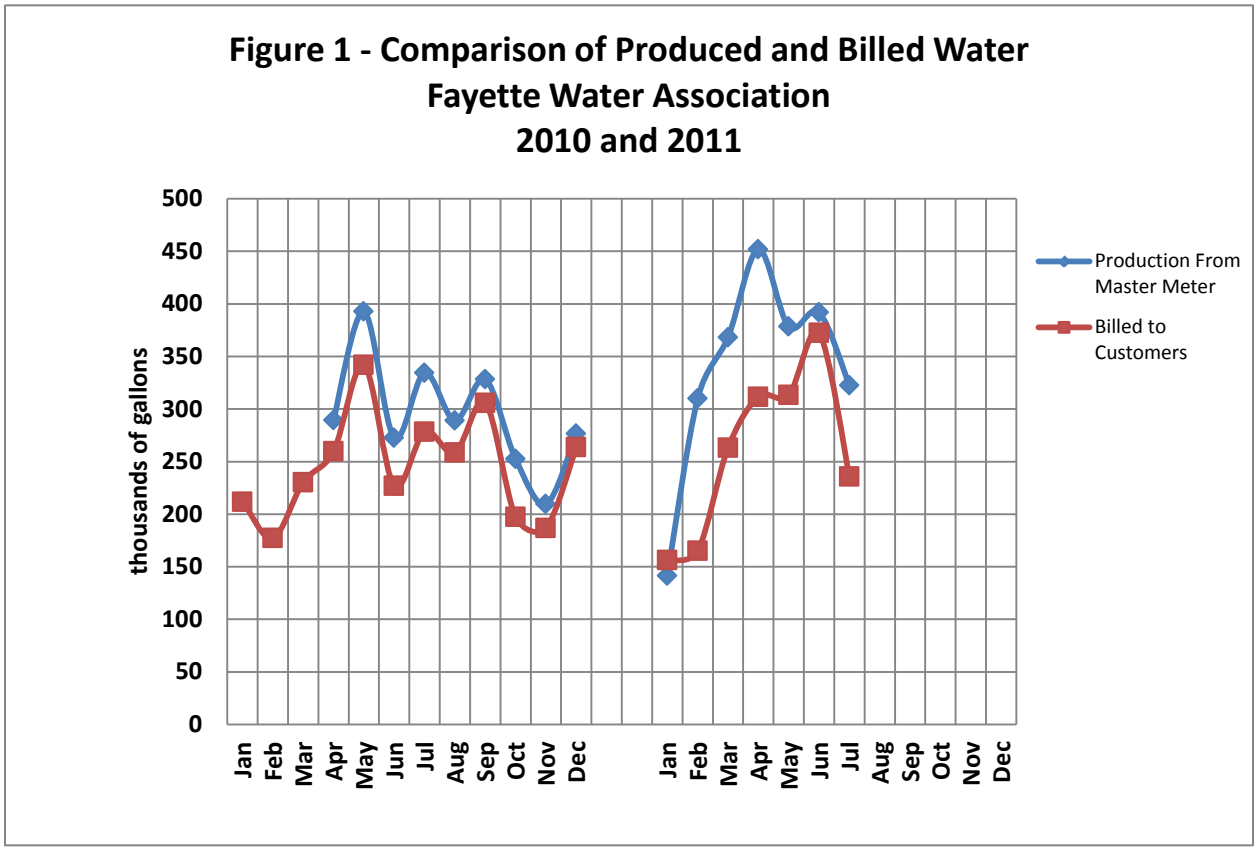
The water loss profile presented in Figure 1 indicates that while non-revenue water was somewhat consistent in 2010, varying from about 6 to 21%, variations in 2011 were substantially greater as was total non-revenue water. During early 2011, water loss varied from positive to negative values. This variation was likely related to not synchronizing the readings of the master meter with the customer meters. It also appears that increased real losses probably occurred in the first half of the year, which were subsequently repaired. It will be important for Fayette to continue to track non-revenue water on a monthly basis to determine if other losses are occurring. Finally, Fayette should consider implementing a more aggressive customer meter replacement program given that over 75% of its customer meters are over 10 years old.

Fayette has unmetered water use associated with filter backwashing and line flushing, which typically constitute between 1 and 2% of total annual water use. Non-revenue water calculations include these losses.

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

Table 1 – Non-Revenue Water Calculation

		Production				
		From Master Meter	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled*	Non-Revenue Water
2010	Jan		212	0%	1.6%	
	Feb		177	0%	1.6%	
	Mar		230	0%	1.6%	
	Apr	289	260	0%	1.6%	10.2%
	May	393	342	0%	1.1%	12.9%
	Jun	273	227	0%	1.7%	16.8%
	Jul	334	278	0%	1.3%	16.8%
	Aug	289	258	0%	1.6%	10.6%
	Sep	328	306	0%	1.4%	6.8%
	Oct	253	198	0%	1.8%	21.8%
	Nov	209	187	0%	2.1%	10.9%
	Dec	277	264	0%	1.6%	4.7%
Total				**0%**	1.5%	**12.3%**
2011	Jan	142	156	0%	3.2%	-10.4%
	Feb	310	165	0%	1.5%	46.7%
	Mar	368	263	0%	1.2%	28.5%
	Apr	452	312	0%	1.0%	31.0%
	May	378	313	0%	1.2%	17.2%
	Jun	392	372	0%	1.1%	5.0%
	Jul	322	236	0%	1.4%	26.9%
	Aug					
	Sep					
	Oct					
	Nov					
	Dec					
Total				**0%**	1.3%	**23.1%**
	* includes filter backwash at 5 gpm every other day for 30 minutes (for both filters)					
		All volumes in thousands of gallons				



Needs/Recommendations

The Fayette Water Company has not identified any specific improvements that are needed to improve water loss management. However, there is a number of best management practices which may help the Fayette Water Company better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Implement program to more aggressively replace customer meters (especially on the largest water use customers) using meters that record in 100 gallon increments for ¾-inch meters.
- Track water use through each meter over time to help prioritize future replacements.
- Install sub-meters and isolation valving in the pipeline system to improve leak detection and system management during leak repairs and other maintenance activities.
- Continue annual system wide audits to identify and characterize unmetered and metered, unbilled water use over time.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

Town of Fowler

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide the Town of Fowler with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide the Town of Fowler with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: Town Parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at your offices on March 9, 2012. The following text and tables summarize the data provided to the District during the audit.

Water Sources	8 groundwater production wells – 2 soft water wells and 6 hard water wells	Soft water is chlorinated then to distribution
Master Meter	8 master meters at the wells	Master meters tested every 2 years
Meter Readings	Monthly (~25th day of the month)	
Billings	Monthly (~1st day of the month)	

The Town has a unique system combining soft water and hard water sources. Soft water is used for potable water uses in residences and commercial settings; whereas hard water is used for irrigation and non-potable residential and commercial uses (e.g., toilet flushing). Soft water is tracked for billing by the

Town; whereas, hard water use is not. Therefore, the audit focused on only the soft water uses, since no billing data (and therefore no demand side data) is available to characterize hard water demands.

Summary of Meters (Potable only)

Meters		**Age (years)**				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	687	5	5	25	22	630
1.5-inch	7				7	
2-inch	4				4	
3-inch	2				2	

Replacement of meters has been occurring as needed based on field observations.

Summary of Pipe

Pipe (feet)	**2-inch**	**4-inch**	**6-inch**	**8-inch**	**12-inch**	**Total**
Steel and Concrete	18,540	6,470	19,870	17,290	1,385	63,555

All pipe constructed in 1977 and earlier.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations based on surface expressions, or customer calls; distribution system appears intact, it is copper pipe going to customers that have been problematic	3 leaks in past 2 years
Leak Repair Costs		$140 per leak in materials
Pipe Replacement	Nothing currently planned	

Water Loss Calculations

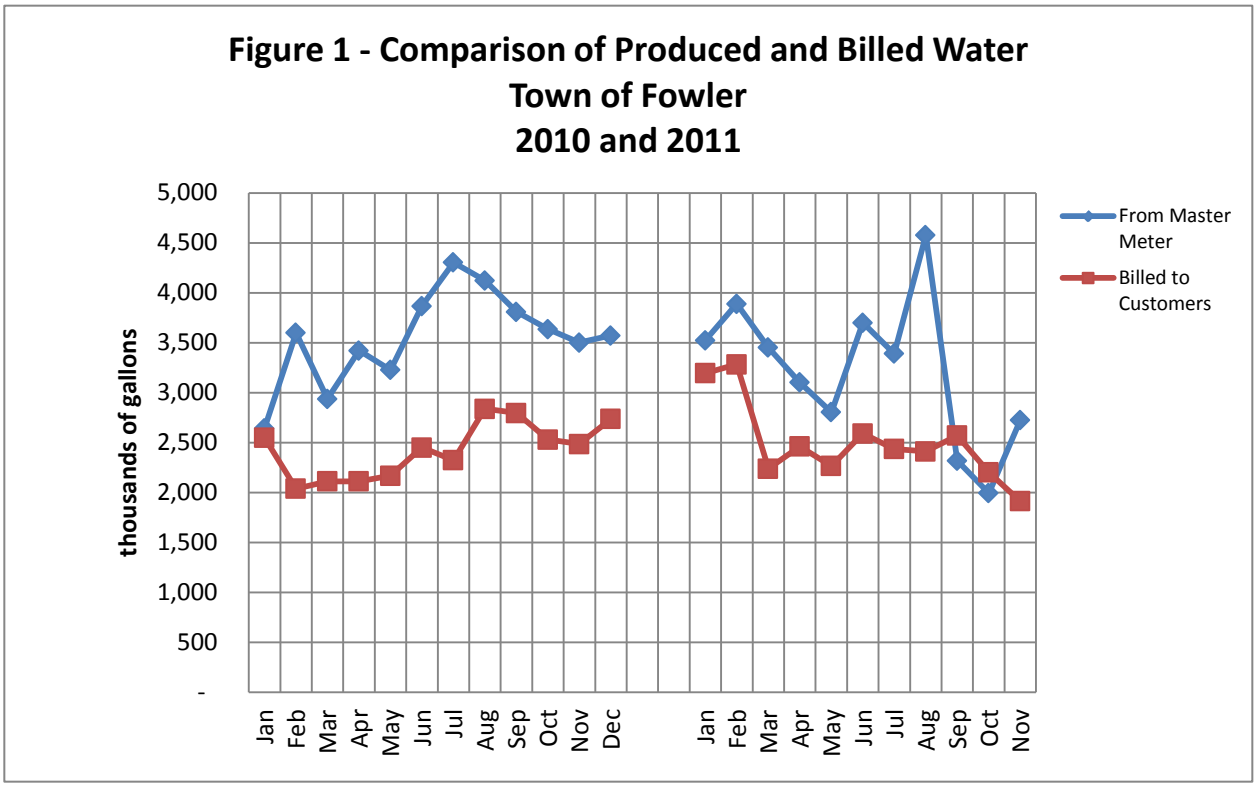
Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010 and 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

The water loss profile presented in Figure 1 indicates that while soft water billings are fairly steady in 2010, well production shows some seasonality. The increase of non-revenue water in the high demand periods may be indicative of unmetered uses increasing during those times (e.g., swamp coolers that are not drawing water from metered lines) or inaccurate customer meters (given that 90% of the Town's customer meters are greater than 10 years old). Variations in non-revenue water in the late part of 2011 (i.e., September and October) likely resulted from inaccurate record keeping associated with either a transcription error or a meter reading error; or a problem with the master meter (which should be tested for accuracy).

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

Table 1 – Non-Revenue Water Calculation

		Production				
		From Master Meter	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled*	Non-Revenue Water
2010	Jan	2,640	2,550	0%	0.0%	3.4%
	Feb	3,598	2,038	0%	0.0%	43.4%
	Mar	2,936	2,112	0%	0.0%	28.1%
	Apr	3,421	2,112	0%	2.2%	38.3%
	May	3,226	2,168	0%	2.3%	32.8%
	Jun	3,867	2,451	0%	1.9%	36.6%
	Jul	4,303	2,323	0%	0.0%	46.0%
	Aug	4,123	2,837	0%	0.0%	31.2%
	Sep	3,809	2,795	0%	2.0%	26.6%
	Oct	3,636	2,530	0%	2.0%	30.4%
	Nov	3,500	2,485	0%	0.0%	29.0%
	Dec	3,571	2,737	0%	0.0%	23.4%
Total				**0%**	0.9%	**31.6%**
2011	Jan	3,524	3,195	0%	0.0%	9.3%
	Feb	3,888	3,283	0%	0.0%	15.6%
	Mar	3,452	2,239	0%	0.0%	35.1%
	Apr	3,102	2,461	0%	2.2%	20.6%
	May	2,804	2,265	0%	2.3%	19.2%
	Jun	3,701	2,590	0%	1.9%	30.0%
	Jul	3,391	2,435	0%	0.0%	28.2%
	Aug	4,576	2,412	0%	0.0%	47.3%
	Sep	2,318	2,569	0%	2.0%	-10.8%
	Oct	1,994	2,201	0%	2.0%	-10.4%
	Nov	2,724	1,913	0%	0.0%	29.8%
	Dec					
Total				**0%**	1.0%	**22.3%**
	* includes seasonal line flushing					
		All volumes in thousands of gallons				



Overall, the Town may want to consider implementing a more rigorous system-wide audit program that will test and evaluate the accuracy of its customer meters, and assess unmetered water uses during peak water use.

The Town of Fowler has some known unmetered water use associated with seasonal line flushing, which typically constitute between 1 and 2% of total annual water use; however, based on the water use profile, it appears that there may be other unmetered uses as described in the paragraphs above. The Town does not have any known metered, unbilled water uses. Non-revenue water calculations include unmetered uses as losses.

Needs/Recommendations

The Town of Fowler has not identified any specific improvements that are needed to improve water loss management. However, there are a number of best management practices which may help the Town of Fowler better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Implement program to more aggressively replace customer meters (especially on the largest water use customers) using meters that record in 100 gallon increments for ¾-inch meters.
- Track water use through each meter over time to help prioritize future replacements.
- Test and repair or replace the Town's master meters as needed.
- Develop methodologies to identify and correct data transcription errors.

- Implement more rigorous annual system-wide audits to identify and characterize unmetered water use over time.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

Hasty Water Company

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide the Hasty Water Company with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide the Hasty Water Company with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at your offices on September 22, 2012. The following text and tables summarize the data provided to the District during the audit.

Water Sources	3 groundwater production wells	Chlorinated then to distribution
Master Meter	3 master meters at the wells plus 7 master meters within distribution	Master meters tested every 4 years; 7 new meters in 2006; rest are more than 10 years old
Meter Readings	Monthly (~20th day of the month)	
Billings	Monthly (26th day of the same month)	

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	117	6	6	18	37	50
1-inch	1					1
3-inch (State Park)	1			1		

Replacement of meters has been occurring as needed based on field observations, which is about 6 per year.

Summary of Pipe

Pipe (feet)	1-inch	2-inch	3-inch	Total
PVC		29,040	23,760	52,800
ABS	2,640			2,640

All pipe constructed in late 1980s, except 2.5 miles of 2-inch PVC which is new in 2011.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations based on surface expressions, or master meters on distribution lines.	5 leaks in past 1 year
Leak Repair Costs	Mostly on main lines	$500-$900 per leak depending on size
Pipe Replacement	Nothing currently planned	

Water Loss Calculations

Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010 and 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

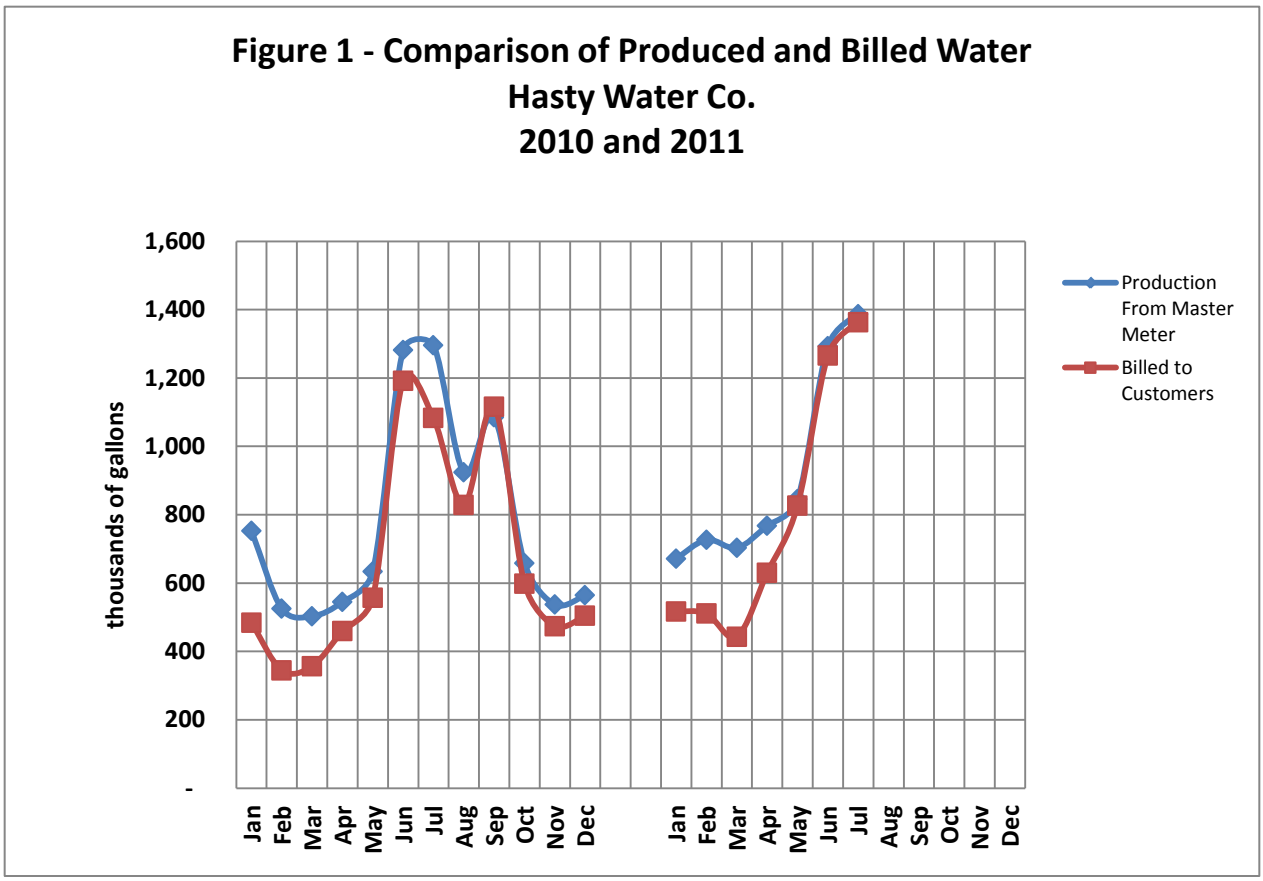
The water loss profile presented in Figure 1 indicates that water losses are largest during non-peak periods perhaps indicative of leaks occurring when system pressure is highest. It may also be that water loss in the Hasty system occurred as a result of a steady leak which is most prevalent during periods of low demand. The 2011 replacement of 2-inch PVC water line may have repaired this real loss as is indicated by the drop of non-revenue water in May. Hasty should also consider replacement of the final ½ mile of ABS pipe in its distribution system, as resources allow. Hasty should continue to monitor non-revenue water monthly to further characterize this trend and verify that other losses are not occurring.

The Hasty Water Company has some unmetered water use associated with seasonal line flushing, and some metered, unbilled water use at the local church and fire department meeting room which

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

Table 1 – Non-Revenue Water Calculation

		Production				
		From Master Meter	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled*	Non-Revenue Water
2010	Jan	753	484	0%	1.0%	35.7%
	Feb	525	345	0%	1.4%	34.3%
	Mar	503	357	0%	1.5%	29.0%
	Apr	545	460	0%	1.4%	15.6%
	May	634	557	0%	1.2%	12.1%
	Jun	1,282	1,192	0%	0.6%	7.0%
	Jul	1,296	1,083	0%	0.6%	16.4%
	Aug	924	829	0%	0.8%	10.3%
	Sep	1,085	1,116	0%	0.7%	-2.9%
	Oct	658	598	0%	1.1%	9.1%
	Nov	537	474	0%	1.4%	11.7%
	Dec	565	505	0%	1.3%	10.6%
Total				**0%**	1.0%	**14.0%**
2011	Jan	671	517	0%	**1.1%**	23.0%
	Feb	727	511	0%	1.0%	29.7%
	Mar	703	443	0%	1.8%	37.0%
	Apr	768	630	0%	1.0%	18.0%
	May	845	827	0%	0.9%	2.1%
	Jun	1,293	1,266	0%	0.6%	2.1%
	Jul	1,387	1,363	0%	0.5%	1.7%
	Aug					
	Sep					
	Oct					
	Nov					
	Dec					
Total				**0%**	0.9%	**13.1%**
	* includes firehouse, hydrant flushing and local church estimated usage					
		All volumes in thousands of gallons				



combined typically constitute about 1% of total annual water use. Non-revenue water calculations include both these losses.

Needs/Recommendations

The Hasty Water Company has not identified any specific improvements that are needed to improve water loss management. However, there is a number of best management practices which may help the Hasty Water Company better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Continue to replace customer meters using meters that record in 100 gallon increments.
- Track water use through each meter over time to help prioritize future replacements.
- Replace ABS pipe as resources allow.
- Develop methodologies to identify and correct data transcription errors.
- Install sub-meters and isolation valving in the pipeline system to improve leak detection and system management during leak repairs and other maintenance activities.
- Continue annual system wide audits to identify and characterize unmetered and metered, unbilled water use over time.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

Hilltop Water Company

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide the Hilltop Water Company with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide the Hilltop Water Company with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at your offices on September 30, 2012. The following text and tables summarize the data provided to the District during the audit.

Water Sources	3 groundwater production wells	Filters and chlorinated then to distribution
Master Meter	3 master meters at the wells	Master meters tested every 3 years; 1 meter is about 5 years old; 2 are about 10 years old.
Meter Readings	Monthly (~25th of the month)	
Billings	Monthly (1st of the month)	

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	118	12	12	36	28	30
1-inch	1				1	

Replacement of meters has been occurring as needed based on field observations totaling 12-24 per year.

Summary of Pipe

Pipe (feet)	1-inch	1.25-inch	1.5-inch	2-inch	2.5-inch	3-inch	4-inch	Total
PVC	3,334	5,675	3,570	21,288	5,020	6,547	2,735	48,169

All pipe is new since the late 1980s, with the 4-inch and 6-inch PVC since 1995.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations based on surface expressions, pressure drops, and customer calls. Soils in the area are subject to shifting which can cause pipe breaks.	5 leaks in past 2 year
Leak Repair Costs		$500 per leak
Pipe Replacement	Nothing currently planned	

Water Loss Calculations

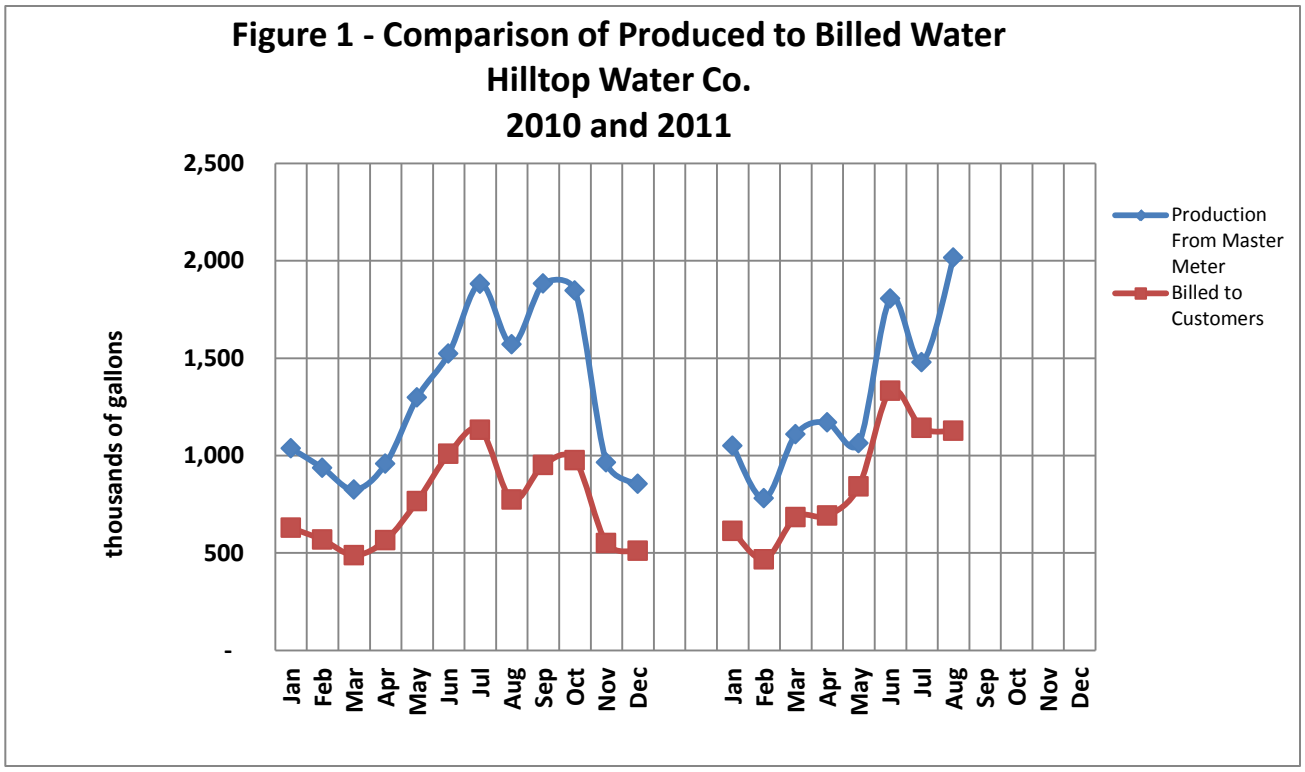
Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010 and 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

The water loss profile presented in Figure 1 indicates that water losses are fairly consistent throughout the year even though no-revenue water was reduced by about 10% between 2010 and 2011. This improvement in water loss may relate to some leak detection and repair that occurred in 2010. However, since the losses are greater than 20% of total water delivered in both years, these losses are likely indicative of systematic meter inaccuracies and data handling issues, as well as other real system losses. It does not appear that the water loss relates to the use of water at the organization's largest customer's meter, since water loss can be as high as 40% or greater during off-peak periods. Therefore, it appears to be a widespread issue, which accumulates into a substantial loss of water sales revenue for the organization. Nonetheless, the largest meter should be tested regularly by Hilltop to ensure its accuracy as should the well master meters. Hilltop should also consider improving its data collection and handling procedures to help reduce month to month variations in water loss. Finally, Hilltop may want to consider installing submeters and isolation valving to help identify system leaks and improve the efficiency of leak repair and water line maintenance.

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

Table 1 – Non-Revenue Water Calculation

		Production				
		From Master Meter	Billed to Customers	Metered/Unbilled		Non-Revenue Water
2010	Jan	1,037	629	0%	3.7%	39.4%
	Feb	937	568	0%	3.7%	39.4%
	Mar	825	489	0%	4.6%	40.7%
	Apr	958	566	0%	3.8%	40.9%
	May	1,298	766	0%	2.9%	41.0%
	Jun	1,524	1,009	0%	2.4%	33.8%
	Jul	1,882	1,133	0%	2.0%	39.8%
	Aug	1,571	774	0%	2.4%	50.7%
	Sep	1,883	952	0%	2.0%	49.4%
	Oct	1,847	977	0%	2.1%	47.1%
	Nov	964	551	0%	3.8%	42.8%
	Dec	854	512	0%	4.4%	40.0%
Total				**0%**	**2.9%**	**42.7%**
2011	Jan	1,050	614	0%	**3.6%**	41.5%
	Feb	780	467	0%	4.4%	40.1%
	Mar	1,109	684	0%	3.4%	38.3%
	Apr	1,170	692	0%	3.1%	40.9%
	May	1,064	842	0%	3.6%	20.9%
	Jun	1,806	1,333	0%	2.0%	26.2%
	Jul	1,479	1,142	0%	2.6%	22.8%
	Aug	2,017	1,128	0%	1.9%	44.1%
	Sep					
	Oct					
	Nov					
	Dec					
Total				**0%**	**2.8%**	**33.3%**
	* includes filter backwash and hydrant flushing					
		All volumes in thousands of gallons				



The Hilltop Water Company has some unmetered water use associated with seasonal line flushing, and filter back wash which is estimated to be about 3% of total annual water use. Non-revenue water calculations include these losses.

Needs/Recommendations

The Hilltop Water Company has not identified any specific improvements that are needed to improve water loss management. However, there is a number of best management practices which may help the Hilltop Water Company better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Continue to replace customer meters (especially on the largest water use customers) using meters that record in 100 gallon increments for ¾-inch taps.
- Track water use through each meter over time to help prioritize future replacements.
- Test master meters and replace or rebuild, as needed.
- Develop methodologies to identify and correct data transcription errors; and collect customer meter readings at the same time as the master meters are read.
- Install sub-meters and isolation valving in the pipeline system to improve leak detection and system management during leak repairs and other maintenance activities.
- Continue annual system wide audits to identify and characterize unmetered and metered, unbilled water use over time.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

Holbrook Center Soft Water Association

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute

On behalf of the

Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide the Holbrook Center Soft Water Association with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide the Holbrook Center Soft Water Association with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at your offices on September 20, 2012. The following text and tables summarize the data provided to the District during the audit.

Water Sources	1 groundwater production wells	Chlorinated then to distribution
Master Meter	1 master meters at the wells	1-inch master meters tested every 2 years; meter is about 5 years old.
Meter Readings	Monthly (last day of the month)	
Billings	When time permits (typically within 1 month of collecting meter data)	

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	27	5	3			20

Replacement of meters has been occurring as needed based on field observations.

Summary of Pipe

Pipe (feet)	2-inch	4-inch	Total
PVC	9,768		9,768
ABS	1,320		1,320
Black-Rolled	6,600		6,600

No records on when pipe installed, but some goes back to original construction in the 1960s. PVC is newer, but install date is not known.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations based on surface expressions, pressure drops, and customer calls, but sandy soil allows leaks to drain without a surface expression.	4 leaks in past 2 year
Leak Repair Costs		$500 per leak
Pipe Replacement	Nothing currently planned	

Water Loss Calculations

Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010 and 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

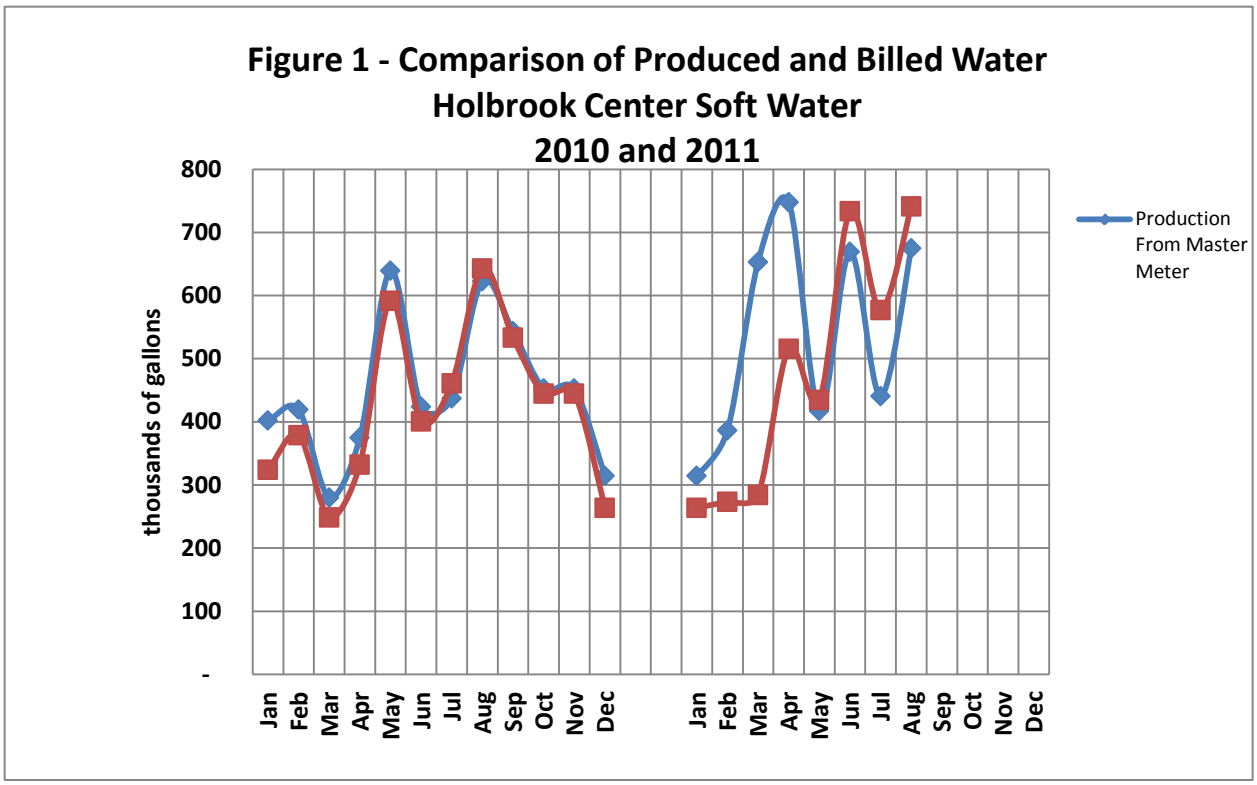
The water loss profile presented in Figure 1 and Table 1indicates that water losses varied by about 20% during 2010, however the amount of non-revenue water became widely erratic in 2011 varying by about 80% between the highest and lowest months. This may be due to a number of factors. For example, the master meter may need to be replaced, for it appears to be reading low (which accounts for appearing to sell more water than is produced. Data transcription errors may also attribute to the wide variation observed, since no leaks were contributing to the large losses that occurred in the early part of 2011. Additional, timely water audits may be helpful to track and identify potential water losses from the system when non-revenue water approaches or exceeds 30% as it did in early 2011.

The Holbrook Center Soft Water Association does not appear to have any unmetered or metered, unbilled water uses.

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

Table 1 – Non-Revenue Water Calculation

		Production				
		From Master Meter	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled	Non-Revenue Water
2010	Jan	402	324	0%	0%	19.4%
	Feb	419	379	0%	0%	9.6%
	Mar	280	249	0%	0%	11.3%
	Apr	375	332	0%	0%	11.4%
	May	640	592	0%	0%	7.4%
	Jun	424	401	0%	0%	5.5%
	Jul	437	461	0%	0%	-5.5%
	Aug	623	643	0%	0%	-3.3%
	Sep	544	534	0%	0%	1.8%
	Oct	453	445	0%	0%	1.8%
	Nov	453	445	0%	0%	1.8%
	Dec	314	264	0%	0%	16.0%
Total				**0%**	**0%**	**5.5%**
2011	Jan	**314**	**264**	0%	0%	16.0%
	Feb	386	273	0%	0%	29.3%
	Mar	653	284	0%	0%	56.5%
	Apr	748	516	0%	0%	31.0%
	May	417	435	0%	0%	-4.2%
	Jun	669	733	0%	0%	-9.6%
	Jul	441	577	0%	0%	-31.0%
	Aug	675	741			
	Sep					
	Oct					
	Nov					
	Dec					
Total				**0%**	**0%**	**11.2%**
		All volumes in thousands of gallons				



Needs/Recommendations

The Holbrook Center Soft Water Association has not identified any specific improvements that are needed to improve water loss management. However, there is a number of best management practices which may help the Holbrook Center Soft Water Association better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Continue to replace customer meters suing meters that record in 100 gallon increments.
- Track water use through each meter over time to help prioritize future replacements.
- Test and replace or rebuild master meter, as needed.
- Develop methodologies to identify and correct data transcription errors.
- Replace ABS pipe as resources allow.
- Install sub-meters and isolation valving in the pipeline system to improve leak detection and system management during leak repairs and other maintenance activities.
- Continue annual system wide audits to identify and characterize unmetered and metered, unbilled water use over time.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

Homestead Improvement Association

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide the Homestead Improvement Association with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide the Homestead Improvement Association with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at your offices on September 21, 2012. The following text and tables summarize the data provided to the District during the audit.

Water Sources	City of La Junta	Filters and chlorinated then to distribution
Master Meter	1 master meters at City connection	Master meters tested every 3 years; new in 2007
Meter Readings	Monthly (end of the month)	
Billings	Monthly (1st of the month)	

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	27	2	1	8	8	8

Replacement of meters has been occurring as needed based or when meters have recorded 2-million gallons of water deliveries.

Summary of Pipe

Pipe (feet)	2-inch	4-inch	6-inch	Total
PVC	3,960	1,600	5,300	10,860

All pipe was installed in 2007, with some 2-inch pre-dating 2007.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations based on surface expressions, comparison of master meter to customer use.	No leaks in past 3 year
Leak Repair Costs		$500 per leak
Pipe Replacement	Nothing currently planned	

Water Loss Calculations

Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

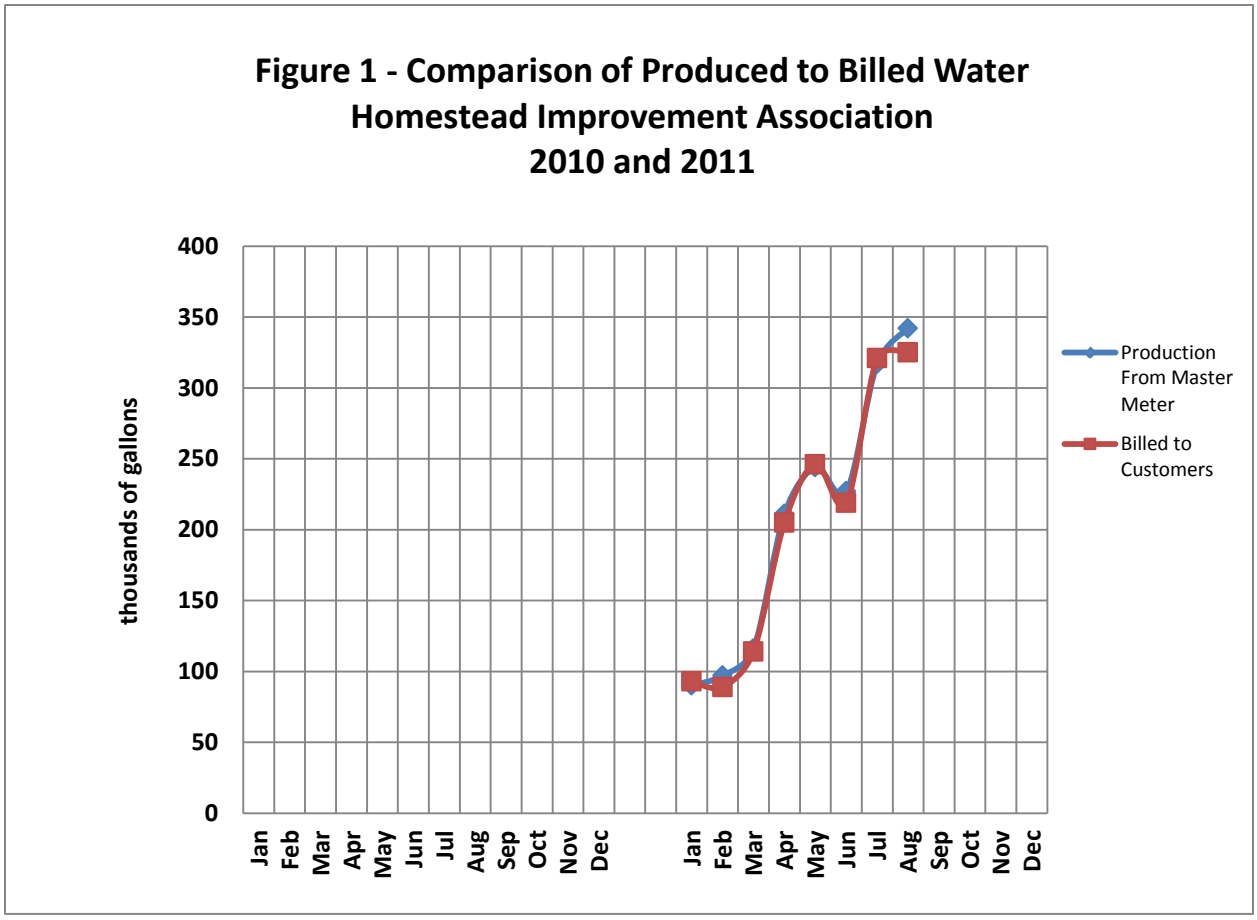
The water loss profile presented in Figure 1 indicates that water losses are fairly small and consistent throughout the year, however the shifting of measured non-revenue from positive to negative is indicative of collecting readings from the master meter on a different day and time from when the customer meters are read. It may also be associated with customer meters reading only to the closest 1,000 gallons, which for a small system can create the observed fluctuations. This issue generally balances itself out over a period of months; however, since Homestead uses these data to identify leaks, it may be worth considering replacing customer meters with new meters that record in 100 gallon increments.

The Homestead Improvement Association does not have any known unmetered or metered, unbilled water use.

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

Table 1 – Non-Revenue Water Calculations

		Production				
		From Master Meter	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled	Non-Revenue Water
2010	Jan					
	Feb					
	Mar					
	Apr					
	May					
	Jun					
	Jul					
	Aug					
	Sep					
	Oct					
	Nov					
	Dec					
Total						
2011	Jan	90	93	0%	0%	-3.3%
	Feb	97	89	0%	0%	8.2%
	Mar	116	114	0%	0%	1.7%
	Apr	211	205	0%	0%	2.8%
	May	244	246	0%	0%	-0.8%
	Jun	227	219	0%	0%	3.5%
	Jul	317	321	0%	0%	-1.3%
	Aug	342	325	0%	0%	5.0%
	Sep					
	Oct					
	Nov					
	Dec					
Total				**0%**	**0%**	**1.9%**
		All volumes in thousands of gallons				



Needs/Recommendations

The Homestead Improvement Association has not identified any specific improvements that are needed to improve water loss management. However, there is a number of best management practices which may help the Homestead Improvement Association better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Continue to replace customer meters using meters that record in 100 gallon increments
- Track water use through each meter over time to help prioritize future replacements.
- Continue annual system wide audits to identify and characterize unmetered and metered, unbilled water use over time.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

The City of La Junta

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide La Junta with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide La Junta with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: City Parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at your offices on August 31, 2011. The following text and tables summarize the data provided to the District during the audit.

Water Sources	15 groundwater production wells including one for industrial use only	Reverse osmosis (RO) and chlorination then to distribution (with RO reject about 30% of total groundwater production on an annual basis)
Master Meter	Various master meters on well and at RO plant. Use of RO plant influent and effluent used to estimate RO reject and non-revenue water	Master meters are tested regularly for accuracy
Meter Readings	Monthly (middle of the month)	Hardcopy records translated to billing software
Billings	Monthly (first part of the month)	

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	2907	20	20	60	60	2747
1-inch	189				53	136
1.5-inch	47					47
2-inch	53					53
3-inch	6					6
4-inch	11					11

The City replaces meters if they are broken or fail their testing. The City is planning on initiating a automated meter reading program, installing touch pad reading devices on about 200 meters, but at the time of the audit, the City only had manual read meters. The City replaces about 15-20 meters a year based on its field testing and verification program.

Summary of Pipe

Pipe (feet)	2-inch	3-inch	4-inch	8-inch	Total
PVC					
Concrete					

Pipe inventory by diameter and age is not available; however, most pipe was installed in the late 1960s, and of about 60 miles of pipe, only about 5 miles is 45 year old or older. About ½ of the system is less than 30 years old, and some is less than 10 years old.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations based on surface expressions, billing system program find irregularities, and on customer calls	10 leaks in the last 1 year with 6 on service lines and 4 on water mains. Averages about 12 per year, but was more than 60 per year before RO (since water was corrosive)
Leak Repair Costs		City budgets about $5,000 per year.
Pipe Replacement	CIP includes some water line replacement projects.	

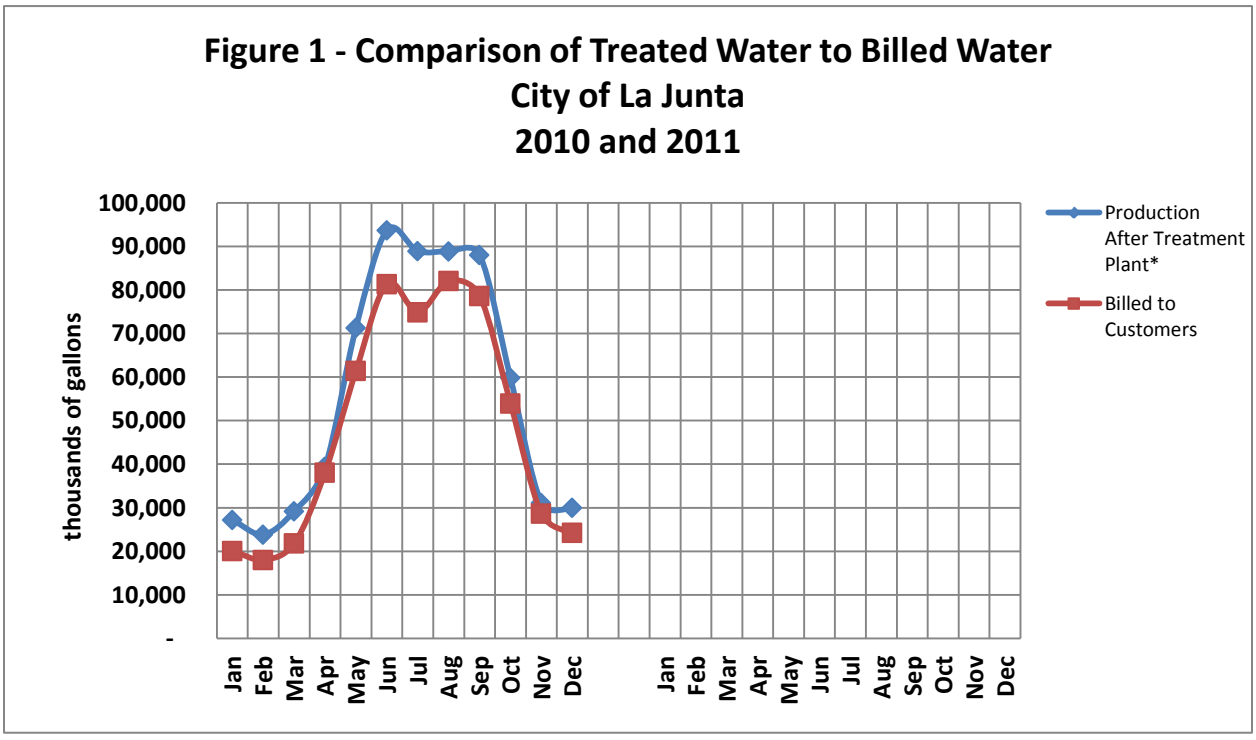
Water Loss Calculations

Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

[1] Non-revenue water is the difference between water produced by the treatment plant (excluding Ro reject) and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is

The data presented in Table 1 indicates that non-revenue water varies between about 8 and 26%, with the largest losses occurring in the wintertime, when system pressure is most likely highest (i.e., during off peak demand)[2]. Therefore, water loss in the La Junta system may be accentuated by increased system pressure or may be the result of ongoing, undetected leaks that constitute a greater percentage of total water deliveries in the winter time when demand is lower than summertime. It is also possible that some water loss relates to inaccurate customer meters (given that over 90% of the City's customer meters are over 10-years old), and data handling procedures (i.e., hard copy meter reading records translated to billings). Overall, non-revenue water, measured by comparing RO plant effluent with water sales, averages about 10% annually over the period 2006-2010. In 2010, water loss was about 3% higher than average, which could relate to either real and/or apparent losses.

The City has some unmetered uses, but has not been able to quantify these completely. The unmetered uses, which have been estimated for purposes of this analysis, include annual line flushing, firefighting and street cleaning. The City also has a small amount of metered, unbilled water use associated with the State and County construction uses, which are measured but not billed. Estimated unmetered water losses are listed in Table 1. Currently metered, unbilled water use is considered to be less than 0.5% of total water deliveries. Non-revenue water includes estimated unmetered and metered, unbilled uses.



comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

[2] Note that if a leak exists continually over a long period of time undetected, it will appear greater in the winter time as compared to the summer time, when measured as a percentage of total water deliveries. In addition, some systems may experience a greater number of leaks when system pressures increase during periods of low water demand.

Table 1 – Non-Revenue Water Calculation

		Production				
		After Treatment Plant*	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled**	Non-Revenue Water
2010	Jan	27,232	20,058	0%	0.3%	26.3%
	Feb	23,856	18,064	0%	0.3%	24.3%
	Mar	29,179	21,845	0%	0.3%	25.1%
	Apr	39,403	38,102	0%	0.2%	3.3%
	May	71,318	61,425	0%	0.1%	13.9%
	Jun	93,671	81,380	0%	0.1%	13.1%
	Jul	88,908	74,900	0%	0.1%	15.8%
	Aug	88,861	82,067	0%	0.1%	7.6%
	Sep	88,063	78,664	0%	0.1%	10.7%
	Oct	59,804	53,965	0%	0.1%	9.8%
	Nov	31,131	28,652	0%	0.2%	8.0%
	Dec	30,018	24,257	0%	0.2%	19.2%
Total				**0%**	**0.1%**	**13.1%**
2011	Jan					
	Feb					
	Mar					
	Apr					
	May					
	Jun					
	Jul					
	Aug					
	Sep					
	Oct					
	Nov					
	Dec					
Total						
	* measured after RO reject removed from treated water volume (i.e., RO reject losses not included in non-revenue water estimate)					
	** includes firefighting, hydrant flushing, street cleaning and sewer collection cleaning					
		All volumes in thousands of gallons				

Needs/Recommendations

The La Junta identified the need for improved metering and data collection to help reduce non-revenue water. The City also has some water line replacement projects in its future capital improvement budgets to address selected distribution system issues. In addition, there are some best management practices which may help the City to better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Continue to replace customer meters, as needed using meters that record in 100 gallon increments for ¾-inch taps.
- Utilize AMR technology whenever possible.
- Improve data handling and recording of customer water use.
- Track water use through each meter over time to help prioritize future replacements.
- Continue to replace inefficient, aging water distribution lines.
- Continue annual system wide audits to identify and characterize unmetered and metered, unbilled water use over time, and estimate real and apparent losses.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

The City of Lamar

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide Lamar with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide Lamar with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: City Parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at your offices on September 29, 2011. The following text and tables summarize the data provided to the District during the audit.

Water Sources	28 groundwater production wells	Chlorination and fluoride addition then to distribution
Master Meter	1 master meter prior to treatment plant	12-inch master meter tested regularly for accuracy; Meter replaced in 2010
Meter Readings	Monthly (First half of the month)	Combination of AMR and manual read meters
Billings	Monthly (1st of the month)	Month plus delay (Jan bill is Nov use)

AMR – automated meter reading devices

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	3025	400	400	1169	200	856
1-inch	267	35	35	80	25	92
1.5-inch	31	4	4	10	2	11
2-inch	96	12	12	30	6	36
3-inch	15	2	2	5	1	5

The City has implemented a meter replacement program installing radio read devices with new meteres starting 5 years ago. Program expected to be complete in 8 to 9 years.

Summary of Pipe

Pipe (feet)	Total
PVC/ductile iron	26,400
Concrete/AC	52,800
Cast Iron/Steel	158,400

Pipe inventory by diameter and age is not available; however, some cast iron and steel pipe was replaced in the 1970s with asbestos concrete (AC) pipe. Some new ductile iron and PVC pipe has been installed. Very little expansion of the City's service has occurred in the last 20 years.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations based on surface expressions, billing system program find irregularities, and on customer calls	30 plus leaks in the last 1 year with 15-20 on service lines and about 15 on water mains.
Leak Repair Costs		City budgets about $80,000 per year including detection and repair.
Pipe Replacement	CIP includes a number of water line replacement projects.	

Water Loss Calculations

Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010 and 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

The data presented in Table 1 indicates that non-revenue water in 2011 varies significantly month to month, which may be indicative of a lack of coordination between master meter readings and customer water use reading that occur when customer meters are read over a long period of time, and compared

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

to instantaneous master meter readings. These inaccuracies will be reduced when the City completes its installation of radio read meters in the next 3 to 4 years. It is also possible that some water loss relates to inaccurate customer meters (given the age of the meters with about 1,000 meters being 10-years or older), and data handling procedures (i.e., hard copy meter reading records translated to billings for those older meters). Finally, non-revenue water may also be influenced by the age of the pipe in the City's distribution system. Given that water loss has more than doubled over the last year, it is likely that all of these factors influence City non-revenue water.

In addition, the City has some unmetered uses, but has not been able to quantify these completely. The unmetered uses, which have been estimated for purposes of this analysis, include annual line flushing, firefighting, various City uses (e.g., City shop, water treatment plant (WTP) uses), and street cleaning. It may be that unmetered uses in April and May 2011 explain the large losses observed in those months; however, there is not adequate information to determine the true impact of unmetered water use on total non-revenue water during that time. The City also has a small amount of metered, unbilled water use associated with the wastewater treatment plant (WWTP) and the Walker Ranches (approximately 635,000 gallons annually), which are measured but not billed. Estimated unmetered water losses are listed in Table 1. Currently metered, unbilled water use is considered to be less than 0.5% of total water deliveries. Non-revenue water includes estimated unmetered and metered, unbilled uses.

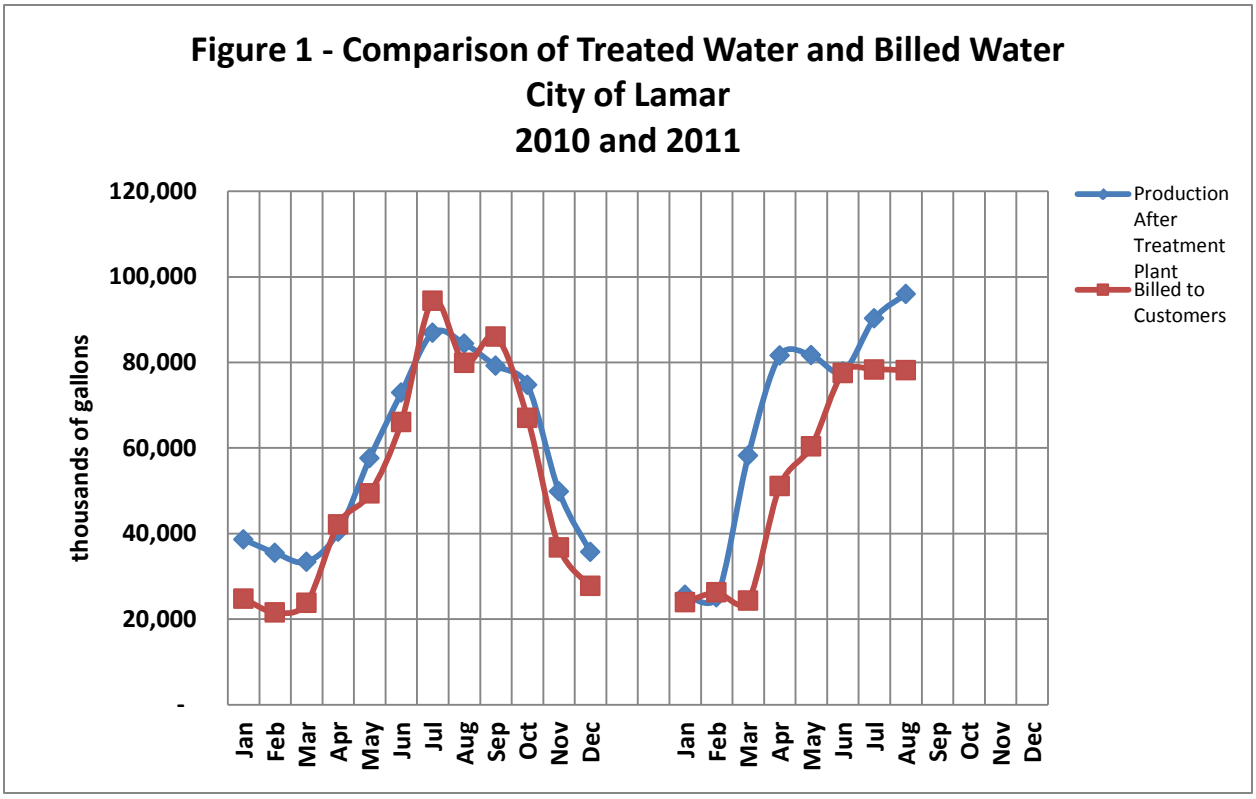


Table 1 – Non-Revenue Water Calculations

		Production				
		After Treatment Plant	Billed to Customers	Metered/Unbilled*	Unmetered/Unbilled**	Non-Revenue Water
2010	Jan	38,600	24,745	0.14%	1.0%	35.9%
	Feb	35,500	21,586	0.16%	1.2%	39.2%
	Mar	33,400	23,816	0.17%	1.1%	28.7%
	Apr	40,400	42,158	0.14%	0.6%	-4.4%
	May	57,600	49,376	0.10%	0.5%	14.3%
	Jun	72,900	66,043	0.08%	0.4%	9.4%
	Jul	86,900	94,415	0.06%	0.3%	-8.6%
	Aug	84,400	79,913	0.07%	0.3%	5.3%
	Sep	79,200	86,041	0.07%	0.3%	-8.6%
	Oct	74,700	67,030	0.07%	0.4%	10.3%
	Nov	49,800	36,769	0.11%	0.7%	26.2%
	Dec	35,700	27,764	0.16%	0.9%	22.2%
Total				0.10%	**0.5%**	**10.1%**
2011	Jan	**25,700**	**23,932**	0.20%	**1.2%**	6.9%
	Feb	25,100	26,237	0.21%	1.3%	-4.5%
	Mar	58,220	24,324	0.09%	0.5%	58.2%
	Apr	81,620	51,102	0.06%	0.4%	37.4%
	May	81,652	60,387	0.06%	0.4%	26.0%
	Jun	77,871	77,496	0.07%	0.4%	0.5%
	Jul	90,261	78,332	0.06%	0.4%	13.2%
	Aug	95,936	78,169	0.05%	0.3%	18.5%
	Sep					
	Oct					
	Nov					
	Dec					
Total				0.08%	**0.5%**	**22.4%**
	* includes metered water to Walker Ranch and wastewater treatment plant (WWTP)					
	** includes firefighting, other city uses, hydrant flushing, street cleaning, WTP uses, and sewer collection cleaning					
		All volumes in thousands of gallons				

Needs/Recommendations

Lamar identified the need for improved metering and data collection to help reduce non-revenue water. The City also has some water line replacement projects in its future capital improvement budgets to address selected distribution system issues. There are also some best management practices which may help the City to better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Continue to replace customer meters, as needed – using meters that record in 100 gallon increments for ¾-inch taps.
- Utilize AMR technology whenever possible.
- Improve data handling and recording of customer water use.
- Track water use through each meter over time to help prioritize future replacements.
- Continue to replace inefficient, aging water distribution lines.
- Continue annual system wide audits to identify and characterize unmetered and metered, unbilled water use over time, and estimate real and apparent losses.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

The City of Las Animas

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide Las Animas with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide Las Animas with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: City Parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at your offices on August 30, 2011. The following text and tables summarize the data provided to the District during the audit.

Water Sources	9 groundwater production wells	Reverse osmosis (RO) treatment with chlorination then to distribution
Master Meter	1 master meter including WTP flows (to distribution including reject)	3-inch master meter tested regularly for accuracy; Meter is more than 10-years old
Meter Readings	Monthly	
Billings	Monthly	One month delay on billings

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	1090	25	25	400	250	390
1-inch	54					54
1.5-inch	4					4
2-inch	17					17
4-inch	1					1
6-inch	1		1			

The City has implemented a meter replacement program installing about 25 radio-read devices per year with new meters starting 2 years ago. Prior to this effort, the City installed about 25 3/4-inch meters per year.

Summary of Pipe

Pipe (feet)	Total
PVC	105,600
Cast Iron/Steel	26,400

Pipe inventory by diameter and age is not available; however, all cast iron and steel pipe was replaced in the downtown area in 2009 with PVC pipe (4-inch, 6-inch and 8-inch diameter). Meters replaced for some customers during this same project.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations based on surface expressions, changes in tank storage, and on customer calls	10-15 plus leaks in the last 1 year with all on water mains.
Leak Repair Costs		City budgets about $100,000 per year including detection and repair. (plus another $50,000 for street repairs)
Pipe Replacement	Capital improvement projects (CIP) includes a number of water line replacement projects.	

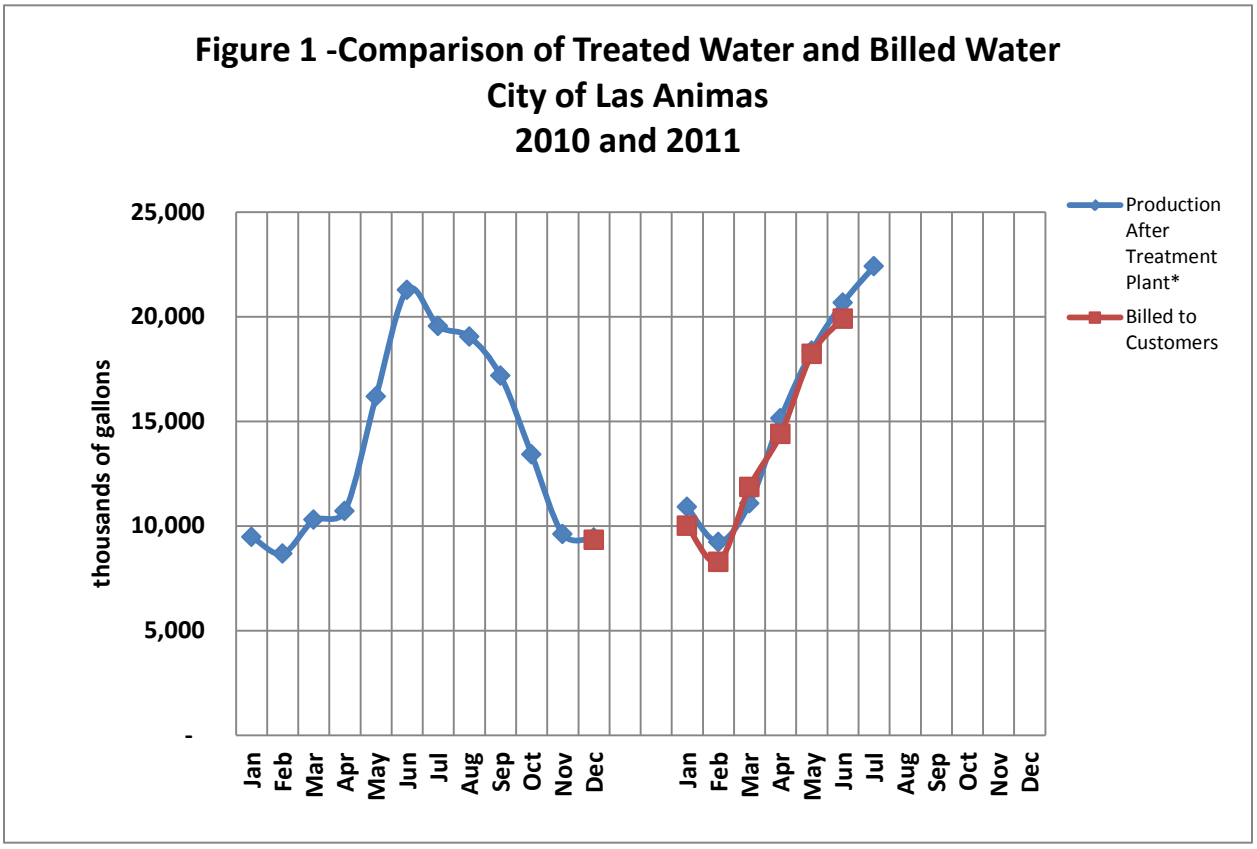
Water Loss Calculations

Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010 and 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

[1] Non-revenue water is the difference between water produced by the treatment plant excluding RO reject and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

The data presented in Table 1 indicates that non-revenue water in 2011 varies from month to month, which may be indicative of a lack of balance between master meter readings and customer water use readings that occur when customer meters are read over a long period of time, versus instantaneous customer meter readings. These inaccuracies are buffered when the data are averaged over a number of months. It also appears that water loss is seasonal (assuming that the low February water loss is averaged over February and March), and that the largest water losses occur in Spring, which may relate to unmetered uses that contribute to overall water loss (e.g., system flushing). It is also possible that some water loss relates to inaccurate customer meters (given the age of the larger meters that are 10-years or older), and data handling procedures (i.e., hard copy meter reading records translated to billings for those older meters). Finally, non-revenue water may also be influenced by the age of the pipe in the City's distribution system[2].

The City has some unmetered uses, but has not been able to quantify these completely. The unmetered uses, which have been estimated to be about 1% of total water deliveries for purposes of this analysis, include annual line flushing, firefighting, and street cleaning. The City also has some metered, unbilled water use associated with various City parks and the City shop. Estimated unmetered water losses are listed in Table 1. Currently metered, unbilled water use is considered to be about 0.6% of total water deliveries. Non-revenue water includes estimated unmetered and metered, unbilled uses.



[2] Although some water lines have been replaced over the past few years, older sections of pipe still exist.

Table 1 – Non-Revenue Water Calculations

		Production				
		After Treatment Plant*	Billed to Customers	Metered/Unbilled**	Unmetered/Unbilled***	Non-Revenue Water
2010	Jan	9,470		0%	1.0%	
	Feb	8,678		0%	1.0%	
	Mar	10,289		0%	1.0%	
	Apr	10,712		0%	1.0%	
	May	16,185		1.2%	1.0%	
	Jun	21,280		0.9%	1.0%	
	Jul	19,549		1.0%	1.0%	
	Aug	19,040		1.1%	1.0%	
	Sep	17,168		1.2%	1.0%	
	Oct	13,410		0%	1.0%	
	Nov	9,610		0%	1.0%	
	Dec	9,442		0%	1.0%	
Total				0.6%	**1.0%**	
2011	Jan	10,900	9,323	0%	1.0%	14.5%
	Feb	9,226	10,010	0%	1.0%	-8.5%
	Mar	11,079	8,272	0%	1.0%	25.3%
	Apr	15,144	11,857	0%	1.0%	21.7%
	May	18,365	14,393	1.1%	1.0%	21.6%
	Jun	20,663	18,213	1.0%	1.0%	11.9%
	Jul	22,400	19,898	0.9%	1.0%	11.2%
	Aug					
	Sep					
	Oct					
	Nov					
	Dec					
Total				0.6%	**1.0%**	**14.7%**
	* measured after RO reject removed from treated water volume (i.e., RO reject losses not included in non-revenue water estimate)					
	** includes water use at City parks and City shop					
	*** includes firefighting, hydrant flushing, street cleaning and sewer collection cleaning					
		All volumes in thousands of gallons				

Needs/Recommendations

Las Animas identified the need for improved metering and data collection to help reduce non-revenue water. The City also has some water line replacement projects in its future capital improvement budgets to address selected distribution system issues. In addition, there are some best management practices which may help the City to better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Continue to replace customer meters, as needed. Utilize AMR technology whenever possible. Use meters that record in 100 gallon increments for ¾ inch taps.
- Track water use through each meter over time to help prioritize future replacements.
- Improve data handling and recording of customer water use to allow for month to month assessment of water losses.
- Continue water line replacement projects to reduce losses from leaks.
- Continue annual system wide audits to identify and characterize unmetered and metered, unbilled water use over time, and estimate real and apparent losses.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

May Valley Water Association

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide the May Valley Water Association with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide the May Valley Water Association with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at your offices on September 29, 2012. The following text and tables summarize the data provided to the District during the audit.

Water Sources	9 groundwater production wells	Iron removal and chlorinated then to distribution
Master Meter	9 master meters at the wells	Master meters tested every 3 years; meters are about 30 years old.
Meter Readings	Monthly (1/4 read each week over the month)	
Billings	Monthly (end of each month)	

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	568	5	5	17	51	490
1-inch	8					8
1.5-inch	5	3				2

Replacement of meters has been occurring as needed based on field observations.

Summary of Pipe

Pipe (feet)	1-inch	1.25-inch	1.5-inch	2-inch	2.5-inch	3-inch	3.5-inch	4-inch	6-inch	Total
PVC	52,536	63,096	143,246	229,046	105,600	156,288	23,760	122,496	1,056	897,125

All pipe is from the 1960s except for approximately 25 miles of extensions.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations based on surface expressions, pressure drops, and customer calls, and from daily metering reading in the field.	18 leaks in past 1 year
Leak Repair Costs	3-inch line is biggest challenge	$7,054 for 18 leaks (~$390 per leak)
Pipe Replacement	Nothing currently planned	

Water Loss Calculations

Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010 and 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

The water loss profile presented in Figure 1 indicates a fairly consistent water loss pattern (except in August 2011), which is indicative of consistent meter reading practices. Water loss is slightly larger during low demand periods (winter time), which may indicate that some amount of non-revenue water is related to higher system pressures; however the fluctuations related to seasonal changes is slight (10 – 15%)[2]. Overall, water loss likely relates to both apparent losses (related to inaccurate meters) and real losses (given the very large amount of distribution pipe in the ground (i.e., nearly 170 miles).

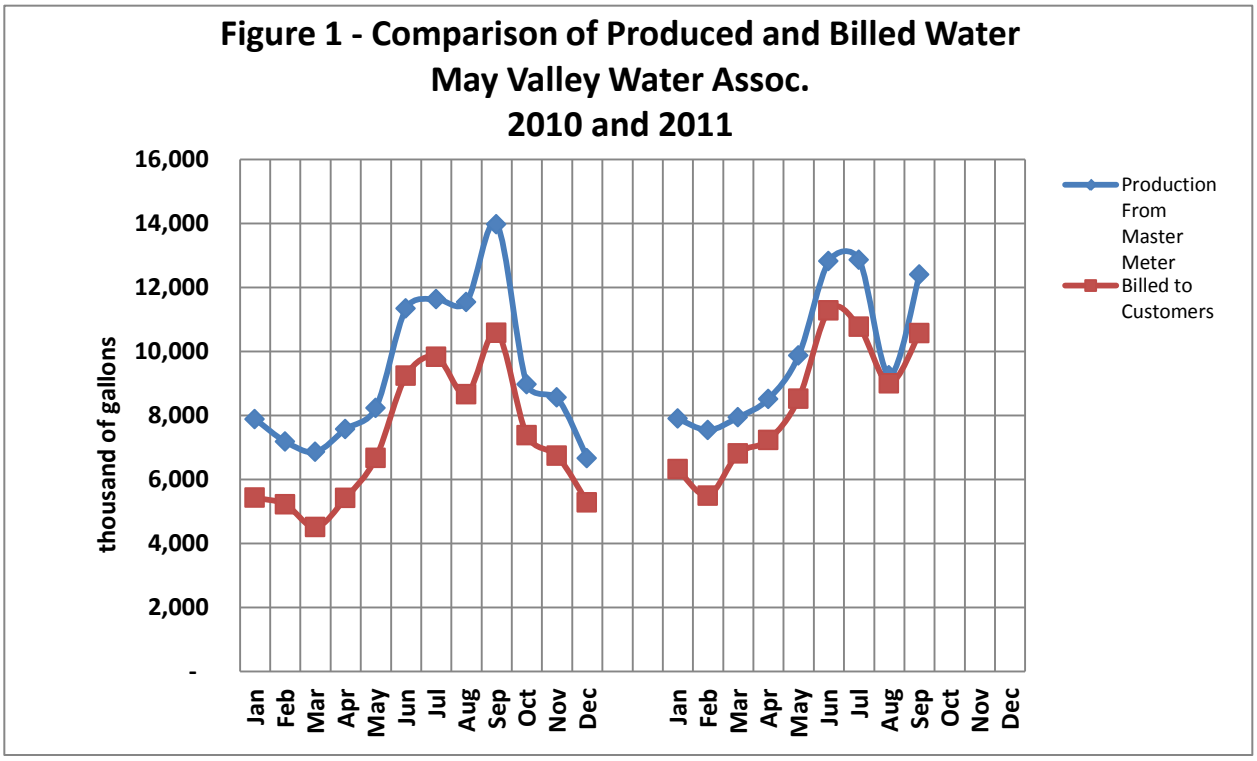
Given the age of its master meters and customer meters, May Valley may want to consider a meter testing and replacement program that is more aggressive than its current program.

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

[2] Note that if a leak exists continually over a long period of time undetected, it will appear greater in the winter time as compared to the summer time, when measured as a percentage of total water deliveries. In addition, some systems may experience a greater number of leaks when system pressures increase during periods of low water demand.

Table 1 – Non-Revenue Water Calculation

		Production				
		From Master Meter	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled*	Non-Revenue Water
2010	Jan	7,888	5,433	0%	3.9%	31.1%
	Feb	7,187	5,222	0%	3.9%	27.3%
	Mar	6,863	4,511	0%	3.9%	34.3%
	Apr	7,578	5,422	0%	4.1%	28.5%
	May	8,240	6,674	0%	4.1%	19.0%
	Jun	11,347	9,244	0%	4.0%	18.5%
	Jul	11,636	9,836	0%	3.9%	15.5%
	Aug	11,547	8,663	0%	3.9%	25.0%
	Sep	13,981	10,590	0%	3.9%	24.3%
	Oct	8,981	7,383	0%	3.9%	17.8%
	Nov	8,562	6,743	0%	3.9%	21.2%
	Dec	6,669	5,284	0%	3.9%	20.8%
Total				**0%**	**4.0%**	**23.1%**
2011	Jan	7,901	6,328	0%	3.9%	19.9%
	Feb	7,546	5,498	0%	3.9%	27.1%
	Mar	7,944	6,816	0%	3.9%	14.2%
	Apr	8,518	7,234	0%	4.1%	15.1%
	May	9,878	8,531	0%	4.0%	13.6%
	Jun	12,823	11,289	0%	4.0%	12.0%
	Jul	12,872	10,772	0%	4.2%	16.3%
	Aug	9,255	9,009	0%	4.0%	2.7%
	Sep	12,403	10,578	0%	3.9%	14.7%
	Oct					
	Nov					
	Dec					
Total				**0%**	**4.0%**	**14.7%**
	* includes filter backwash and hydrant flushing (museum usage over 4,000 gal per month not included)					
		All volumes in thousands of gallons				



The May Valley Water Association does have some unmetered water use, related to line flushing and filter backwash activities. These losses have been estimated in Table 1. May Valley also has some metered, unbilled water uses related to flushing when power outages occur. These losses are expected to be less than 0.5% of total water deliveries. Both unmetered and metered, unbilled losses are included in the estimate of non-revenue water.

Needs/Recommendations

The May Valley Water Association has not identified any specific improvements that are needed to improve water loss management. However, there are some best management practices which may help the May Valley Water Association better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Initiate more aggressive replacement of customer meters and use meters that record in 100 gallon increments
- Track water use through each meter over time to help prioritize future replacements.
- Install and/or test new master meters
- Install sub-meters and isolation valving in the pipeline system to improve leak detection and system management during leak repairs and other maintenance activities.
- Continue annual system wide audits to identify and characterize unmetered and metered, unbilled water use over time.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

McClave Water Association

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide the McClave Water Association with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide the McClave Water Association with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at your offices on September 29, 2012. The following text and tables summarize the data provided to the District during the audit.

Water Sources	4 groundwater production wells	Chlorinated then to distribution
Master Meter	4 master meters at the wells	1.5-inch and 2-inch (two each) master meters tested every 4 years; meters new, one each in 2002, 2004, 2005 and 2006
Meter Readings	Monthly (~20th of the month)	
Billings	Monthly (before the end of each month)	

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	165	6	6	18	10	125
1-inch	2				2	

Replacement of meters has been occurring as needed based on field observations.

Summary of Pipe

Pipe (feet)	1-inch	1.25-inch	1.5-inch	2-inch	2.5-inch	3-inch	3.5-inch	4-inch	6-inch	Total
PVC	52,536	63,096	143,246	229,046	105,600	156,288	23,760	122,496	1,056	897,125

All pipe is from the 1960s except for a few (approximately 25 miles) of extensions.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations based on surface expressions, pressure drops, and customer calls; but some leaks difficult to locate	5 leaks in past 1 year
Leak Repair Costs		$600-900 per leak
Pipe Replacement	Nothing currently planned	

Water Loss Calculations

Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010 and 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

The water loss profile presented in Figure 1 indicates a fairly consistent water loss pattern (except in early 2010, and June 2011). Overall, water loss which is decreasing over time, likely relates to both apparent losses (related to inaccurate meters) and real losses. The real losses associated with past leak detection and repair appears to be decreasing. To support its leak detection and repair practices, McClave may want to consider installing sub-meters to improve leak detection; and isolation valving within the distribution system to improve the efficiency of leak repair and system maintenance.

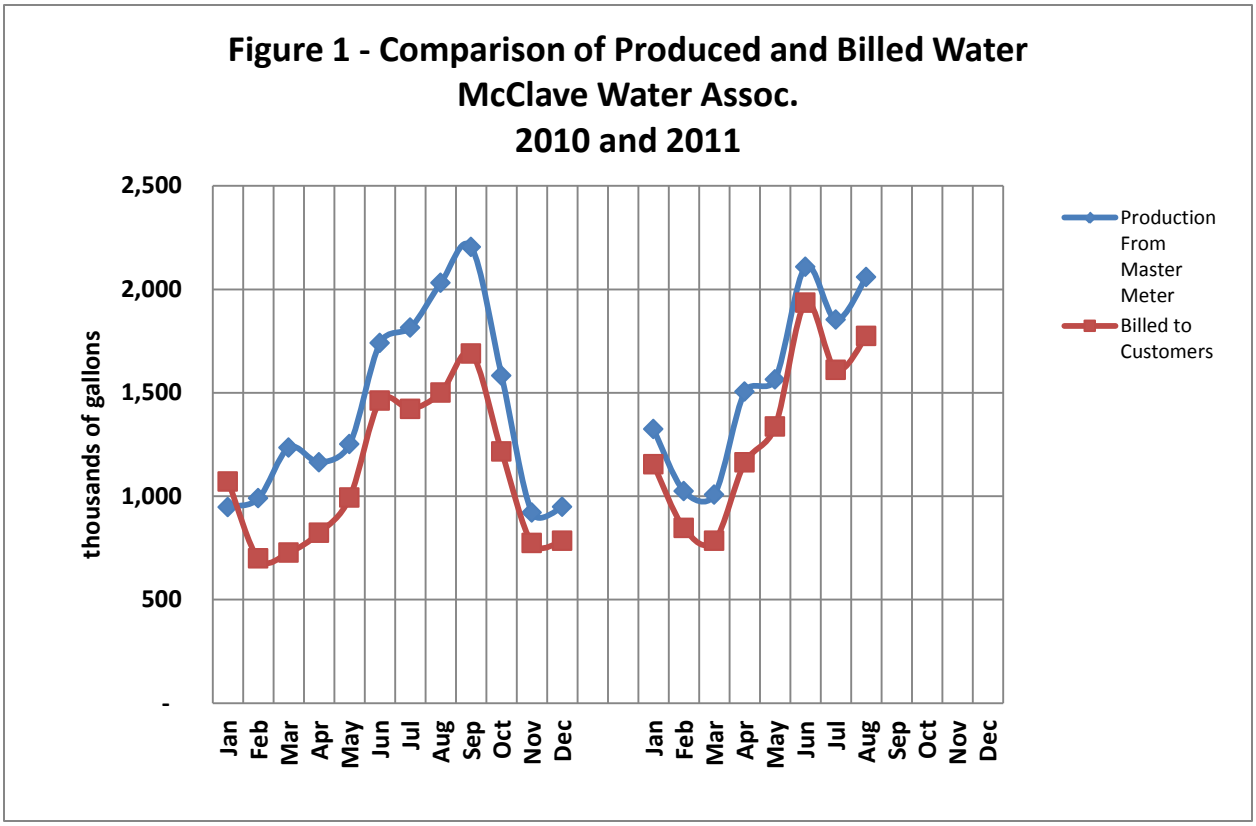
The apparent losses observed by McClave may relate to aging customer water meters, which tend to under measure water use over time. McClave may choose to test and/or install new customer meters to reduce apparent losses associated with old, under-performing meters.

The McClave Water Association does have some unmetered water use, related to line flushing and firefighting; however these uses are small and inconsistent. McClave also has some small amount of metered, unbilled water use related to the Town Park irrigation and athletic field (which may explain the uptick in non-revenue water in the spring and summer of 2010 and spring of 2011. These combined

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

Table 1 – Non-Revenue Water Calculation

		Production				
		From Master Meter	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled	Non-Revenue Water
2010	Jan	947	1,071	0%	0%	-13.1%
	Feb	990	699	0%	0%	29.4%
	Mar	1,235	728	0%	0%	41.1%
	Apr	1,164	823	0%	0%	29.3%
	May	1,251	993	0%	0%	20.6%
	Jun	1,741	1,462	0%	0%	16.0%
	Jul	1,814	1,422	0%	0%	21.6%
	Aug	2,031	1,501	0%	0%	26.1%
	Sep	2,204	1,690	0%	0%	23.3%
	Oct	1,583	1,216	0%	0%	23.2%
	Nov	920	773	0%	0%	16.0%
	Dec	948	785	0%	0%	17.2%
Total				**0%**	**0%**	**21.8%**
2011	Jan	1,324	1,154	0%	0%	12.8%
	Feb	1,024	846	0%	0%	17.4%
	Mar	1,007	784	0%	0%	22.1%
	Apr	1,505	1,163	0%	0%	22.7%
	May	1,564	1,336	0%	0%	14.6%
	Jun	2,109	1,935	0%	0%	8.3%
	Jul	1,853	1,610	0%	0%	13.1%
	Aug	2,059	1,774	0%	0%	13.8%
	Sep					
	Oct					
	Nov					
	Dec					
Total				**0%**	**0%**	**14.8%**
		All volumes in thousands of gallons				



losses are expected to be less than 0.5% of total water deliveries. Both unmetered and metered, unbilled losses are included in the estimate of non-revenue water.

Needs/Recommendations

The McClave Water Association has not identified any specific improvements that are needed to improve water loss management. However, there is a number of best management practices which may help the McClave Water Association better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Increase the rate of replacing customer meters and use meters that record in 100 gallon increments.
- Track water use through each meter over time to help prioritize future replacements.
- Install sub-meters and isolation valving in the pipeline system to improve leak detection and system management during leak repairs and other maintenance activities.
- Continue annual system wide audits to identify and characterize unmetered and metered, unbilled water use over time.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

Newdale-Grand Valley Water Company

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide the Newdale-Grand Valley Water Company with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide the Newdale-Grand Valley Water Company with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at your offices on September 30, 2012. The following text and tables summarize the data provided to the District during the audit.

Water Sources	4 groundwater production wells	Filtration and chlorinated then to distribution
Master Meter	4 master meters at the wells; and 1 master meter before storage and treatment	2-inch master meter tested every 3 years; meters new in 2005 (well meters new in 2004 (3) and 2007 (1))
Meter Readings	Monthly (~25th of the month)	
Billings	Monthly (26th of each month)	

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	191	12	12	36	61	70
1-inch	2				2	

Replacement of meters has been occurring as needed based on field observations. Installations have been including new yoke and backflow preventers.

Summary of Pipe

Pipe (feet)	1.5-inch	2-inch	2.5-inch	3.5-inch	4-inch	6-inch	Total
PVC	31,900	12,480	6,000	21,000	15,600	18,000	104,980

Pipe age is unknown, however PVC along Route 50 is new in 2008 (4-inch PVC).

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations based on surface expressions, pressure drops, and customer calls; but some leaks difficult to locate	4-6 leaks in past 1 year
Leak Repair Costs		$300-400 per leak
Pipe Replacement	Nothing currently planned	

Water Loss Calculations

Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010 and 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

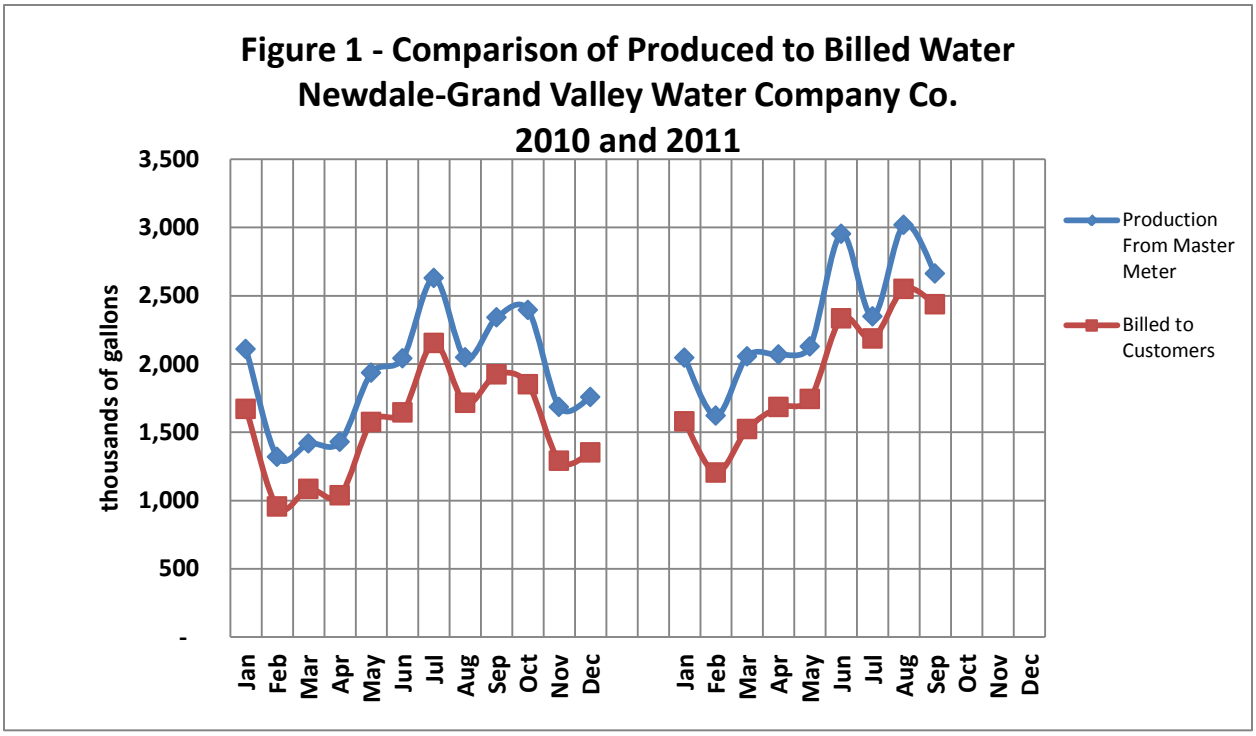
The water loss profile presented in Figure 1 indicates a fairly consistent water loss pattern. Overall, water loss likely relates to both apparent losses (related to inaccurate meters) and real losses. There is some indication that water loss, as a percentage of total water deliveries increase during the winter months, perhaps indicating that non-revenue water increases when system pressures increase during non-irrigation months[2]. In addition, the variability of water loss recorded in June through September of 2011 appears to be indicative of customer meters reading to the closest 1000 gallons, when total usage is only a few thousand gallons a month. In situations like this, water loss can "bounce" from one month to the next with greater than average followed by lower than average (or in this case negative water loss). The impact of meter reading graduation effects is buffered over time; however Newdale-Grand

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

[2] Note that if a leak exists continually over a long period of time undetected, it will appear greater in the winter time as compared to the summer time, when measured as a percentage of total water deliveries. In addition, some systems may experience a greater number of leaks when system pressures increase during periods of low water demand.

Table 1 – Non-Revenue Water Calculations

		Production				
		From Master Meter	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled*	Non-Revenue Water
2010	Jan	2,108	1,670	0%	1.9%	20.8%
	Feb	1,320	956	0%	2.7%	27.6%
	Mar	1,418	1,085	0%	2.8%	23.5%
	Apr	1,429	1,038	0%	2.7%	27.4%
	May	1,935	1,575	0%	2.0%	18.6%
	Jun	2,041	1,645	0%	1.9%	19.4%
	Jul	2,629	2,154	0%	1.5%	18.1%
	Aug	2,047	1,715	0%	1.9%	16.2%
	Sep	2,340	1,925	0%	1.6%	17.7%
	Oct	2,396	1,852	0%	1.6%	22.7%
	Nov	1,684	1,292	0%	2.3%	23.3%
	Dec	1,758	1,352	0%	2.2%	23.1%
Total				**0%**	**2.0%**	**21.0%**
2011	Jan	2,046	1,579	0%	1.9%	22.8%
	Feb	1,621	1,204	0%	2.5%	25.7%
	Mar	2,056	1,523	0%	2.6%	25.9%
	Apr	2,070	1,684	0%	1.8%	18.6%
	May	2,128	1,744	0%	1.9%	18.0%
	Jun	2,952	2,333	0%	1.3%	21.0%
	Jul	2,349	2,187	0%	1.7%	6.9%
	Aug	3,018	2,550	0%	1.3%	15.5%
	Sep	2,661	2,436	0%	1.4%	8.5%
	Oct					
	Nov					
	Dec					
Total				**0%**	**1.7%**	**17.5%**
	* including filter backwash, hydrant flushing and fire fighting					
		All volumes in thousands of gallons				



Valley, which uses this balance to identify potential leaks, may want to consider installing meters that record use in 100 gallon increments. Finally, the age of Newdale-Grand Valley's customer meters warrants testing and/or replacement of these meters to ensure that all water deliveries are accurately recorded and biiled.

The Newdale-Grand Valley Water Company does have some unmetered water use, related to filter back wash, line flushing and firefighting; these items are included in Table 1. Newdale-Grand Valley does not have any metered, unbilled water use. Unmetered water losses are included in the estimate of non-revenue water.

Needs/Recommendations

The Newdale-Grand Valley Water Company has not identified any specific improvements that are needed to improve water loss management. However, there is a number of best management practices which may help the Newdale-Grand Valley Water Company better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Continue to replace customer meters which record in 100 gallon increments.
- Track water use through each meter over time to help prioritize future replacements.
- Install sub-meters and isolation valving in the pipeline system to improve leak detection and system management during leak repairs and other maintenance activities.
- Continue annual system wide audits to identify and characterize unmetered and metered, unbilled water use over time.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

North Holbrook Water Company

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide the North Holbrook Water Company with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide the North Holbrook Water Company with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at your offices on August 31, 2012. The following text and tables summarize the data provided to the District during the audit.

Water Sources	1 groundwater production well	Chlorinated then to distribution
Master Meter	No master meter at the well	No information on how water produced is measured
Meter Readings	Monthly (1st of the month)	
Billings	Monthly (1st of each month)	

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	24	1	1	2		20

Replacement of meters with backflow preventers has been needed but organization lacks financial resources to install the equipment. No annual budget for meter replacement.

Summary of Pipe

Pipe (feet)	2-inch	Total
PVC	31,680	31,680

Pipe age is from 1991, which is when North Holbrook was formed and purchased a private well.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations based on water use over a month	None reported
Leak Repair Costs		No data
Pipe Replacement	Nothing currently planned	

Water Loss Calculations

Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010 and 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1. Note that it is unclear from the audit where the production water volume is measured. It will be important for North Holbrook to have a calibrated master meter installed in the future to ensure that the water loss calculations can be verified.

Based on the water loss profile presented in Figure 1, North Holbrook maintains a fairly low amount of non-revenue water; however, in 2011, non-revenue water increased and appears to demonstrate a seasonal influence, with greater water loss (apparent and/or real) occurring during highest demand. This observation may indicate that the customer meters are inaccurate causing apparent losses. It may also indicate that there are some unauthorized uses that have been occurring in the recent past. It is also possible that the original owner of the well, who receives free water from North Holbrook, has increased his/her water use.

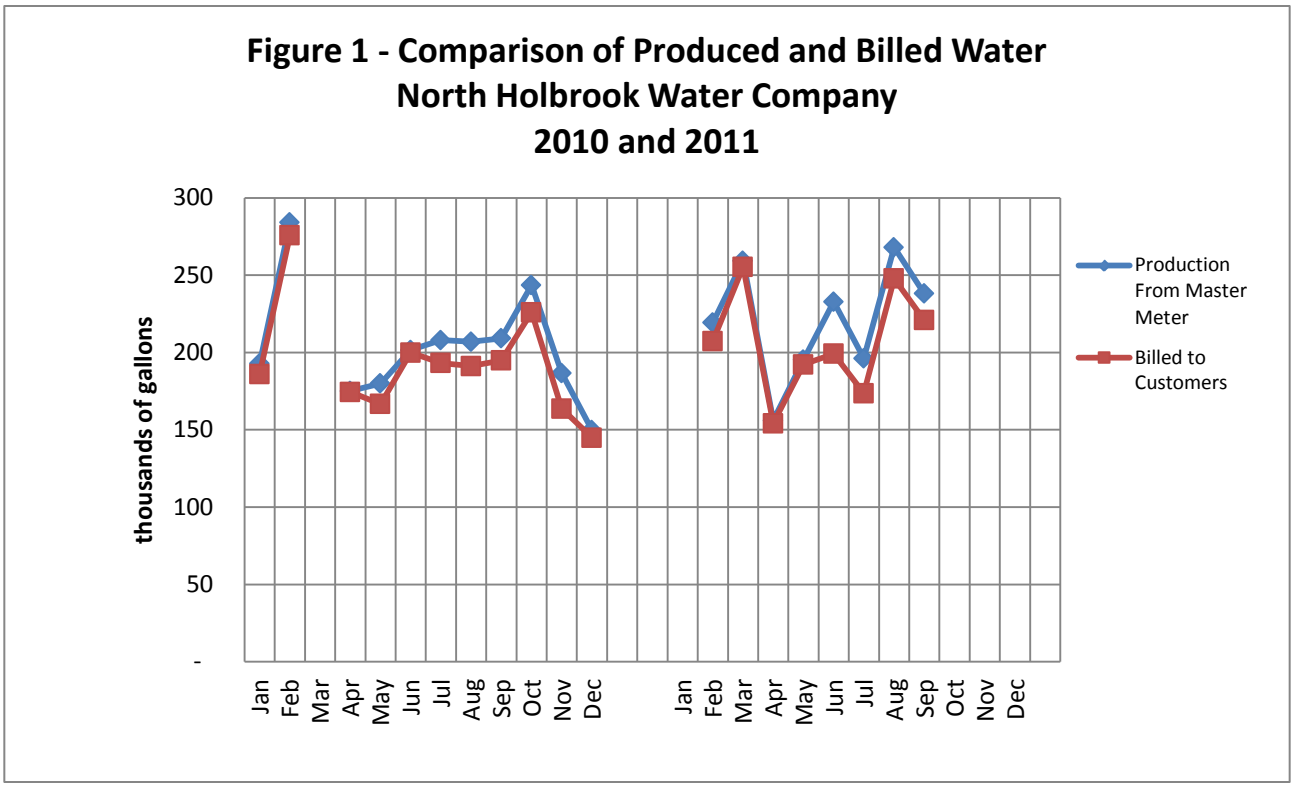
The North Holbrook Water Company does have some unmetered water use, related to flushing of the cistern to remove sediment. The unmetered water use is estimated to be less than 0.05% of total water deliveries. Metered, unbilled water use has not been estimated, but may be more than 2% of total

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

Table 1 – Non-Revenue Water Calculation

		Production From Master Meter	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled	Non-Revenue Water
2010	Jan	193	186	0%	0%	3.6%
	Feb	284	276	0%	0%	2.9%
	Mar			0%	0%	
	Apr	175	175	0%	0%	0.3%
	May	180	167	0%	0%	7.3%
	Jun	202	200	0%	0%	0.8%
	Jul	208	193	0%	0%	7.1%
	Aug	207	191	0%	0%	7.6%
	Sep	209	195	0%	0%	6.9%
	Oct	244	226	0%	0%	7.2%
	Nov	187	164	0%	0%	12.3%
	Dec	150	145	0%	0%	3.2%
Total				**0%**	**0%**	**5.4%**
2011	Jan					
	Feb	**219**	**207**	0%	0%	5.5%
	Mar	259	255	0%	0%	1.5%
	Apr	156	154	0%	0%	1.2%
	May	195	192	0%	0%	1.6%
	Jun	233	199	0%	0%	14.4%
	Jul	196	174	0%	0%	11.5%
	Aug	268	248	0%	0%	7.5%
	Sep	238	221	0%	0%	7.2%
	Oct					
	Nov					
	Dec					
Total				**0%**	**0%**	**6.5%**

All volumes in thousands of gallons



water deliveries. Unmetered and metered, unbilled water losses are included in the estimate of non-revenue water.

Needs/Recommendations

The North Holbrook Water Company has not identified any specific improvements that are needed to improve water loss management. However, there are some best management practices which may help the North Holbrook Water Company better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Continue to replace customer meters using meters that record in 100 gallon increments and install backflow preventers.
- Track water use through each meter over time to help prioritize future replacements.
- Install a master meter on the production well or before water goes to distribution.
- Install sub-meters and isolation valving in the pipeline system to improve leak detection and system management during leak repairs and other maintenance activities.
- Continue annual system wide audits to identify and characterize unmetered and metered, unbilled water use over time (including the water use by the well owner).
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, new meter installation, etc.).

Patterson Valley Water Company

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide the Patterson Valley Water Company with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide the Patterson Valley Water Company with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at a meeting at Otero Junior College on August 30, 2012. The following text and tables summarize the data provided to the District during the audit.

Water Sources	1 groundwater production well	Filtration and chlorinated then to distribution
Master Meter	1 master meter on the well	1-inch master meter tested occasionally; meter new in 2007
Meter Readings	Monthly (end of the month)	
Billings	Monthly (end of each month)	

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	40			20	10	10

Replacement of meters has been occurring as needed based on field observations.

Summary of Pipe

Pipe (feet)	1.5-inch	2-inch	3-inch	4-inch	Total
PVC	25,080	7,920	7,920	2,640	43,560
ABS	7,920		15,840		23,760

Pipe age is unknown, however the ABS is original (1960s). The PVC was installed starting in the 1980s.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations based on surface expressions, pressure drops, and water quality.	4 leaks in past 2 years
Leak Repair Costs		$400-500 per leak
Pipe Replacement	Nothing currently planned	

Water Loss Calculations

Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010 and 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

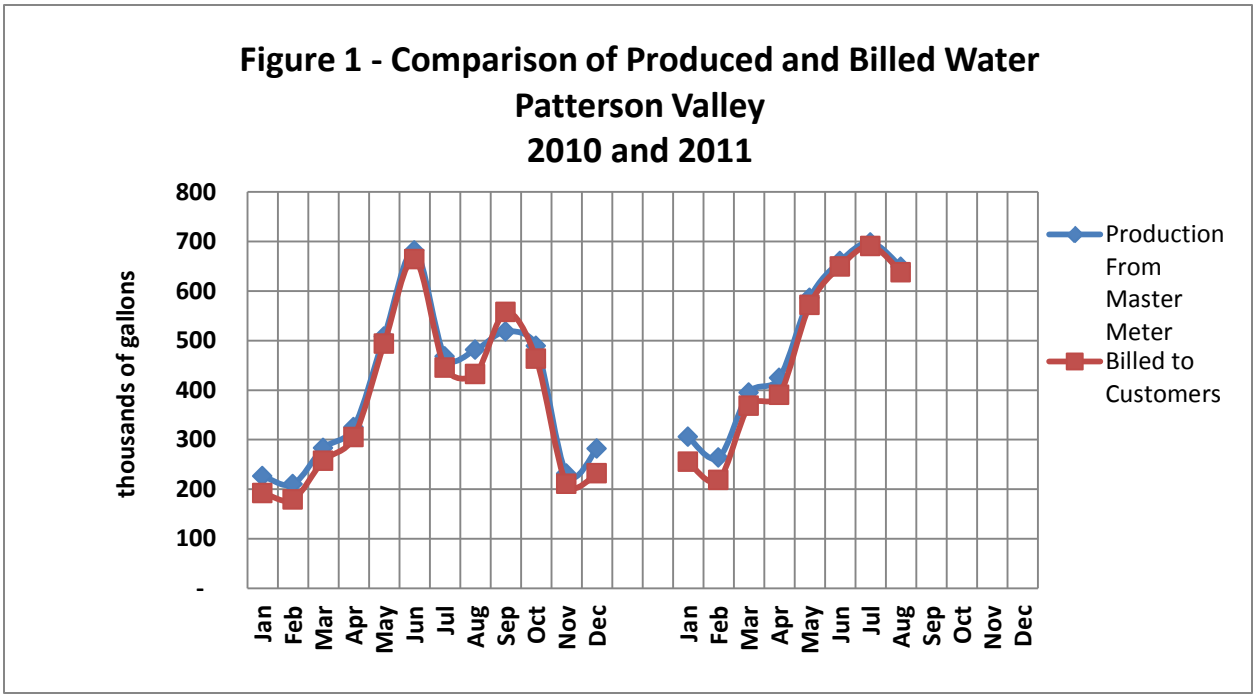
The water loss profile presented in Figure 1 indicates a fairly consistent water loss pattern (except for August and September 2010, when data collection efforts may have not coordinated meter reading to occur on the same day). Overall, water loss likely relates to both apparent losses (related to inaccurate meters) and real losses. There is some indication that water loss, as a percentage of total water deliveries, increase during the winter months, perhaps indicating that non-revenue water increases when system pressures increase during non-irrigation months. ABS pipe, which Patterson Valley has, may be particularly venerable to increases in system pressures during period of off-peak demands.

The Patterson Valley Water Company does have some unmetered water use, related to filter back wash activities which happen regularly. This water use is included in Table 1. Patterson Valley does not have any metered, unbilled water use. Unmetered water losses are included in the estimate of non-revenue water.

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

Table 1 – Non-Revenue Water Calculation

		Production				
		From Master Meter	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled*	Non-Revenue Water
2010	Jan	226	192	0%	1.3%	14.9%
	Feb	210	179	0%	1.4%	14.7%
	Mar	283	258	0%	1.1%	9.0%
	Apr	325	305	0%	0.9%	6.2%
	May	508	494	0%	0.6%	2.8%
	Jun	682	664	0%	0.4%	2.6%
	Jul	468	446	0%	1.3%	4.8%
	Aug	481	432	0%	1.2%	10.2%
	Sep	519	557	0%	0.8%	-7.5%
	Oct	489	464	0%	0.8%	5.3%
	Nov	232	211	0%	1.7%	9.1%
	Dec	282	232	0%	1.4%	17.6%
Total				**0%**	**1.0%**	**5.8%**
2011	Jan	306	255	0%	**1.0%**	16.5%
	Feb	264	218	0%	1.1%	17.2%
	Mar	395	368	0%	0.8%	6.7%
	Apr	425	390	0%	0.7%	8.1%
	May	586	572	0%	0.7%	2.4%
	Jun	660	650	0%	0.9%	1.6%
	Jul	698	691	0%	0.6%	1.1%
	Aug	649	638	0%	0.6%	1.7%
	Sep					
	Oct					
	Nov					
	Dec					
Total				**0%**	**0.8%**	**5.0%**
	* includes filter backwash					
		All volumes in thousands of gallons				



Needs/Recommendations

The Patterson Valley Water Company has not identified any specific improvements that are needed to improve water loss management. However, there are some best management practices which may help the Patterson Valley Water Company better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Continue to replace customer meters which record in 100 gallon increments
- Track water use through each meter over time to help prioritize future replacements.
- Install sub-meters and isolation valving in the pipeline system to improve leak detection and system management during leak repairs and other maintenance activities.
- Replace all ABS pipe when possible, and tie these activities to water rates.
- Continue annual system wide audits to identify and characterize unmetered water use over time.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

City of Rocky Ford

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide the City of Rocky Ford with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide Rocky Ford with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: City Parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at your offices on August 31 and September 6, 2011. The following text and tables summarize the data provided to the District during the audit.

Water Sources	3 groundwater production wells (which will change when new WTP comes online in 2013)	Chlorination then to distribution
Master Meter	3 master meters on wells	8-inch master meter tested annually for accuracy; Meters are more than 10-years old
Meter Readings	Monthly	Hand written notes
Billings	Monthly	One month delay on billings

Summary of Meters

Meters (including Hancock)		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	1649	25	25	10	96	1493
1.5-inch	4					4
2-inch	2					2
4-inch	1					1

The City has implemented a meter replacement program installing about 25 radio-read devices per year with new meters starting 2 years ago. Prior to this effort, the City installed few 3/4-inch meters per year in association with broken meters and customer complaints of high usage.

Summary of Pipe

Pipe (feet)	Total
PVC	
Cast Iron/AC	

Pipe inventory by material, diameter and age is not available; however, most pipe is cast iron and asbestos concrete installed in 1970s or earlier. Some PVC since 1970s.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations based on surface expressions, flooded meter pits, and on customer calls	4-6 plus leaks per month on supply side of service lines
Leak Repair Costs		City budgets about $100,000 per year including detection and repair. (plus another $50,000 for street repairs)
Pipe Replacement	Nothing planned at this time.	

Water Loss Calculations

Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010 and 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

The data presented in Table 1 indicates that non-revenue water in 2011 is very large, and may be indicative of any number of issues including:

- Inaccurate customer meters
- Systematic data handling errors
- Substantial real line losses in service lines and/or distribution lines

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

- Inaccurate master meters
- Unbilled water use
- Unmetered water use
- A combination of all or some of these items

To proceed, the City may benefit from a rigorous system wide water audit that will include meter testing, billing and production records review, and tracking and verification of specific unmetered and metered, unbilled water uses. It is possible that real losses for the City are substantially less than 40% as indicated in Table 1; however it is not possible to characterize the actual water loss without more detail system wide analysis.

The City has identified some unmetered uses, but has not been able to quantify these completely. The unmetered uses, which have not been estimated, include annual line flushing, and firefighting. The City also has some metered, unbilled water use associated with water use at various City parks, and the cemetery and the City shop. Currently unmetered and metered, unbilled water use have not been estimated, but non-revenue water includes unmetered and metered, unbilled uses.

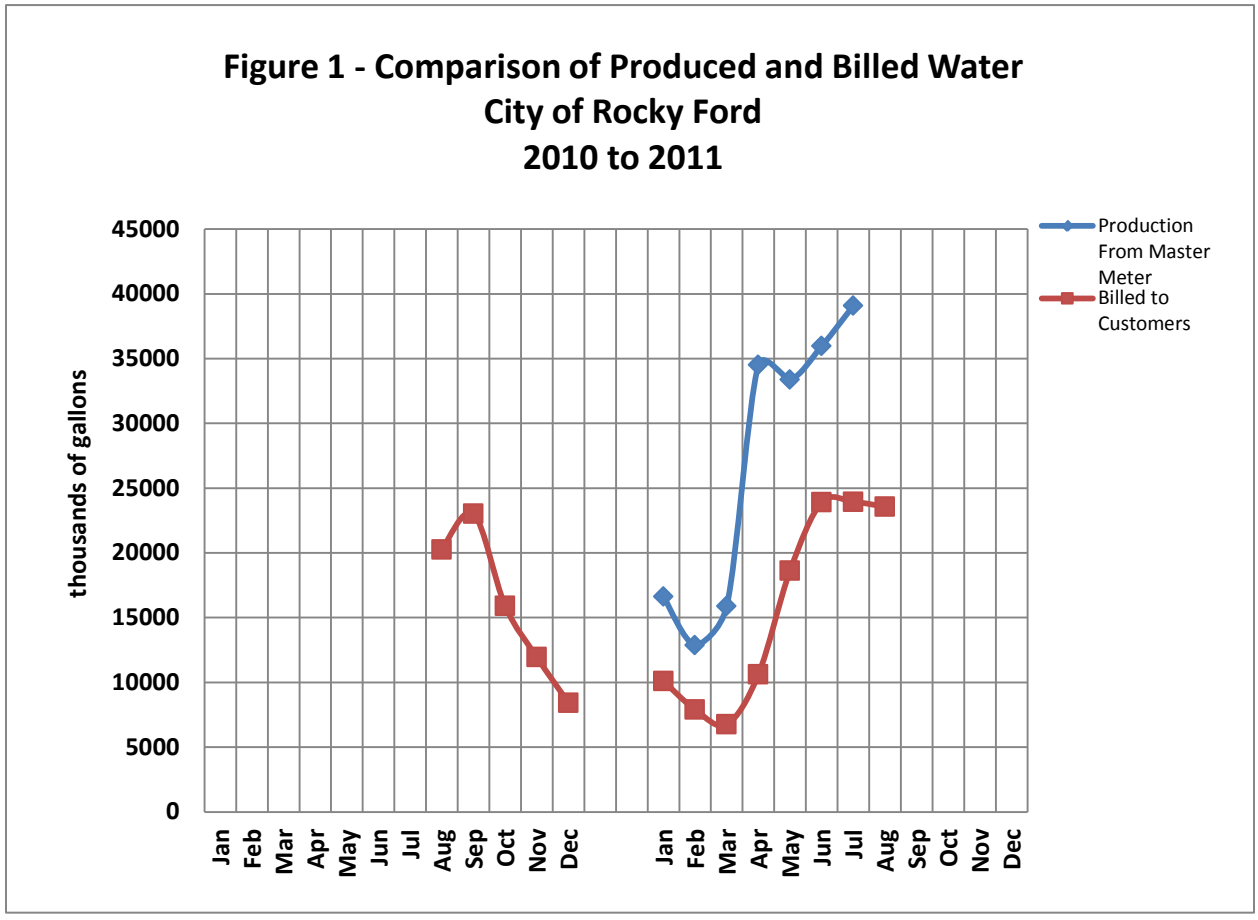


Table 1 – Non-Revenue Water Calculation

		Production				
		From Master Meter	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled	Non-Revenue Water
2010	Jan					
	Feb					
	Mar					
	Apr					
	May					
	Jun					
	Jul					
	Aug		20,257	0%	0%	
	Sep		23,024	0%	0%	
	Oct		15,908	0%	0%	
	Nov		11,951	0%	0%	
	Dec		8,430	0%	0%	
Total						
2011	Jan	16,641	10,112	0%	0%	39.2%
	Feb	12,875	7,904	0%	0%	38.6%
	Mar	15,888	6,760	0%	0%	57.5%
	Apr	34,533	10,615	0%	0%	69.3%
	May	33,376	18,635	0%	0%	44.2%
	Jun	35,970	23,910	0%	0%	33.5%
	Jul	39,090	23,942	0%	0%	38.8%
	Aug		23,565			
	Sep					
	Oct					
	Nov					
	Dec					
Total				**0%**	**0%**	**45.9%**
		All volumes in thousands of gallons				

Needs/Recommendations

Rocky Ford identified the need for improved metering, telemetry and data collection to help reduce non-revenue water. The City also has some water line replacement projects in its future capital improvement budgets to address selected distribution system issues. There are also some best management practices which may help the City to better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Continue to replace customer meters, as needed, using meters that record in 100 gallon increments.
- Track water use per meter to prioritize meter replacement activities.
- Utilize AMR technology whenever possible.
- Track water use through each meter over time to help prioritize future replacements.
- Improve data handling and recording of customer water use.
- Continue water line replacement projects to reduce losses from leaks.
- Continue annual system wide audits to identify and characterize unmetered and metered, unbilled water use over time, and estimate real and apparent losses.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

South Side Water Association

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide the South Side Water Association with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide the South Side Water Association with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at a meeting at your offices on September 23, 2012. The following text and tables summarize the data provided to the District during the audit.

Water Sources	1 groundwater production well; plus interconnect with East Side for summer demands	Filtration and chlorinated then to distribution
Master Meter	1 master meter on the well (and one on interconnect with East Side)	1-inch master meter tested every three years; meter new in 2009
Meter Readings	Every other month (last day of the month)	
Billings	Every other month (first day of the month)	

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	24	5	5	11		3

Replacement of meters has been occurring as needed based on field observations.

Summary of Pipe

Pipe (feet)	1.5-inch	2-inch	3-inch	Total
PVC	5,280	5,280	6,600	17,160
Black Rolled	5,280			5,280

PVC was installed in 2005, black rolled pipe from 1998.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations based on surface expressions, pressure drops, and customer calls; or based on pump hours of operation.	1 leaks in past year (none since replacement of 2-inch black rolled pipe section to west
Leak Repair Costs		$200 per leak
Pipe Replacement	Nothing currently planned	

Water Loss Calculations

Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010 and 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

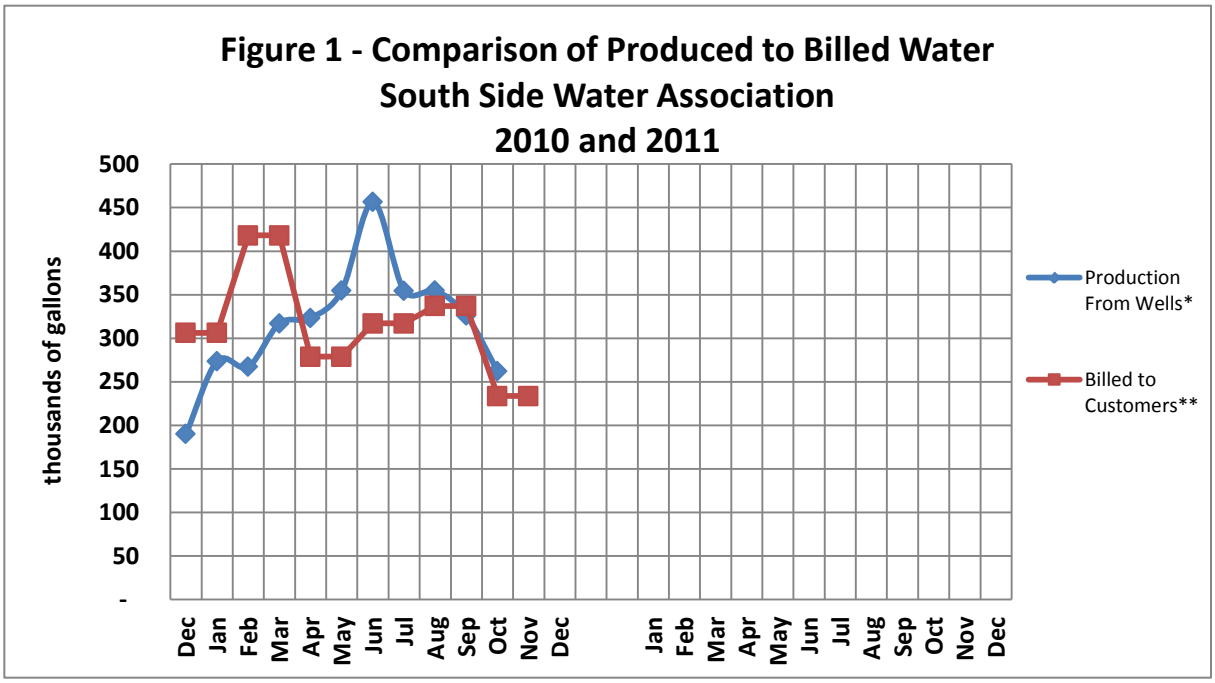
The water loss profile presented in Figure 1 indicates that South Side's customers were overbilled in the winter of 2010 and under billed in the summer of 2010, equating to a total water loss of about 5% through that year. It is difficult to determine the exact cause of this occurrence since the billings data are only available in two month blocks. It may be that the meters used to measure customer water use have 1000 gallon increments, even though average water use in the few thousand gallons range. More accurate monthly or bi-monthly readings could be obtained if 100 gallon increment meters were installed.

Overall, the water loss appears to be slight over the year; however it is difficult to evaluate the accuracy of this observation given the potential that customer water use data may be inaccurate. It would be of benefit to South Side to conduct a more rigorous audit of its customer water use and data management policies to more accurately characterize non-revenue water.

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

Table 1 – Non-Revenue Water Calculation

		Production				
		From Wells*	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled	Non-Revenue Water
	Dec	190				
2010	Jan	274	613	0%	0%	
	Feb	267		0%	0%	
	Mar	317	836	0%	0%	
	Apr	323		0%	0%	
	May	355	558	0%	0%	
	Jun	457		0%	0%	
	Jul	354	634	0%	0%	
	Aug	355		0%	0%	
	Sep	326	674	0%	0%	
	Oct	262		0%	0%	
	Nov		467	0%	0%	
	Dec			0%	0%	
Total				**0%**	**0%**	**4.7%**
2011	Jan					
	Feb					
	Mar					
	Apr					
	May					
	Jun					
	Jul					
	Aug					
	Sep					
	Oct					
	Nov					
	Dec					
Total						
	* January reading includes December 2009 production					
		All volumes in thousands of gallons				



*production data includes December 2009

**customer billings which are once every other month were averaged to estimate monthly usage.

The South Side Water Association does have some unmetered water use, related to system flushing activities which happen regularly. This water use is estimated to be less than 0.5% on an annual basis. South Side does not have any metered, unbilled water use. Unmetered water losses are included in the estimate of non-revenue water.

Needs/Recommendations

The South Side Water Association has not identified any specific improvements that are needed to improve water loss management. However, there is a number of best management practices which may help the South Side Water Association better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Continue to replace customer meters which record in 100 gallon increments.
- Initiate customer meter reading and billing monthly (to support more accurate tracking of non-revenue water).
- Track water use through each meter over time to help prioritize future replacements.
- Install sub-meters and isolation valving in the pipeline system to improve leak detection and system management during leak repairs and other maintenance activities.
- Conduct a more rigorous system wide audit to identify and characterize customer water use, as well as unmetered water use over time.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

South Swink Water Company

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide South Swink Water with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide South Swink Water with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at your offices on September 21, 2012. The following text and tables summarize the data provided to the District during the audit.

Water Sources	4 groundwater production wells	Filtration and chlorinated then to distribution
Master Meter	4 master meters at the wells; and 2 at the WTP	3-inch and 1.5-inch master meters at the WTP tested every 2-3 years; meter ages unknown; calibration between well and WTP master meters occurs daily
Meter Readings	Monthly (end of the month)	
Billings	Monthly (1st of each month)	

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	219	20	20	60	119	
1.5-inch	1			1		

Replacement of meters has been occurring as needed in addition to 10% per year based on tracking of water volume measured by each meter (South Swink changes out meters routinely per every 2 million gallons of usage).

Summary of Pipe

Pipe (feet)	1-inch	1.25-inch	2-inch	3-inch	4-inch	6-inch	Total
PVC			65,920	51,040	22,230	4,900	144,090
ABS	3,400	2,640	15,840	6,640	4,640		33,160

Pipe age is unknown; however PVC replacement of ABS has been ongoing with latest PVC installation in 2010.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations based on surface expressions, pressure drops, and customer calls; most leaks traceable to ABS pipe and service lines	22 leaks in past 2 years
Leak Repair Costs		$300-400 per leak
Pipe Replacement	Nothing currently planned	

Water Loss Calculations

Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010 and 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

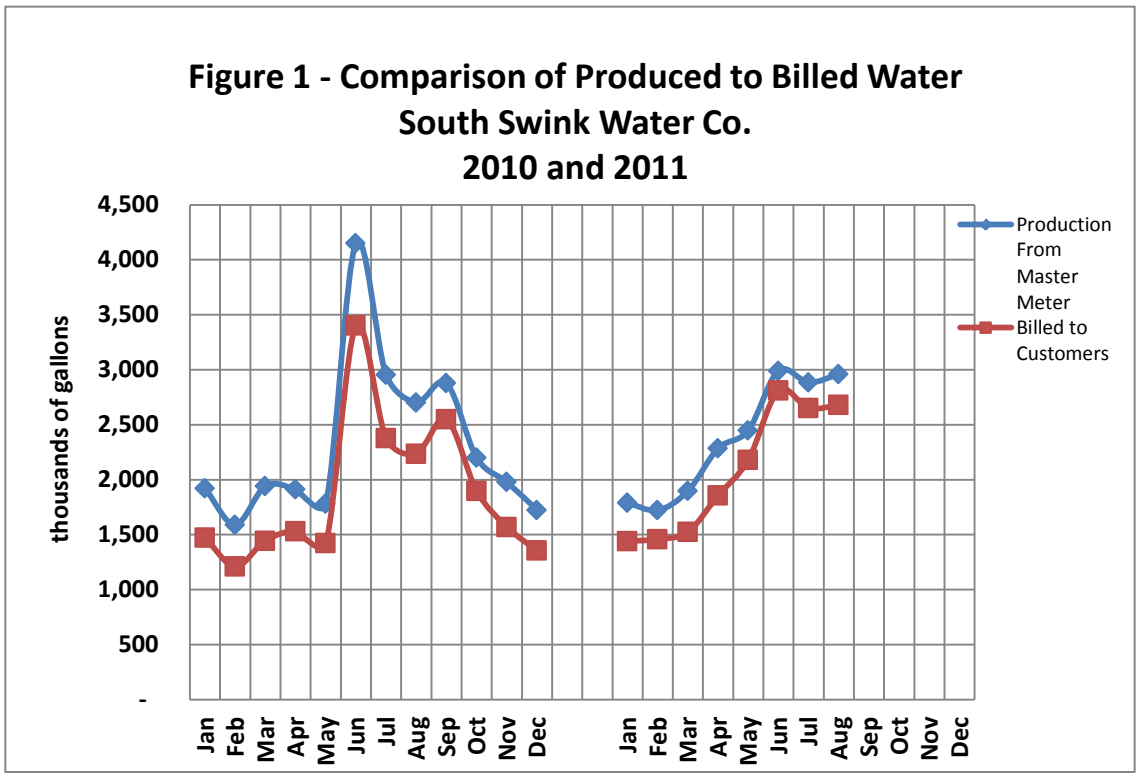
The water loss profile presented in Figure 1 indicates a fairly consistent water loss pattern which has been reduced between 2010 and 2011. Overall, water loss likely relates to both apparent losses (related to inaccurate meters) and real losses. There is some indication that water loss, as a percentage of total water deliveries increases during the winter months, perhaps indicating that non-revenue water increases when system pressures increase during non-irrigation months. This observation is consistent with many other communities in the Lower Arkansas Valley[2].

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

[2] Note that if a leak exists continually over a long period of time undetected, it will appear greater in the winter time as compared to the summer time, when measured as a percentage of total water deliveries. In addition, some systems may experience a greater number of leaks when system pressures increase during periods of low water demand.

Table 1 – Non-Revenue Water Calculation

		Production				
		From Master Meter	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled*	Non-Revenue Water
2010	Jan	1,922	1,473	0%	3.4%	23.4%
	Feb	1,590	1,211	0%	3.8%	23.8%
	Mar	1,942	1,446	0%	3.3%	25.5%
	Apr	1,912	1,531	0%	3.4%	19.9%
	May	1,783	1,425	0%	3.4%	20.1%
	Jun	4,151	3,402	0%	2.5%	18.0%
	Jul	2,955	2,378	0%	2.9%	19.5%
	Aug	2,702	2,236	0%	3.0%	17.2%
	Sep	2,878	2,550	0%	2.8%	11.4%
	Oct	2,201	1,899	0%	3.4%	13.7%
	Nov	1,979	1,571	0%	3.3%	20.6%
	Dec	1,725	1,356	0%	3.5%	21.4%
Total				**0%**	**3.1%**	**19.0%**
2011	Jan	1,792	1,441	0%	2.5%	19.6%
	Feb	1,723	1,460	0%	2.6%	15.3%
	Mar	1,898	1,525	0%	2.4%	19.7%
	Apr	2,285	1,857	0%	2.2%	18.7%
	May	2,449	2,181	0%	2.2%	10.9%
	Jun	2,991	2,811	0%	1.8%	6.0%
	Jul	2,884	2,651	0%	1.9%	8.1%
	Aug	2,962	2,682	0%	1.9%	9.5%
	Sep					
	Oct					
	Nov					
	Dec					
Total				**0%**	**2.1%**	**12.5%**
	* includes filter backwash and stand pipe water use					
		All volumes in thousands of gallons				



In addition, the ABS pipe, which South Swink has, is a typical culprit for line leaks, which is partially evidenced by the reduction of observed water loss in the summer of 2011 after ABS pipe was replaced in 2010 by PVC pipe. There are additional pipe replacement projects warranted if South Swink has the resources.

The South Swink Water does have some unmetered water use, related to filter back wash, line flushing and some other small uses (e.g., coin operated stand pipe for construction water which is located before the WTP master meter). These items are included in Table 1. South Swink does not have any metered, unbilled water use. Unmetered water losses are included in the estimate of non-revenue water.

Needs/Recommendations

The South Swink Water has not identified any specific improvements that are needed to improve water loss management. However, there is a number of best management practices which may help the South Swink Water better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Replace customer meters which record in 100 gallon increments and continue to track water use through each meter over time to help prioritize future replacements.
- Install sub-meters and isolation valving in the pipeline system to improve leak detection and system management during leak repairs and other maintenance activities.
- Plan for and conduct pipe replacement projects focused on removing ABS pipe from service.
- Continue annual system wide audits to identify and characterize unmetered water use over time.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

St. Charles Mesa Water District

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide the St. Charles Mesa Water District with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide the St. Charles Mesa Water District with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at your offices on September 6, 2011. The following text and tables summarize the data provided to the District during the audit.

Water Sources	Summer – Bessemer Ditch Water Winter – 1.5 cfs from Arkansas River plus 4 groundwater production wells	Filtration and chlorination then to distribution
Master Meter	Master meters in the WTP at each filter and totalizers at influent and effluent; plus master meters on each well.	All master meters tested annually
Meter Readings	Monthly	Includes automated meter reading (AMR) devices and manual read meters
Billings	Monthly	

cfs – cubic feet per second

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by ¾	3945	400	400			3145
1-inch	104		58			46
1.5-inch	5		5			
2-inch	7		7			
3-inch	1		1			
4-inch	1		1			

The St. Charles Mesa Water District has been replacing old and manual read meters with automated meter reading (AMR) devices and new meters under a grant from the Colorado Water Conservation Board starting in 2010.

Summary of Pipe

Pipe (feet)	Total
PVC	538,560
ABS	475,200
Ductile Iron	1,000

Pipe age unavailable; however, PVC dates back to 1988. Pipe diameters unavailable; however the District has about 4 miles of 14-inch PVC and 1 mile of 18-inch PVC.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations based on surface expressions, and on customer calls. Also the District has a sound detector, but it has limited utility on with the PVC pipe.	No information available of number of leaks per year.
Leak Repair Costs		Maintenance of water line is about $10,000 per year, including curb and paving allowances.
Pipe Replacement	About 3,000 feet of replacement water line in capital improvement projects for coming 5 years.	

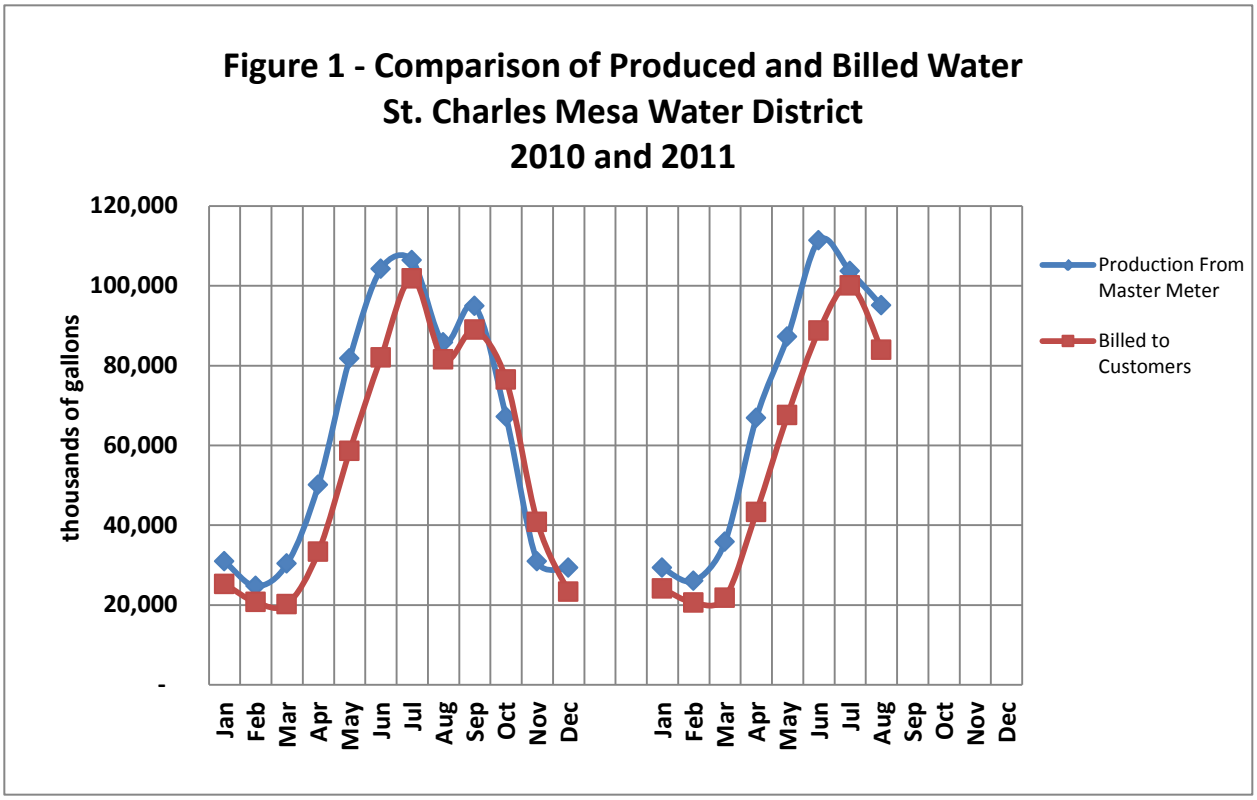
Water Loss Calculations

Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010 and 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

[1] Non-revenue water is the difference between water produced at the treatment plant and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

Table 1 – Non-Revenue Water Calculation

		Production				
		From Master Meter	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled*	Non-Revenue Water
2010	Jan	30,874	25,246	0%	0%	18.2%
	Feb	24,715	20,690	0%	0%	16.3%
	Mar	30,343	20,191	0%	0%	33.5%
	Apr	50,072	33,324	0%	0%	33.4%
	May	81,798	58,571	0%	0%	28.4%
	Jun	104,226	81,970	0%	0%	21.4%
	Jul	106,366	101,838	0%	0%	4.3%
	Aug	85,818	81,516	0%	0%	5.0%
	Sep	94,941	88,960	0%	0%	6.3%
	Oct	67,188	76,494	0%	0%	-13.9%
	Nov	30,876	40,756	0%	0%	-32.0%
	Dec	29,310	23,278	0%	0%	20.6%
Total				**0%**	**0%**	**11.4%**
2011	Jan	29,327	24,098	0%	0%	17.8%
	Feb	25,985	20,550	0%	0%	20.9%
	Mar	35,793	21,804	0%	0%	39.1%
	Apr	66,867	43,227	0%	0%	35.4%
	May	87,244	67,557	0%	0%	22.6%
	Jun	111,344	88,710	0%	0%	20.3%
	Jul	103,647	100,043	0%	0%	3.5%
	Aug	95,048	83,968	0%	0%	11.7%
	Sep					
	Oct					
	Nov					
	Dec					
Total				**0%**	**0%**	**19.0%**
	* filter backwash water is recycled into raw water supply					
		All volumes in thousands of gallons				



The data included in Table 1 and shown in Figure 1 indicate that the District realizes water losses early in the year, which are offset by water sales surpluses in the later part of the year, when water losses are recorded as negatives. This observation is typically consistent with a water system that is placing water into storage in the beginning of the year, and taking water out of storage to support water demand late in the year (this shift can be observed in Figure 1). For systems that operate in this manner, it is often valuable to have metering of water and pressure tanks in the system to monitoring changes in storage over time and allow for a more accurate tracking of real time (or at least monthly) tracking of non-revenue water.

St. Charles Mesa Water District has some unmetered uses, but has not been able to quantify these. The unmetered uses which occur include occasional line flushing, which is estimated to be less than 0.5% of total water deliveries. Filter back wash is recycled back into the raw water influent, such that it does not constitute an unmetered use. There are no metered, unbilled uses in the District. Non-revenue water includes all unmetered uses in the calculation.

Needs/Recommendations

The St. Charles Mesa Water District has identified some water line replacement and AMR meter installations as part of its plans to improve water loss management. In addition, there are some best management practices which may help the St. Charles Mesa Water District to better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Continue to replace customer meters, especially for customers with large taps (i.e., greater than 1-inch) using AMR technology.
- Install meters that record in 100 gallon increments on ¾-ing meters.
- Installing meters on storage facilities to help balance monthly water use.
- Track water use through each meter over time to help prioritize future replacements.
- Install sub-meters and isolation valving in the pipeline system to improve leak detection and system management during leak repairs and other maintenance activities.
- Replace older ABS pipe as resources permit.
- Continue annual system wide audits to identify and characterize unmetered water uses; and non-revenue water over time.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

Town of Sugar City

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide the Town of Sugar City with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide Sugar City with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: Town Parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at your offices on September 30, 2011. The following text and tables summarize the data provided to the District during the audit.

Water Sources	4 groundwater production wells	Chlorination addition then to distribution
Master Meter	1 master meters at central tank	4-inch master meter tested; unknown when meters tested; meters are more than 10-years old
Meter Readings	Monthly (25th of the month)	All meters radio read as of 2005
Billings	Monthly (1st of the month)	

Summary of Meters

Meters (including Hancock)		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	169				159	10
1-inch	1					1
1.5-inch	3					3
2-inch	2					2

The Town implemented a meter replacement program installing all new radio-read devices on all ¾-inch meters in 2004 and 5 (with the exception of 10 ¾-inch meters). Many radio-read meters will need new batteries in the next 2-3 years. The Town replaces meters that are broken or that freeze, as needed.

Summary of Pipe

Pipe (feet)	3-inch	4-inch	6-inch	8-inch	Total
PVC	10,000	14,652	6,956	2,812	34,420

Information on pipe age was not available.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations based on surface expressions, and review of usage reports.	1-2 leaks per year
Leak Repair Costs		Not available
Pipe Replacement	Nothing planned at this time.	

Water Loss Calculations

Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010 and 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

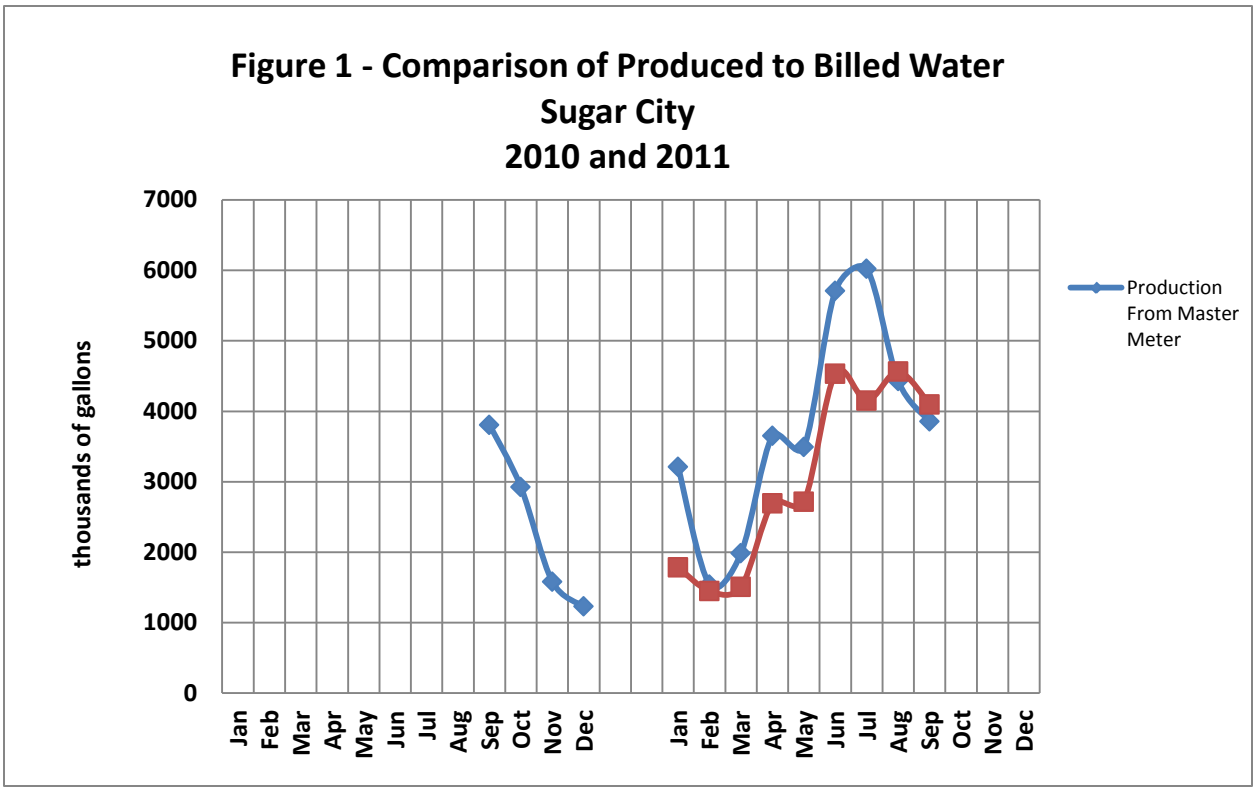
The data presented in Table 1 indicates that non-revenue water is significant during most of the months with data available. Given that the non-revenue water remains above 20% for a number of consecutive months, the water loss does not appear to be a function of systematic measurement errors, rather it appears that a combination of real and/or apparent losses are contributing to the observed levels of water loss.

One key element of the non-revenue water maybe the Town's unmetered uses, which include The Fire Department, two Town parks, the Town shop and perhaps the senior center. Given that these facilities have meters, but the meters are not read, it would be of benefit for the Town to include the consumption information from these various uses in its characterization of non-revenue water. The amount of consumption associated with these uses is estimated in Table 1. The estimate of non-revenue

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

Table 1 – Non-Revenue Water Calculation

		Production				
		From Master Meter	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled*	Non-Revenue Water
2010	Jan					
	Feb					
	Mar					
	Apr					
	May					
	Jun					
	Jul					
	Aug					
	Sep	3,807				
	Oct	2,924				
	Nov	1,582				
	Dec	1,231				
Total						
2011	Jan	3,212	1,787	0%	0.5%	44.4%
	Feb	1,538	1,448	0%	1.0%	5.8%
	Mar	1,985	1,508	0%	0.8%	24.0%
	Apr	3,652	2,694	0%	0.4%	26.2%
	May	3,492	2,716	0%	0.4%	22.2%
	Jun	5,710	4,534	0%	0.3%	20.6%
	Jul	6,021	4,151	0%	0.2%	31.1%
	Aug	4,430	4,563	0%	0.3%	-3.0%
	Sep	3,857	4,096	0%	0.4%	-6.2%
	Oct					
	Nov					
	Dec					
Total				**0%**	**0.4%**	**18.9%**
	* includes fire fighting, city parks, town hall and town shop (which have meters, but meters are not read)					
		All volumes in thousands of gallons				



water includes these unmetered uses. There are no known metered, unbilled water uses beyond those described for various Town uses (which are metered but are not read or recorded).

Needs/Recommendations

Sugar City did not identify any specific projects that are needed to reduce non-revenue water. There are; however, some best management practices which may help the Town to better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Continue to replace customer meters, as needed, with meters that record in 100 gallon increments, and replace radio-read batteries.
- Track water use through each meter over time to help prioritize future replacements.
- Test and replace large customer meters when possible.
- Read meters that track Town facility water use and record.
- Improve data handling and recording of water production.
- Continue annual system wide audits to identify and characterize unmetered and metered, unbilled water use over time, and estimate real and apparent losses.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

Town of Crowley

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide the Town of Crowley with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide the Town of Crowley with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: Town Parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at your offices on September 8, 2011. The following text and tables summarize the data provided to the District during the audit.

Water Sources	5 Crowley County groundwater production wells	Chlorination then to distribution
Master Meter	1 master meter maintained by Town	8-inch master meter rebuilt 10-year ago and not tested for accuracy
Meter Readings	Monthly (last working day of the month)	
Billings	Monthly (first of the month)	

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	110					110

The Town does not currently have a meter repair or replacement program.

Summary of Pipe

Pipe (feet)	2-inch	3-inch	4-inch	8-inch	Total
PVC	limited		13,200	1,800	15,000

Pipe age is generally from 1981, with some 2-inch pipe replaced in the 1990s.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations, but sandy soils in area limit surface expressions. Corrosive soils and copper service lines are an issue	20 leaks in the last 2 years
Leak Repair Costs		$500 per leak
Pipe Replacement	Nothing currently planned	

Water Loss Calculations

Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010 and 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

The Town appears to experience its greatest water loss during off demand periods – i.e., in the wintertime when system pressures are highest. It is therefore likely that a significant portion of the Town's non-revenue water is lost to small leaks that do not surface and are activated or accentuated by high system pressures during off peak demand; and/or are undetected leaks that exist year round but are most prevalent during off-peak periods. Given the substantial amount of water loss experienced by the Town, it is likely that a portion of the non-revenue water results from inaccurate customer meters, which are all 10 years or older. The Town may want to consider implementing a meter replacement program to allow for the Town to bill for actual water use, improving its cash flow and water sales receipts.

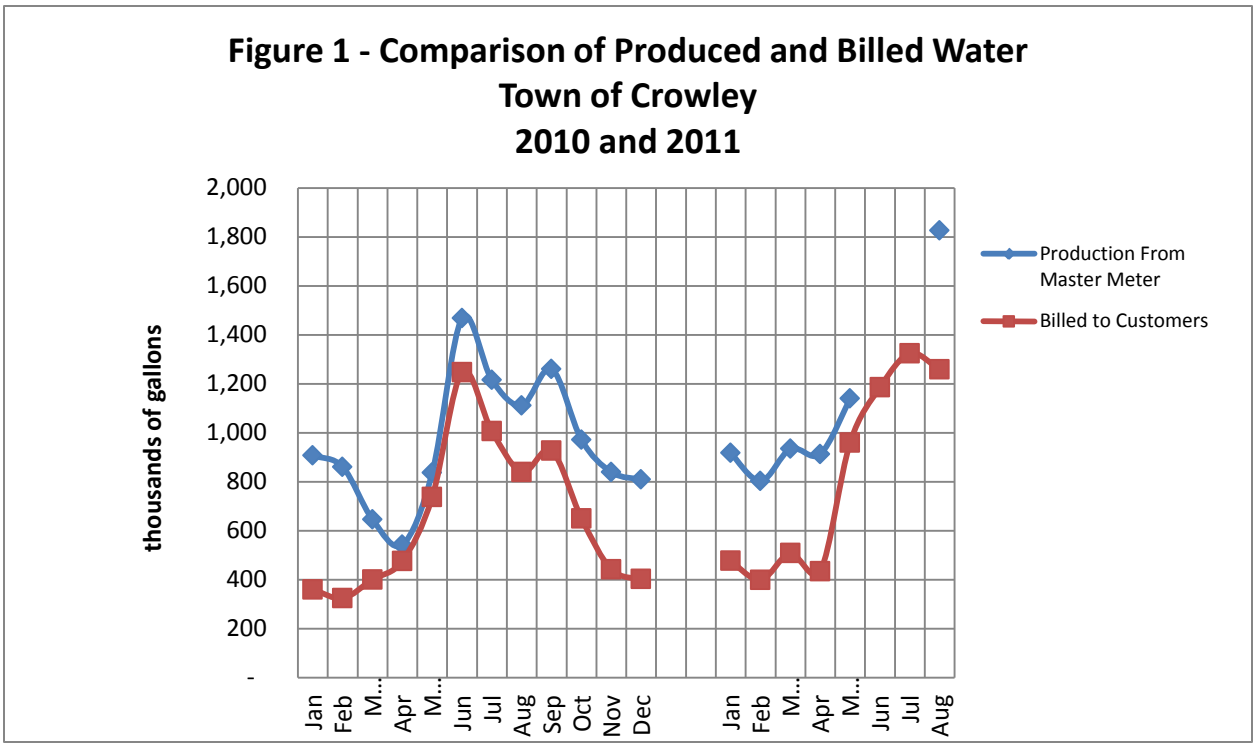
Other actions that may improve Town water sales may include improved data collection and handling methods; expanded leak detection and repair (including replacing copper service lines).

The Town has some unmetered uses, but has not been able to quantify these. The unmetered uses, which have been estimated for purposes of this analysis, are at the Town Park, the Town fire station,

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

Table 1 – Non-Revenue Water Calculation

		Production				
		From Master Meter	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled*	Non-Revenue Water
2010	Jan	908	360	0%	1%	60.3%
	Feb	861	325	0%	1%	62.3%
	Mar	646	401	0%	1%	38.0%
	Apr	543	476	0%	5%	12.3%
	May	837	737	0%	6%	11.9%
	Jun	1,468	1,247	0%	4%	15.0%
	Jul	1,216	1,006	0%	8%	17.2%
	Aug	1,112	840	0%	8%	24.5%
	Sep	1,260	927	0%	4%	26.5%
	Oct	972	650	0%	1%	33.1%
	Nov	839	442	0%	1%	47.4%
	Dec	810	403	0%	1%	50.3%
Total				**0%**	3%	**31.9%**
2011	Jan	918	478	0%	1%	47.9%
	Feb	803	399	0%	1%	50.3%
	Mar	934	509	0%	1%	45.5%
	Apr	913	435	0%	3%	52.4%
	May	1,140	960	0%	4%	15.8%
	Jun		1,186	0%		
	Jul		1,324	0%		
	Aug	1,827	1,259	0%	5%	31.1%
	Sep					
	Oct					
	Nov					
	Dec					
Total				**0%**	5%	**38.2%**
	* includes fire station use, Town Park, and line flushing annually					
		All volumes in thousands of gallons				



annual line flushing and some county construction. The Town also has a small amount of metered, unbilled water use associated with the sewer plant and the Heritage Center that could be identified, but not estimated. Currently metered, unbilled water use is considered to be less than 0.5% of total water deliveries. Non-revenue water calculations include both unmetered and metered, unbilled water use.

Needs/Recommendations

The Town of Crowley identified the need for improved metering and data collection, as well as the replacement of copper service lines, to help reduce non-revenue water. In addition, there are some best management practices which may help the Town to better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Implement program to more aggressively replace customer meters and yokes (especially on the largest water use customers) using meters that record in 100 gallon increments for ¾-inch meters.
- Track water use through each meter over time to help prioritize future replacements.
- Replace copper service lines on the Town's side of its customer meters.
- Improve data handling and recording of customer water use.
- Continue annual system wide audits to identify and characterize unmetered and metered, unbilled water use over time.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

Town of Eads

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide the Town of Eads with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide the Town of Eads with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: Town Parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at your offices on September 23, 2011. The following text and tables summarize the data provided to the District during the audit.

Water Sources	7 groundwater production wells 3 in Town and 4 NE of Town	Chlorination then to distribution
Master Meter	9 master meters maintained by Town (4 for the wells NE of Town; 2 master meters in Town on water tanks; 3 on wells in Town)	All master meters on wells tested every 3 years; meters on water tanks not tested; all master meters are more than 10-years old
Meter Readings	Monthly (~ 25th day of the month)	
Billings	Monthly (first of the month)	

Note that golf course is on its own well, and this well will remain in operation regardless of the AVC construction.

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	401	12	12	36	60	281
1-inch	1					1
1.5-inch	3					3
2-inch	7					7
3-inch	3					3
4-inch	3					3

The Town replaces meters if they are broken or fail their testing. The Town typically replaces about 12 meters per year.

Summary of Pipe

Pipe (feet)	1.25-inch	2-inch	4-inch	6-inch
PVC/Ductile Iron/AC	1,200	4,250	22,300	10,340
	8-inch	**10-inch**	**12-inch**	**Total**
PVC/Ductile Iron/AC	14,300	1,800	400	54,590

Pipe age dates back into the 1950s, in general. Some new PVC pipe was installed in 2000.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations based on surface expressions, and on customer calls	6 leaks in the last 11 years
Leak Repair Costs		$50 per leak in materials (Town has its own staff to repair leaks)
Pipe Replacement	Nothing currently planned	

Water Loss Calculations

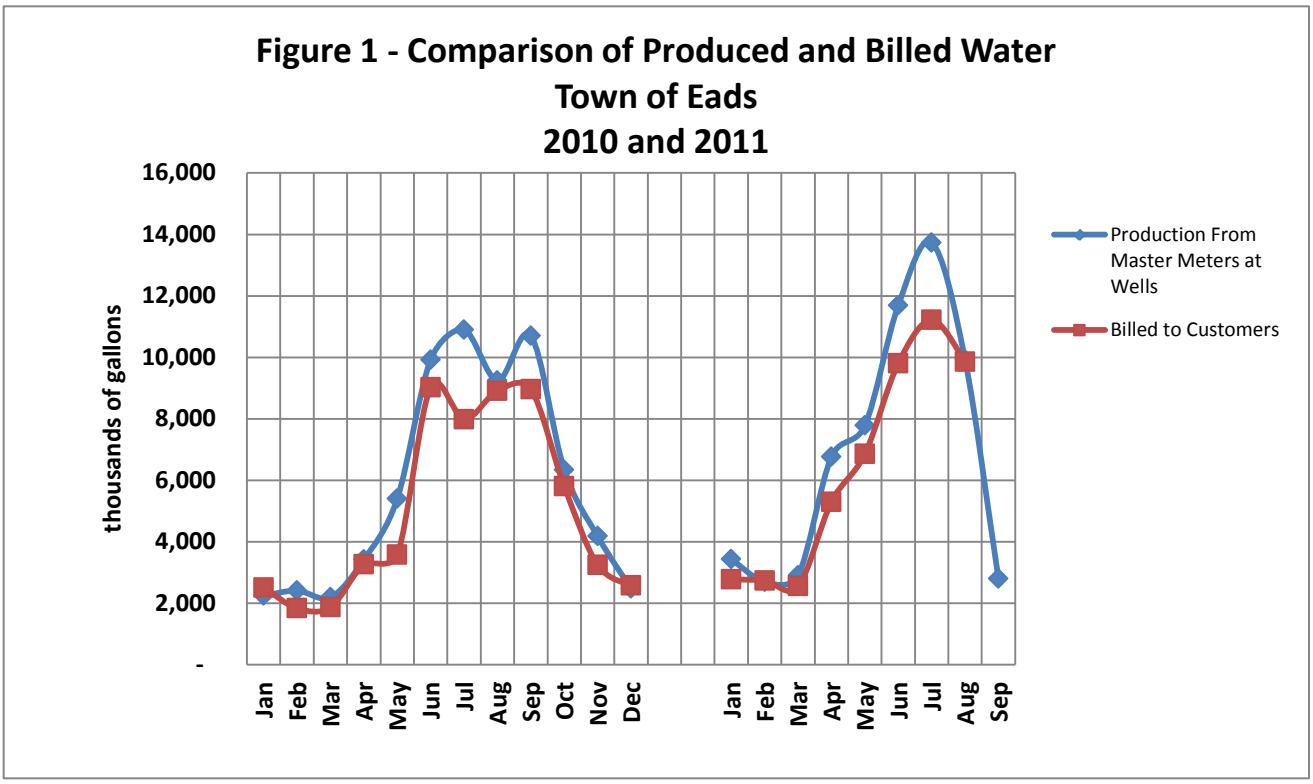
Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010 and 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

The Town's non-revenue water fluctuates month to month from double digit to single digit losses (represented as a percentage of total water deliveries), which was most obvious in 2010. These fluctuations are typically indicative of customer meters recording in 1000 gallon increments, when customer water use is in the same range. To alleviate this fluctuation, which balances itself over a number of months, but impacts the Town's ability to detect month to month changes in water loss, the Town may consider installing customer meters that record in 100 gallon increments. In this way the Town can use monthly water loss calculations to identify leaks and real losses.

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

Table 1 – Non-Revenue Water Calculation

		Production				
		From Master Meters at Wells	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled	Non-Revenue Water
2010	Jan	2,245	2,508	0%	0%	-11.7%
	Feb	2,408	1,837	0%	0%	23.7%
	Mar	2,194	1,870	0%	0%	14.8%
	Apr	3,416	3,269	0%	0%	4.3%
	May	5,401	3,574	0%	0%	33.8%
	Jun	9,922	9,026	0%	0%	9.0%
	Jul	10,900	7,983	0%	0%	26.8%
	Aug	9,246	8,909	0%	0%	3.6%
	Sep	10,699	8,957	0%	0%	16.3%
	Oct	6,340	5,802	0%	0%	8.5%
	Nov	4,177	3,244	0%	0%	22.3%
	Dec	2,475	2,582	0%	0%	-4.3%
Total				**0%**	**0%**	**14.2%**
2011	Jan	**3,436**	**2,776**	0%	0%	19.2%
	Feb	2,696	2,735	0%	0%	-1.4%
	Mar	2,905	2,552	0%	0%	12.1%
	Apr	6,764	5,298	0%	0%	21.7%
	May	7,780	6,855	0%	0%	11.9%
	Jun	11,690	9,807	0%	0%	16.1%
	Jul	13,732	11,217	0%	0%	18.3%
	Aug	9,921	9,854	0%	0%	0.7%
	Sep	2,795				
	Oct					
	Nov					
	Dec					
Total				**0%**	**0%**	**13.3%**
		All volumes in thousands of gallons				



Another practice that the Town may consider relates to updating its customer meters, since over 70% are 10 years or older. Older meters tend to under read actual water use, creating apparent water loss and reducing Town water sales revenue.

The Town has some unmetered uses, but has not been able to quantify these. The unmetered uses which occur infrequently include occasional line flushing, street cleaning, and firefighting. Currently, unmetered water use is considered to be less than 0.5% of total water deliveries. The Town does not have any known metered, unbilled water uses. Non-revenue water includes unmetered water uses.

Needs/Recommendations

The Town of Eads has not identified any specific improvements that are needed to improve water loss management. However, there are some best management practices which may help the Town to better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Implement program to more aggressively replace customer meters (especially on the largest water use customers) using meters that record in 100 gallon increments for ¾-inch meters.
- Track water use through each meter over time to help prioritize future replacements.
- Continue annual system wide audits to identify and characterize unmetered and metered, unbilled water use over time.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

Town of Manzanola

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide the Town of Manzanola with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide the Town of Manzanola with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: Town parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at your offices on September 7, 2011. The following text and tables summarize the data provided to the District during the audit.

Water Sources	3 groundwater production wells with both soft and hard water sources	Filtration and chlorination then to distribution
Master Meter	1 master meter	6-inch master meter older than 10-years ago; no record for when tested for accuracy
Meter Readings	Monthly (25th of the month)	
Billings	Monthly (1st of the month)	

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	180	24				156
1.5-inch	4	1				3
2-inch	3	2				1

The Town began a meter repair or replacement program about 1 year ago. Replacements are made to meters observed by the Town to be broken or not functioning.

Summary of Pipe

Pipe (feet)	2-inch	3-inch	6-inch	8-inch	Total
PVC	5,280		20,400		25,680

Pipe age is not well known, however, most PVC was installed in 1972 with 2-3 miles replaced since 1999.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations, as surface expressions or drop in system pressure.	1-2 leaks in the last 2 years
Leak Repair Costs		$300 per leak
Pipe Replacement	Nothing currently planned	

Water Loss Calculations

Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010 and 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

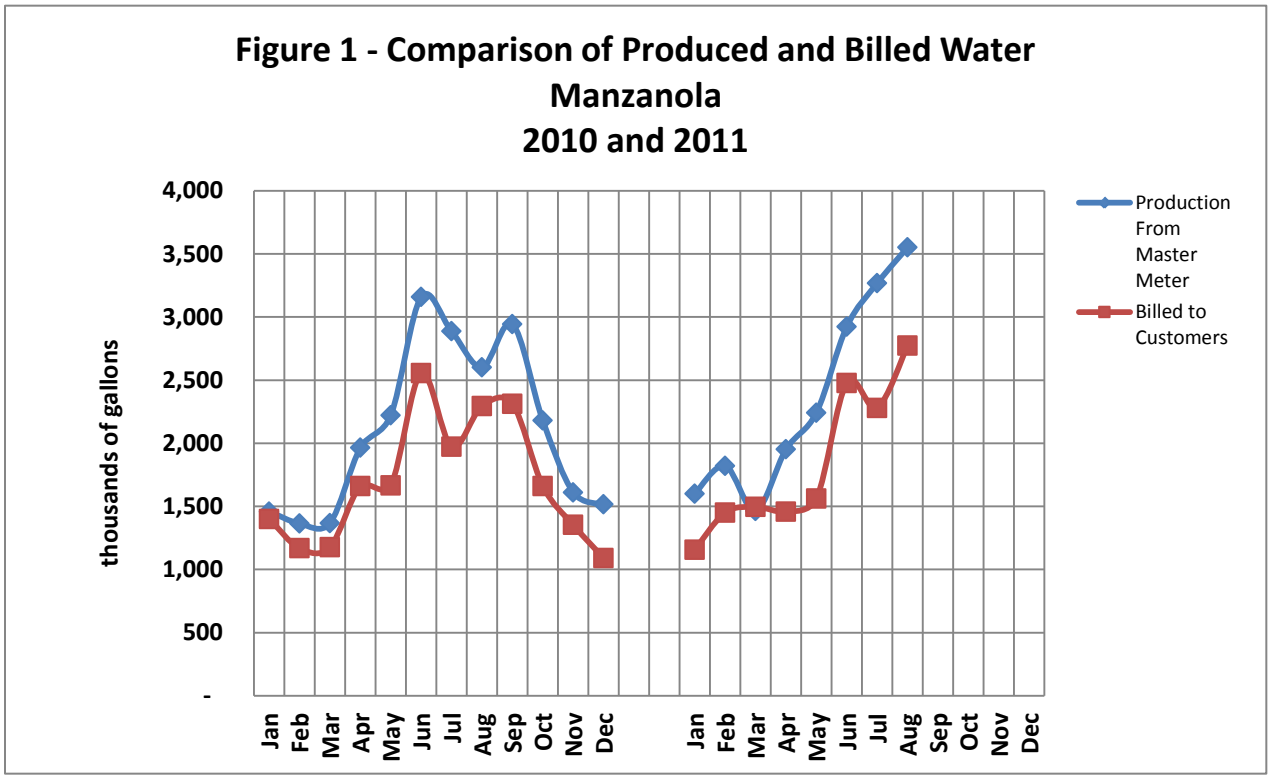
The Town appears to have water loss that varies from the norm – high one month and low the next – which is indicative of customer meters reading in 1000 gallon increments, when typical monthly water use is in the range of a few thousand gallons per month. Over several months these inaccuracies are buffered. Since the Town uses monthly balance of non-revenue water to help identify leaks, the Town may want to consider replacing customer meters with devices that measure using 100 gallon increments.

Additionally, Town water loss may be related to both real and apparent losses. Given the age of the Town's customer meters, it is likely that some metering inaccuracies contribute to total water loss. Water leaks from older water lines and service lines prior to customer meters likely also contribute to total non-revenue water.

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

Table 1 – Non-Revenue Water Calculation

		Production				
		From Master Meter	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled*	Non-Revenue Water
2010	Jan	1,460	1,400	0%	2.4%	4.1%
	Feb	1,364	1,169	0%	2.6%	14.3%
	Mar	1,368	1,178	0%	2.6%	13.9%
	Apr	1,965	1,662	0%	3.3%	15.4%
	May	2,222	1,667	0%	2.9%	25.0%
	Jun	3,159	2,557	0%	2.0%	19.1%
	Jul	2,887	1,973	0%	2.2%	31.6%
	Aug	2,601	2,296	0%	2.5%	11.7%
	Sep	2,944	2,313	0%	2.2%	21.4%
	Oct	2,180	1,662	0%	1.6%	23.8%
	Nov	1,612	1,354	0%	2.2%	16.0%
	Dec	1,516	1,091	0%	2.3%	28.0%
Total				**0%**	**2.4%**	**19.6%**
2011	Jan	1,599	**1,157**	0%	**2.2%**	27.7%
	Feb	1,822	1,451	0%	1.9%	20.3%
	Mar	1,465	1,496	0%	2.4%	-2.2%
	Apr	1,952	1,458	0%	3.3%	25.3%
	May	2,243	1,562	0%	2.9%	30.3%
	Jun	2,924	2,478	0%	2.2%	15.2%
	Jul	3,268	2,280	0%	2.0%	30.2%
	Aug	3,551	2,775	0%	1.8%	21.9%
	Sep					
	Oct					
	Nov					
	Dec					
Total				**0%**	2.3%	**22.1%**
	* includes filter backwash, fire fighting, town parks, town shop and town hall water use					
		All volumes in thousands of gallons				



The Town has some unmetered uses, but has not been able to quantify these. The unmetered uses, which have been estimated for purposes of this analysis, relate to filter backwash, firefighting, Town Hall and Town Shop water use, and exercising fire hydrants. The Town does not appear to have any metered, unbilled water use. Non-revenue water calculations include both unmetered and metered, unbilled water use.

Needs/Recommendations

The Town of Manzanola has not identified any specific improvements that they will be implementing over the next few years. There are, however, some best management practices which may help the Town to better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Replace customer meters and yokes, and radio-read data collection devices, if possible – using meters that record in 100 gallon increments..
- Replace and/or test the Town's master meter, which is over 10-years old.
- Track water use through each meter over time to help prioritize future replacements.
- Improve data handling and recording of customer water use.
- Continue annual system wide audits to identify and characterize unmetered water use over time.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

Town of Olney Springs

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide the Town of Olney Springs with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide the Town of Olney Springs with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at your offices on September 8, 2011. The following text and tables summarize the data provided to the District during the audit.

Water Sources	1 groundwater production well and nine springs (manifold to a single line)	Chlorination then to distribution
Master Meter	2 master meters maintained by Town (one on the well and one for the springs)	8-inch master meter on well, new in 2010, tested annually; 3-inch master meter on springs, new in 2004, tested annually
Meter Readings	Monthly (end of the month)	
Billings	Monthly (1st of the month)	

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	110	60	60	100		20
2-inch	3	2				1

The Town does not currently have a meter repair or replacement program.

Summary of Pipe

Pipe (feet)	3-inch	4-inch	6-inch	8-inch	Total
PVC	1,160	7,970	9,990	5,295	24,415

Pipe age is variable, with some dating back to 1912; however, most is new lines installed in 2004. Old pipes have been abandoned in nearly all locations.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations. Also, leaks can occur (as overflow) from water tanks in Town if not properly balanced (which is currently conducted manually)	No records on leaks in past year.
Leak Repair Costs		No data
Pipe Replacement	Nothing currently planned	

Water Loss Calculations

Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010 and 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

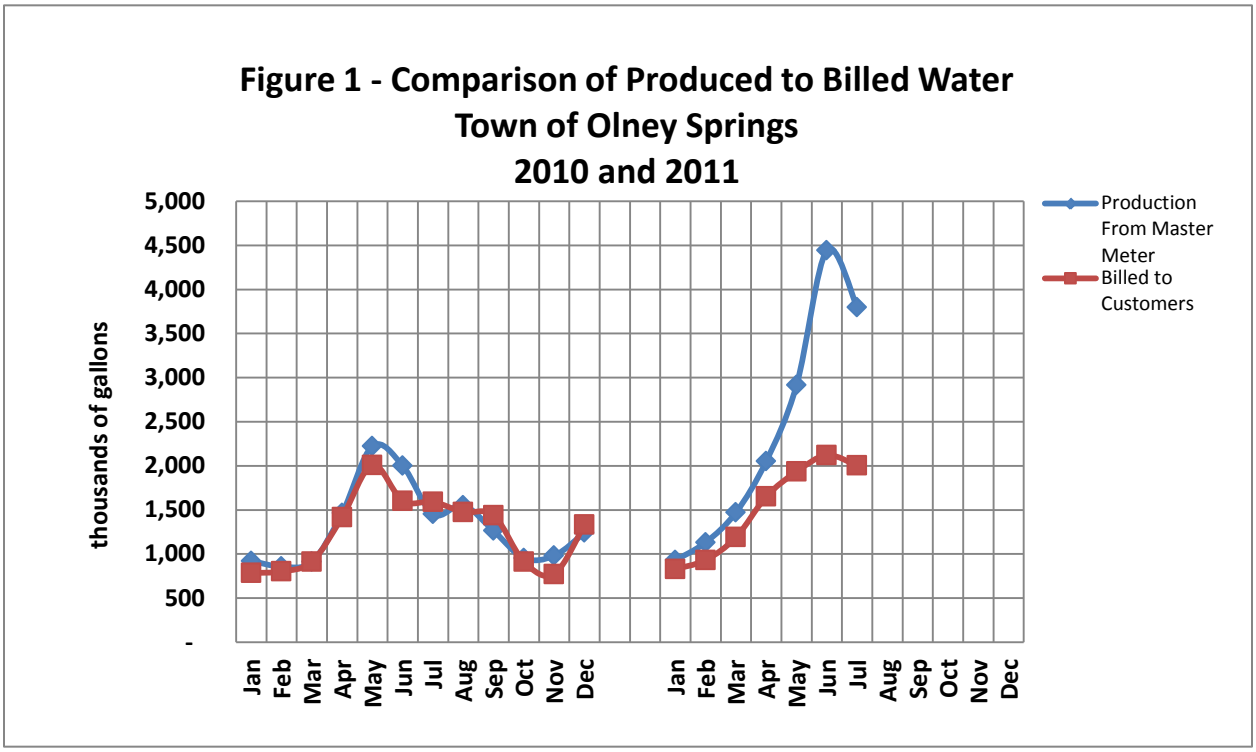
The Town appears to experience its greatest water loss in the summer of 2011 when substantial overflows occurred related to over filling the Town's water tanks (which are balanced and monitored manually). These overflows are observed, but unmetered water uses. In addition, the Town has other unmetered water uses related to tank and water line flushing practices that occur regularly, and contribute to non-revenue water, albeit at a rate significantly less than the overflows.

Water loss is also observed to be highest (as a percentage of total water deliveries) during off demand periods – i.e., in the wintertime when system pressures are highest. It is therefore likely that a significant portion of the Town's non-revenue water is lost to small leaks that do not surface and are activated or accentuated by high system pressures during off peak demand. In addition, the variability of water loss recorded in the second half of 2010 appears to be indicative of customer meters reading to the closest 1000 gallons, when total usage is only a few thousand gallons a month. In situations like this,

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

Table 1 – Non-Revenue Water Calculation

		Production				
		From Master Meter	Billed to Customers	Metered/Unbilled*	Unmetered/Unbilled**	Non-Revenue Water
2010	Jan	920	783	0%	0.0%	14.9%
	Feb	858	803	0%	0.0%	6.4%
	Mar	912	912	0%	0.2%	0.0%
	Apr	1,463	1,418	0%	0.1%	3.0%
	May	2,223	2,009	0%	1.6%	9.6%
	Jun	2,000	1,602	4%	1.8%	19.9%
	Jul	1,451	1,592	5%	0.1%	-9.7%
	Aug	1,553	1,475	5%	0.1%	5.0%
	Sep	1,263	1,440	0%	0.0%	-14.1%
	Oct	953	913	0%	0.0%	4.2%
	Nov	980	772	0%	0.2%	21.2%
	Dec	1,242	1,335	0%	0.2%	-7.5%
Total				**1.9%**	**0.5%**	**4.8%**
2011	Jan	930	830	0%	0.0%	10.7%
	Feb	1,131	932	0%	0.0%	17.6%
	Mar	1,471	1,190	0%	0.1%	19.1%
	Apr	2,053	1,651	0%	0.1%	19.6%
	May	2,914	1,935	0%	14.1%	33.6%
	Jun	4,444	2,121	2%	27.3%	52.3%
	Jul	3,798	2,004	2%	26.7%	47.2%
	Aug					
	Sep					
	Oct					
	Nov					
	Dec					
Total				**0.9%**	**15.8%**	**36.3%**
	* includes 2 town parks					
	** includes occasional tank sediment cleaning, system flushing flows and overflow line discharges					
		All volumes in thousands of gallons				



water loss can "bounce" from one month to the next with greater than average readings one month followed by lower than average readings the next (producing negative water loss in this case). The impact of meter reading graduation effects is buffered over time; however the Town, which uses the water loss calculation to identify potential leaks, may want to consider installing meters that record use in 100 gallon increments.

The Town has some unmetered uses, but has not been able to quantify these explicitly. The unmetered uses, which have been estimated for purposes of this analysis, include fire fighting, system line flushing and flushing of the Town's water tanks, as well as the overflow line (which can be substantial). The Town also has some known metered, unbilled water use associated with irrigation on two Town parks, and water supplied to the local church and Town Hall. Non-revenue water calculations include both unmetered and metered, unbilled water use.

Needs/Recommendations

The Town of Olney Springs identified the need for automating the balancing and filing mechanisms on the Town's water tanks, which would prevent/minimize future overflows. In addition, there are some best management practices which may help the Town to better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Continue to replace customer meters, using those with an accuracy of 100 gallons (rather than 1000 gallons).
- Track water use through each meter over time to help prioritize future replacements.

- Add meters to unmetered uses.
- Improve data handling and recording of customer water use, including recording metered, unbilled uses.
- Continue annual system wide audits to identify and characterize unmetered and metered, unbilled water use over time.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

Town of Ordway

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide the Town of Ordway with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide the Town of Ordway with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: Town Parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at your offices on September 9, 2011. The following text and tables summarize the data provided to the District during the audit.

Water Sources	5 Crowley County groundwater production wells plus 8 Town wells	Chlorination then to distribution
Master Meter	2 master meter maintained by Town	2-inch master meter2 replaced 10 to 15-years ago and tested for accuracy every 5 years
Meter Readings	Monthly (~ 20th day of the month)	
Billings	Monthly (first of the month)	

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	530	40	40	100		349
1-inch	6	2			4	
2-inch	10	3			2	5

The Town replaces meters if they are broken or fail their testing. The Town has initiated a meter replacement program for the entire Town over three years beginning in 2011; including 40 radio read meters. The Town has about 55 inactive meters.

Summary of Pipe

Pipe (feet)	2-inch	3-inch	4-inch	8-inch	Total
PVC	21,120		52,800	21,120	95,040
ABS	36,960				36,960

Pipe age varies by type and diameter – 2-inch ABS is chiefly in alleys and dates back to the 1980s or earlier; the 8-inch PVC is from 1980, the 4-inch PVC is from 2007 and the 2-inch PVC varies.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations based on surface expressions, and on customer calls	8 leaks in the last 2 years
Leak Repair Costs		$50 per leak in materials (Town has its own staff to repair leaks)
Pipe Replacement	Nothing currently planned	

Water Loss Calculations

Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

Data indicates that there are wide variations (more than 60%) in measured non-revenue water from month to month. These variations may be the result of many issues including:

- Lack of coordination between collecting master meter and customer meter readings;
- Inaccurate master and/or customer meters;
- Variability in real loses due to leaks;
- Inconsistent data handling methods; and
- Impacts of unmetered and metered, unbilled water uses.

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

The Town may want to consider conducting a more rigorous system wide audit to determine why water loss data are so variable; including evaluating master meter and customer meter use records; sources of unmetered and metered, unbilled water use; testing the accuracy of master meters and customer meters; and evaluating current data collection and handling procedures. Conducting the audit and acting on audit recommends will likely substantially stabilize the Town's water loss and subsequently the Town's water sales revenues. Better data to characterize water loss will also allow the Town to more effectively identify leaks and other water losses real and apparent. Finally, the Town may want to consider a more aggressive customer meter replacement program given that more than 60% of its customer meters are 10 years or older.

The Town has some unmetered uses, but has not been able to quantify these. The unmetered uses, which have been estimated for purposes of this analysis, include annual line flushing and some county construction. It is possible that the Town has other unmetered uses, but the timing and volume of these uses is currently unknown. The Town also has a small amount of metered, unbilled water use associated with the Town Hall, Shop and Park that could be identified, but not estimated. Currently metered, unbilled water use is considered to be less than 0.5% of total water deliveries. Non-revenue water calculations include unmetered and metered, unbilled uses.

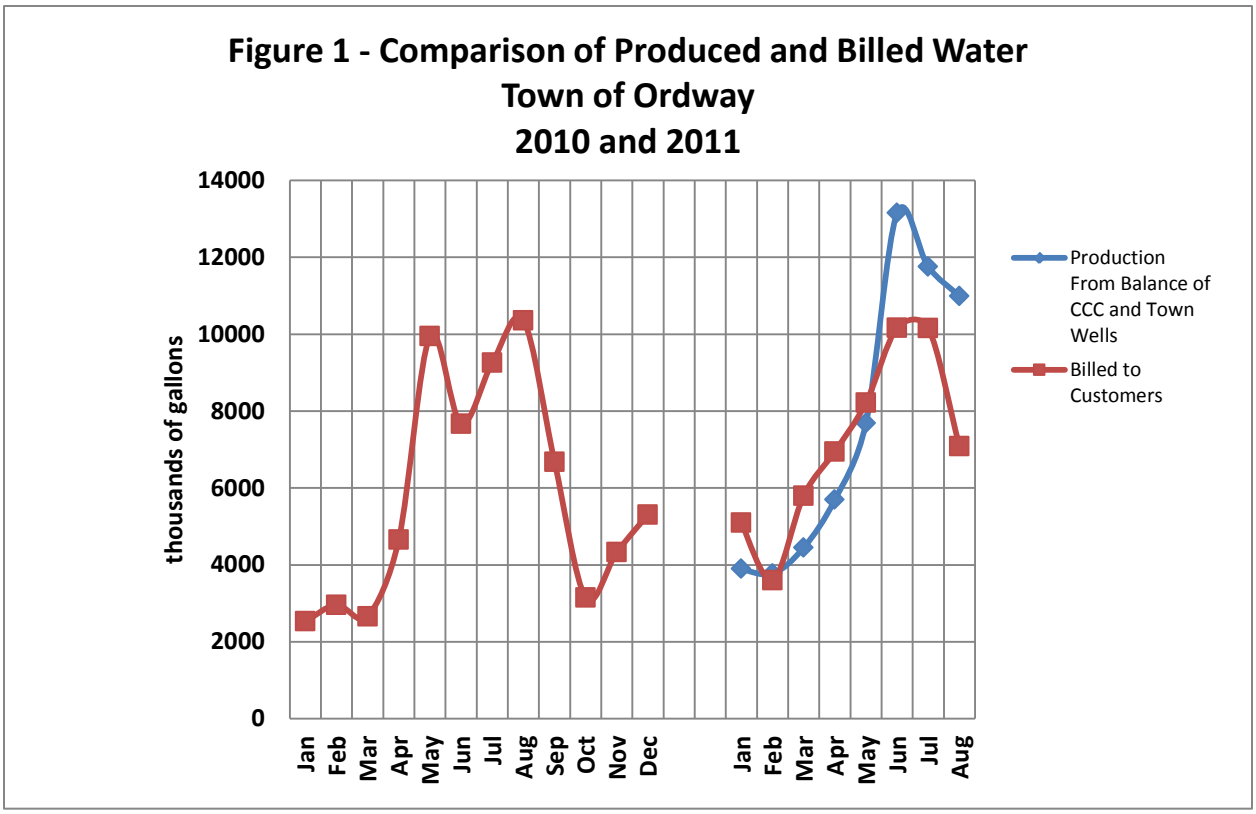


Table 1 – Non-Revenue Water Calculation

		Production				
		From Balance of CCC and Town Wells	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled*	Non-Revenue Water
2010	Jan		2,536			
	Feb		2,961			
	Mar		2,665			
	Apr		4,660			
	May		9,948			
	Jun		7,673			
	Jul		9,258			
	Aug		10,355			
	Sep		6,680			
	Oct		3,150			
	Nov		4,330			
	Dec		5,311			
Total						
2011	Jan	3,897	5,098	0%	0%	-30.8%
	Feb	3,772	3,601	0%	0%	4.6%
	Mar	4,449	5,801	0%	0%	-30.4%
	Apr	5,695	6,949	0%	2%	-22.0%
	May	7,690	8,220	0%	1%	-6.9%
	Jun	13,152	10,169	0%	1%	22.7%
	Jul	11,754	10,157	0%	0%	13.6%
	Aug	10,989	7,092	0%	0%	35.5%
	Sep					
	Oct					
	Nov					
	Dec					
Total				**0%**	**1%**	**7.0%**
	* includes line flushing					
		All volumes in thousands of gallons				

Needs/Recommendations

The Town of Ordway identified the need for improved metering and data collection to help reduce non-revenue water. However, there are some best management practices which may help the Town to better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Implement program to more aggressively replace customer meters (especially on the largest water use customers) using meters that record in 100 gallon increments for ¾-inch meters.
- Track water use through each meter over time to help prioritize future replacements.
- Install sub-meters and isolation valving in the pipeline system to improve leak detection and system management during leak repairs and other maintenance activities.
- Test the accuracy of the County and Town master meters; and replace and repair as needed.
- Improve data handling and recording of customer water use, including coordinating the reading of customer meters with the master meters.
- Conduct a more rigorous system wide audit to identify and characterize unmetered and metered, unbilled water use over time; and conduct meter testing.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

Town of Swink

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide the Town of Swink with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide the Town of Swink with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: Town Parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at your offices on September 1, 2011. The following text and tables summarize the data provided to the District during the audit.

Water Sources	3 groundwater production wells for potable use (3 other non-potable wells are not included in this evaluation)	Filtration and chlorination then to distribution
Master Meter	1 master meter maintained by Town	2-inch master meter tested every 4 years; age of meter not known
Meter Readings	Monthly (~ 23rd day of the month)	
Billings	Monthly (first of the month)	

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	302				302	
1-inch	2				2	
2-inch	1				1	

The Town replaced all meters in 2005 with new meters, radio-read devices, and backflow preventers. Will need all new batteries for automatic meter reading devices (AMR) devices in next 2-3 years.

Summary of Pipe

Pipe (feet)	2-inch	3-inch	4-inch	6-inch	8-inch	Total
PVC	1,460	1,210	2,710	5,530	8,360	19,270

The Town replaced all ABS and steel pipe in 2005 with PVC. Water consumption dropped immediately by 40% due to improved metering accuracy (see above) and reduced distribution system losses.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations based on surface expressions, and on customer calls.	16 leaks in the past two years, all on service lines
Leak Repair Costs		$800 per leak
Pipe Replacement	Nothing currently planned	

Water Loss Calculations

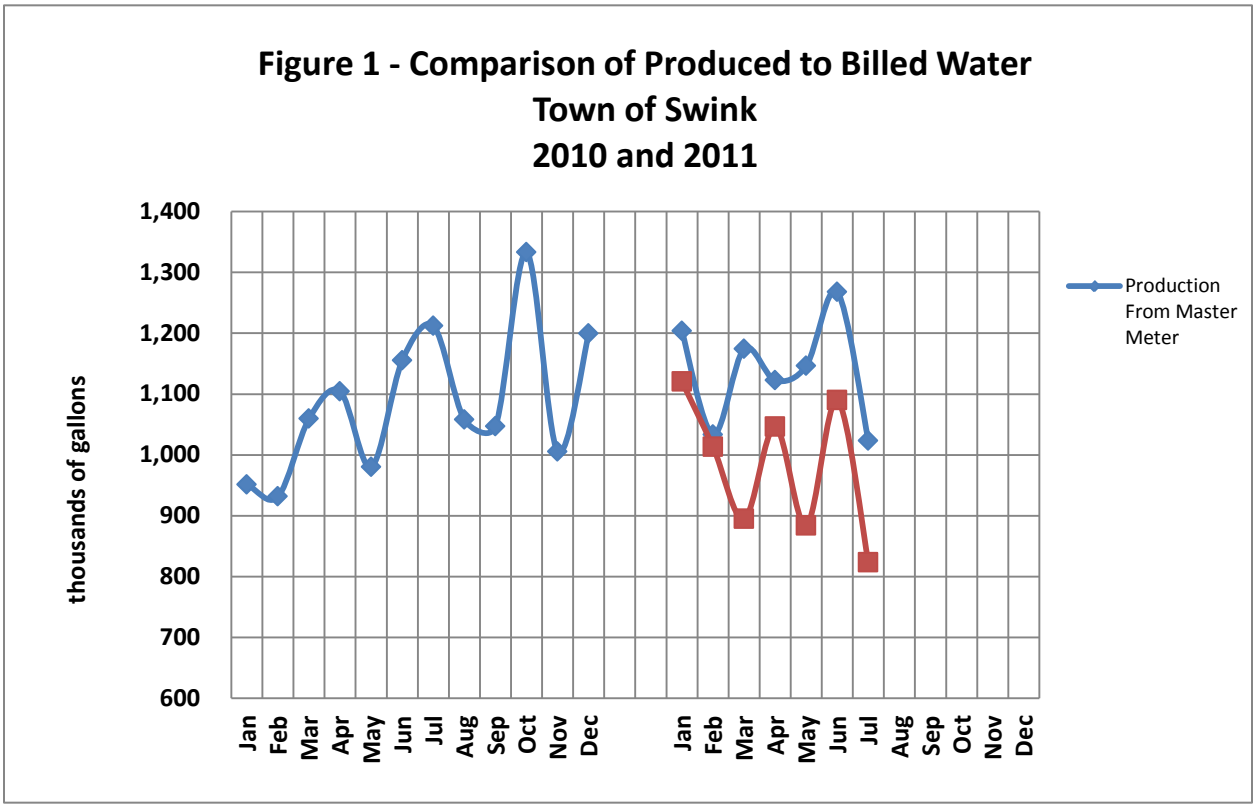
Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010 and 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

The observed difference between billed and produced water depicted in Figure 1 illustrates that the Town experiences water loss "swings" from about 1 to 24% over the last year. This wide variation from month to month, in a pattern of up one month and down the next, is indicative of having meters that read on 1000 gallon increments, when water use by its customers are in the range of a few thousand gallons per month. Because of this, individual monthly comparisons of billed to produced water do not provide an accurate portrayal of non-revenue water; however over a number of months, the variations between meter reading increments and customer water use "even out" and average water loss can be estimated. Unfortunately, having meters reading at increments which are similar in volume to customer water use can mask other water loss characteristics, which may be seasonal or otherwise. The Town should consider beginning to replace older or broken meters with meters that read in 100 gallon increments.

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

Table 1 – Non-Revenue Water Calculation

		Production				
		From Master Meter	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled*	Non-Revenue Water
2010	Jan	951				
	Feb	932				
	Mar	1,060				
	Apr	1,104				
	May	980				
	Jun	1,155				
	Jul	1,212				
	Aug	1,058				
	Sep	1,047				
	Oct	1,333				
	Nov	1,005				
	Dec	1,199				
Total						
2011	Jan	1,204	1,121	0%	0.2%	6.9%
	Feb	1,033	1,013	0%	0.0%	1.9%
	Mar	1,174	895	0%	1.3%	23.8%
	Apr	1,123	1,046	0%	0.1%	6.8%
	May	1,146	884	0%	1.3%	22.9%
	Jun	1,268	1,090	0%	0.1%	14.0%
	Jul	1,023	823	0%	0.1%	19.6%
	Aug					
	Sep					
	Oct					
	Nov					
	Dec					
Total				**0%**	**0.5%**	**13.8%**
	* includes hydrant flushing, firefighting and street cleaning					
		All volumes in thousands of gallons				



The Town has some unmetered uses, but has not been able to quantify these. The unmetered uses which are related to line flushing, street cleaning and firefighting, were estimated for the Town as indicated in Table 1. Currently, unmetered water use is considered to be less than 0.5% of total water deliveries. The Town does not have any metered, unbilled water uses. Non-revenue water amounts include unmetered water use.

Needs/Recommendations

The Town of Swink has not identified any specific improvements that are needed to improve water loss management. However, there are some best management practices which may help the Town to better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Replace customer meters on an as needed basis, using meters that read in 100 gallon increments.
- Consider replacing service lines.
- Track water use through each meter over time to help prioritize future replacements.
- Use annual system wide audits to identify and characterize unmetered and metered, unbilled water use over time; and characterize the impact and cost of the many service line leaks on the true cost of water to the community.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

Town of Wiley

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide the Town of Wiley with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide the Town of Wiley with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at your offices on September 22, 2011. The following text and tables summarize the data provided to the District during the audit.

Water Sources	2 groundwater production wells plus 2 other emergency wells which are not included in this evaluation	Filtration and chlorination then to distribution
Master Meter	2 master meters on the wells, plus 1 maser meter measuring water to distribution	2-inch master meter tested every 3 years; new in 2004; and 1.5-inch master meter new in 2005
Meter Readings	Monthly (~ 25th day of the month)	
Billings	Monthly (before the end of the month)	

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	218			218		
1.5-inch	4	1				3
2-inch	3	1				2

The Town replaced all meters in past five years except those noted above. No ongoing meter replacement occurring.

Summary of Pipe

Pipe (feet)	4-inch	6-inch	8-inch	Total
PVC	5,280	21,120	25,080	51,480

The Town replaced all ABS and steel pipe in 1980s with PVC.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations based on surface expressions, and on customer calls.	3 leaks in the past year
Leak Repair Costs		Town has labor and equipment – cost is just parts
Pipe Replacement	Nothing currently planned	

Water Loss Calculations

Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010 and 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

The Town appears to suffer from seasonal water losses, with greater water loss occurring in the winter when water demand is low and system pressures are higher. This observation is consistent with many other communities in the Lower Arkansas Valley[2].

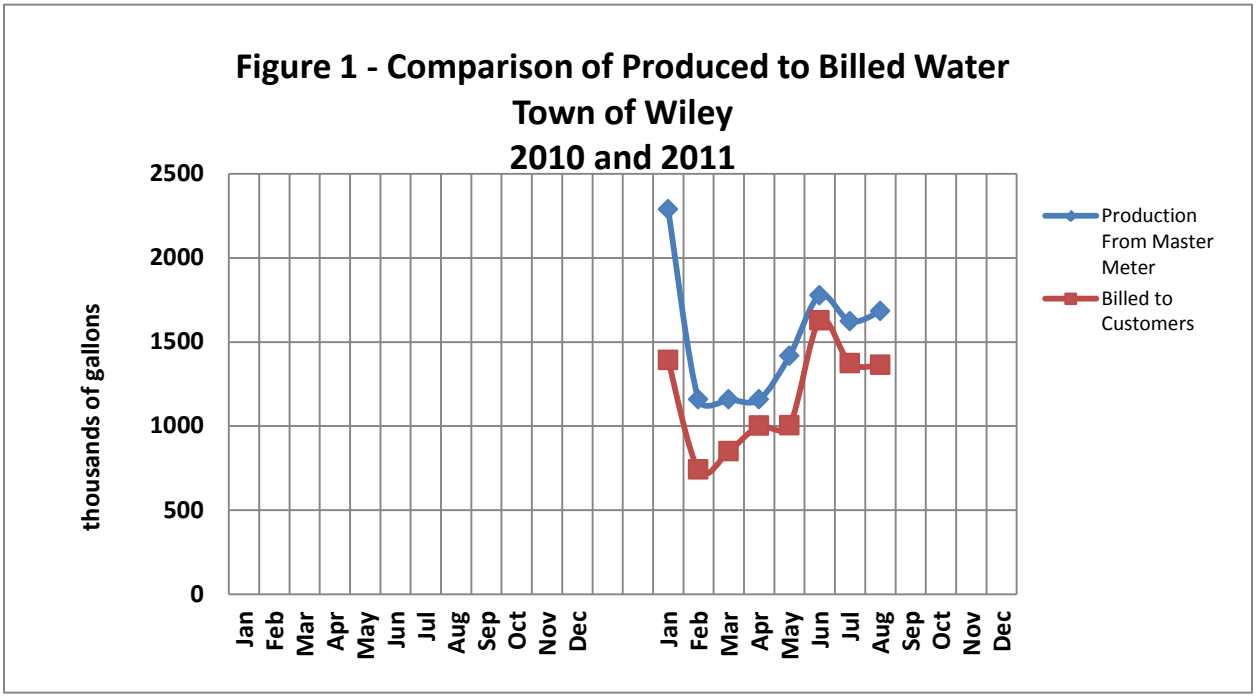
Another circumstance that may be influencing water loss characterization for the Town relates to having meters reading at increments which are similar in volume to customer water use. Customer meters that read in 1000 gallon increments can mask other water loss characteristics, which may be seasonal or otherwise. The Town should consider beginning to replace older or broken meters with meters that read in 100 gallon increments.

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

[2] Note that if a leak exists continually over a long period of time undetected, it will appear greater in the winter time as compared to the summer time, when measured as a percentage of total water deliveries. In addition, some systems may experience a greater number of leaks when system pressures increase during periods of low water demand.

Table 1 – Non-Revenue Water Calculation

		Production				
		From Master Meter	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled*	Non-Revenue Water
2010	Jan					
	Feb					
	Mar					
	Apr					
	May					
	Jun					
	Jul					
	Aug					
	Sep					
	Oct					
	Nov					
	Dec					
Total						
2011	Jan	2,288	1,391	0%	1.3%	39.2%
	Feb	1,158	741	0%	2.6%	36.0%
	Mar	1,158	850	0%	2.6%	26.6%
	Apr	1,158	1,001	0%	5.2%	13.6%
	May	1,417	1,004	0%	6.4%	29.1%
	Jun	1,776	1,627	0%	5.1%	8.4%
	Jul	1,623	1,373	0%	3.7%	15.4%
	Aug	1,682	1,364	0%	3.6%	18.9%
	Sep					
	Oct					
	Nov					
	Dec					
Total				**0%**	**3.7%**	**23.7%**
	* includes filter backwash					
		All volumes in thousands of gallons				



Overall, it is unclear what portion of the Town's water loss relates to real losses versus apparent losses. To better characterize each, additional, more rigorous system-wide audits are suggested to measure unmetered, and metered, unbilled water use; and customer water use as well.

The Town does have some unmetered water use, related to filter back-wash, system flushing and firefighting. Unmetered water use, which is provided in Table 1, is estimated to be about 3-4% of total water deliveries on an annual basis. Metered, unbilled water uses, which include Town Hall, the Community Center and the School may be significant and have not been estimated herein. Unmetered, and metered, unbilled water losses are included in the estimate of non-revenue water.

Needs/Recommendations

The Town has not identified any specific improvements that are needed to improve water loss management. However, there is a number of best management practices which may help the Town better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Continue to replace customer meters, as needed, which record in 100 gallon increments.
- Track water use through each meter over time to help prioritize future replacements.
- Install sub-meters and isolation valving in the pipeline system to improve leak detection and system management during leak repairs and other maintenance activities.
- Conduct a more rigorous system wide audit to identify and characterize customer water use, as well as unmetered, and metered, unbilled water use over time.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

Valley Water Company

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide the Valley Water Company with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide the Valley Water Company with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at a meeting at your offices on September 29, 2012. The following text and tables summarize the data provided to the District during the audit.

Water Sources	2 groundwater production wells	Filtration and chlorinated then to distribution
Master Meter	2 master meter on the wells	2-inch master meters tested every three years; age of meters unknown, one well was constructed in 1993
Meter Readings	Monthly (~25th of the month)	
Billings	Monthly (1st of the month)	

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	115	2	2	6	5	100

Replacement of meters has been occurring as needed based on field observations.

Summary of Pipe

Pipe (feet)	1-inch	1.5-inch	2-inch	4-inch	6-inch	Total
PVC	6,336	12,672	12,672	15,840	15,840	63,360
ABS	3,960					3,960

PVC was installed to help reduce leaks associated with ABS pipe. Dates of upgrades are not known.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations based on surface expressions, pressure drops, and customer calls which occur with "red" water in pipes. Some leaks do not surface in sandy soils.	4 leaks in past year including large leak in September 2011.
Leak Repair Costs		$300-1,000 per leak
Pipe Replacement	Nothing currently planned	

Water Loss Calculations

Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010 and 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

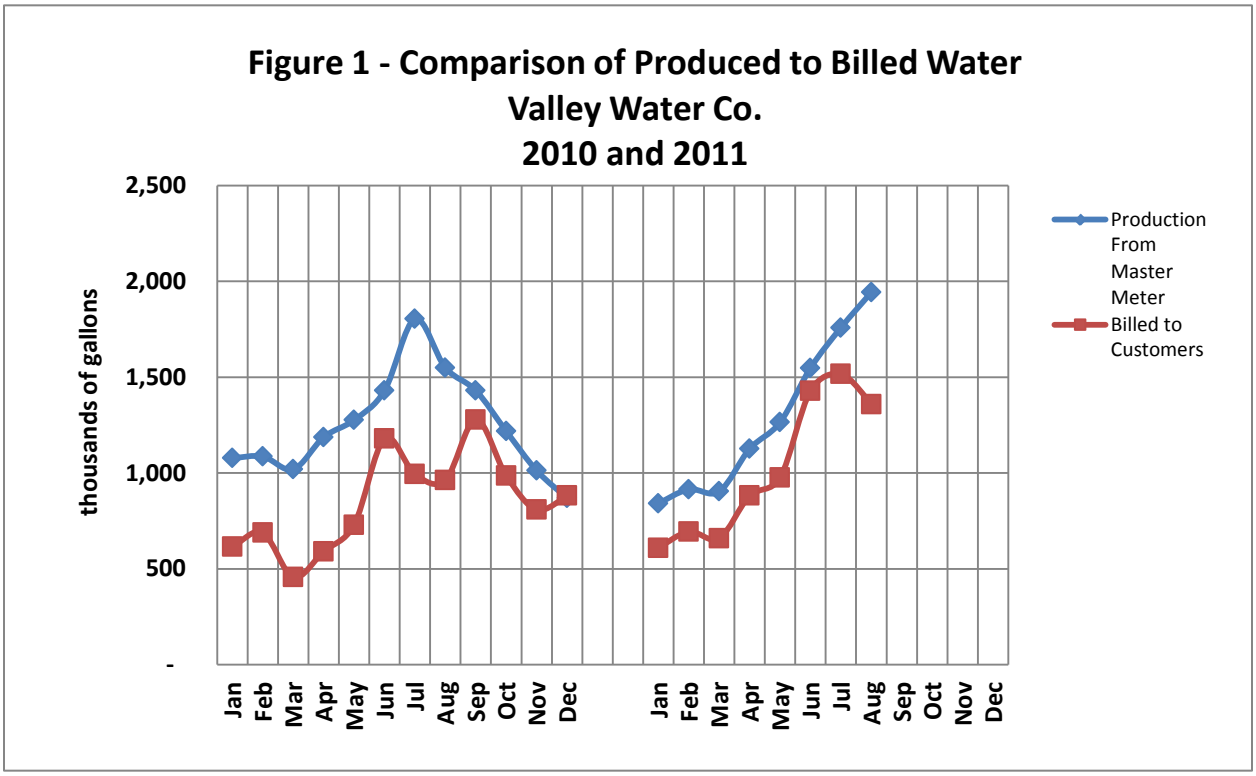
The water loss profile presented in Figure 1 and Table 1 indicates that water loss has significantly decreased in the past two years, perhaps as a result of new pipe installations, replacing ABS with PVC; and/or other leak detection and repair activities. Water loss did increase in August 2011 as a result of a leak that spilled nearly ½ million gallons of water. Valley would find benefit from not only replacing the remaining ABS in its distribution system, but also by installing sub-meters in the distribution system (to help identify and quantify leaks) and isolation valving (to support more efficient leak repair and pipe replacement).

Although water loss appears to be on a downward trend, the exact amount of water loss is difficult to quantify due to the age of customer meters; the master meters; and the amount of unmetered water uses – all of which can impact the accuracy of calculating non-revenue water. It would be of benefit to

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

Table 1 – Non-Revenue Water Calculation

		Production				
		From Master Meter	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled*	Non-Revenue Water
2010	Jan	1,078	617	0%	1.0%	42.8%
	Feb	1,087	689	0%	1.0%	36.6%
	Mar	1,019	457	0%	1.1%	55.2%
	Apr	1,187	592	0%	0.9%	50.2%
	May	1,277	730	0%	0.9%	42.8%
	Jun	1,430	1,180	0%	0.8%	17.5%
	Jul	1,804	994	0%	0.6%	44.9%
	Aug	1,550	963	0%	0.7%	37.9%
	Sep	1,431	1,279	0%	0.8%	10.6%
	Oct	1,218	986	0%	0.9%	19.1%
	Nov	1,013	809	0%	1.1%	20.1%
	Dec	870	883	0%	1.3%	-1.5%
Total				**0%**	**0.9%**	**32.0%**
2011	Jan	841	609	0%	**1.3%**	27.5%
	Feb	915	694	0%	1.2%	24.1%
	Mar	904	660	0%	1.2%	27.0%
	Apr	1,126	883	0%	1.0%	21.6%
	May	1,265	976	0%	0.9%	22.9%
	Jun	1,548	1,429	0%	0.7%	7.7%
	Jul	1,758	1,517	0%	0.6%	13.7%
	Aug	1,943	1,359	0%	0.6%	30.0%
	Sep					
	Oct					
	Nov					
	Dec					
Total				**0%**	**0.9%**	**21.1%**
	* includes filter backwash, hydrant flushing and firefighting					
		All volumes in thousands of gallons				



Valley to conduct a more rigorous audit of its customer water use; meter accuracy; and data management policies to more accurately characterize non-revenue water.

The Valley Water Company does have some unmetered water use, related to filter back-wash, and system flushing activities which happen regularly. This water use is estimated to be about 1% of total water deliveries on an annual basis as indicated in Table 1. Valley does not have any metered, unbilled water use. Unmetered water losses are included in the estimate of non-revenue water.

Needs/Recommendations

The Valley Water Company has not identified any specific improvements that are needed to improve water loss management. However, there is a number of best management practices which may help the Valley Water Company better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Continue to replace customer meters, as needed, which record in 100 gallon increments.
- Track water use through each meter over time to help prioritize future replacements.
- Continue to replace ABS pipe as resources allow.
- Install sub-meters and isolation valving in the pipeline system to improve leak detection and system management during leak repairs and other maintenance activities.
- Conduct a more rigorous system wide audit to identify and characterize customer water use, as well as unmetered water use over time.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

Vroman Water Company

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide the Vroman Water Company with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas Vroman Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide the Vroman Water Company with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at a meeting at your offices on September 21, 2012. The following text and tables summarize the data provided to the District during the audit.

Water Sources	1 groundwater production well	Filtration and chlorinated then to distribution
Master Meter	2 master meters: one on the well, one on the post-treatment pump	2-inch master meters tested every two to three years; meter on well replaced in 1998; meter on pump replaced 2009.
Meter Readings	Monthly (~25th of the month)	
Billings	Monthly (1st of the month)	

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	59					59

Replacement of meters has been occurring as needed based on field observations.

Summary of Pipe

Pipe (feet)	1.25-inch	1.5-inch	2-inch	2.5-inch	3-inch	4-inch	Total
PVC	8,766	7,500	10,923	5,280	12,400	12,600	57,469
ABS		7,920					7,920

PVC was installed to help reduce leaks associated with ABS pipe. Dates of upgrades are not known.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations based on surface expressions, pressure drops, and customer calls which occur with "red" water in pipes. Some leaks do not surface in sandy soils.	6 leaks in the past 2 years (mainly on ABS line)
Leak Repair Costs		$250-400 per leak
Pipe Replacement	Nothing currently planned	

Water Loss Calculations

Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010 and 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

The water loss profile presented in Figure 1 indicates that water loss is significant year round; however, filter back wash and other unmetered uses may constitute 1/3 to 1/2 of Vroman's non-revenue water. In addition, Vroman appears to suffer from seasonal water losses, with greater water loss occurring in the winter when water demand is low and system pressures are higher. This observation is consistent with many other communities in the Lower Arkansas Valley[2].

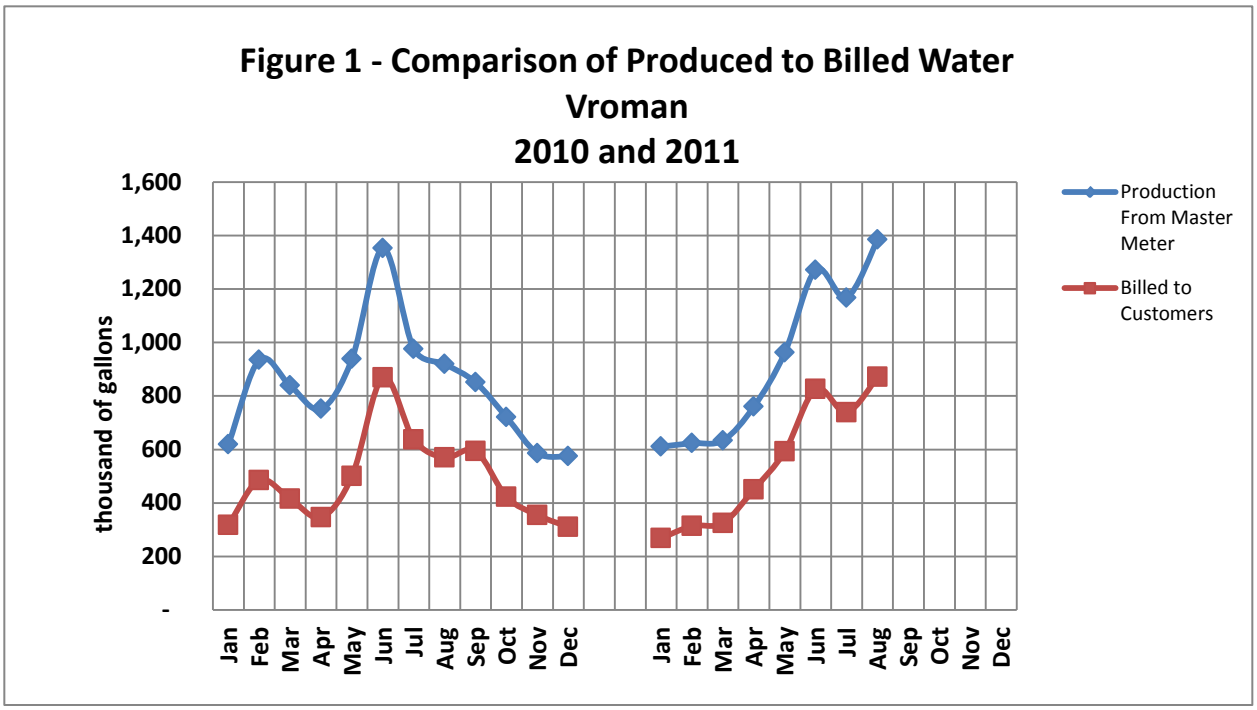
Vroman's high water losses likely include both real and apparent losses, with apparent losses being related to inaccurate customer metering. Given the age of the meters in place to measure customer

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

[2] Note that if a leak exists continually over a long period of time undetected, it will appear greater in the winter time as compared to the summer time, when measured as a percentage of total water deliveries. In addition, some systems may experience a greater number of leaks when system pressures increase during periods of low water demand.

Table 1 – Non-Revenue Water Calculation

		Production				
		From Master Meter	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled*	Non-Revenue Water
2010	Jan	619	318	0%	16%	48.6%
	Feb	935	485	0%	14%	48.1%
	Mar	839	416	0%	14%	50.4%
	Apr	752	347	0%	14%	53.9%
	May	938	500	0%	13%	46.7%
	Jun	1,352	869	0%	13%	35.7%
	Jul	976	638	0%	13%	34.7%
	Aug	919	570	0%	13%	38.0%
	Sep	851	595	0%	13%	30.1%
	Oct	721	423	0%	14%	41.3%
	Nov	586	355	0%	14%	39.5%
	Dec	575	311	0%	14%	46.0%
Total				**0%**	**14%**	**42.1%**
2011	Jan	611	268	0%	**14%**	56.1%
	Feb	624	314	0%	14%	49.7%
	Mar	634	325	0%	14%	48.7%
	Apr	761	451	0%	14%	40.7%
	May	962	593	0%	14%	38.4%
	Jun	1,271	826	0%	13%	35.0%
	Jul	1,168	739	0%	15%	36.7%
	Aug	1,385	872	0%	20%	37.0%
	Sep					
	Oct					
	Nov					
	Dec					
Total				**0%**	**15%**	**40.8%**
	* includes filter backwash and cistern losses					
		All volumes in thousands of gallons				



water use, it is likely that a significant amount of the water loss observed by Vroman relates to inaccurate water meters.

As indicated earlier, Vroman Water Company does have some unmetered water use, related to filter back-wash and losses in the cistern (which happen regularly), and system flushing activities which happen irregularly. This water use is estimated to be about 15% of total water deliveries on an annual basis as indicated in Table 1. Vroman does not have any metered, unbilled water use. Unmetered water losses are included in the estimate of non-revenue water.

Needs/Recommendations

The Vroman Water Company has not identified any specific improvements that are needed to improve water loss management. However, there is a number of best management practices which may help the Vroman Water Company better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Continue to replace customer meters, as needed, which record in 100 gallon increments.
- Track water use through each meter over time to help prioritize future replacements.
- Replace remaining ABS pipe as resources allow.
- Repair cistern to reduce leaks and overflow.
- Install sub-meters and isolation valving in the pipeline system to improve leak detection and system management during leak repairs and other maintenance activities.
- Conduct a more rigorous system wide audit to identify and characterize customer water use, as well as unmetered water use over time.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

West Grand Valley Water

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide West Grand Valley Water with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas West Grand Valley Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide West Grand Valley Water with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at a meeting at your offices on September 30, 2012. The following text and tables summarize the data provided to the District during the audit.

Water Sources	2 groundwater production wells	Filtration, ozonation, and chlorinated then to distribution
Master Meter	2 master meters: one on the well, one on the post-treatment pump	2-inch master meters tested every three years; meters replaced 2 and 4 years ago.
Meter Readings	Monthly (~25th of the month)	
Billings	Monthly (1st of the month)	

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	36	6	6	8	10	6

Replacement of meters has been occurring as needed based on field observations at a rate of about 4-6 per year.

Summary of Pipe

Pipe (feet)	1.25-inch	2-inch	4-inch	6-inch	Total
PVC	16,368	13,728	15,312	7,920	53,328

PVC was installed to help reduce leaks associated with ABS pipe. Most new pipe installed in 2009 and 2010.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations based on surface expressions, pressure drops, and customer calls.	No record on number of leaks in the past two years.
Leak Repair Costs		No information
Pipe Replacement	Nothing currently planned	

Water Loss Calculations

Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010 and 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

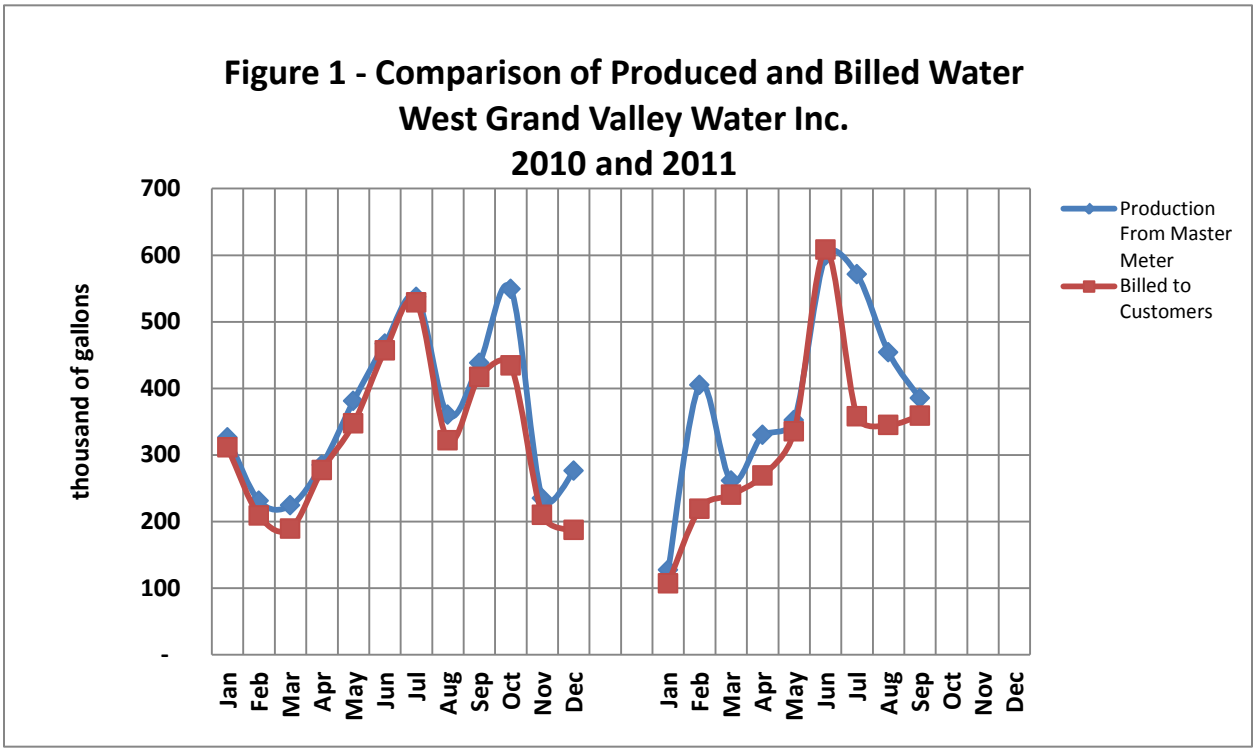
The water loss profile presented in Figure 1 indicates that water loss has nearly doubled over the past two years perhaps as the result of individual leaks and water line failures (which are exemplified by large losses in February, July and August of 2011). Excluding these losses, the water loss in 2011 would be approximately on par with the 2010 water loss (i.e., 6.6% versus 8.2%[2]). For this reason, it would appear that West Grand Valley should focus its efforts on preventing future leaks and investing in equipment and infrastructure that support quick leak detection and repair. For example, West Grand Valley would benefit from submetering in its distribution system (to aid in locating and detecting leaks) and in isolation valving (to aid in leak repair and pipe replacement).

Another issue that may influence West Grand Valley's water loss month to month is the measurement increment on its customer meters. If West Grand Valley has meters that read in 1000 gallon increments,

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).
[2] 8.2% is the 2010 non-revenue water excluding December, which appears to have been impacted by a leak.

Table 1 – Non-Revenue Water Calculation

		Production				
		From Master Meter	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled*	Non-Revenue Water
2010	Jan	326	311	0%	2.9%	4.6%
	Feb	231	209	0%	3.6%	9.5%
	Mar	224	189	0%	4.2%	15.6%
	Apr	285	277	0%	3.2%	2.8%
	May	381	347	0%	2.4%	8.9%
	Jun	467	457	0%	1.9%	2.1%
	Jul	537	529	0%	1.7%	1.5%
	Aug	360	322	0%	2.6%	10.6%
	Sep	438	417	0%	2.1%	4.8%
	Oct	549	434	0%	1.7%	20.9%
	Nov	235	210	0%	3.8%	10.6%
	Dec	276	187	0%	3.4%	32.2%
Total				**0%**	**2.5%**	**9.7%**
2011	Jan	127	107	0%	7.3%	15.7%
	Feb	405	219	0%	2.1%	45.9%
	Mar	261	240	0%	3.6%	8.0%
	Apr	330	269	0%	2.7%	18.5%
	May	352	335	0%	2.6%	4.8%
	Jun	599	608	0%	1.5%	-1.5%
	Jul	571	358	0%	1.6%	37.3%
	Aug	454	345	0%	2.0%	24.0%
	Sep	385	359	0%	2.3%	6.8%
	Oct					
	Nov					
	Dec					
Total				**0%**	**2.4%**	**18.5%**
	* includes filter backwash.					
		All volumes in thousands of gallons				



it is likely that individual month water loss calculations will be inaccurate since most customers only use a few thousand gallons per month. Over time this inaccuracy evens out, but it would be good practice to begin replacing meters with 100 gallon gauging increments rather than 1000 gallon.

West Grand Valley Water does have some unmetered water use, related to filter back-wash which happens regularly. This water use is estimated to be about 2.5% of total water deliveries on an annual basis as indicated in Table 1. West Grand Valley does not have any metered, unbilled water use. Unmetered water losses are included in the estimate of non-revenue water.

Needs/Recommendations

The West Grand Valley Water has not identified any specific improvements that are needed to improve water loss management. However, there is a number of best management practices which may help the West Grand Valley Water better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Continue to replace customer meters, as needed, which record in 100 gallon increments.
- Track water use through each meter over time to help prioritize future replacements.
- Install sub-meters and isolation valving in the pipeline system to improve leak detection and system management during leak repairs and other maintenance activities.
- Conduct a more rigorous system wide audit to identify and characterize customer water use, as well as unmetered water use over time.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).

West Holbrook Pipeline Co.

System Wide Audit White Paper

May 2012

Prepared by:

Great Western Institute
On behalf of the
Southeastern Colorado Water Conservancy District

Introduction

The purpose of this white paper is to provide West Holbrook with information and feedback related to the system-wide water audits that were conducted by the Southeastern Colorado Water Conservancy District (District) last year, as part of the Arkansas West Holbrook Conduit project, in general, and the Regional Water Conservation Plan (Plan), in particular. To support the overall regional planning effort, this white paper provides the following:

- An overview of the audit program
- A summary of the data collected from your organization

Please take a few minutes to review the information that is provided and please let us know if you identify any errors or inaccuracies in the reported information.

One last note is that the District will be conducting a workshop within the next two to four months to provide West Holbrook with an overview of the Regional Water Conservation Plan and the District's efforts to coordinate this plan with other District programs.

System Wide Audit

Objectives

The overall objective of the system wide audit was to develop an understanding of the challenges faced and successes realized by the Plan participants in managing ongoing water loss - including both real and apparent losses - from their collective water supply systems. Key tasks of the project were therefore performed to:

- Inventory existing infrastructure including number and sizes of master meters, customer meters, treatment works and distribution piping (including materials);
- Identifying best management practices addressing leak detection and repair, meter testing and replacement, and meter reading and billing protocols; and
- Understand overall data handling practices.

These data were used to characterize and calculate water losses for your water supply system, from the production wells to the customer meters. These data were also used to support development of water conservation programs which may be considered by the District and the Plan participants to improve local water use efficiency. Finally, the system wide audits were used to identify potential benefits to your organization associated with the proposed AVC Project related to reduced energy costs and water loss.

One other objective of the project is to identify potential regional, state and federal funding programs (e.g., grants, low or no interest loans) that may be used to support and/or fund local water use efficiency improvements. Potential funding options will be discussed in the System Wide Audit Report, prepared by the District, rather than in this white paper.

Preliminary Audit Tasks/Data Collection Request

Prior to the audits being performed, communications were made with your organization to inform you and your Board of the nature and intent of the water audit; and to request that specific data be made available for the audit team on their arrival. The transmittal included:

- A request for the definition of the system boundaries and area;
- Setting a specific time period over which data will be collected; and
- Setting the units of measure (e.g., gallons of water delivered).

Based on this request, your organization was asked to assemble the data and have it prepared to provide to the audit team upon their arrival. Due to the efforts of your organization, data was prepared and provided to the District in hard copy format, and anecdotally, in a timely manner.

The specific data your organization provided included the following:

- List of all the meters you service by size.
- Approximate age of the meters.
- Identification of customers with the largest meters.
- A map showing locations of well head(s) and other source water, master meter and service area.
- Estimates of master meter size and age.
- Monthly master meter data for two years, with date read.
- Monthly water delivery data for all customers for two years (unbilled, billed, and date billed).
- List and/or map of water distribution system with pipe size and material; age of pipe.
- Listing of metered, unbilled accounts, if they exist (for example: parks, water treatment use, and so on).
- List of unmetered water use for past two years (examples include flushing flows, firefighting, filter backwash, leaks and line breaks).
- Any other useful data.

Although some of the data provided to the District was anecdotal in nature, and included estimates, it was deemed adequate to characterize current water loss in your system.

Results and Summaries

The audit was conducted at a meeting at your offices on August 29, 2012. The following text and tables summarize the data provided to the District during the audit.

Water Sources	2 groundwater production wells	Chlorinated then to distribution
Master Meter	2 master meters: one on each well	5/8-inch master meters tested every three years; meters replaced 1 year ago.
Meter Readings	Monthly, when possible; some meters read bi-monthly	Records kept by hand
Billings	Monthly, when possible; some meters read bi-monthly	

Summary of Meters

Meters		Age (years)				
		<1	1 to 2	2 to 5	5 to 10	>10
5/8 by 3/4	12	2	1	3	2	4

Replacement of meters has been occurring as needed based on field observations at a rate of about 1 or 2 per year.

Summary of Pipe

Pipe (feet)	1-inch	6-inch	Total
PVC	5,280	6,600	11,880
ABS	1,320		1,320

PVC was installed to help reduce leaks associated with ABS pipe. Most new pipe installed in the 1990s.

Summary of Leak Detection Methods and Costs, and Ongoing Pipe Replacement Efforts

Leak Detection Methods	Typically field observations based on surface expressions, pressure drops, and customer calls; and meter data 3 times per week.	1 leak in the past year.
Leak Repair Costs		No information
Pipe Replacement	Nothing currently planned	

Water Loss Calculations

Water loss, calculated as non-revenue water[1], was developed based on water production and water billings for 2010 and 2011. Table 1 on the next page provides those data used to calculate non-revenue water. The resulting calculations are presented graphically in Figure 1.

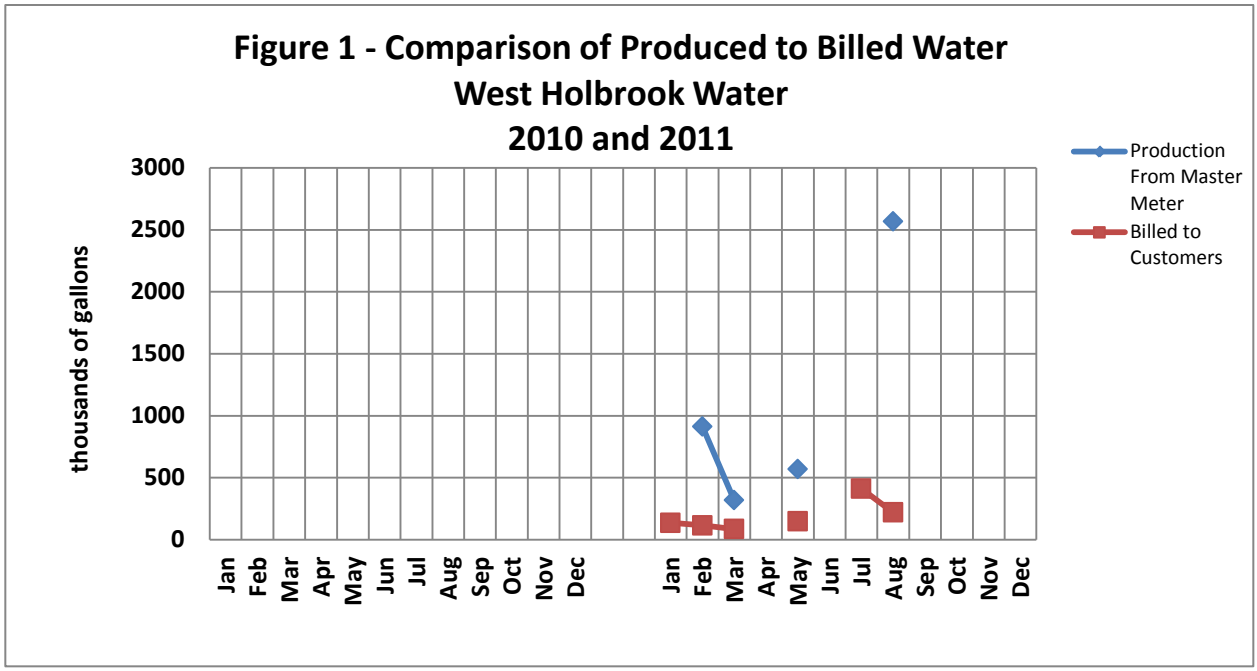
The water loss profile presented in Figure 1 indicates that water loss is difficult to track given the data that is collected by West Holbrook. This is due to the apparent fact that master meter readings are not coordinated with customer meter reading efforts and meter reading occurs at irregular intervals. However, based on a balance of water produced versus water sold in 2011, water loss totals nearly 75%.

This amount of water loss requires attention to better characterize the source of the loss – real or apparent – and identify practices that will help reduce water loss and improve revenue generation for West Holbrook. To begin with, West Holbrook may want to consider collecting customer and master meter readings on the same day of each month for 6 to 9 consecutive months; and monitoring unmetered and metered, unbilled uses, such that a consistent definition of water use and water production costs and revenues can be ascertained. This effort would bring West Holbrook to a level of water data records consistent with the other water companies in the area. It would also help West

[1] Non-revenue water is the difference between produced water and water sold to the customers excluding unmetered uses and unbilled, metered uses. Non-revenue water is comprised of real loses (leaks in pipes) and apparent losses (due to inaccurate meters, data handling errors (e.g., not identifying unbilled uses)).

Table 1 – Non-Revenue Water Calculation

		Production				
		From Master Meter	Billed to Customers	Metered/Unbilled	Unmetered/Unbilled	Non-Revenue Water
2010	Jan					
	Feb					
	Mar					
	Apr					
	May					
	Jun					
	Jul					
	Aug					
	Sep					
	Oct					
	Nov					
	Dec					
Total						
2011	Jan		136	0%	0%	
	Feb*	912	115	0%	0%	
	Mar	318	86	0%	0%	
	Apr			0%	0%	
	May	569	148	0%	0%	
	Jun			0%	0%	
	Jul		410	0%	0%	
	Aug	2,568	220	0%	0%	
	Sep					
	Oct					
	Nov					
	Dec					
Total				**0%**	**0%**	**74.5%**
	• February water produced dated from December 2010					
		All volumes in thousands of gallons				



Holbrook to identify practices that may help reduce real and apparent water losses, and set water rates that are based on the actual cost of service.

West Holbrook does not have any known unmetered water uses. The water system manager's water use is metered but unbilled. No information was available on the volume of metered, unbilled water used. Unmetered, and metered, unbilled water uses are included in the estimate of non-revenue water.

Needs/Recommendations

West Holbrook has not identified any specific improvements that are needed to improve water loss management. However, there is a number of best management practices which may help West Holbrook better characterize non-revenue water and improve organizational cash flow.

The potential improvements may include:

- Initiate a 6-9 month meter reading program to develop a consistent data collection process.
- Continue to replace customer meters, as needed, which record in 100 gallon increments.
- Track water use through each meter over time to help prioritize future replacements.
- Install sub-meters and isolation valving in the pipeline system to improve leak detection and system management during leak repairs and other maintenance activities.
- Conduct a more rigorous system wide audit to identify and characterize customer water use, as well as unmetered, and metered, unbilled water use over time.
- Conduct water rate studies to allow for rates to be set at cost of service (including water line replacement, expected water loss, etc.).