Water Conservation Plan

Prepared for **Town of Silver City, New Mexico**

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A AWWA Performance Indicators

Executive Summary

The Town of Silver City initiated a water conservation planning process to evaluate ways to sustain and conserve its municipal groundwater supply. The water conservation plan was developed with guidance and review of a stakeholder group that included representation from the Town, water associations, environmental groups, local committees, the local business community, the New Mexico Environment Department, the Southwest New Mexico Council of Governments, and the general public.

The Town of Silver City supplies water to about 10,000 residents within the Town and to additional customers outside of the Town, serving a total of about 5,300 homes and 600 commercial accounts. Additionally, the Town water system sells water to five water associations (the Arenas Valley Water Association, Pinos Altos Mutual Domestic Water Consumers' Association [MDWCA], Rosedale MDWCA, Tyrone Property Owners Association (TPOA), and Tyrone MDWCA), resulting in a total population receiving water from the system of about 20,000. The total metered production in 2011 was 926,261,000 gallons (2,842 acre-feet) and in 2012, 823,500,000 gallons (2,527 acre-feet).

Silver City currently relies exclusively on groundwater from well fields located in both the Mimbres and Gila-San Francisco Basins (from aquifers of the Upper and Middle Gila Group). Water is supplied by Frank's well field (two wells in production), the Gabby Hayes well, and the Woodward well field (five wells in production). The Frank's well field is located in the Gila-San Francisco Basin; the Woodward well field and Gabby Hayes well are located in the Mimbres Basin.

Prior to identifying conservation programs, it is important to audit existing water use patterns to identify areas where conservation can be most beneficial. Accordingly, an audit was conducted that included analyses of historical and current water use and evaluation of the meters and billing system that are used to record water use.

Historical monthly water production data from 1989, 1996, and 2002 through 2012 were used to establish baseline historical water use. Historical data indicate that water production is greatest during the summer months, with June water production being the highest. Summer water use is greater in all three sectors, but especially in the residential sector, due to outdoor water use and the widespread use of swamp coolers for air conditioning.

Evaluation of the largest water users can help to target conservation efforts where they will have the greatest impact. In 2011, the top user was the Ben Altamirano municipal sports complex, which irrigates an area of 11.5 acres. The remaining top users include multiple Western New Mexico University (WNMU) and Silver City Schools facilities, the Gila Regional Medical Center, some apartments and mobile home parks, the Grant County Court House, several commercial customers (e.g., laundry, real estate, lodging, and churches), and Gough Park.

Issues unique to Silver City that affect the goals and design of the conservation program include a large groundwater supply, the need for a revenue-neutral conservation program, the ongoing application for return-flow credit where wastewater discharge is recharging the aquifer, and the sizing of the new solar array at the wastewater treatment plant. Considering these unique issues, the Town of Silver City has outlined the following goals for its water conservation program: reduce outdoor water use, reduce water waste, reduce peak summer demands for more efficient system operation and reduced energy use, reduce pumping and treatment costs, ensure a revenue-neutral program that can be financed by the Town, strengthen ordinances and policies relating to water conservation, minimize nonpoint source pollution by integrating stormwater management into the water conservation program, educate the public about water conservation, and incentivize conservation behavior. Performance measures and fiscal impacts are outlined in this plan.

The Town anticipates a phased implementation program. Addressing water conservation will not be a one-time event. After the first 5 years of the program, the Town will revisit its longer-term goals. It will be important to continue to carefully monitor water use and assess how uses are changing in response to (1) specific conservation practices and (2) the general trend of hotter and drier weather. Thus, efficient measurement and reporting will be a key component of the water conservation program.

The water conservation plan is intended to provide a model for discussion with local water associations and the broader regional area of Grant County, including Santa Clara, Bayard, and

Hurley, to develop at their discretion water conservation programs and strategies for their own communities. The Town of Silver City provides bulk water to five water associations that operate and maintain their own systems. The information and recommendations in this plan may be helpful to these associations in developing and obtaining their own water conservation goals, but the Town recognizes that the associations are independent and are not bound by the Town's recommendations.

1. Introduction

The Town of Silver City relies entirely on groundwater from aquifers of the Upper and Middle Gila Group for its municipal water supply. To evaluate ways to sustain and conserve this water supply into the future, the Town initiated a water conservation planning process. The water conservation planning process is also intended to increase public awareness and support for water conservation, reduce peak summer demands, and strengthen ordinances and policies relating to water conservation. The Town contracted with Daniel B. Stephens & Associates, Inc. (DBS&A), who worked in conjunction with subcontractor Joanne Hilton, to complete the water conservation plan under the guidance of a steering committee consisting of staff from the Community Development Department, the Office of Sustainability, the Utilities Director, and a local non-profit involved in water issues.

Water conservation is an important component of the Town of Silver City water planning process for several reasons:

- Water conservation can provide cost savings in reduced pumping and water and wastewater treatment costs.

- The New Mexico water code calls for conservation planning as a prerequisite for applying for funding from key state funding agencies (NMSA 1978, Section 72-14-3.2).

- The Arizona Water Settlements Act of 2004, P.L 108-451 (AWSA), can potentially provide funding for water conservation efforts, but initial auditing of existing efficiencies and water conservation plans is required before project funding will be provided.

- Water conservation can prevent or delay the need for expensive capital expenditures for developing new water supplies and acquiring additional water rights.

This water conservation plan addresses the above state conservation requirements and presents multiple conservation methods that can reduce per capita demand. This plan will assist the Town of Silver City in making efficient use of its existing resources by allowing for a reduction in groundwater withdrawals, thus extending the available water supply.

This water conservation plan was developed with guidance and review of a stakeholder group that included representation from the Town, water associations, environmental groups, local committees, the local business community, the New Mexico Environment Department (NMED), the Southwest New Mexico Council of Governments, and the general public. Efforts were made to contact representatives from all water user groups to participate in the stakeholder group, and all meetings were advertised and open to the public.

The water conservation plan is also intended to provide a model for discussion with local water associations and the broader regional area of Grant County, including Santa Clara, Bayard, and Hurley, to develop at their discretion water conservation programs and strategies for their own communities. The Town of Silver City provides bulk water to five water associations that operate and maintain their own systems. The information and recommendations in this plan may be helpful to the associations in developing and obtaining their own water conservation goals, but the Town recognizes that the associations are independent and are not bound by the Town’s recommendations.

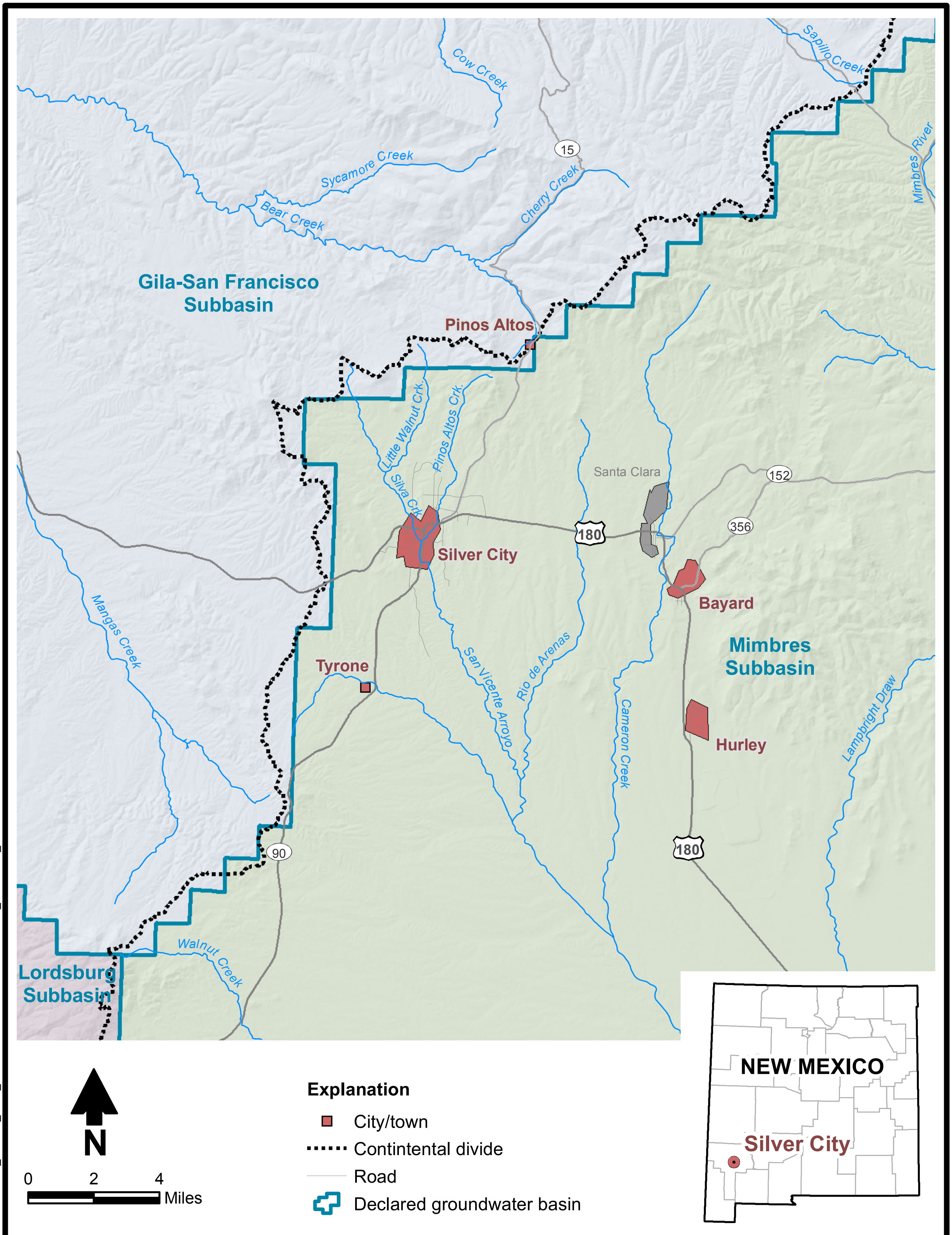
2. Water System and Supply

The Town of Silver City supplies water to about 10,000 residents within the Town and to additional customers outside of the Town, serving a total of about 5,300 homes and 600 commercial accounts. Additionally, the Town water system sells water to five water associations (the Arenas Valley Water Association, Pinos Altos Mutual Domestic Water Consumers' Association [MDWCA], Rosedale MDWCA, Tyrone Property Owners Association (TPOA), and Tyrone MDWCA), resulting in a total population receiving water from the system of about 20,000. The total metered production in 2011 was 926,261,000 gallons (2,842 acre-feet) and in 2012, 823,500,000 gallons (2,527 acre-feet).

Silver City currently relies exclusively on groundwater from well fields located in both the Mimbres and Gila-San Francisco Basins (Figure 1). Water is supplied by Frank's well field (two wells in production), the Gabby Hayes well, and the Woodward well field (five wells in production). The Frank's well field is located in the Gila-San Francisco Basin; the Woodward well field and Anderson and Gabby Hayes wells are located in the Mimbres Basin. Wells range in depth between 547 and 1,095 feet below ground surface (ft bgs), with an average depth of 911 ft bgs for the eight wells in production. The principal aquifer that supplies the Town's wells is the later Tertiary- to early Quaternary-aged Upper Gila Group, supplying the Woodward well field, and the late Tertiary-aged Middle Gila Group, supplying the Frank's well field (Hawley et al., 2000).

Previous planning efforts by the Town of Silver City (Engineers Inc., 1993) have indicated that groundwater use exceeded recharge rates and that water levels in the Town wells were dropping at a rate of 1.5 to 5 feet per year. The earlier work also indicated that the projected lifetime of the existing wells is around 30 to 50 years from the time of the study (Engineers, Inc., 1993). An initial water conservation plan was developed (Engineers Inc., 1996) to help extend the viability of the existing wells and groundwater supply. This conservation plan updates that initial effort considering recent trends and current data.

The U.S. Census Bureau reported that 10,315 people lived in Silver City in 2010, a 2.2 percent decrease from the total population in 2000 (U.S. Census, 2010). The 2010 census listed



SILVER CITY CONSERVATION

Project Area

Figure 1

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6/13/2013
WR12.0082

4,900 housing units in Silver City, with an average household size of 2.25 people. There were 511 vacant housing units in Silver City in 2010, compared to 530 vacant housing units in 2000 (U.S. Census, 2010). As noted above, the water system also supplies water to communities outside the Town limits and over time may serve additional out-of-town connections other than the existing associations and connections. Therefore, even though population in the Grant County has declined slightly, there is potential for system growth.

3. Water Audit

Prior to identifying conservation programs, it is important to audit existing water use patterns to identify areas where conservation can be most beneficial. Accordingly, this section includes a description of the meters and billing system that are used to record water use, analyses of historical water production, historical water use by sector, billed and metered production, and top water users, a description of the International Water Association/American Water Works Association (IWA/AWWA) guidelines for water audits, and the results of the 2011 water audit using Town data.

The historical water use summary includes general water use data from 1995 to the present. The detailed analysis of water use data was initiated in mid-2012 and was based on 2011 data by sector and includes production as well as billed data; the IWA/AWWA water audit was also based on the detailed 2011 data. DBS&A subsequently obtained 2012 data and reviewed it in a more general format.

3.1 Water System Meters

When considering an audit of water use data, it is important to evaluate the accuracy of the data, which for Silver City is collected through production and customer water meters. Meter error is most accurately estimated by performing actual system-specific field surveys. Such surveys are done for the Town's production well meters and for the meters for the water association bulk sales, but not for customer meters; therefore, customer meter error has been estimated.

3.1.1 Production Meter Error

The Town has been conducting production meter accuracy testing on an annual basis and has recently increased the testing frequency to twice per year. After testing, each production meter is calibrated to 100 percent (Esqueda, 2012). The 2012 testing indicated that the meters on all eight wells that are currently in production were over-reporting, by a range of 1.2 to 16.5 percent, meaning that all eight meters were reporting more water than was actually pumped from the wells. The average meter error was calculated by weighting the total production for each of the nine wells, resulting in an average over-reporting error of 5.4 percent.

In 2011, the production meter testing indicated that the Town's production meters were off by between 18 percent under-reporting and 92 percent over-reporting, for a weighted average of 13.9 percent over-reporting (Esqueda, 2012). This meter error was largely due to the Woodward well 3 meter, which was over-reporting by approximately 92 percent. Following the 2011 meter testing, piping modifications were made at Woodward well 3 to address turbulent flow, and in 2012, this well meter was over-reporting by only 1.5 percent (Esqueda, 2012).

3.1.2 Customer Meter Error

Most customer meters are positive displacement meters, which have either an oscillating piston or rotating disc that moves to allow water to pass through the meter, translating measurements of volume into measurements of flow (Vickers, 2001). Positive displacement meters will give inaccurate readings if the piston/disc is damaged or if they wear out by operating at high flows for long periods of time (Vickers, 2001). The rate of decline in accuracy will depend on (1) the sand content and quality of the water that flows through the meter and (2) changes in system pressure. Customer meter accuracy also depends on whether the appropriate meter size is used for a connection, based on the typical range of flow through the meter.

The age of customer meters in Silver City ranges from new to approximately 30 years old (Esqueda, 2012). There isn't a specific goal for the number of customer meters that are replaced each year; rather the Town replaces meters as needed due to age and condition (Esqueda, 2012).

The normal operating range of customer meters differs by size: the larger the meter, the higher the minimum normal operating range flow. The majority of customer meters in Silver City are ¾-inch, with a few 1- and 1½-inch diameter meters within the commercial sector (Esqueda, 2012). The AWWA standard requires that ¾-inch meters measure flow between 3 and 25 gallons per minute (gpm) within ±1.5 percent accuracy (AWWA, 2012). For the larger meter sizes, AWWA standards require meters to measure within 1.5 percent accuracy flows of 4 to 40 gpm for 1-inch meters and 8 to 50 gpm for 1½-inch meters (AWWA, 2012).

Because the majority of the customer meters are ¾-inch and the Town replaces meters as needed, customer meter error has been estimated to be 2 percent for the purposes of the water audit analysis. AWWA standards require ¾-inch positive displacement meters to measure flows of 2 to 30 gpm with an error of ±1.5 percent (AWWA, 2012). New meters are expected to perform better than this acceptance standard; however, older meters may have higher errors. The 2 percent estimate represents a moderately low meter error, reflective of the Town's existing meter replacement program.

3.1.3 Meter Accuracy at Low Flows

Because use of evaporative coolers is widespread in Silver City and evaporative coolers use water steadily at low flow rates, the accuracy of meters at low flow rates could be important. Evaporative cooler demand is believed to be accurately measured by new meters, but is assumed to not register completely on older meters.

Evaporative cooler demand was calculated for Silver City for a 1,700-square foot house (based on Wilson [1996]) assuming that Silver City has the same number of cooling hours per cooling season as Albuquerque (1,130 hours) and that the evaporative coolers do not have recirculating bleed-off systems (Wilson [1996] presents estimates for the number of cooling hours for a short list of communities, and the design temperatures cited for Albuquerque compare best to Silver City). From this calculation, each evaporative cooler is estimated to use approximately 18,000 gallons per year. The 2010 census indicates that there are 4,900 housing units in Silver City (U.S. Census, 2010). Assuming that all housing units have evaporative coolers, total residential evaporative cooler demand would be 88,200,000 gallons per year or approximately 270 acre-feet per year (ac-ft/yr) (this estimate does not include evaporative coolers used in the commercial sector). This estimate represents an approximation; evaporative cooler use may vary depending on air temperatures, actual number of hours of cooler usage, and the presence of commercial cooling units.

AWWA low-flow accuracy standards vary by meter size, increasing with larger meter sizes. For ¾-inch meters (the size for most residential water meters in Silver City) AWWA specifies that the meters should accurately read flows of ½ gpm and above (AWWA, 2012). For 1- and 1½-inch meters, they should accurately read flows as low as 1-½ and 2 gpm, respectively

(AWWA, 2012). Flows less than these standards are expected to occur at night, when demand is minimized.

Assuming that low-flow accuracy standards are being met, for flows less than the standard for each meter size, meter reading error will be up to 5 percent, with the unmetered flows resulting in non-revenue water. For an 8-hour period where flow through a ¾-inch meter is less than ½ gpm, up to 240 gallons could be unmeasured for each meter per day (number of minutes in 8 hours multiplied by ½ gpm). Therefore, the maximum amount of water not measured by the ¾-inch residential water meters in Silver City due to flows less than ½ gpm not registering is 4,116,000 gallons per cooling season (multiplying the number of housing units in Silver City by 240 gallons per day [gpd] for a 70-day cooling season [based on the number of cooling hours as cited in Wilson, 1996], and multiplying by the meter reading error rate of 5 percent). This compares to approximately 0.5 percent of total Town production in 2011. Given differences between conditions in Silver City and those in communities from which the values used in the estimate were derived, the actual amount of unmeasured water due to evaporative cooler demand is likely somewhat less than this estimate.

3.2 Billing System and Database Error

The Town of Silver City uses an automated billing system to track water use by customer. Since 1996 the Town has been using HTE billing software. Data queries and reports can be run within the system, providing various data for the periods of interest.

To help determine the water use data accuracy, database entries are evaluated to see if they appear to be inconsistent with physical data. In particular, evaluation of the validity of entries that are either zero or blank can help determine the accuracy of billing system reporting. Inaccuracies in the non-zero values are more difficult to detect and evaluate; such additional inaccuracies may stem from problems with data collection.

Of the 90,708 possible database entries in the 2011 database, approximately 7.8 percent (7,097 entries) are zero and 16.1 percent (14,637 entries) are blank. There are two valid reasons for blank or zero values: inactive accounts and low usage.

- Some of the blank entries counted may represent inactive accounts. In the 2011 database 429 accounts had no usage in 2011, accounting for 5,148 monthly entries (429 accounts times 12 months). Of the 4,900 housing units in Silver City, 511 units are vacant (U.S. Census, 2010). If 511 accounts are inactive, the number of monthly entries that could be blank or zero due to housing vacancies is 6,132 (511 accounts times 12 months). Town staff indicated that the database should not include blank values except in cases where an account was set up sometime within the year (consumption would be blank for months that pre-date account set up [Nuñez, 2012]).

- Low usage results in zero values because the Town bills customers in increments of 1,000 gallons, and the database should contain zero values for months in which a customer used less than 1,000 gallons (these customers are still billed the minimum monthly charge [Nuñez, 2012]). Town staff estimate that approximately 2,500 customers (47 percent of residential accounts) use less than 1,000 gallons each month (Nuñez, 2012), which could account for as many as 30,000 zero or blank values in the 2011 database. The Town evaluates customer water use on a monthly basis and does not sum readings from multiple months to obtain readings of over 1,000 gallons for these low water using customers. If a customer uses less than 1,000 gallons per month each month, the billing database will show zero for every month for that customer. The customer still pays for water (the fee for up to 1,000 gallons), but the billing database doesn’t show that these customers used any water.

The total number of cells that are expected to be zero or blank because of the number of vacant housing units in Silver City (6,132 entries) and the number of customers that use less than 1,000 gallons per month (30,000 entries) more than covers the number of cells that were blank or zero in 2011 (21,734 entries). Therefore, although database error is not expected to be zero, it has been estimated as zero. In order to better account for customer water use, actual volumes used by each customer should be entered into the Town billing database, regardless of how small the usage. Given the total number of low-water-use customers (approximately 2,500 accounts), these small volumes (less than 1,000 gallons per month) can add up to a significant volume of water, especially over a full year. For example, assuming that the accounts that use less than 1,000 gallons per month and are reported in the billing database as zero actually use between 400 and 900 gallons per month, the total annual usage for these accounts would be between 12 and 27 million gallons (400 to 900 gallons per month x 12 months x 2,500 accounts) or approximately 37 to 83 ac-ft/yr.

3.3 Historical Water Use

Historical monthly water production data from all pumping wells from 1995 to 2012 were obtained from the Town (Table 1 and Figure 2). Maximum production during this period occurred in 2000 (992,045,946 gallons), and minimum production occurred in 2012 (823,524,100 gallons). Average water production ranged between approximately 68 and 83 million gallons per month (209 to 255 ac-ft/yr). Monthly water production for 2011 and 2012 is shown on Figures 3 and 4, respectively. Both of these figures indicate that water production is greatest during the summer months, with June water production being the highest. Water demand during May through September varies from year to year, depending on how much rain the Town receives, while demand is fairly consistent year to year for the other months (Esqueda, 2012).

Annual demand data by sector were obtained for 1989 through 1996 and 2002 through 2012 (Table 2). Annual totals were also obtained for 1997 through 2001 (Esqueda, 2013), but sector level data were unavailable for these years (Smith, 2013; Esqueda, 2013). The Town purchased the current billing software in about 1995, but the utility billing was not fully implemented until 2001 (Fortenberry, 2012). Demand data from before the current billing system went live are not available, and so historical billing data by sector were not available for 1997 through 2001.

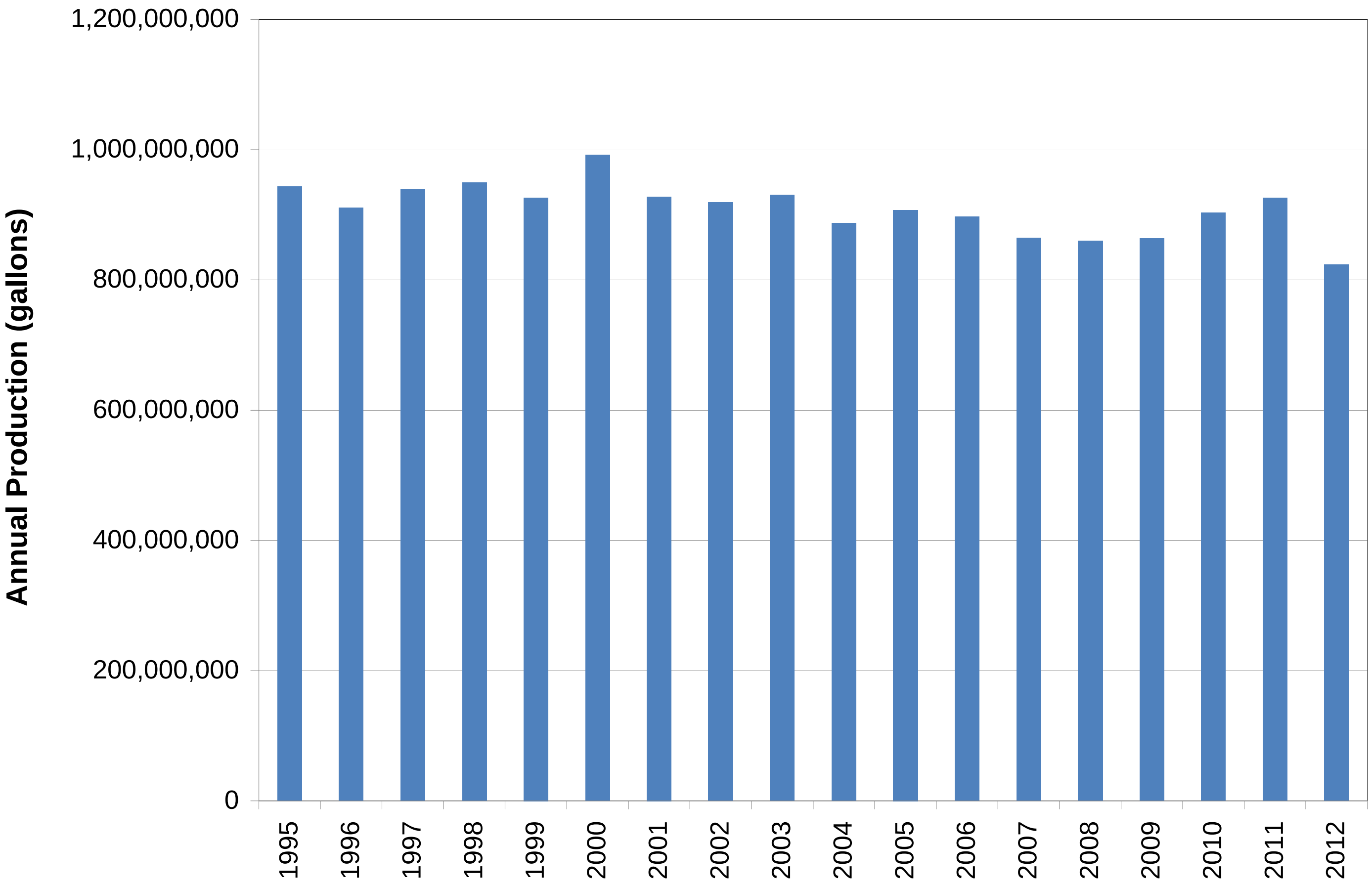
Based on the available historical data, the minimum, maximum, and average uses for the residential, commercial, commercial with residential rates, and combined associations and other accounts are shown on Table 3. This information represents baseline data that the Town can use to evaluate the performance of future water conservation efforts.

Table 1. Monthly Water Production
1995 through 2012

Month	Water Production (gallons)																	
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Jan	55,591,300	59,457,000	62,135,200	70,087,960	58,454,000	61,287,230	59,798,000	62,252,000	62,002,000	59,377,000	54,949,000	59,062,000	58,129,000	58,346,000	56,899,000	52,502,000	60,947,800	50,940,200
Feb	52,573,200	54,498,600	54,521,720	49,070,520	66,743,000	61,304,990	53,178,000	47,602,000	50,307,000	52,430,000	50,567,000	55,681,000	52,506,500	54,477,000	51,956,000	47,114,000	54,918,000	51,000,000
Mar	87,656,100	71,068,400	59,589,200	64,833,110	81,202,600	70,039,890	69,859,000	68,624,000	55,693,000	63,674,000	59,124,000	65,779,000	70,377,000	64,523,000	64,599,000	63,459,000	72,589,000	55,899,000
Apr	58,389,000	84,428,000	76,841,580	74,467,100	75,183,200	88,180,416	77,387,000	104,070,900	73,695,000	69,700,000	76,653,000	86,730,000	71,565,000	81,803,000	76,646,000	65,930,932	90,002,200	68,114,000
May	127,528,100	119,811,800	97,518,200	119,152,300	98,034,350	113,993,200	99,759,000	105,189,800	102,563,000	111,243,900	95,457,000	106,748,000	78,036,000	91,684,000	90,818,000	92,948,800	98,057,000	89,652,000
Jun	106,460,700	107,135,360	115,142,300	101,589,020	101,667,000	115,906,190	112,299,200	103,983,000	106,735,000	94,470,200	107,885,000	112,175,700	98,840,000	108,139,000	93,380,100	116,761,700	108,552,000	103,633,000
Jul	90,568,600	78,390,920	99,666,510	87,310,890	82,877,340	86,833,400	86,743,000	84,911,000	103,425,000	103,149,400	111,982,600	91,461,000	84,661,000	77,229,000	94,155,600	94,343,800	98,752,000	74,625,000
Aug	108,303,200	80,909,800	82,069,650	89,545,000	74,356,790	97,770,140	92,458,944	89,751,000	88,289,000	77,969,000	80,185,000	66,538,000	77,938,300	73,039,000	89,229,100	96,909,700	72,559,000	82,997,000
Sep	71,475,759	65,330,840	89,093,520	88,519,700	79,094,400	100,399,090	72,588,000	71,173,700	87,772,700	77,197,000	84,118,800	68,615,000	84,976,200	64,216,000	67,244,000	83,502,000	79,541,000	74,305,000
Oct	76,483,900	70,385,700	75,943,000	71,328,700	72,475,400	72,146,400	77,628,600	71,374,000	81,614,000	63,130,400	65,215,600	65,461,000	70,904,100	70,148,400	66,129,000	76,533,000	71,785,800	68,935,000
Nov	53,333,600	59,340,500	65,150,000	65,982,000	68,254,320	66,601,000	64,934,900	57,693,400	59,944,000	57,176,600	64,553,000	60,544,000	60,315,000	59,256,000	58,706,600	58,395,500	66,455,000	49,878,000
Dec	55,275,600	60,056,900	62,358,400	68,173,120	68,312,530	57,584,000	61,385,000	52,225,000	58,387,000	58,214,000	56,918,000	58,378,000	56,376,000	57,378,000	54,256,000	54,665,700	52,102,300	53,545,900
Total (gal)	943,639,059	910,813,820	940,029,280	950,059,420	926,654,930	992,045,946	928,018,644	918,849,800	930,426,700	887,731,500	907,608,000	897,172,700	864,624,100	860,238,400	864,018,400	903,066,132	926,261,100	823,524,100
(ac-ft/yr)	2,896.12	2,795.00	2,884.65	2,915.43	2,843.61	3,044.28	2,847.80	2,819.66	2,855.19	2,724.17	2,785.16	2,753.14	2,653.26	2,639.80	2,651.40	2,771.23	2,842.40	1,998.22
% WR [a]	—	61.20	63.17	63.84	62.27	66.66	62.36	61.74	62.52	59.65	60.99	60.29	58.10	57.81	58.06	60.68	62.24	43.76

[a] Percentage of available water rights

gal = Gallons
ac-ft/yr = Acre-feet per year



SILVER CITY CONSERVATION

Total Annual Production

Daniel B. Stephens & Associates, Inc.

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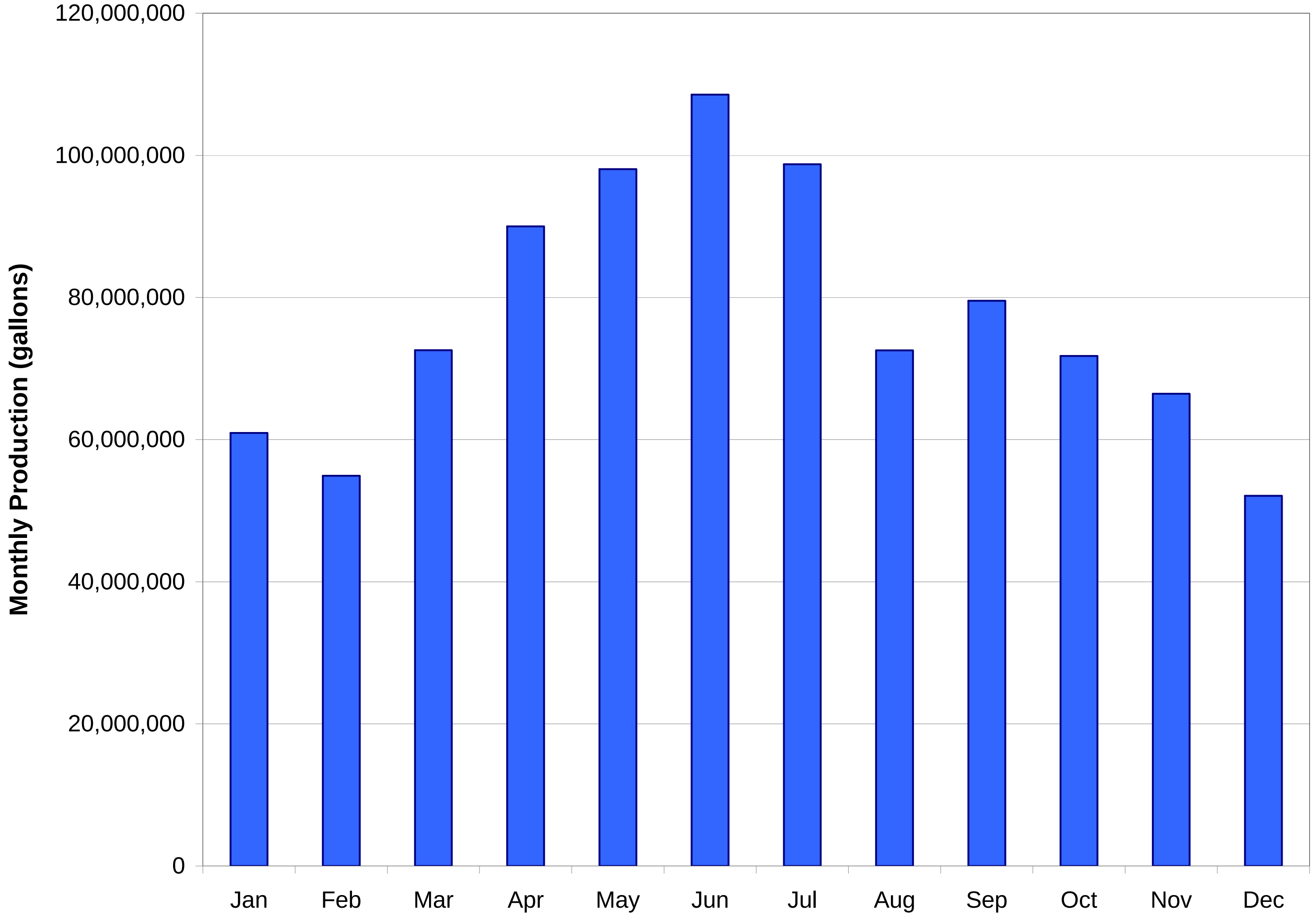
Figure 2



SILVER CITY CONSERVATION

Monthly Production 2011

Figure 3

Daniel B. Stephens & Associates, Inc.

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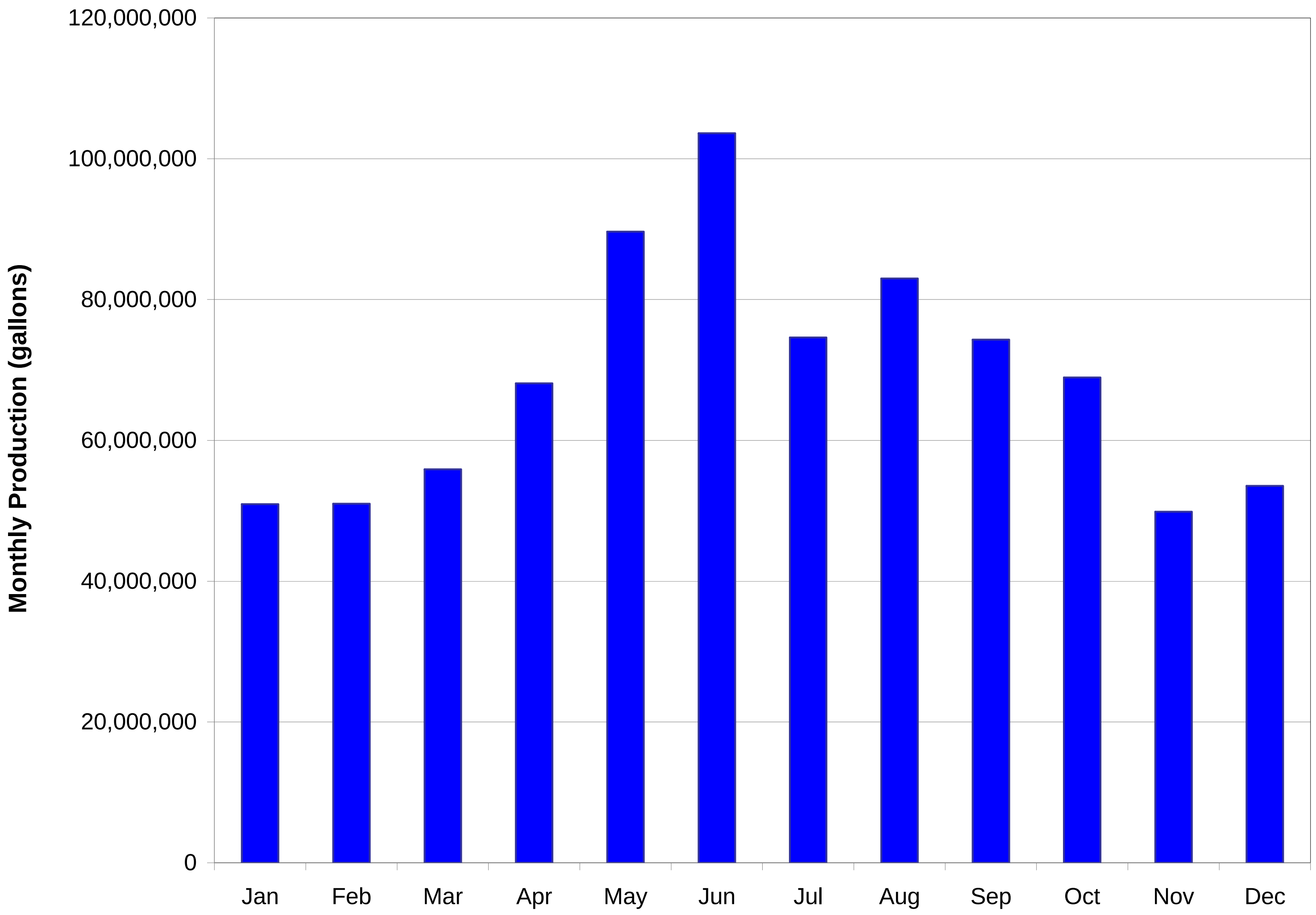

SILVER CITY CONSERVATION

Monthly Production 2012

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Figure 4

Table 2. Annual Usage by Sector
1989 Through 1996 and 2002 Through 2012

Sector	Usage (gallons)																		
	1989	1990	1991	1992	1993	1994	1995	1996 [a]	2002 [a]	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Arenas Valley MDWCA	10,292,000	11,892,000	14,887,000	17,667,000	19,531,000	27,349,000	27,224,000	26,971,000	35,489,000	38,341,000	40,308,000	39,529,000	39,775,000	39,092,000	35,796,000	38,945,000	64,690,000	42,252,000	44,835,000
Commercial	178,555,000	166,343,000	171,767,000	180,417,000	182,641,000	176,894,000	175,443,000	201,879,000	130,082,000	114,171,000	107,761,000	119,337,000	130,410,000	244,955,000	124,987,000	154,379,000	101,813,000	117,283,000	112,188,000
Commercial with Residential Rates	—	—	—	—	—	—	—	—	100,066,000	100,055,000	87,307,000	139,026,000	219,768,000	86,657,000	111,674,000	84,250,000	94,517,000	111,966,000	85,600,000
Pinos Altos MDWCA	4,982,000	5,025,000	4,984,000	5,804,000	6,077,000	7,996,000	7,053,000	7,653,000	11,021,000	10,038,000	11,264,000	10,284,000	8,308,000	8,250,000	7,798,000	7,707,000	8,145,000	9,223,000	8,560,000
Residential	428,980,000	382,877,000	383,694,000	394,323,000	416,358,000	465,523,000	464,960,000	484,708,000	500,908,000	512,644,000	440,364,000	491,201,000	480,132,000	479,148,000	456,527,000	500,786,000	461,116,000	503,728,000	505,222,000
Rafter 2S	—	—	—	—	—	—	—	—	2,552,000	1,085,000	715,000	537,000	1,047,000	10,390,000	1,010,000	945,000	608,000	975,000	1,562,000
Rosedale MDWCA	—	—	—	—	—	—	—	—	7,457,000	5,974,000	6,060,000	6,923,000	6,557,000	6,532,000	6,927,000	6,132,000	13,137,000	6,598,000	6,390,000
Tyrone Townsite (TPOA)	84,741,510	74,703,700	73,892,400	70,551,000	76,945,100	76,094,000	86,436,000	60,808,000	30,446,000	32,174,000	34,708,000	29,072,000	25,770,000	31,535,000	114,301,000	26,111,000	22,845,000	37,663,000	23,374,000
Tyrone Commercial (Tyrone MDWCA)	—	—	—	—	—	—	—	—	93,199,000	984,371,000	243,795,000	106,471,000	13,089,000	3,340,000	26,717,000	19,881,000	28,461,000	16,294,000	16,325,000
Woodward	—	—	—	—	—	—	—	—	1,341,000	1,300,000	1,596,000	1,586,000	2,356,000	2,331,000	2,477,000	1,921,000	1,218,000	1,543,000	1,314,000
Woodward Agreement 2	—	—	—	—	—	—	—	—	147,000	216,000	81,000	102,000	343,000	146,000	82,000	318,000	209,000	359,000	198,000
Other	—	—	—	6,659,000	12,171,000	11,680,200	13,071,700	11,937,000	—	—	—	—	—	—	—	—	—	—	—
Total	707,550,510	640,840,700	649,224,400	675,421,000	713,723,100	765,536,200	774,187,700	793,956,000	912,708,000	1,800,369,000	973,959,000	944,068,000	927,555,000	912,376,000	888,296,000	841,375,000	796,759,000	847,884,000	805,568,000
Total Assn [b]	100,015,510	91,620,700	93,763,400	94,022,000	102,553,100	111,439,000	120,713,000	95,432,000	177,612,000	1,070,898,000	336,135,000	192,279,000	93,499,000	88,749,000	191,539,000	98,776,000	137,278,000	112,030,000	99,484,000

Sources: 1989-1995: Engineers, Inc., 1996
2002-2011: Fortenberry, 2012
2012: Fortenberry, 2013

[a] Complete data not available for 1996 through 2001
[b] Water association total

MDWCA = Mutual domestic water consumers' association
— = Data not available
TPOA = Tyrone Property Owners Association

Table 3. Baseline Historical Water Use Data by Sector

Sector	Annual Historical Water Use [a]					
	Minimum		Maximum		Average	
	(gal)	(ac-ft/yr)	(gal)	(ac-ft/yr)	(gal)	(ac-ft/yr)
Residential	382,877,000	1,175	512,644,000	1,573	460,694,684	1,414
Commercial	101,813,000	312	244,955,000	752	152,173,947	467
Commercial with residential rates	84,250,000	259	219,768,000	674	110,989,636	341
All water users associations and other accounts	88,749,000	272	1,070,898,000	3,286	179,359,879	550
Total for all sectors	640,840,700	1,966	1,797,768,000	5,516	856,485,669	2,628

[a] Based on Water Use Data by Sector 1989, 1996, and 2002-2012 (Fortenberry, 2012). Values for each category and sector are determined independently (e.g., minimum and maximum for each sector, as well as for the total, may not be from the same year).

gal = Gallons
ac-ft/yr = Acre-feet per year

3.4 Billed and Metered Production

Total metered production by the Town wells was 926,261,000 gallons (2,842 acre-feet) in 2011 (Table 4). In that year the Town billed customers for 847,884,000 gallons (2,602 acre-feet), including the water that is sold to the Arenas Valley Water Association, Pinos Altos MDWCA, Rosedale MDWCA, TPOA, and Tyrone MDWCA.

The New Mexico OSE has developed a gallons per capita per day (GPCD) calculation methodology to standardize per capita water use calculations in New Mexico. GPCD values provide a baseline of water use that is not as susceptible to changes in population and can be used to evaluate water conservation potential and to track conservation programs' implementation results (NM OSE, 2009). The user inputs population, household size, and occupancy data from the most recent U.S. Census, as well as system-specific monthly data for as many as five years at a time, and the GPCD calculator returns per capita values for several categories (NM OSE, 2009). The OSE GPCD calculator can be easily updated as more data become available, providing water suppliers with comparisons in per capita use over time.

Table 4. Town of Silver City Water Production and Water Billed for 2011

Month	Total Production (gallons)	Water Billed [a] (gallons)
January	60,947,800	50,276,000
February	54,918,000	54,353,000
March	72,589,000	44,463,000
April	90,002,200	62,054,000
May	98,057,000	83,295,000
June	108,552,000	99,908,000
July	98,752,000	98,917,000
August	72,559,000	77,714,000
September	79,541,000	83,241,000
October	71,785,800	79,496,000
November	66,455,000	55,750,000
December	52,102,300	58,417,000
Total	926,261,000	847,884,000

Source: Esqueda, 2012; Fortenberry, 2012

[a] Includes water sold to the water associations

The OSE GPCD calculator was used to calculate the Town's per capita use on a monthly basis for 2011, the year for which the full AWWA water audit was performed. The 2011 monthly per capita values for the Town's water system are shown in Table 5. These values should be treated as estimates, as the number of water system connections was not available on a monthly basis (the December 2011 value was used for each month in 2011). The single family residential sector was analyzed separately from the system totals; however, the Silver City billing database does not allow for the multi-family housing accounts to be easily identified, so this sector was not separately analyzed. The scope of the conservation plan limited the data analysis to one year; subsequent years of data may be added in the future to analyze any changes in per capita use over time.

Table 5. Town of Silver City Monthly Single Family Residential Per Capita Water Use for 2011

Month	System Per Capita Use [a] (gallons per day)
January	90
February	121
March	75
April	109
May	141
June	188
July	191
August	145
September	156
October	128
November	109
December	99

[a] Calculated using OSE GPCD calculator (NM OSE, 2009).

Another simple method of calculating per capita use is to divide the total water produced by the population served. This method provides a good estimate of the relative magnitude of the per capita use when all the information needed for the OSE GPCD calculator is not available. Using this simpler method, per capita usage for all sectors was 203 gpd in 2011, based on (1) the adjusted production of 762,212,902 gallons for Town of Silver City customers (not including the water association water sales) and (2) a Silver City population of 10,315 (from census data). Per capita use for the residential sector only was 116 gpd in 2011.

Billing and production totals do not always compare well, with billing totals exceeding production totals in some months. The lag time between production and customer meter readings may contribute to the discrepancy between billing and production totals (Esqueda, 2012). Production well meters are read on the first business day of each month for the previous monthly period. Customer meters are read between the 1st and 20th of each month (Esqueda, 2012). For the 2011 data, the non-revenue water is about 8 percent. A much more detailed analysis of the billed versus production data, using the IWA/AWWA water audit methodology, is provided in Section 3.7.

3.5 Sector Analysis

Town of Silver City data tracks water use for 11 sectors (Table 6). Water is sold to four water associations (Arenas Valley Water Association, Pinos Altos MDWCA, Rosedale MDWCA, and TPOA) under special agreements (Sections 4.3.1 through 4.3.4) and to the Tyrone MDWCA at out-of-town water rates (Section 4.3.5). The Rafter and Woodward accounts are billed under account-specific agreements with the Town, because the Town well fields (Frank's and Woodward, respectively) are located on their private land (Engineers Inc., 1993).

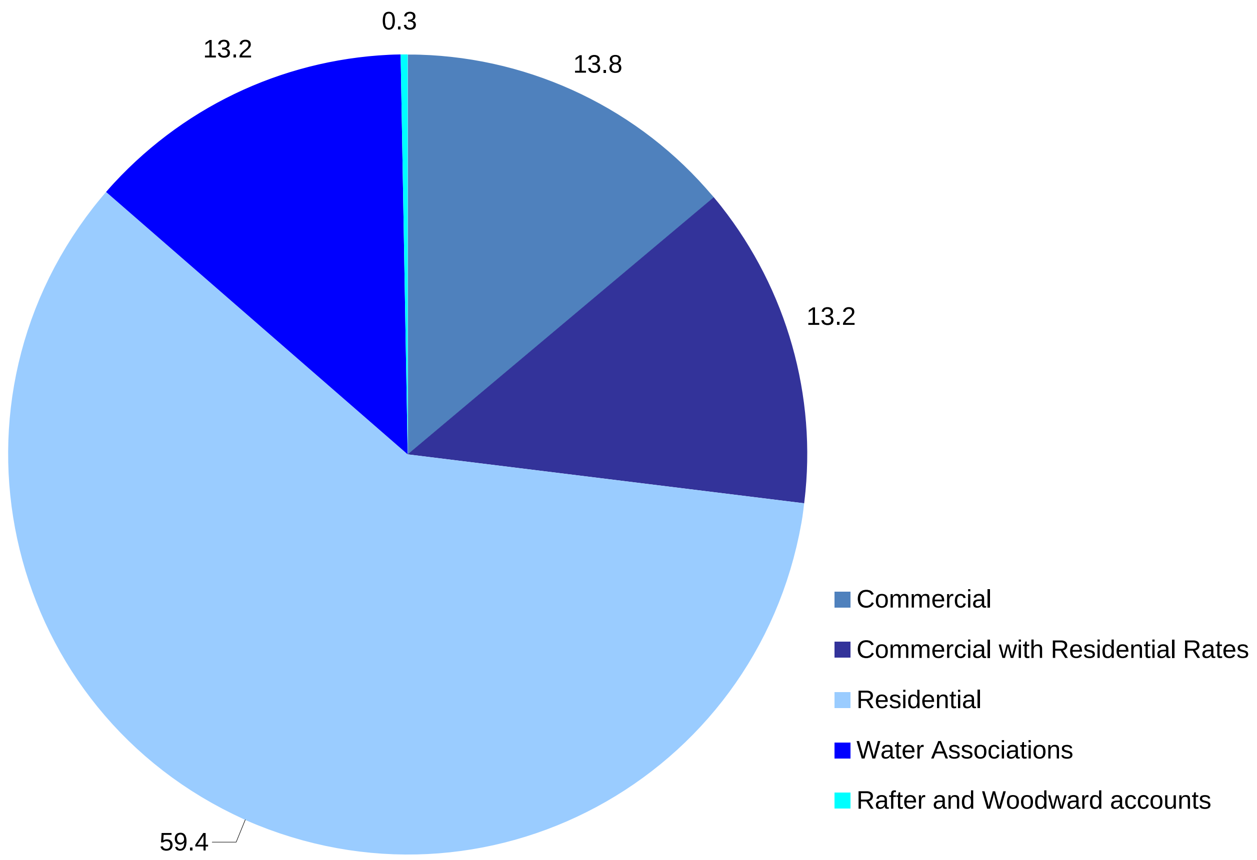
Table 6. Town of Silver City Water Use Sectors

Sector Abbreviation	Types of Accounts by Sector
CO	Commercial
CR	Commercial with Residential Rates
RE	Residential
AV	Arenas Valley
PA	Pinos Altos
RF	Rafter 2S
RW	Rosedale Water
T2	Tyrone Commercial (Tyrone MDWCA)
TT	Tyrone Townsite (TPOA)
WO	Woodward
WW	Woodward Agreement 2

Source: Fortenberry, 2012

Figure 5 shows the breakdown of billed water by sector in 2011. This chart indicates that the residential sector used the majority of water in 2011, while uses by the commercial, commercial with residential rates, and water association sectors were also significant.

Once bulk water is sold to Associations, the Town is not involved in billing individual customers of those associations and therefore does not have records of the end users (except in the case of the TPOA, for which Town staff also collect meter readings and do the customer billing). Monthly water billing data have been analyzed for the three sectors that are served directly by the Town system: (1) commercial, (2) commercial with residential rates, and (3) residential.



SILVER CITY CONSERVATION

Billed Water by Sector

Daniel B. Stephens & Associates, Inc.

2/28/13

Figure 5

Multi-family housing water use has not been broken out separately, due to a lack of information. The amount of water billed in 2011 by month for each sector (as well as the number of accounts analyzed for each of the three sectors) is provided in Table 7.

Table 7. Metered Water Use by Sector in 2011

Month	Metered Water Use in 2011 (gallons)		
	CO	CR	RE
Number of accounts [a]	*125*	*464*	*5,293*
January	5,799,000	5,334,000	29,839,000
February	6,766,000	5,327,000	36,078,000
March	5,808,000	4,492,000	24,846,000
April	12,046,000	7,621,000	34,976,000
May	11,599,000	16,986,000	46,583,000
June	15,190,000	10,384,000	60,294,000
July	15,053,000	10,349,000	63,155,000
August	12,798,000	8,279,000	47,984,000
September	9,779,000	15,621,000	50,044,000
October	9,647,000	6,872,000	42,440,000
November	7,656,000	5,589,000	34,889,000
December	5,142,000	15,112,000	32,600,000
Total	117,283,000	111,966,000	503,728,000

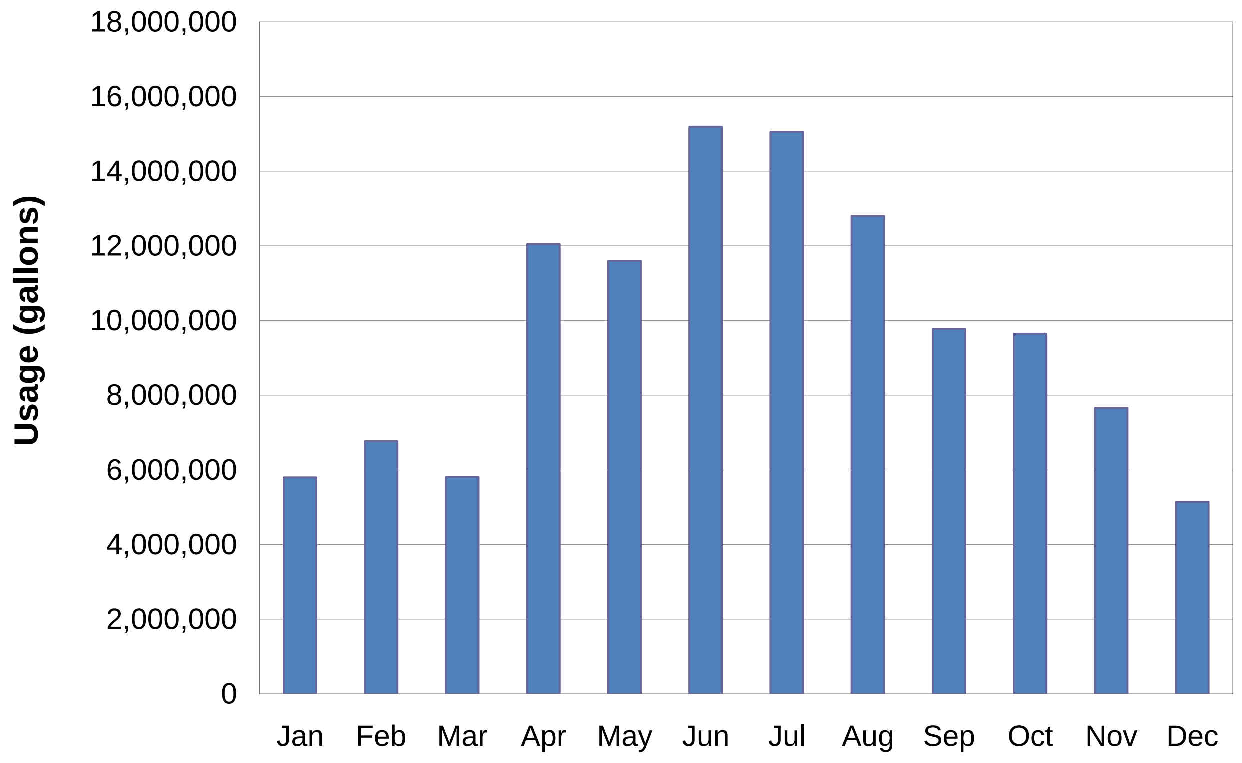
Source: Fortenberry, 2012

[a] Reflects December 2011 data for a total of 5,882 accounts

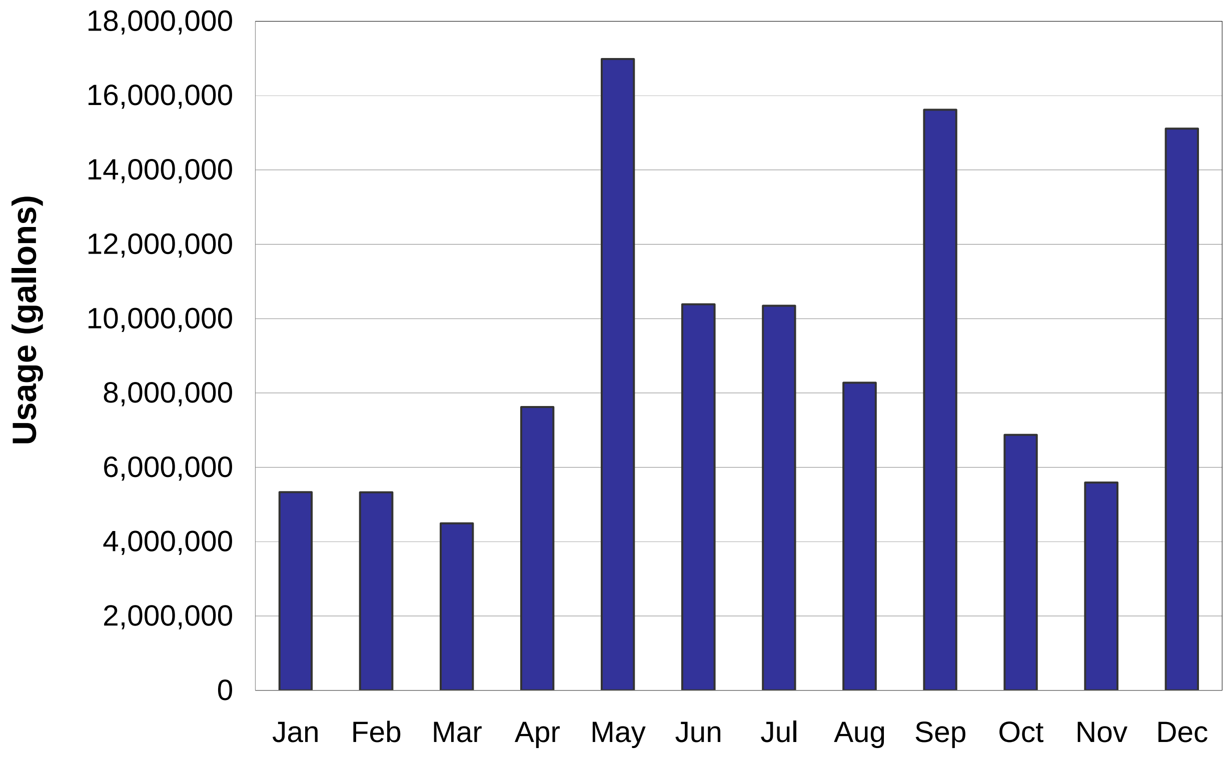
CO = Commercial
CR = Commercial with residential rates
RE = Residential

Figure 6 shows billed 2011 water totals by month for the commercial, commercial with residential rates, and residential sectors. As shown in Figure 6a, monthly water use in the commercial sector was greatest during May through October. Monthly water use in the commercial with residential rates sector increased between May through October, with spikes that approximately doubled demand for this sector during May, September, and December (Figure 6b). Monthly water use in the residential sector is greatest during May through October (Figure 6c). Summer water use is greater in all three sectors, especially in the residential sector. This is due to outdoor water use and the widespread use of swamp coolers for air conditioning.

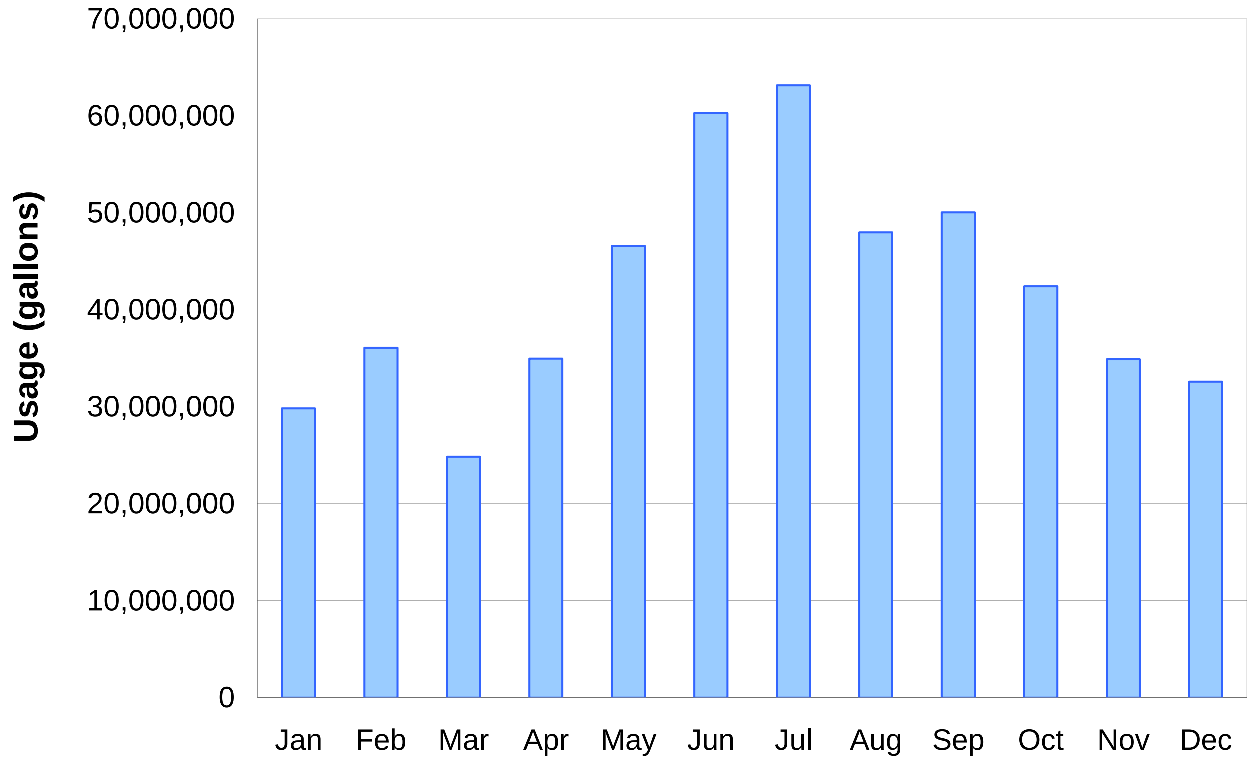
a. Commercial



b. Commercial with Residential Rates



c. Residential



SILVER CITY CONSERVATION
Monthly Billed Water in 2011
by Sector

Daniel B. Stephens & Associates, Inc.
2/28/13

Figure 7 shows billed 2011 water totals by month for the four water associations the Town sells water to under special agreements, as well as Tyrone MDWCA. Data for TPOA are thought to be in error for October 2011 based on discussions with TPOA staff, although a corrected value was not obtained. TPOA staff indicated that whenever a meter reading looks inaccurate, TPOA requests a new reading of their master meter (Jordan, 2012). The Tyrone MDWCA data vary widely with no visible trend, although this system only buys water from the Town when demand exceeds production from their own well, so these data are not thought to be in error.

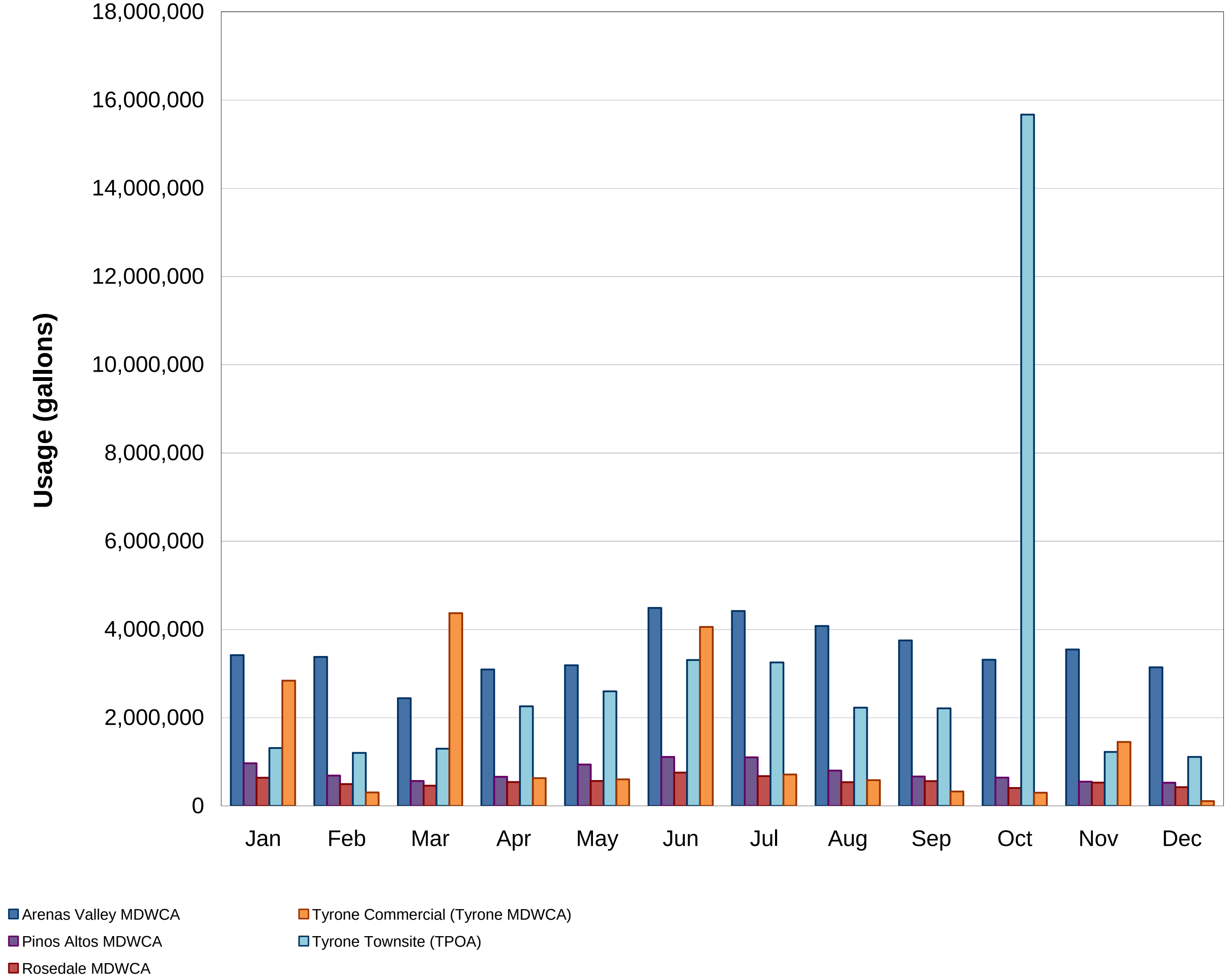
Small commercial customers (with usage of less than 100,000 gallons per month) pay residential water rates (Nuñez, 2012). However, review of the 2011 data indicated that 82 customers that used less than 100,000 gallons during each month of 2011 paid commercial rates, and two customers that used more than 100,000 gallons in each of the months in 2011 paid residential rates.

3.6 Analysis of Top Users

Evaluation of the largest water users can help to target conservation efforts where they will have the greatest impact. In 2011 27 customers were billed for more than 2 million gallons of water (Table 8), accounting for 18 percent of total billed metered water use in 2011. The top 3 customers were each billed for more than 10 million gallons for the year. Together, these top 3 customers accounted for more than 6 percent of total billed metered water use in 2011.

The top user in 2011 was the Altamirano municipal sports complex, which irrigates an area of 11.5 acres. The remaining top users include multiple Western New Mexico University (WNMU) and Silver City Schools facilities, the Gila Regional Medical Center, some apartments and mobile home parks, the Grant County Court House, several commercial customers (e.g., laundry, real estate, lodging, and churches), and Gough Park (Table 8).

In 2012 25 accounts were billed for more than 2 million gallons of water, accounting for 16 percent of total billed metered water use (Table 8). The four top users were the same in 2011 and 2012, and the full list of top users compares well between these two years (Table 8). Significant changes between the two years of data included water use increases exceeding



SILVER CITY CONSERVATION

Monthly Billed Water in 2011
Water Associations

Figure 7

Daniel B. Stephens & Associates, Inc.

2/28/13

Table 8. Town of Silver City Top Water Users in 2011 and 2012

Customer Name [a]	Sector [b]	Billed Total (gallons)		Identified Water Use Area [c]
		2011	2012	
Silver City Schools ballfield park	CO	20,364,000	19,734,000	Ballfield
WNMU – Fine Arts Building	CO	17,552,000	17,937,000	Baseball fields and men's dorm
Western New Mexico University	CR	10,653,000	9,805,000	Library, museum, women's dormitory
Silver Consolidated Schools	RE	9,969,000	9,384,000	La Plata Middle School
Western NM University	CR	5,041,000	7,907,000	Football field, Police training academy
Gila Regional Medical Center	CO	5,306,000	6,373,000	Entire hospital
Silver Consolidated Schools	CO	6,396,000	6,157,000	Fox Field
Western New Mexico University	CO	4,990,000	5,352,000	Juan Chacon building
Silver Cliffs Village Apts.	RE	5,563,000	4,969,000	Low income apartments
LDS The Church of Jesus	CO	5,044,000	4,617,000	Church, irrigation of baseball field
WNMU - Swimming Pool	CO	5,575,000	3,830,000	Not operable
Housing Authority	RE	2,738,000	2,922,000	Apartments at Swan and Silver
American Laundry	CO	2,715,000	2,678,000	Laundry and car wash
Town of Silver City - Gough Park	CO	2,194,000	2,627,000	Town park
MKK Investments LLC	RE	2,710,000	2,588,000	Apartments
KM River Properties LLC	CR	2,642,000	2,553,000	Los Cerros apartments
Capstone Real Estate	CO	2,458,000	2,503,000	Apartments (Gateway or Lintero)
Silver City Associates	RE	—	2,484,000	Apartments
Laundryland	CO	2,514,000	2,406,000	Laundry
Grant County Court House	CR	2,457,000	2,394,000	Irrigation, old part of courthouse
Southwest Concrete	CO	—	2,352,000	Concrete mixing for commercial sale
Silver School - Jose Barrios	CR	2,511,000	2,331,000	School grounds irrigation
Enchanted Trail Lodging	CO	2,221,000	2,321,000	Holiday Inn
Silver Consolidated Schools	RE	2,873,000	2,237,000	6th Street Schools
WNMU – Men’s dorm/married housing	CR	—	2,155,000	Men’s dormitory/married student housing
Silver Star Mobile Manor	RE	2,460,000	—	Trailer park
WNMU - Athletic Complex	CO	2,383,000	—	Old James Stadium irrigation
Sanctuary Water Assoc.	RE	2,287,000	—	25 to 30 households
WNMU - Cooler/Cafeteria	CR	2,093,000	—	Administration building
Silver City Care Center	CO	2,010,000	—	Senior citizens care center
Total		135,719,000	130,616,000	

Source: Fortenberry, 2012
(unless otherwise noted)

[a] In order of usage ranking in 2012

[b] CO = Commercial
CR = Commercial with residential rates
RE = Residential

[c] McNeil, 2012

— = Customer not in top 25 users for the year

1 million gallons for (1) the Gila Regional Medical Center, (2) the WNMU football field and police training academy, and (3) the WNMU men’s dormitory and married student housing.

3.7 International Standard Water Audit

The international standard water audit format is illustrated in Table 9.

Table 9. International Standard Water Audit Format

Own sources	System input (allow for known errors)	Water exported	Authorized consumption	Billed authorized consumption	Revenue water	Billed water exported
						Billed metered consumption
						Billed unmetered consumption
				Unbilled authorized consumption	Non-revenue water	Unbilled metered consumption
						Unbilled unmetered consumption
Water imported		Water supplied	Water losses	Apparent losses		Unauthorized consumption
						Customer metering inaccuracies and data handling error
				Real losses		Leakage on mains
						Leakage and overflows at storages
						Leakage on service connections up to point of customer metering

Source: AWWA, 2003 (after Alegre et al., 2000)

The international standard water audit methodology requires estimation of unmetered water use, leaks, illegal connections, meter accuracy, and database errors, so that a more detailed assessment of actual losses can be made. This provides a higher level of understanding about where system improvements are needed than a simple analysis of unaccounted water.

Unmetered water use in Silver City includes water used by the Town for street cleaning and water used for fire hydrant testing and fires. The City uses one street sweeper, with a capacity of approximately 100 gallons. The street sweeper is filled from Town hydrants two to three times per day, five days per week (Esqueda, 2012). Assuming that the street sweeper is used

40 weeks per year (Esqueda, 2012), total use of unmetered water for street cleaning is estimated to have been between 40,000 and 60,000 gallons in 2011.

The Town Fire Department uses unmetered water for hydrant testing and training purposes and for fires. Hydrant testing involves opening the hydrant and allowing the water to run, at rates between 250 and 1,500 gpm (Esqueda, 2012). The Town has a total of 862 fire hydrants (604 in town and 258 outside of town), and all of the hydrants are tested annually (Esqueda, 2012). Assuming that hydrants are run for an average of 1,000 gpm for 5 minutes each, a total of 4,310,000 gallons of water would be used for hydrant testing each year. Annual unmetered water use for personnel training and fires has not been estimated.

The Town contracts with a leak detection firm twice per year, conducting week-long leak detection projects; the report for the recent March 2012 leak detection study included an estimated volume of the water being lost as a result of the leaks that it pinpointed (22,104 gpd or 8,067,960 gallons per year) (USA, 2012).

The other apparent sources of losses included in the international standard water audit are illegal connections and theft. On several instances in 2011, surrounding volunteer fire departments used Town fire hydrants to fill their fire trucks (Esqueda, 2013); assuming that four of these incidents occurred, with a 2,000-gallon fire truck filled on each occasion, 8,000 gallons would have been taken. This quantity of water use is negligible in relation to other uses. Meter accuracy and database errors that were used in the audit are discussed in Sections 3.1 and 3.2, respectively.

Table 10 provides a breakdown of the comprehensive water audit balance for Silver City in 2011. Many of the values that are presented in Table 10 (e.g., customer meter error, unmetered consumption, and low-flow inaccuracies) were estimated as described in Sections 3.1 and 3.2. As a result, values presented in Table 10 for total potential real water loss and total non-revenue water are also estimates. A list of recommended actions has been developed (Section 6), including suggestions for collection of additional data that can provide observation-based values for those items that have been estimated. Subsequent analyses should use these additional data to further refine the values presented in Table 10.

Table 10. Comprehensive Water Audit Balance for the Town of Silver City, New Mexico January 1 through December 31, 2011

Item	Amount	
	Gallons	% of Total
Water Production		
1a. Metered production	926,261,000	
1b. Production meter error [a]	50,018,094	
1c. Exported water (five water associations)	112,030,000	
1d. Adjusted production	*764,212,906*	*100*
Authorized Consumption		
2a. Billed metered, commercial	117,283,000	15.35
2b. Billed metered, commercial with a residential rate	111,966,000	14.65
2c. Billed metered, residential	503,728,000	65.91
2d. Billed metered, Rafter and Woodward accounts	2,877,000	0.38
2e. Total billed metered	*735,854,000*	*96.29*
3. Total billed unmetered	*0*	*0*
4. Total unbilled metered	*0*	*0*
5a. Unbilled unmetered, Fire Department	4,310,000	0.56
5b. Unbilled unmetered, Streets Department	50,000	0.01
5c. Total unbilled unmetered	*4,360,000*	*0.57*
6. Total authorized consumption	*740,214,000*	*96.86*
Apparent Losses		
7. Estimated customer meter error [b]	14,717,080	1.93
8. Additional loss to low-flow inaccuracies (due to low flow not detected by customer meters)	4,116,000	0.54
9. Illegal connections and theft	8,000	0.00
10. Database errors	0	0.00
11. Total apparent losses	*18,841,080*	*2.47*
Real Water Loss Potential		
12a. Reported water loss	NA	0
12b. Identified water loss	8,067,960	1.06
12c. Total potential real water loss [c]	*5,157,826*	*0.67*
Non-Revenue Water		
5c. Total authorized unbilled unmetered	4,360,000	0.57
11. Total apparent losses	18,841,080	2.47
12c. Total potential real water loss	5,157,826	0.67
13. Total non-revenue water	*28,358,906*	*3.71*

[a] The production total has been adjusted downward to account for production meter error, based on data indicating that the production meters were over-reporting by a weighted average of 5.4% in 2012.

[b] Estimates that customer meters are under-reporting by 2%.

[c] Value calculated by subtracting authorized consumption and apparent losses from adjusted production.

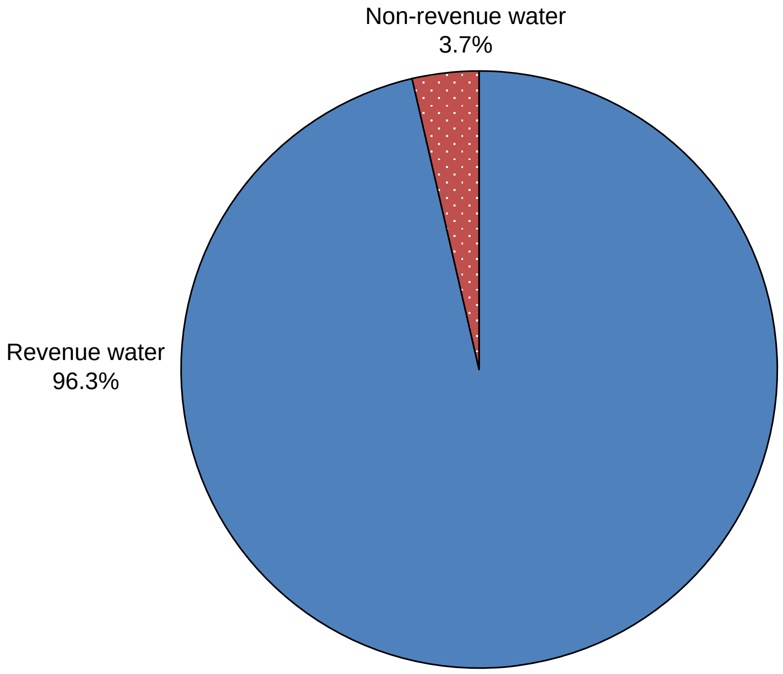
Total authorized consumption accounted for more than 96 percent of the Town's adjusted production in 2011, with the estimate for unmetered unbilled water use (for the streets and fire departments) accounting for less than 1 percent of adjusted production.

Total potential real water loss is calculated by subtracting authorized consumption and apparent losses from adjusted production. This value is an estimate of the amount of real water that was lost in 2011 and reflects the volume of water not accounted for by authorized consumption or apparent losses. The total potential real water loss estimate for Silver City accounted for less than 1 percent of adjusted production in 2011, although given that the amount estimated in the latest leak detection survey (March 2012) exceeds the 2011 estimate for total potential real water loss, real water loss was likely higher than estimated.

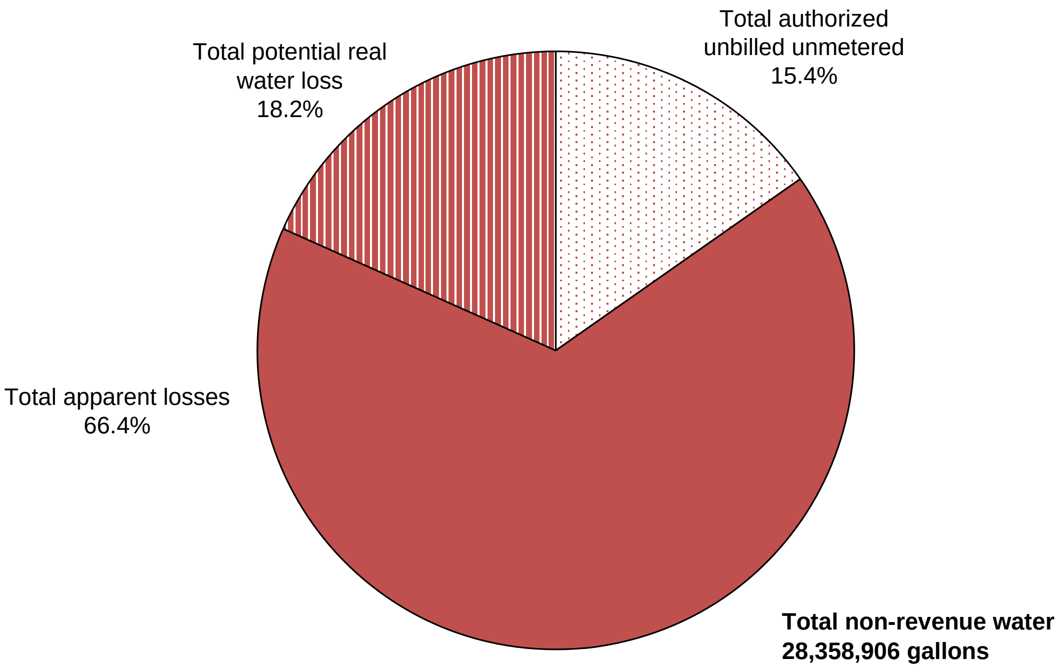
Other issues in the water audit calculations are (1) the inconsistency between production and consumption values and (2) database errors. As discussed in Section 3.4, the difference between production and authorized consumption likely stems from the lag time between when production meter readings and customer meter readings are collected. Database errors have not been estimated because the number of blank and zero entries in the database can be explained by the number of inactive and low-water-use water accounts (Section 3.2). As recommended in Section 6, the water audit calculations should be refined after the Town begins implementing automatic meter reading, which will minimize the lag time between the production and customer meter readings, and the actual consumption volumes for the low water users should be included in the database.

Figure 8a shows the breakdown between revenue and non-revenue water in Silver City in 2011. Revenue water consists of billed water by sector (Figure 5); non-revenue categories include total authorized unbilled unmetered use (i.e., by the fire and streets departments), total apparent losses (estimated customer meter error, total low flow inaccuracies, illegal connections and theft, and database errors), and total potential real water loss (calculated by subtracting authorized consumption and apparent losses from adjusted production). Revenue water accounted for 96.3 percent of total adjusted production in 2011, and non-revenue water accounted for 3.7 percent of total adjusted production. This is a relatively low percentage for non-revenue water, likely due to the Town's efforts to identify and fix leaks, and accurately meter water use.

a. Town of Silver City Revenue vs. Non-Revenue Water in 2011



b. Town of Silver City Non-Revenue Water in 2011



SILVER CITY CONSERVATION

Revenue vs. Non-Revenue Water in 2011

Daniel B. Stephens & Associates, Inc.

2/28/13

Figure 8

States have previously set standards for the percentage of unaccounted for water that is considered to be reasonable, and a survey of these standards indicated a range of between 7.5 and 20 percent in 2002 (AWWA, 2003). The AWWA international water audit methodology was established in 2000 with the goal of accounting for all water that is produced and minimizing both physical and paper losses (AWWA, 2003). The goal set by the international water audit methodology is to reduce losses to the level of unavoidable real losses (AWWA, 2003).

Figure 8b further breaks down the 3.7 percent of total non-revenue water between total potential real water loss (18.2 percent), total authorized unbilled unmetered water use (15.4 percent), and total apparent losses (66.4 percent). As shown by the 2011 data (Table 10), in addition to continuing to calibrate production meters on a semiannual basis, identify and fix leaks, and replace customer meters when needed, the best target for further minimizing Silver City's non-revenue water is customer meter error, as this is estimated to be the largest component of non-revenue water.

3.8 AWWA Performance Indicators

In addition to the international standard water audit methodology, the AWWA Water Loss Control Committee has developed a related spreadsheet-based water audit tool to help water systems quantify and track water losses associated with distribution systems and to help identify areas for improved efficiency and cost recovery (AWWA, 2010). System and financial information were obtained from Town of Silver City staff (Esqueda, 2013) and input into the most up-to-date AWWA water audit software (Version 4.2) (AWWA, 2010) to evaluate performance indicators for Silver City. The results of that analysis are provided in Appendix A and discussed below.

The total water system operational cost for 2011 was $1,279,000. Total annual water system variable cost (the sum of all treatment and power costs) was $499,000. The cost to produce and supply the next million gallons of water (total annual water system variable cost divided by the Town's adjusted production for 2011), termed the variable production cost by AWWA, was calculated to be approximately $653. Customer retail unit cost in Silver City during 2011 was calculated to be $4.63 per 1,000 gallons (this value includes the cost for water, wastewater, and sewer).

The AWWA water audit software estimates that in 2011, the annual cost of apparent losses in Silver City was $87,288 and the annual cost of real losses was $3,373. Apparent losses were calculated to be 8.77 gallons per connection per day, while real losses were calculated to be 2.41 gallons per connection per day.

The infrastructure leak index (ILI) is an AWWA performance indicator used to compare utility performance in operational management of real losses. The lower the amount of leakage and real losses in a system, the lower the ILI will be. AWWA lists a target ILI range of 3.0 to 5.0 as appropriate for systems operating where water resources are believed to be sufficient to meet long-term needs, but demand management interventions (leakage management, water conservation) are included in long-term planning (AWWA, 2010), as is the case for Silver City. With a calculated ILI value of 0.11, Silver City is well below this range, although because the calculations that lead to this ILI value rely on multiple estimates, this number should be viewed as an estimate.

Using data from 2011, the AWWA water audit software calculated a water audit data validity score of 60 percent for the Town of Silver City. The software indicated that the Town’s audit accuracy can be improved by addressing the accuracy of the production volume with meter calibration and error adjustments, installing new and/or replacing defective meters, installing automatic meter reading (AMR) in one or more pilot areas, and performing audits of the computerized billing records.

4. Existing Water Conservation Practices

The Town of Silver City currently promotes conservation through several activities and programs. Existing Town of Silver City water conservation practices are described in Sections 4.1 through 4.3.

4.1 Leak Detection

The Town contracts with a leak detection firm to conduct week long leak detection projects twice per year, during the spring and fall (Esqueda, 2012). The annual budget for this runs approximately $10,000 to $12,000 (Esqueda, 2012). Additionally, Town personnel routinely look for leaks when they are conducting other business, and utility personnel aggressively respond to leaks, digging up and replacing water lines (Esqueda, 2012). If a meter reading suggests that there is a leak, Town staff will investigate and repair it as needed.

The March 2012 leak detection survey included approximately 34 miles of water infrastructure and pinpointed leaks in water mains, valves, service lines, hydrants, meters, and a curbstop (USA, 2012). The leak detection consultant estimated that 22,104 gallons were lost each day (8,067,960 gallons per year) as a result of the identified leaks (USA, 2012).

4.2 Water System Upgrades and Operation

The Town of Silver City has been engaged in maintenance and upgrades of the equipment necessary for efficient operation and tracking of water use by conducting the following activities:

- The Town tests and calibrates its production well meters semiannually as described in Section 3.1.1.
- The utility actively replaces old customer meters as described in Section 3.1.2.
- The Town replaced all of the pump motors at the municipal wells in the last few years, installed a supervisory control and data acquisition (SCADA) system to remotely monitor and manage municipal wells, booster stations, and storage tanks, and recently replaced one of the motors at one of the booster stations.

4.3 Water Rates

Water rates can be a reliable method of encouraging voluntary water conservation. The Town has an inverted water rate structure in place; that is, residents pay more as their demand increases. Town water rates were last raised in August 2012, with the increases taking effect in September 2012.

Town Ordinance 1209 details the current water rates (Table 11) and specifies that the water rates be annually reviewed and adjusted by the Town Council during its consideration of the next fiscal year budget. In addition to addressing residential and commercial water rates, Ordinance 1209 also increased the water association rates by 3 percent. The current rate structure includes a base fee for the first 3,000 gallons and a higher unit fee for use over 3,000 gallons to provide an incentive for larger users to minimize their use. Effective July 1, 2013, the base fee now applies to 2,000 rather than 3,000 gallons, with the base rate and unit fees remaining the same. There are different water rates for the residential and commercial sectors, and for in-town and out-of-town customers (Table 11). Commercial in-town customers generally pay residential water rates if they use less than 100,000 gallons per month (Nuñez, 2012).

Table 11. Current Water Rates

Range (gallons per month)	Fee per 1,000 gallons ($)			
	In-Town		Out-of-Town	
	Residential	Commercial [a]	Residential	Commercial [b]
0 – 3,000	10.25	10.25	18.02	18.02
3,000 – 13,000	3.44	—	5.90	5.90
> 13,000	4.21	—	6.98	6.98
3,000 – 417,000	—	3.44	—	—
> 417,000	—	4.21	—	—

Source: Esqueda, 2012 — = No applicable rate for this sector/volume

[a] In-town commercial rates generally apply to customers that use more than 100,000 gallons per month. Commercial customers that use less than 100,000 gallons per month pay residential water rates.

[b] Out-of-town commercial rates generally apply to commercial customers that use less than 100,000 gallons per month.

Table 12 lists the number of residential and commercial connections and the average monthly fee, including the meter service charge, for other New Mexico communities of comparable size.

Water rates for Silver City are lower than average compared to both other towns of similar size and the statewide average (with the exception of residential water rates in Deming and Sunland Park).

Table 12. Water Rates in New Mexico Communities

	Residential		Commercial	
Municipality	Number of Connections	Monthly Charge [a] ($/6,000 gallons)	Number of Connections	Average Monthly Rate [a] ($)
Deming	5,308	12.84	288	23.12
Gallup	4,877	33.80	1,761	41.69
Las Vegas	5,668	23.60	777	171.05
Los Alamos	6,884	32.69	397	49.14
Portales	4,343	21.20	578	21.20
Silver City	5,675	19.97	588	19.97
Sunland Park	4,467	15.52	329	22.65
Average of all New Mexico towns/cities	4,432	25.65	527	32.48

Source: NMED, 2012 (reflects data for 2011)

[a] Includes monthly meter service charge

As noted above, in addition to raising the Town water rates (Table 11), the Town Ordinance 1209 passed in August 2012 raised all water association rates by 3 percent. Sections 4.3.1 through 4.3.5 summarize the agreements between the town and the five water associations. The rates listed in these subsections come from the water association agreements, which generally pre-date the passage of Ordinance 1209 and therefore do not reflect the 3 percent increase.

All of the water association rates reflect an inverted block rate structure, to encourage water conservation by charging higher unit rates for greater usage volumes. However, the increase fee for larger users, which is less than 1 dollar per thousand gallons, may not be high enough to maximize an incentive for conservation. The Town may consider conducting a detailed review of account records to determine how many accounts are lowering their water use after experiencing increased fees and may want to consider a higher differential when future rates are calculated.

4.3.1 Arenas Valley Water Association

The Town agreement with the Arenas Valley Water Association is a joint powers agreement dated May 19, 2008. With this agreement, the Town committed to supplying Arenas Valley with no more than 200 acre-feet (65,180,000 gallons) of water per year. Table 13 lists the water rates outlined by the Arenas Valley agreement. The agreement specifies that the Town may implement automatic annual water rate increases of 1.5 percent, but includes a clause specifying that any water rate increase must be at the same percentage as increases charged to in-town water customers. The Arenas Valley agreement is valid through July 1, 2018.

Table 13. Arenas Valley Water Association Water Rates

Range (gallons per month)	Fee per 1,000 gallons [a] ($)
0 – 3,000	6.303220
3,000 – 13,000	4.494807
> 13,000	5.291069

Source: Esqueda, 2012

[a] Rates do not include a 3 percent increase that went into effect in September 2012 as a result of Town Ordinance 1209, or any automatic annual increases that may have gone into effect since the agreement was signed in 2008.

4.3.2 Pinos Altos Mutual Domestic Water Consumer's Association

The Town agreement with the Pinos Altos MDWCA is a memorandum of agreement dated November 19, 2009. With this agreement, the Town committed to supplying the Pinos Altos MDWCA with no more than 200 acre-feet (65,180,000 gallons) of water per year. Table 14 lists the water rates outlined by the Pinos Altos agreement. The agreement includes a clause specifying that any water rate increase must be at the same percentage as for in-town water customers. The Pinos Altos MDWCA agreement is valid through November 19, 2019.

Table 14. Pinos Altos MDWCA Water Rates

Range (gallons per month)	Fee per 1,000 gallons [a] ($)
0 – 3,000	6.994764
3,000 – 13,000	4.394807
> 13,000	5.291069

Source: Esqueda, 2012

[a] Rates do not include a 3 percent increase that went into effect in September 2012 as a result of Town Ordinance 1209.

4.3.3 Rosedale Mutual Domestic Water Consumer's Association

The Town agreement with the Rosedale MDWCA is a joint powers agreement dated May 14, 2008. With this agreement, the Town committed to supplying the Rosedale MDWCA with no more than 35 acre-feet (11,406,500 gallons) of water per year. Table 15 lists the water rates outlined by the Rosedale MDWCA agreement. The agreement specifies that the Town may implement automatic annual water rate increases of 1.5 percent, but includes a clause specifying that any water rate increase must be at the same percentage as for in-town water customers. The Rosedale MDWCA agreement is valid through August 1, 2018.

Table 15. Rosedale MDWCA Water Rates

Range (gallons per month)	Fee per 1,000 gallons [a] ($)
0 – 3,000	7.95197
3,000 – 13,000	4.71163
> 13,000	5.30087

Source: Esqueda, 2012

[a] Rates do not include a 3 percent increase that went into effect in September 2012 as a result of Town Ordinance 1209, or any automatic annual increases that may have gone into effect since the agreement was signed in 2008.

At one of the project stakeholder meetings, Rosedale system representatives indicated that their system has a few large water users, who are happy to pay for the water they use, as well as many users with low water use who are on fixed incomes. The Rosedale water association watches water consumption closely.

4.3.4 Tyrone Property Owners Association

The Town agreement with the TPOA is a water and wastewater service agreement dated September 26, 2012. The Town reads both the TPOA master meter and all individual customer meters monthly and bills the individual TPOA customers for their use, in addition to billing TPOA for the difference between the sum of the customer meter readings and the master meter reading. The Town-TPOA agreement outlines a $3.50 monthly administrative fee per customer, with administrative fee increases of 5 percent that take effect on March 1, 2013 and March 1, 2018. TPOA water rates reflect the Town water rates (Table 11), plus 10 percent. The TPOA agreement is valid through September 26, 2052 (a 40-year term).

TPOA has on the order of 90 acres that could be developed in the future, which could increase their water demands (Jordan, 2012). TPOA has received funding from the U.S. Department of Agriculture Rural Development (USDA-RD) program for the infrastructure necessary to send their wastewater to the Town for treatment (replacing their lagoons), so their wastewater will likely be sent to the Town's wastewater treatment plant in the future (Jordan, 2012). The current Town-TPOA agreement also outlines the wastewater service agreement and fees.

4.3.5 Tyrone Mutual Domestic Water Consumer's Association

The Tyrone MDWCA has a well and a connection to the Town water system. They supply customers with water from their own well, supplemented with water that they buy from the Town at the out-of-town rates (the Town does not have a special agreement in place with Tyrone MDWCA) (Esqueda, 2012).

4.4 Drought Ordinance

In May 2009, the Town of Silver City passed a *Water Shortage Response Plan for Demand Reduction During Emergency, Operational, and Drought Situations* (Town of Silver City, 2009b). The Water Shortage Response Plan (WSRP) provides systematic responses and methods to reduce customer water demand due to a water supply shortage from an emergency, drought event, or operational situation.

The objective of the WSRP is to establish actions and procedures for evaluating supply options and managing water demand during a water supply shortage, in advance of such conditions occurring. It is intended for use during infrequent and unusual events and is not a substitute for the development of water supply projects and long-term conservation programs. The WSRP is a tool to help the Town of Silver City be prepared to maintain essential public health and safety and minimize adverse impacts to residents and businesses, should a water shortage event occur.

The WSRP provides approaches that can be tailored to specific water shortages. The responses become more aggressive as conditions become progressively more serious. These responses are presented in 4 stages: Advisory, Voluntary, Mandatory, and Rationing:

- In the "Advisory" stage, customers are informed as early as meaningful data are available that water supply and demand conditions may result in a less than normal supply of water.

- If the supply and demand situation foreseen at the Advisory stage develops, the WSRP moves to the "Voluntary" stage, which relies on the voluntary cooperation and support of customers to meet water use reduction goals. Water users are given the opportunity to contribute their share of water savings to achieve a Town-wide goal of reduced consumption.

- If the Voluntary measures have not or are not able to provide the necessary reduction in water use the WSRP moves to the "Mandatory" stage.

- The "Rationing" stage is used when extraordinary levels of reduction are required to ensure that demand does not exceed the supply and that public health and safely are not compromised.

A menu of water use reduction measures have been developed for each WSRP stage. Actions to respond to the specific water shortage situation can be tailored through choices within the menus. More severe stages build on the measures in previous stages, with all objectives and actions from less severe stages considered for implementation in a more severe stage. During a water shortage situation, a Task Force established by the ordinance will provide a recommendation for specific implementation of the WSRP to the Mayor and Council.

4.5 Wastewater Reuse

The Town of Silver City golf course uses reuse effluent from the wastewater treatment plant to irrigate year-round and has requested additional reuse water (Esqueda, 2012). The amount of reuse effluent provided to the golf course is currently limited by the availability of reuse water (Esqueda, 2012). Scott Park was previously watered with wastewater, before the grass was replaced with artificial turf.

4.6 Reductions in Outdoor Watering

The Town has implemented water conservation practices to reduce outdoor water use, including:

- As noted in Section 4.5, the Town provides wastewater reuse for irrigation of the golf course. Demand exceeds the reuse supply during the summer.

- The grass at the Town's softball fields at Scott Park was recently replaced with artificial turf.

- Water harvesting projects have been implemented, mostly on private land, that help conserve the Town's groundwater supply by using rainfall and stormwater runoff to replace groundwater pumping.

Water harvesting projects in Silver City have largely been designed and built by Stream Dynamics, Inc. to date, although there is significant local interest and the number of projects is expected to increase in the next few years. The NMED sponsored a two-day rainwater harvesting workshop in Silver City in October 2012, and there were more than 30 participants. Water harvesting projects are reviewed by the Town on a case-by-case basis (Peña, 2013). Five projects have been implemented, mostly on private land, that guide street runoff into basins and channels to irrigate trees and other vegetation, often through carefully designed curb cuts. During large rain events, a significant amount of water runs off of Silver City streets, and to the extent that it can be used for recharge or outdoor watering, it can replace groundwater pumping. Projects must be designed to be in compliance with the Town of Silver City stormwater drainage policies and to ensure that water is ponded only temporarily, to avoid the necessity of a surface water storage right and to avoid creating a breeding area for mosquitoes.

The water-harvesting project on Town-owned land irrigates the 1-acre Silva Creek Botanical Gardens site, located on Virginia Street at the edge of a tributary of the Big Ditch (historical San Vicente Creek) in Silver City. Runoff from a 75-acre urban neighborhood now enters a short diversion channel, passes through a caprock flow limiter, and flows into a cobble-lined basin. The overflow from this basin travels as sheet flow and gets trapped behind a series of two raised-path banana berms, creating temporary ponding approximately 6 inches deep. A collector channel for overflow returns this water to the Big Ditch. A local gardener who is active in the Gila Native Plant Society has planted hundreds of native plants in this area, which are now watered when it rains.

5. Water Conservation Goals and Performance Measures

To establish an effective water conservation program, it is important to establish definitive goals for water conservation and to outline a system of evaluation to determine how successful the Town is at meeting it goals. This evaluation program will allow for adaptive management of the water conservation practices and inclusion of additional practices as needed to meet the Town's goals. Additionally, in order to determine which programs and priorities will be implemented first, within the Town's limited budget, performance measures are needed to determine which conservation practices will have the most value for the Town. These performance measures can be expanded to evaluate the success of the program after implementation.

Issues unique to Silver City that affect the goals and design of the conservation program include:

- A large groundwater supply
- The need for a revenue-neutral conservation program
- The ongoing application for return-flow credit where wastewater discharge is recharging the aquifer
- The sizing of the new solar array at the wastewater treatment plant

These issues are discussed below.

Extent of groundwater supply: Because Silver City relies on a groundwater reserve that is not tied physically to an annual influx of water (such as a stream that would have a varied inflow each year), supply is not physically limited in the short term (Balleau, 2006). Groundwater is recharged to some extent each year and recharge rates may diminish in times of drought, but large volumes in storage allow for use beyond the annual recharge. The potential for increasing drought frequency and duration, and the resulting implications for recharge, may make long-term sustainability issues more important over time.

There are water rights permit limits, but these have not yet been exceeded by the Town; whereas the Town is permitted to divert 4,566.64 ac-ft/yr of water from the Town's wells (Gabby Hayes, Franks, and Woodward wells) (Esqueda, 2013), in 2012, the total use by the Town was about 2,527 acre-feet. The Town's expectations for using its full water rights are outlined in the 40-Year Water Plan (Engineers, Inc., 1993). Conserving groundwater by lowering water use is desirable primarily for reasons of long-term sustainability rather than an immediate need to balance supply and demand. That is, the greater the savings now, the longer the groundwater supply will be available into the future without requiring new wells, water rights, or development of alternative water supplies.

Revenue neutrality: Much of the funding for operation, maintenance and infrastructure replacement for the Town water system comes from water user fees, which are lower when water use is reduced. Therefore, while water conservation can have long-term benefits, it is important to also consider the potential loss in revenue from water savings. When aggressive conservation measures have been enacted by other communities in response to drought or sudden emergency shortages, water supplies were successfully conserved, but significant anticipated revenue losses negatively impacted utility operations and infrastructure debt financing. Silver City intends to work toward a goal of revenue neutrality by implementing a phased conservation program which initially targets projects that do not result in a loss of revenue, seeking grant funding or specific financing for large water conservation efforts and periodically reviewing rates in relation to operational costs so that a revenue deficit does not occur.

Return flow credits. The Town has applied to the OSE for return flow credits for its wastewater discharge. If the application is approved, the Town will be able to pump additional water from the well field based on the recognition that some of the pumped water is returned to the aquifer.

Solar array overproduction and the power purchase agreement: Electricity costs at the Town's wastewater treatment plant are being substantially reduced through the installation of the solar array that offsets approximately 80 percent of the electricity costs for wastewater treatment. The 20-year power purchase agreement stipulates that the Town is responsible for paying a flat rate of 6.9 cents for the solar electricity produced, even if wastewater use and corresponding fees for wastewater treatment decrease. A substantial decrease in the amount of wastewater needing treatment could affect the negotiated stipulations concerning overproduction that are included in the Power Purchase Agreement.

For these reasons, the Town believes that reduction in outdoor water use, which would not decrease the amount of wastewater that is generated, provides the best opportunity to responsibly conserve water.

Considering these unique issues, the Town of Silver City has outlined the following goals for its water conservation program:

- Reduce outdoor water use.
- Reduce water waste; not allowing wasted water to run down the streets will enhance public education efforts regarding the importance of water conservation.
- Reduce peak summer demands for more efficient system operation and reduced energy use.
- Reduce pumping and treatment costs.
- Ensure a revenue-neutral program that can be financed by the Town.
- Strengthen ordinances and policies relating to water conservation.
- Minimize nonpoint source pollution by integrating stormwater management into the water conservation program.
- Educate the public about water conservation and sustainable supply issues.
- Incentivize conservation behavior.

The Town anticipates a phased implementation program. After the first 5 years of the program, the Town will revisit its longer-term goals.

Types of performance measures for evaluating the various conservation options include those that evaluate the benefits (relative water savings) and those that consider the cost of the option, and performance measures can be set to consider the ratio of benefits to costs. For clarity in evaluating the program, the benefit and cost performance measures are discussed separately herein. Performance measures that evaluate the benefits of a water conservation program include:

- *Total water saved:* The total amount of water that can be saved by implementing the conservation practice, typically expressed as gallons or acre-feet per year of savings.

- *Return flow impacts:* The impact of any of the savings on return flow is helpful in evaluating the total benefit, as initiatives that result in less return flow may mean less wastewater available for reuse or fewer return flow credits for water rights considerations.

- *Reductions in peak demand:* Savings during summer months when use is greatest can have added value in terms of minimizing infrastructure expansion as well as long-term sustainability of the groundwater resources.

- *Secondary benefits:* Conservation practices could have benefits not directly related to water savings, such as improvements in water quality or shade tree retention for reduced energy use due to water harvesting projects and better customer satisfaction due to improved billing software.

Water conservation goals and implementation priorities need to consider both the amount of water that can be saved from the conservation program and the fiscal impact to the Town. In addition to the overall cost of the potential water conservation projects, fiscal impacts to consider include:

- Whether there is a potential funding source for the project separate from the Town budget (i.e., grant programs that are designed to support water conservation projects).

- Whether there would be a loss of revenue as a result of the project. For example, water conservation projects in parks and Town facilities, for which the Town pays the cost of water, have a lower fiscal impact than those that will result in lower revenue from water sales.

- Whether there will be longer-term efficiencies (cost reductions), for example by implementing projects that will reduce staff time, or conversely, if there will be higher maintenance costs due to implementing a program that will need staff time to be successful.

These performance measures are discussed further in Section 6, in relation to recommended water conservation practices, to assist in prioritizing implementation of the selected water conservation programs. Additional performance measures, such as degree of participation and actual costs, will be applied when evaluating the success of the water conservation program after implementation, as discussed in Section 6.8.

6. Recommended Water Use Efficiency Projects and Programs

The intention of the Town in developing a water conservation plan is to:

- Identify and rank water use efficiency projects and programs in order to develop a flexible portfolio to best meet water savings goals

- Identify and incorporate proven, cost-effective innovations and technologies into the final list of water efficiency program recommendations

- Include an analysis of active (device-driven) and passive (legislative, ordinance, behavioral) water savings

A broad range of water conservation programs may help the Town of Silver City to meet these objectives. Types of water conservation programs that are planned to meet the goals listed in Section 5 have been grouped into the following categories:

- Programs that minimize water losses and improve efficiencies in system operation
- Programs that promote outdoor water conservation
- Programs that promote indoor water conservation
- Statutes, ordinances and policies
- Public education programs

Sections 6.1 through 6.5 discuss these programs. A summary of the relative benefits and costs of these programs in relation to performance measures is provided in Section 6.6. An implementation schedule, based on prioritizing programs with the highest ranking performance measures, is provided in Section 6.7. Additional performance measures that will be used to evaluate the program success are discussed in Section 6.8.

The recommendations, schedule, and implementation steps outlined in this plan pertain to the Town of Silver City. Water associations and other nearby communities may find some of the same conservation programs valuable to them in reducing water use. However, individual water conservation plans for each association and community can be optimized by evaluating information specific to them, such as the Town information that was analyzed in this plan, including:

- Review top users to identify any specific problems to be addressed or initiatives that could reduce water use for the largest users.
- Conduct other water auditing as outlined in Section 3.
- Test meter accuracy.
- Conduct leak detection.
- Work with the Town on education aspects of the water conservation plan implementation.

The information presented in Sections 6.1 through 6.5, as well as the summary of performance measures, includes discussion of the relative benefits and costs of various programs. This discussion relies in part on a study by the Water Conservation Alliance of Southern Arizona (Water CASA), referred to as the ECOBA study (Evaluation and Cost Benefit Analysis of Municipal Conservation Programs). The intent of the ECOBA study was to provide water conservation decision makers a thorough analysis of water conservation practices that have been or are currently being implemented by multiple municipalities and utilities, in order to ascertain the actual water savings and the direct costs and benefits from each program's implementation (Water CASA, 2006). The ECOBA study analyzed data from 42 different programs from both large and small municipal utilities, considering only data that included at least two years of record before and after a conservation program was implemented. Control group data were also used, to compare locations where a water conservation program was implemented to one where it was not. The cost component of the study included only the actual costs to implement the conservation program, not avoided costs. Similarly, lost revenue was not considered a cost because it was assumed to be made up over time.

6.1 System Operation Efficiency Programs

Addressing water conservation will not be a one-time event. Instead, water conservation practices will be implemented over time and it will be important to continue to carefully monitor water use and assess how uses are changing in response to specific conservation practices. Thus, efficient measurement and reporting is a key component of a water conservation program.

The water audit discussed in Section 3.1 indicated that there are inefficiencies in the current system due to billing system and meter errors, and that leaks do occur and ongoing leak detection programs are therefore needed. Improvements in these areas will allow for optimization of conservation initiatives as the Town implements its water conservation program.

6.1.1 Automatic Meter Reading Meters and Individual Account Water Auditing

The water audit discussed in Section 3.1 indicated that there is a discrepancy between production and customer meter readings and that improved meter efficiency would be beneficial. The Town staff would like to have automatic meter reading (AMR) for the customer accounts in Town (Esqueda, 2012). These devices could also be installed in the out-of-town subdivisions where Town personnel take the meter readings. Even if the meters are read at the physical meter, having these devices will eliminate the possibility for any meters not being read, as well as for transcription errors. Meter replacements could be phased in over multiple years, with the software being purchased and the first few thousand meters being installed during the first year of the program, and then subsequent groups of meters being replaced in following years. Arenas Valley recently installed AMR, and the software was the bulk of the expense (Esqueda, 2012).

With a radio read program, data accuracy is increased, and more detailed data such as the amount of water used by day and hour for each account (giving the water system the ability to run water use profiles on customers in the event a question arises) are available. This type of information could help to identify slow leaks by analyzing water use when no one is home (working with the customer to identify those times) or during the night. Implementation of AMR also eliminates estimation when meters are hard to read, as well as transcription errors. AMR program data could also be used in public education campaigns.

After an AMR program is initiated, the Town may want to consider implementing a program for residential and/or commercial water auditing. The water audits would involve a trained person from the Town meeting with residents who have requested a voluntary audit. The AMR data, along with an assessment of appliances, toilets, leaks, and outdoor landscaping, would be used to help individual residents or commercial users determine ways in which they could realize water savings.

The ECOBA study indicated considerable variability in predicted savings due to water audits, but showed that on average, expected savings could be about 15 gpd (Water CASA, 2006). For the approximately 5,900 water accounts in Silver City, this would result in an annual savings of 32,300,000 gallons (about 99 acre-feet), although actual savings may vary from the ECOBA-reported average. If one anomalous very high cost was not counted, the study indicated an average cost of $1,284 per acre-foot for the water audit programs (this cost does not include the cost of the AMR program).

6.1.2 New Billing Software

Tracking non-revenue water and large uses or leaks is best done with an automated billing system. Under current conditions, requests for a particular set of information on different days can yield different values for each request (Esqueda, 2012). The Town would like to have a billing system that will consistently report water use accurately, with staff trained to use whatever billing system is selected (the billing staff are not trained to run reports in the current system).

The billing database should include data for all customers with any usage each month, with the actual consumption volumes being entered into the Town billing database, regardless of how small the usage may be. Water use by the lowest users (customers that use less than 1,000 gallons per month) is currently entered as zero in the billing database (Nuñez, 2012), since the Town bills for water use by the thousands of gallons, even though the total combined water use by these customers is significant. The existing or new software could be used to enter monthly water use by low-water-using customers into the database. The Town's water use accounting would be much more accurate if these uses were documented.

It is difficult to attribute any specific water savings due to better billing software, but indirectly, efficient accounting and reporting will lead to better management of the system and should lead to reductions in non-revenue water over time. Once the initial cost of the software and training has been included in the Utility budget, there should be efficiencies in staff time over the long-term.

6.1.3 Replace Booster Station Flow Meters and Continue Meter Testing

The Town of Silver City has proposed to install three new meters at two booster stations, in order to measure the amount of water being pumped into the distribution system, and has been looking for funding for the project. Silver City has already installed a SCADA system to remotely monitor and manage well and booster station pumping; however, the water pumped into the distribution system from two of the booster stations is not currently measured because the meters are inoperable, and one booster station has an operable but aged meter that needs to be replaced. The Town would like to replace these meters (two non-functional flow meters at the Woodward booster station and one older meter at the Franks booster station) to increase the accuracy of the measurement of the volume of water being pumped from the booster stations into the distribution system.

The Town routinely conducts maintenance surveys and will continue to identify system repairs and upgrades that will promote water conservation. As the Town periodically prepares capital outlay plans for the water system, other system and meter upgrades needed to improve efficiencies will be identified.

It is also recommended that the Town continue with the twice annual production meter testing and calibration. It is important to know the volume of water that is being produced, and production meters lose precision over time. Continued testing of the water association meters is also recommended. Replacement and testing of the meters will not directly result in any water savings, but will ensure accurate accounting of the amount of water the Town produces and sells to associations. Better accuracy in future water auditing will help the Town optimize any needed adaptations to its conservation program and will help minimize non-revenue water, thus aiding in achieving the Town's goals for a revenue-neutral program.

6.1.4 Leak Detection

As discussed in Section 4.1, the Town of Silver City conducts annual leak detection programs and personnel also routinely look for leaks when working on other projects or reading meters. These programs should be continued in the future. In particular, due to the length of the transmission lines from the wells to the Town system, ongoing leak detection in the transmission lines is recommended. As discussed in Section 6.1.1, installation of AMR meters will also help to quickly identify leaks so that they can be repaired.

The relative savings of water losses from a leak detection program can be highly variable. As discussed in Section 4.1, the March 2012 leak detection study estimated the volume of water being lost as a result of the leaks that it pinpointed as 22,104 gpd or 8,067,960 gallons per year (USA, 2012). This is about 1 percent of the total water usage from the system in 2011. The 1 percent loss is relatively low, but losses could have been considerably higher if the leak detection program did not lead to finding and repairing leaks in a timely manner. The savings potential of a leak detection program is somewhat dependent on the age of the infrastructure and can be extremely variable depending on the magnitude and timing of leaks, which cannot be predicted ahead of time. Nonetheless, leak detection is an effective way of avoiding water waste and is recommended as a continuing program.

6.2 Outdoor Watering Conservation Programs

Outdoor water conservation programs can be very important, because the savings from outdoor water use reflect water that would not otherwise result in return flow to groundwater or to the wastewater treatment plant, where return flow credits can be obtained. Due to the hot, arid climate in Silver City, outdoor water use can be very high, and even relatively small percentage changes can result in significant water savings. Additionally, the Town of Silver City pays directly for the outdoor water use at Town parks and recreational facilities, and so savings in those areas will support a revenue-neutral program. Consequently, the Town of Silver City has identified reductions in outdoor watering as a goal of its water conservation program, as discussed in Section 5.

6.2.1 Smart Irrigation

The Town of Silver City began installing a “smart” irrigation system in July 2013 on the Altamirano sports fields (the top water user in 2011 and 2012 [Section 3.6]), to increase both water and energy efficiency. This type of project is the highest priority in consideration of performance measures because:

- Outdoor water use does not result in return flow to the wastewater treatment system that can be either re-used or applied as return flow credits for the Town’s water rights.
- The water use at Altamirano sports complex is paid for by the Town, so the water use reductions will not lead to a loss of revenue, but will reduce the Town’s irrigation costs.

Funding for installing the smart irrigation system, estimated to cost $50,000, is provided through a grant from the New Mexico Interstate Stream Commission (ISC) (awarded June 2013). Although the Altamirano sports fields are the top priority for reducing irrigation water use within the Town, installation of smart irrigation systems at other locations may also be beneficial in the longer term.

The total use at the Altamirano sports fields in 2012 was 19,734,000 gallons (61 acre-feet), or 2.4 percent of the total use in the Town. It is estimated that the amount of water conserved will be more than 24 acre-feet of water per year, which equals 7,845,909 gallons of water. Thus implementation of smart irrigation over a period of 20 years could result in a savings of 480 acre-feet of water, at a cost of $104 per acre-foot. The cost calculation assumes that there will be no change in maintenance costs; maintenance is already required for operation of the fields and no additional maintenance will be required as a result of the new irrigation system.

6.2.2 Revision of the School System Maintenance Agreement

Although the Town bears the cost of irrigating the Altamirano sports fields, the Altamirano irrigation system is maintained by the school system staff. Given their lack of responsibility for the water bills, the schools do not have an incentive to conserve water. Accordingly, the Town may want to revise their agreement with the school system regarding the Altamirano and any other sports fields, so that the schools pay for the water used. This would likely lead to changes in the irrigation methods and times, resulting in conservation. An alternative could be to impose a cap on the amount of water that the Town provides free of cost, with the school system having to pay for any additional water usage.

6.2.3 Turf Replacement

The Town could evaluate the possibility of changing some portion of the Altamirano or other sports fields to artificial turf, reducing the amount of water that would be necessary for irrigation. The grass at the Town's Scott Park multi-use fields was recently replaced with artificial turf, and the Town staff sees this as a possible conservation option for additional areas (Esqueda, 2012). However, there are potential issues with using turf, such as heat exposure, the presence of metals or bacteria on the turf, and expense, so a careful analysis should be conducted prior to implementing additional turf projects.

The OSE has quantified landscape irrigation water requirements by vegetation and irrigation type for each county in New Mexico, and their estimate of the landscape irrigation water requirement using flood or sprinkler irrigation for Bermuda grass in Grant County is 27.70 gallons per square foot per year (Wilson, 1996). This translates to a water savings of about 3.7 ac-ft/yr per acre of turf replacement, or a total of 18.5 acre-feet for each 5-acre field replaced. The actual water savings would be slightly less, as some water would continue to be used to keep the turf cool and clean. The total cost of the recent turf replacement at the Scott Park multi-use fields was approximately $4,000,000 for the 300,000 square feet of grass (8 acres) that was replaced. The estimated annual savings is approximately 29.6 acre-feet (8 acres x 3.7 acre-feet per acre per year). Assuming that the artificial turf will last for 20 years, a total of approximately 590 acre-feet of water would be saved (8 acres x 3.7 acre-feet per acre per year x 20 years) at a cost of approximately $6,800 per acre-foot ($4,000,000,000 divided by 590 acre-feet).

6.2.4 Xeriscape Programs

Xeriscaping is a type of landscaping that can significantly reduce outdoor water use, especially during the summer months. Xeriscaping is typically implemented in two ways: (1) for outdoor areas for which the Town owns the lands, the Town may directly implement projects that replace high-water-use plants with xeriscaping, and (2) for residential or commercial areas owned by others, the Town could provide a rebate program to encourage voluntary xeriscaping. Other New Mexico cities, including Albuquerque and Alamogordo, have xeriscape rebate programs to help reduce outdoor water use. The Town of Silver City could promote xeriscaping through public education, rate structures that provide an incentive for voluntary conservation practices, and development of xeriscape demonstration projects at Town facilities.

Xeriscaping involves more than removing grass and replacing it with gravel or other types of turf. A number of different principles or approaches are considered xeriscaping:

- *Low-water-use plants:* Select plant varieties that are most appropriate for the landscape design and that require low amounts of water.

- *Soil improvement:* Improve soil composition to increase water retention and promote root development and proper drainage.

- *Small turf areas:* Limit turf to small areas for a specific function or aesthetics, and use low-water-use grass varieties.

- *Efficient irrigation:* Design a landscape by zoning plants according to water needs, and use efficient watering techniques such as drip irrigation, which delivers water directly to the roots of the plant. Maintenance of an irrigation system is essential.

- *Soil covering:* Use mulch to cover the soil, thereby reducing evaporation and erosion. This practice may have particular value during drought. Diversion of woody biomass from the landfill by chipping/shredding it would provide a source of mulch. Purchase of required equipment is recommended.

Permaculture principles that promote healthy water and soil management and potential growing of food crops may be integrated into xeriscape designs.

The largest water savings associated with replacement of existing turf with xeriscape is expected to come from the residential sector, because it accounts for the majority of water use in the Town and because outdoor watering is expected to be lower in the other sectors. Water use is also higher in the summer months for the commercial sector (Section 3.5), in part because of outdoor landscaping, and so there is also potential for water savings due to xeriscaping in the commercial sector.

As discussed in Section 6.2.3, the OSE estimates that the landscape irrigation water requirement using flood or sprinkler irrigation for Bermuda grass in Grant County is 27.70 gallons per square foot per year (Wilson, 1996). Bermuda is a warm season grass commonly used in the Southwest. Assuming that households are irrigating 600 square feet of Bermuda grass (20 by 30 feet), the landscape irrigation water requirement would be 16,620 gallons per year. While the actual irrigation use will vary for each residence, with some not watering regularly and others using more water (because grass is generally over-watered), this figure provides a ballpark estimate of current residential irrigation usage. The 2011 Town of Silver City water billing database includes 5,293 residential accounts (Table 7). If 5 to 10 percent of households (265 to 530 households) were to remove 600 square feet of grass, 4.4 to 8.8 million gallons (13.5 to 27 acre-feet) of water would be saved each year.

The magnitude of water savings would be reduced if grass were replaced with xeriscape, although replacing grass with low-water-use plants would still lead to significant water savings. Xeriscaping has been shown to reduce outdoor water use by 50 percent or more (NM OSE, 2001). Replacing a 600-square foot area of Bermuda grass with xeriscape could yield a water savings of 8,310 gallons per year (50 percent of the 16,620-gallon per year Bermuda grass irrigation requirement). If 5 to 10 percent of households (265 to 530 households) were to replace 600 square feet of grass with xeriscape, 2.2 million to 4.4 million gallons (7 to 14 acre-feet) of water would be saved each year. More significant savings could be made if larger areas and/or more households were to replace existing grass with xeriscape.

The ECOBA study (Water CASA, 2006) indicated that savings from landscape conversion programs ranged from 11,400 to 39,700 gallons (0.03 to 0.1 acre-foot) per year per participant, with an average savings of 21,900 gallons or 11.6 percent. The cost ranged from $236 to $3,338 per acre-foot with an average cost of $1,099 per acre-foot (Water CASA, 2006).

6.2.5 Water Harvesting

The goal of water harvesting projects is to spread and infiltrate water, to be used by plants and/or for aquifer recharge. There are three primary types of water harvesting:

- *Rainwater harvesting* captures precipitation and uses it in an area close to where it falls (Lancaster, 2009). Tanks or cisterns are sometimes used for storage, or the topography of a site can be used for water capture and water storage in the soil. Harvesting rainwater can decrease erosion, reduce flooding, minimize water pollution, and improve soil fertility, vegetative production, and ecosystem function (Lancaster, 2009), while reducing the amount of groundwater that is used for landscape irrigation.

- *Stormwater harvesting* involves allowing runoff from streets or other impervious surfaces to run onto a property through a curb cut or other method, where topography is used to route the water and the soil is used for water treatment and storage. Stormwater may also be captured from the roofs of large public buildings and/or private residences and stored in tanks for use in firefighting (harvested water from large public buildings) or outdoor watering.

- *Graywater harvesting* involves reusing wastewater generated in a home (except water from toilets) for other purposes, especially landscape irrigation.

Public participation is seen as the key to water harvesting-type programs. Conservation through water harvesting was discussed during the stakeholder meetings conducted for the Silver City conservation plan, and these methods are seen favorably by the community. Rainwater, stormwater, and graywater harvesting projects have already begun to be implemented in Silver City although their implementation could be expanded.

Implementation of water harvesting systems will lead to conservation of the Town’s groundwater resources, with less groundwater being used for landscape irrigation. Small-scale earthwork strategies that absorb the harvested water within a couple of hours should be used to ensure that standing water is not available for mosquitoes to breed (mosquitoes need standing water for three days in order to hatch) (Lancaster, 2009). If tanks or cisterns are used for water storage, access needs to be limited to keep insects out. It is also important to plan for an overflow route for harvested water so that excess harvested water has a way to leave a site during large storms (Lancaster, 2009).

Western Regional Climate Center (WRCC) climatological records were reviewed, and the Silver City climate data collection station, for a period of record of January 1914 through October 1964, reported an annual precipitation average of 16.08 inches (WRCC, 2012). Other nearby stations with more current data include the Cliff 11 SE and Fort Bayard stations, which had periods of record of January 1937 through December 2005 and February 1897 through December 2005, respectively. The data from these stations indicated annual precipitation averages of 14.24 and 15.66 inches, respectively (WRCC, 2012). With an average annual rainfall of approximately 16 inches on an area of 10 square miles, approximately 8,500 acre-feet of water fall on Silver City each year. If 5 to 10 percent of that water can be harvested, the result would be approximately 425 to 850 ac-ft/yr. Due to the intermittent nature of rainfall, harvesting of water during a few large events or wet periods does not replace groundwater pumping during extended dry periods. If a larger percentage of the harvested water, beyond what is needed for short-term watering, can be used for aquifer recharge or can be stored for future use, then even greater benefits will result. The schools, hospital, Town, WNMU, and County Courthouse are large water users, and so there may be opportunities for targeting water harvesting measures for these users.

The Gila-San Francisco declared basin's rules and regulations are determined by *Arizona v. California,* 376 U.S. 340 (1964). Water rights in this basin have been fully allocated, and if outdoor use is proposed as part of a domestic well permit application, the applicant must purchase and transfer water rights to cover the outdoor consumptive use (DBS&A, 2005). Because of *Arizona v. California*, the water harvesting regulations differ between the Gila and Mimbres groundwater basins. Outdoor water harvesting is limited in the Gila watershed, with an outdoor water rights permit being required to harvest water into rain barrels and cisterns, although downspout discharge can be routed into earthen basins in the Gila Basin (Clothier, 2012). Water can be harvested for small residential projects in the Mimbres Basin (Clothier, 2012).

6.2.6 Graywater Reuse

A bill passed by the 2003 New Mexico Legislature (House Bill 114, codified at 74-6-2 and 74-6-4 NMSA 1978) allows reuse of up to 250 gpd of residential graywater for household gardening, composting, or landscape irrigation without a permit (NMED, 2013). NMED issued a graywater irrigation guide outlining the conditions that apply to graywater reuse in New Mexico (available at http://www.nmenv.state.nm.us/OOTS/gray%20water%20irrigation%20guide1.pdf). One of the conditions calls for graywater storage tanks to be covered to restrict access and eliminate habitat for mosquitoes. In addition, graywater may not be applied within 100 feet of a domestic well or within 200 feet of a public water supply well (NMED, 2013). In areas where soils are not adequately permeable, discharge of graywater may present a ponding problem. Therefore, site-specific evaluations should be completed before installing graywater systems.

Household water demand in Silver City was estimated to be approximately 95,200 gallons per household per year (calculated by dividing the total billed water use for the residential sector in 2011 [503,728,000 gallons] by the number of residential accounts [5,293 accounts]). Not all of a household’s wastewater is available for graywater harvesting, as some of a household’s water is classified as black water (e.g., water used in toilets, kitchen sinks, dishwashers, and laundering of material soiled with human excrement).

The state allows up to 250 gpd per household of graywater reuse. Implementation of graywater harvesting systems reusing 250 gallons per day in 10 percent of Silver City’s 5,293 households (Table 7) would translate to approximately 150 acre-feet of water savings per year. Graywater use could be encouraged by requiring graywater systems in new construction, or alternatively, by offering a rebate program for installation of graywater systems.

6.2.7 Wastewater Reuse

Projects involving reuse of treated effluent from wastewater treatment plants typically provide treated water for watering of outdoor landscaping, thus reducing the need for pumping groundwater for that purpose. The Town of Silver City golf course uses wastewater treatment plant effluent rather than potable water for irrigation (Esqueda, 2012). Other uses for treated effluent would need to be evaluated considering the beneficial aquifer recharge from wastewater discharge and the cost of electricity to pump the water. The Town has a pending return flow credit application with the Office of the State Engineer that would officially recognize the value of the wastewater discharge recharging the aquifer. Approval of the application would expand the Town's water right to include the amount of recharge. A substantial decrease in the amount of wastewater being discharged could affect the recharge amount.

6.3 Indoor Water Conservation Programs

As discussed in Section 5, reductions in outdoor water use are a primary goal of the Town of Silver City. Indoor water conservation is less important, because indoor water is routed to the wastewater treatment plant and can be applied as return flow credits. Nevertheless, there can be benefits in terms of energy saved and timing of water use from indoor conservation programs. So while the Town does not intend to focus on indoor water conservation initially, it may have a longer-term goal of reducing indoor water use.

Toilets, washing machines, faucets, and showers account for more than 90 percent of indoor water use (Vickers, 2001), and efficient-water-use appliances can significantly reduce indoor water use. Incentives for installation of efficient-water-use appliances that could be considered include supplying the public with free toilet leak detection kits and/or free retrofit kits that include low-flow showerhead and faucet components. The ECOBA study indicated that the success of device giveaway programs was highly variable and there was not a definitive measurable impact of the programs. The costs ranged from $1 to $12 per participant, so these can be relatively inexpensive in relation to other water conservation practices (Water CASA, 2006).

Programs providing rebates or even free fixtures can be offered as an incentive to encourage households to replace older, higher-water-using toilets, dishwashers, or washing machines. Studies of toilet replacement programs indicated significantly greater water savings when toilets were provided directly rather than with rebate programs (Water CASA, 2006). The ECOBA indicated a large range of variability in savings from this type of program; average water savings were 26,890 gallons per participant at an average cost of $181 per acre-foot (Water CASA, 2006).

Savings may also be obtained in the commercial sector, particularly for large indoor water users such as hotels. Either through education or through incentives such as water rates or rebates, hotels, restaurants, and other businesses may be encouraged to install devices such as flow arresters and to make use of low-water-use appliances.

The relative savings from various conserving vs. non-conserving appliances can be calculated as shown in Table 16 (Vickers, 2001).

Table 16. Potential Demand Reduction for Indoor Use

Use	Average Indoor Per Capita Water Use (gpcd)		
	Conserving Household [a]	Non-Conserving Household [b]	Potential Savings
Toilets	8.2	18.5	10.3
Showers	8.8	11.6	2.8
Faucets	10.8	10.9	0.1
Baths	1.2	1.2	0.0
Dishwashers	0.7	1.0	0.3
Clothes washers	10.0	15.0	5.0
Leaks	4.0	9.5	5.5
Other domestic	1.6	1.6	0.0
Total indoor water use	45.3	69.3	24.0

[a] Water use based on the following fixture flow rates (Vickers, 2001):

Toilets:	1.6 gallons per flush
Showerheads:	2.5 gpm at 80 psi
Faucets:	2.0 gpm at 80 psi
Clothes washers:	27 gallons per load
Dishwashers:	7.0 gallons per load

[b] Vickers, 2001

gpcd = Gallons per capita per day
gpm = Gallons per minute
psi = Pounds per square inch

The possibility of offering indoor rebate programs for installing water use efficient fixtures was discussed at Steering Committee meetings. With the exception of Tyrone and Rosedale, multiple septic systems are used to treat water association wastewater (which is therefore not sent to the Town for treatment), so indoor conservation practices implemented in these residences will not reduce demands on the Town’s sewer system. TPOA has received funding from the U.S. Department of Agriculture Rural Development (USDA-RD) program for the infrastructure necessary to send their wastewater to the Town for treatment (replacing their lagoons), so their wastewater will likely be sent to the Town for treatment in the future (Jordan, 2012).

6.4 Statutes, Ordinances, and Regulations

As discussed in Section 4.3, the Town's current rate structure encourages water conservation by including higher unit rate charges for higher water use. However, additional conservation incentives should be considered in future rate evaluations. Two components may be valuable:

- It may be useful to reconsider the usage level for minimum monthly charges, which was revised from 3,000 to 2,000 gallons per month in July 2013 (i.e., the household pays the same base charge for any amount of water use up to 2,000 gallons per month) for both the Town and the water associations. Further reductions in the number of gallons per month for the base rate charge should be evaluated in conjunction with future rate evaluations.

- Over time, the Town may wish to set higher rates, to offset the loss of revenue from lower water usage.

- While there is an increased unit charge for higher water use, the incentive to conserve could be increased by a greater differential charge for higher levels of water use. For example, calculations were done to evaluate the rate structure invoked for the unit charge at usage above 3,000 gallons. Based on the rates presented in Table 11, a household using 13,000 gallons pays a total of $45.05 per month ($10.65 base rate plus 10,000 gallons at $3.44 per 1,000 gallons). After 13,000 gallons, the unit rate rises to $4.21 (e.g., a household using 17,000 gallons will pay a total of $69.59 per month [$10.65 base rate plus 14,000 gallons at $4.21 per 1,000 gallons]). The Town may want to consider higher unit charges when considering future water rates. However, the higher unit charges must also be weighed against reasonable uses for larger households; the 13,000-gallon limit for the lower rate represents 144 gallons per capita per day (gpcd) for a 3-person household for a 30-day month (217 and 108 gpcd for 2- and 4-person households, respectively). When considering future rates, the advantages and disadvantages of using rates, which are a larger issue for low-income households, versus limits on water use (e.g., outdoor watering restrictions), should be evaluated.

In addition to the rate structures, other regulations that the Town Council may want to consider include a water waste ordinance and/or a more comprehensive water conservation ordinance that ties water conservation restrictions to drought conditions and builds upon the emergency water shortage ordinance discussed in Section 4.4.

A water waste ordinance would allow the existing code enforcement officers to write tickets for customers who allow water to run off of their property. Locations that chronically waste water were discussed in the stakeholder meetings and include Gough Park, the Grant County Court House, and some churches. Western New Mexico University may also benefit from reductions in water waste. Because there is no documentation of the amount of water currently being wasted, the amount of water that can be saved with a waste ordinance cannot be quantified and possibly may be relatively low. Regardless, the ordinance would support other conservation practices by indicating that the Town takes water conservation seriously. Additionally, there is little cost involved in a water waste ordinance if Town employees can enforce the ordinance in the course of conducting other business. The cost for developing the ordinance would be minimal, as Town personnel could use existing ordinances from other communities as a model for discussion with the Town Council.

The Town may want to adopt a more comprehensive water conservation ordinance that goes beyond addressing water waste. Other conservation practices that could be included are time of day watering restrictions and restrictions on car washing or other specific activities during drought periods. This type of ordinance typically involves increasing conservation practices when various drought triggers are realized. Since the Town relies entirely on a groundwater reserve, there are no particular supply-related drought triggers, such as low reservoir levels, that would apply. However, demand typically increases during droughts due to outdoor watering, so setting increased restrictions such as time of day or alternate day watering or increased fees during various drought stages may be valuable.

In a broader sense, the Town may benefit by linking water conservation goals to its Climate Action Plan (Town of Silver City, 2009a). Pumping and treating less water will have a direct benefit in terms of saving energy costs and thus reducing climate impacts. Other links between water conservation and energy savings policies include:

- Residential energy efficiency programs that improve insulation and home cooling efficiencies should result in lower water use by swamp coolers.

- Rebate programs that encourage newer water-saving appliances will also result in energy savings, as the newer appliances are generally both water- and energy-efficient.

- Water harvesting projects that the Town and its residents engage in can be used to encourage retention of shade trees in key locations, while replacing non-beneficial high-water-use vegetation.

6.5 Public Education

Input on how to inform the public about water conservation was solicited at one of the Steering Committee meetings, and school programs were identified as the favorite public outreach method, with community events, radio stories, and the use of a community educator also receiving broad support. Other methods recommended by the group included:

- Tours of completed projects
- Newspaper and website articles
- Community meetings
- Water conservation tips provided in the weekly Around Silver City column published by the Town in the Silver City Daily Press.
- Very short conservation tips printed on billing postcards
- Printed material included in monthly statements from Town businesses such as banks and utilities
- Information from the planning process posted on the Town website and the Grant County website

- Information posted on the Gila Community Forum
- Information posted on road signs

Education and demonstration projects were seen as important for encouraging public participation in the water conservation program. The Town of Silver City Office of Sustainability plans to set up a demonstration project at their new office space (Annex II at 1106 North Pope Street). Rainwater harvesting is also planned for the Volunteer Center. The Office of Sustainability completed an Energy Sense program where they evaluated conservation-related fixtures such as low-flow shower heads, aerators, and light bulbs in about 800 residential homes. The project included installation of low-flow shower heads in about 300 homes.

There was a suggestion that the planning process include development of a Silver City-specific educational brochure or fact sheet pertaining to Silver City water conservation that could be provided to the public and/or included with Town funding applications. The water conservation measures that are identified as part of the planning process will be voluntary for all residents, and while separate audits will not be completed for the water associations, the Town encourages their participation in the process. The audits can be an important part of the education/outreach program, by providing specific information regarding the greatest potential for water savings.

Increasing public awareness of personal use could be enhanced by providing information on their bills comparing year to year and month to month use. This type of detailed information would be difficult to provide given the current billing system, but could be an added benefit of a new radio read system and/or enhanced software and employee training.

The public education component of the water conservation program will be ongoing. As projects are completed, the Town can highlight information about successful projects and can draw attention to particularly successful projects through an Awards Recognition Program. Additionally, education programs can be developed for top users (Section 3.6). For example, WNMU and the Silver City Public Schools, in addition to being very large users, have large audiences of young people that targeted education programs and demonstration projects can help to educate regarding water conservation measures.

The public education program is more likely to result in direct water savings when done in conjunction with other conservation measures. For example, if the Town passes a water waste ordinance or implements time of day watering restrictions, compliance with those measures will be greater if the public understands the importance of the program and the consequences for non-compliance. Similarly, if a voluntary xeriscape or other rebate program is implemented, participation will be dependent on the public awareness and acceptance of the program.

6.6 Summary of Water Conservation Programs in Relation To Performance Measures

In determining how to prioritize water conservation project implementation, it is important to consider each of the types of conservation projects listed in Sections 6.1 through 6.5 in relation to defined performance measures. As discussed previously, evaluating water conservation options in relation to potential water savings and other benefits, as well as to fiscal considerations, is important. Additionally, because the Town's conservation program is voluntary, a qualitative evaluation of public support for various options is important to consider when ranking various options.

The Steering Committee provided input on possible performance measures, including the

- Total savings in the amount of water pumped
- Total savings in amount of water consumptively used
- Program cost per acre-foot of water conserved
- Availability of funding/financing
- The level of participation in rebate programs, educational events, and other conservation programs

The group opinion was mixed about raising water rates, but there was general support for seeking funding for implementation of the conservation plan.

The water conservation options discussed in Sections 6.1 through 6.5 were evaluated by the consultants, with input from the Town and stakeholder group, in relation to the water savings, cost, and public acceptance of the performance measures. The evaluation results are summarized in Table 17.

6.7 Implementation Schedule and Budget

When developing an implementation schedule for the water conservation program, it is important to collect baseline data and then phase in conservation practices in a manner that will allow for effective tracking of the performance measures. For example, implementing only one conservation practice at a time in a given location will allow for comparison of water use data before and after the practice was implemented as well as in comparison to other locations.

The implementation schedule shown on Table 18 was developed by considering the performance measures shown in Table 17 and giving implementation priority to projects that would result in the greatest water savings in relation to fiscal concerns, as well as public acceptance.

There is no specific annual budget for a water conservation program – the level of cost and effort is dependent on how aggressive a utility wants to be in reducing demands. Due to Silver City's fiscal concerns as well as the greater benefit received from reductions in outdoor watering, the initial implementation priorities identified on Table 18 include smart irrigation, reductions in Town outdoor watering, water harvesting, water waste reduction projects, and public education. These projects will not result in a loss in revenue for the Town, as the Town currently does not collect revenue for watering of parks and other public facilities. Grant or other specific funding will be sought for the larger projects, and these projects will not be implemented until funds are specifically arranged. Applications for grant funding and oversight of the projects and planning for future projects, as well as coordination of the public education program, are estimated to require a half- to full-time position within the Office of Sustainability.

Table 17. Evaluation of Water Conservation Projects

	Rating [a]							
	Water Savings				Cost			
Water Conservation Program	Total Annual Water Savings	Return Flow Impacts	Reduction in Peak Demand	Secondary Benefits	Cost per Acre-Foot Saved	Funding Available	Maintenance Costs	Public Acceptance
System Operation Efficiency								
Automatic meter reading	5	3	4	4	3	3	5	4
New billing software	3	2	2	2	3	3	5	3
Meter replacement / testing	3	3	3	3	3	2	4	3
Leak detection	4	3	3	3	4	2	3	4
Outdoor Watering Conservation Programs								
Smart irrigation	5	5	5	3	3	5	2	5
Turf replacement	5	5	5	3	2	4	4	3
School maintenance agreements	4	5	5	4	3	5	3	4
Xeriscape programs	5	5	5	4	5	2	2	5
Water harvesting	4	5	5	5	4	4	4	5
Indoor Water Conservation Programs								
Device giveaways	3	2	3	3	5	4	3	3
Appliance rebates (dishwashers and washing machines)	4	2	3	3	3	4	2	3
Toilet rebates	4	2	3	3	3	4	2	3
Ordinances and Policies								
Rate ordinances	4	2	4	3	5	3	3	1
Water waste ordinance	2	4	3	4	3	3	3	4
Water conservation ordinance (with drought triggers)	4	3	5	4	4	4	2	3
Public Education	3	3	4	4	5	5	3	5

[a] Rating scale: 1 = Lowest benefit or highest cost
3 = Medium benefit or cost, or neutral impact
5 = Highest benefit or lowest cost

Table 18. Water Conservation Project Implementation Schedule

	Implementation Time Frame			
Water Conservation Program	1 to 2 Years	3 to 6 Years	7 to 10 Years	Long-Term[a]
System Operation Efficiency				
Automatic meter reading	x			
Residential water audits		x	x	x
New billing software	x			
Meter replacement / testing	x	x	x	x
Leak detection	x	x	x	x
Outdoor Watering Conservation Programs				
Smart irrigation	x	x		
School maintenance agreements	x	x		
Xeriscape programs[c]	x	x	x	x
Water harvesting	x	x	x	x
Indoor Water Conservation Programs				
Device giveaways			x	
Appliance rebates (dishwashers and washing machines)			x	
Toilet rebates				x
Ordinances and policies				
Rate ordinances		x		
Water waste ordinance	x			
Comprehensive water conservation ordinance (with drought triggers)		x		
Public education	x	x	x	x

[a] Reconsider after evaluating the success of the first measures implemented and re-evaluating Town goals.

[b] Including permaculture

6.8 Post-Implementation Performance Measures

To evaluate the success of any conservation program, the actual water use savings should be tracked. While there are multiple sources of good information for estimating potential water savings from conservation programs, it can be difficult to quantify actual savings from a given program. This is because often multiple conservation practices are in effect at the same time, and there is natural variability in demand due to climatic or other conditions as wells as errors due to billing cycles, meters, or other issues. The ECOBA study (Water CASA, 2006) showed considerable variation is measured water savings from different programs, and sometimes water use was higher in relation to a control group after a water conservation practice was implemented.

To effectively analyze the success of various conservation practices, it will be optimal to stagger initiation of various programs, so that multiple practices will not create confusion about whether each one is effective. Other recommendations for post-implementation performance measures include:

- For larger users, the reduction in use for just that account should be tracked separately. For example, as smart irrigation is implemented at the Ben Altamirano sports fields, use for Ben Altamirano should be carefully tracked.

- Records regarding participation should be carefully tracked. These may include number of participants at educational events, type and number of advertisements, and number and type of participants in voluntary rebate programs.

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Appendix A

AWWA Performance Indicators

AWWA WLCC Free Water Audit Software: Reporting Worksheet

WAS v4.2

Back to Instructions

? Click to access definition

Water Audit Report for: Town of Silver City
Reporting Year: 2011 1/2011 - 12/2011

Please enter data in the white cells below. Where available, metered values should be used; if metered values are unavailable please estimate a value. Indicate your confidence in the accuracy of the input data by grading each component (1-10) using the drop-down list to the left of the input cell. Hover the mouse over the cell to obtain a description of the grades

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

WATER SUPPLIED

<< Enter grading in column 'E'

Volume from own sources:	?	8	926.261	Million gallons (US)/yr (MG/Yr)
Master meter error adjustment (enter positive value):	?	5	50.018	over-registered MG/Yr
Water imported:	?	n/a	0.000	MG/Yr
Water exported:	?	6	112.030	MG/Yr
WATER SUPPLIED:			764.213	MG/Yr

AUTHORIZED CONSUMPTION

Click here: ? for help using option buttons below

					Pcnt:		Value:
Billed metered:	?	8	735.854	MG/Yr			
Billed unmetered:	?	n/a	0.000	MG/Yr			
Unbilled metered:	?	n/a	0.000	MG/Yr			
Unbilled unmetered:	?	2	4.360	MG/Yr		○ ●	4.360
AUTHORIZED CONSUMPTION:	?		740.214	MG/Yr			

Use buttons to select percentage of water supplied
OR
value

WATER LOSSES (Water Supplied - Authorized Consumption)

23.999 MG/Yr

Apparent Losses

					Pcnt:		Value:
Unauthorized consumption:	?		0.000	MG/Yr		○ ●	

Enter a positive value, otherwise a default percentage of 0.25% and a grading of 5 is applied

Customer metering inaccuracies:	?	6	18.833	MG/Yr		○ ●	18.833
Systematic data handling errors:	?		0.000	MG/Yr			

Systematic data handling errors are likely, please enter a non-zero value; otherwise grade = 5

Apparent Losses:	?	18.833	

Choose this option to enter a percentage of billed metered consumption. This is NOT a default value ?

Real Losses (Current Annual Real Losses or CARL)

Real Losses = Water Losses - Apparent Losses:	?	5.166	MG/Yr
WATER LOSSES:		23.999	MG/Yr

NON-REVENUE WATER

NON-REVENUE WATER:	?	28.359	MG/Yr

= Total Water Loss + Unbilled Metered + Unbilled Unmetered

SYSTEM DATA

Length of mains:	?	10	104.0	miles
Number of active AND inactive service connections:	?	4	5,882	
Connection density:			57	conn./mile main
Average length of customer service line:	?	4	25.0	ft (pipe length between curbstop and customer meter or property boundary)
Average operating pressure:	?	4	80.0	psi

COST DATA

Total annual cost of operating water system:	?	4	$1,279,000	$/Year
Customer retail unit cost (applied to Apparent Losses):	?	4	$4.63	$/1000 gallons (US)
Variable production cost (applied to Real Losses):	?	4	$652.96	$/Million gallons

PERFORMANCE INDICATORS

Financial Indicators

Non-revenue water as percent by volume of Water Supplied:	3.7%
Non-revenue water as percent by cost of operating system:	7.3%
Annual cost of Apparent Losses:	$87,288
Annual cost of Real Losses:	$3,373

Operational Efficiency Indicators

Apparent Losses per service connection per day:	8.77	gallons/connection/day
Real Losses per service connection per day*:	2.41	gallons/connection/day
Real Losses per length of main per day*:	N/A	
Real Losses per service connection per day per psi pressure:	0.03	gallons/connection/day/psi
? Unavoidable Annual Real Losses (UARL):	48.29	million gallons/year
From Above, Real Losses = Current Annual Real Losses (CARL):	5.17	million gallons/year
? Infrastructure Leakage Index (ILI) [CARL/UARL]:	0.11	

* only the most applicable of these two indicators will be calculated

WATER AUDIT DATA VALIDITY SCORE:

***** YOUR SCORE IS: 60 out of 100 *****

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

PRIORITY AREAS FOR ATTENTION:

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

1: Volume from own sources
2: Master meter error adjustment
3: Total annual cost of operating water system

For more information, click here to see the Grading Matrix worksheet

AWWA WLCC Free Water Audit Software: Water Balance

WAS v4.2

Water Audit Report For: Town of Silver City

Report Yr: 2011

<table>
<tr><td rowspan="8">Own Sources
(Adjusted for known errors)
876.243</td><td>Water Exported
112.030</td><td colspan="4">Billed Water Exported</td></tr>
<tr><td rowspan="10">Water Supplied
764.213</td><td rowspan="4">Authorized Consumption
740.214</td><td rowspan="2">Billed Authorized Consumption
735.854</td><td>Billed Metered Consumption (inc. water exported)
735.854</td><td rowspan="2">Revenue Water
735.854</td></tr>
<tr><td>Billed Unmetered Consumption
0.000</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption
4.360</td><td>Unbilled Metered Consumption
0.000</td><td rowspan="8">Non-Revenue Water (NRW)
28.359</td></tr>
<tr><td>Unbilled Unmetered Consumption
4.360</td></tr>
<tr><td rowspan="6">Water Losses
23.999</td><td rowspan="3">Apparent Losses
18.833</td><td>Unauthorized Consumption
0.000</td></tr>
<tr><td>Customer Metering Inaccuracies
18.833</td></tr>
<tr><td>Systematic Data Handling Errors
0.000</td></tr>
<tr><td rowspan="3">Water Imported
0.000</td><td rowspan="3">Real Losses
5.166</td><td>Leakage on Transmission and/or Distribution Mains
Not broken down</td></tr>
<tr><td>Leakage and Overflows at Utility's Storage Tanks
Not broken down</td></tr>
<tr><td>Leakage on Service Connections
Not broken down</td></tr>
</table>