

**FINAL**

**UNMETERED RESIDENTIAL AND NON-RESIDENTIAL  
WELL USE IN THE SIERRA VISTA SUBWATERSHED,  
ARIZONA**

**October 2013**

*Prepared for:*

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# UNMETERED RESIDENTIAL AND NON-RESIDENTIAL WELL USE IN THE SIERRA VISTA SUBWATERSHED, ARIZONA

## 1.0 INTRODUCTION

This report presents an estimate of unmetered well use in the Sierra Vista Subwatershed (SVS) of southeastern Arizona. More specifically, it provides an estimate of residential and non-residential water demands that are not currently served by a Community Water System (CWS) or otherwise reported.<sup>1</sup> The study area covers approximately 1,035 square miles and includes the communities of Sierra Vista, Huachuca City, Tombstone, Naco, Elgin and much of the town of Bisbee as well as Fort Huachuca. The San Pedro Riparian National Conservation Area (SPRNCA) is also located in the SVS and was established by Congress in 1988 to preserve a riparian ecosystem along the San Pedro River (**Figure 1**).

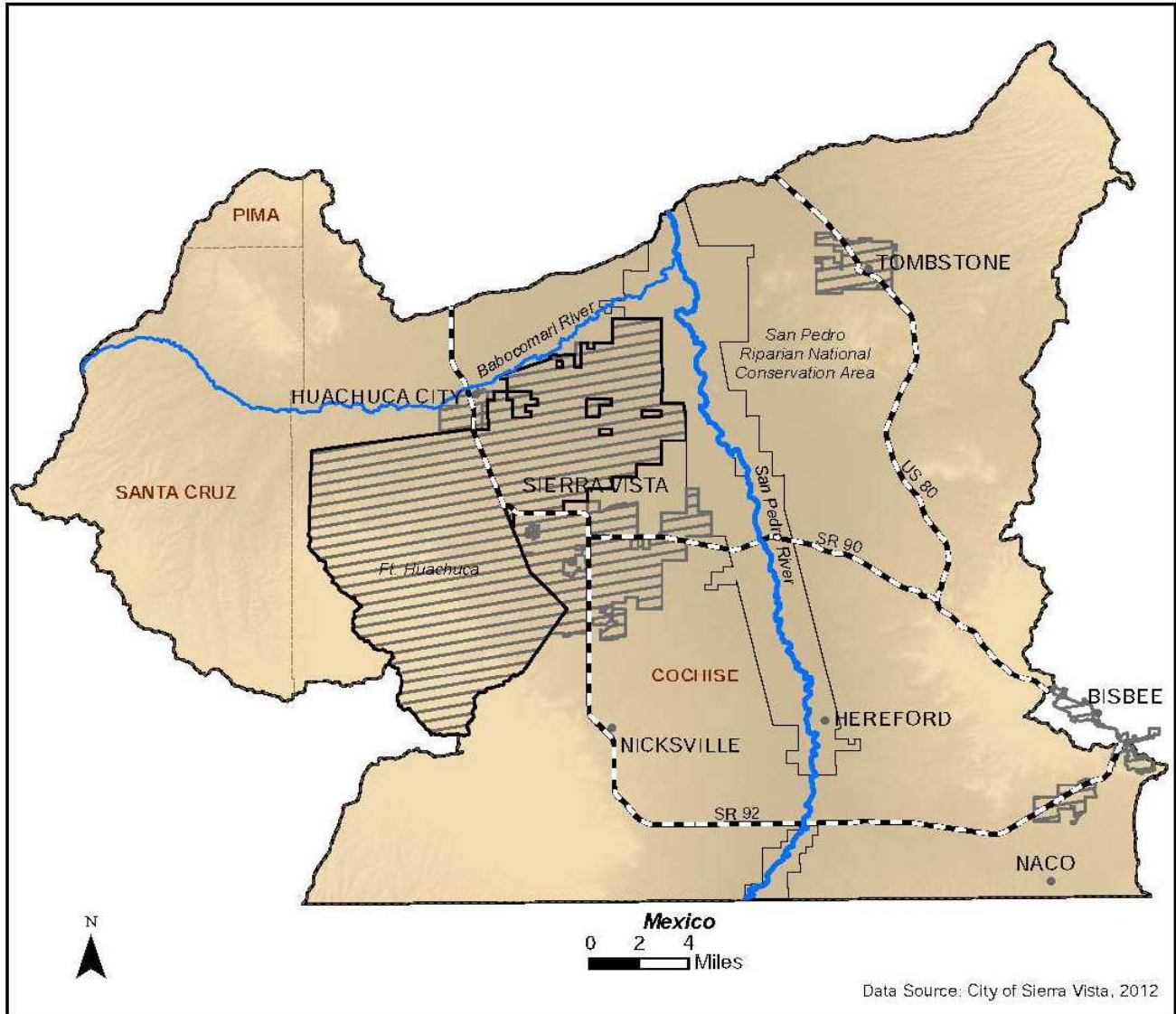
Plateau Resources LLC (Plateau) was contracted by the City of Sierra Vista in March 2013 to conduct this study on behalf of the Technical Committee (Tech) of the Upper San Pedro Partnership (USPP). The partnership is consortium of 21 agencies and organizations formed to “monitor and manage our water, build projects to enhance our water resources, and provide education and public policy recommendations in an effort to help state and local governments better manage water resources” (USPP, 2011). Public Law 108-136, the 2004 National Defense Authorization Act, has required that the USPP submit annual reports to Congress through 2011 describing its progress toward restoring and maintaining the regional aquifer system that supports flows in the San Pedro River.

Numerous scientific studies and several hydrologic models have been completed for the SVS that estimate residential and non-residential water demands. Well pumpage in the SVS is currently calculated to exceed aquifer recharge, a condition known as overdraft.



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<sup>1</sup> A CWS is a local water provider that serves at least 15 connections used by year-round residents or regularly serves at least 25-year-round residents. Each CWS is required by law to submit an annual water use report to the Arizona Department of Water Resources (ADWR) that lists its water source(s), quantity of water withdrawn, number of residential and non-residential connections, and the quantity of water delivered.

**FIGURE 1. SIERRA VISTA SUBWATERSHED**



**Legend**

- City or Town
- - - Road
-  Incorporated Area
-  County



Better understanding the components of the region's water demands enables local decision makers to develop strategies to mitigate this overdraft and reduce potential impacts from well pumpage on the river.

Because non-community water systems and private wells are exempt from metering and reporting requirements, their water use must be estimated. In May 2012, Plateau completed an initial evaluation of unmetered residential well use in the study area as part of its analysis of the water demand and conservation potential of domestic wells (Plateau, 2012). This study builds on that earlier work and provides an updated, independent estimate of unmetered residential well use plus unmetered non-residential well use in the SVS.

As described in more detail below, this report presents an alternative, and we believe more rigorous, estimation of unmetered well use than is usually provided in water budgets and demand estimates. Rather than assuming what percentage of the population is not served by water providers and applying a uniform per capita consumption rate or estimating well use by the number of registered wells, our approach evaluated unmetered well use from the bottom up, starting with the number of homes and businesses in the area. This was a time consuming process that involved integrating the review of thousands of parcel and well records, interviews with nearly 100 home and business owners, analysis of annual reports from over 20 local water providers, and four field visits.

The remainder of this report is organized into six sections. Section 2 presents a list of the current SVS water providers and a map of their service areas. Sections 3 and 4 describe how unmetered residential and non-residential well uses were estimated, both inside and outside of the service areas, and the results. Study limitations are discussed in Section 5 followed by a summary of findings in Section 6 and references in Section 7.

A draft of this report was submitted to Tech in August 2013 for review. Several committee members commented in writing and Plateau addressed their comments at a

September 2013 presentation in Sierra Vista. This final report incorporates the written comments plus additional feedback from Tech during the presentation.

## **2.0 SVS WATER PROVIDERS**

**Table 1** lists current water providers in the SVS based on CWS reports from ADWR (2013a) and annual reports and eDOCKET filings from the Arizona Corporation Commission (2013). **Figure 2** shows the service area of these water providers based on Geographic Information System (GIS) data from Cochise County (2011). Plateau supplemented the county's GIS data using ADWR CWS records and by contacting one of the water providers (Huachuca City, 2013) for an updated service area map.



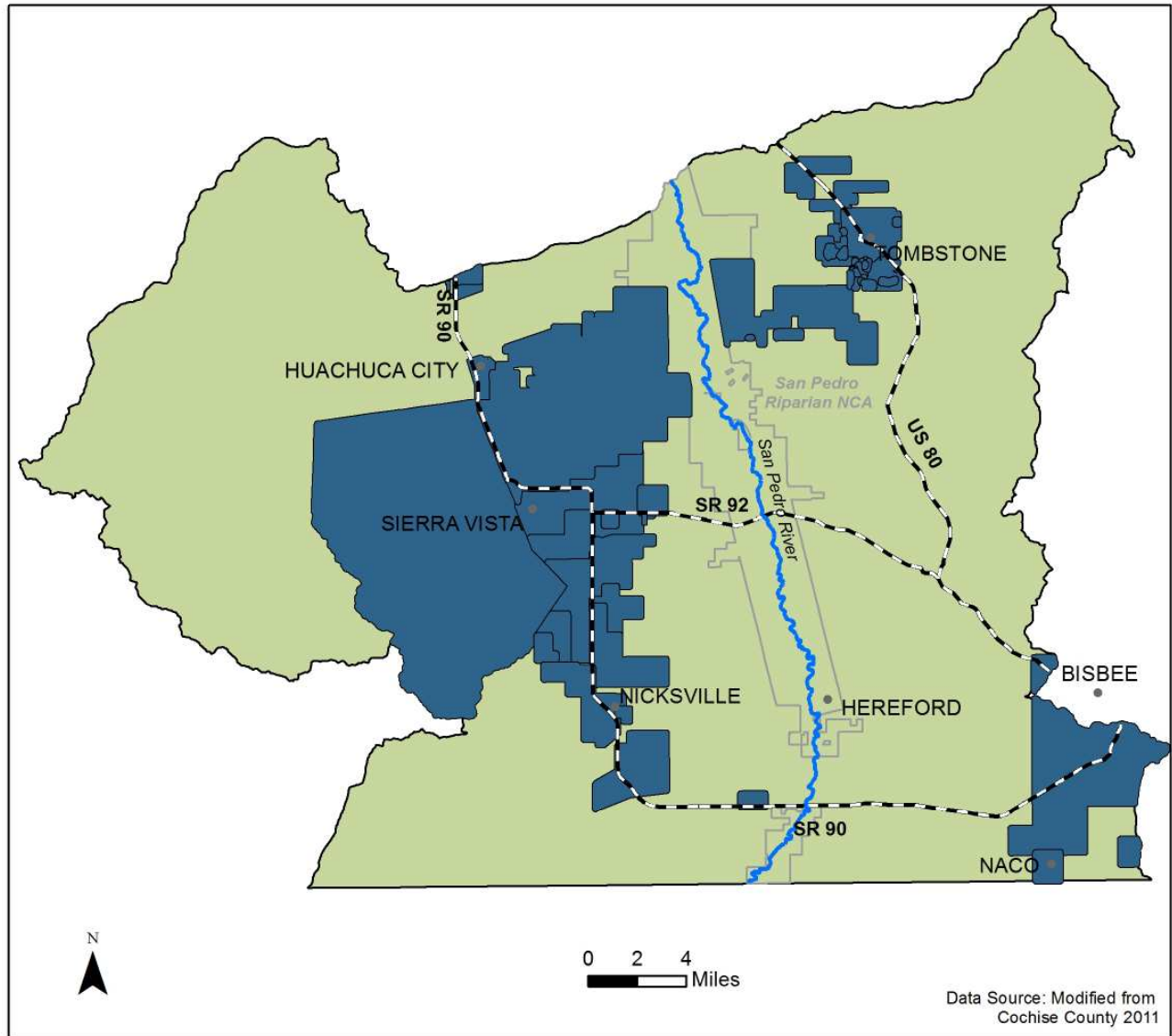
**TABLE 1. SVS WATER PROVIDERS**

WATER PROVIDER <sup>a</sup>
Antelope Run
Ashley's Mobile Home Park (Quail Ridge RV Resort)
Arizona Water Company - Bisbee
Arizona Water Company - Sierra Vista
Bella Vista Water Inc.-City <sup>b</sup>
Bella Vista Water Inc.-South (formerly Nicksville Water Company) <sup>b</sup>
Cloud Nine Water Company
Desert Winds Mobile Home Park
East Slope Water Company
Fort Huachuca
Holiday Water Company
Huachuca City
Indiada Water Company
Naco Water Company
Naco Water Company LLC
Northern Sunrise Water Company <sup>b,c</sup>
Palominas Water and Sewer Company <sup>d</sup>
Pueblo del Sol Water Company
Sierra Vista Mobile Home Village
Southern Sunrise Water Company <sup>b,e</sup>
Southland Utilities - Golden Acres
Sunrise Mobile Home Park
Tombstone, City of





Notes:

- <sup>a</sup> See **Figure 2** for a map of the water provider service areas.
- <sup>b</sup> Owned by Liberty Utilities.
- <sup>c</sup> Includes former Coronado Estates, Crystal, Mustang and Sierra Sunset water companies.
- <sup>d</sup> Currently out of business based on Arizona Corporation Commission records.
- <sup>e</sup> Includes former Cochise, Horseshoe Ranch, Lucky Hills, and Miracle Valley water companies.

## FIGURE 2. SERVICE AREAS FOR SVS WATER PROVIDERS



### Legend

-  Water Provider Service Areas
-  Area Outside of Water Provider Service Area
-  City or Town
-  Roads

### **3.0 UNMETERED RESIDENTIAL WELL USE**

This section presents Plateau’s estimate of unmetered residential well use outside of SVS water provider service areas (Section 3.1) and inside of those areas (Section 3.2). Each subsection describes the methodologies used followed by a brief discussion of our results.

#### **3.1 Outside Service Areas**

In general, Plateau estimated unmetered residential well use outside of SVS water provider service areas by first determining the number of older (pre-1997) and newer homes in the area. An annual water use rate was then estimated for the two home ages and total residential water use calculated by multiplying by the associated number of homes.

##### Methodology

To determine the number of older and newer homes outside of the water provider service areas, Plateau combined the service area map shown in **Figure 2** with Cochise County (2013) assessor records. The latter provides various parcel improvement categories including single family residences and mobile homes and associated dates of construction. Other parcel improvements such as non-residential buildings and yard improvements were not considered at this stage.<sup>2</sup>

In its prior study, Plateau noted that the assessor listed nearly 4,000 SVS parcels outside of the service areas without any improvements. For this study, each of these parcels was checked against 2010 aerial imagery and those with apparent homes were recorded. Since home construction dates were not available from the assessor for these parcels, Plateau used dates of well construction as a proxy for home age. Using well registry records from ADWR (2013b), several wells were successfully matched to these apparent homes and, depending on the date of well construction, the parcels were counted as an “unimproved parcel with apparent home” either with an “older (pre-1997) well” or “newer well” in the

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<sup>2</sup> Homes on the western side of the study area, outside of Cochise County, were identified by reviewing June 2010 aerial photography. This area covers portions of Santa Cruz and Pima counties and has a relatively low housing density.

area. For several other parcels with apparent homes, dates of well construction were not readily available as a proxy for home age, either due to multiple wells on or near the parcel, the construction date was not listed in the well registry, or no registered well was found in the area.

To determine the rate of residential water use by homes identified outside of the service areas, interior and exterior water use rates were estimated separately and then combined. As described in Plateau (2012), indoor residential water use in the study area was estimated by assuming a relationship exists between home age and fixture efficiency. Based on studies by AWWA (1999) and Aquacraft (2011), per capita interior water use was determined to be higher for homes constructed before 1997 and lower for newer homes. Interior water use per household was calculated by assuming 2.4 people per home based on US Census (2011) data for the study area.

Exterior residential water use in the study area was estimated using recent data from four SVS water providers with metered residential connections – Bella Vista City and South systems, Northern Sunrise, Pueblo del Sol and Southern Sunrise (Stitzer, 2011). For the homes served by these providers, it was assumed that water is only used for interior purposes during the water provider’s lowest water use month. Uses above this base during other months therefore represent exterior residential uses.<sup>3</sup> The percentage of residential water demand for exterior use was calculated by adding all monthly residential water deliveries above the base for each water provider year of record and dividing by the total annual residential water delivery. The results were used as a proxy for the percentage of exterior water use by SVS homes not served by water providers.<sup>4</sup>

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<sup>3</sup> There is likely some outdoor water use even during the lowest use month, but this is considered minor and in the SVS would not include irrigation which is typically the largest component of exterior use.

<sup>4</sup> In its previous study, Plateau (2012) evaluated exterior water uses outside of the service areas through analysis of 2010 aerial photography. Potential errors in this approach were noted and include a lack of high resolution imagery that may have caused smaller areas of irrigation to be missed and deficit-irrigated and xeriscaped areas to be mistaken for natural vegetation. Other limitations include being unable to assess water use by evaporative coolers and livestock. Finally, this method cannot detect other potential exterior water uses such as car and equipment washing, dust control and cleaning of hardscapes. As described further in Section 4.1, Plateau decided for this study to use its analysis of the 2010 aerial photography only to identify relatively large (>0.3-acre) areas of exterior water use. Smaller, incidental exterior water uses were estimated using the monthly residential water provider data described above.

## Results

**Table 2** lists the number of homes that Plateau identified outside of the water provider service areas using parcel and well registry records and review of aerial photography. The total number of homes in this area is estimated to range from 4,530 to 4,990. Of these homes, 2,000 to 2,240 were determined to be older (pre-1997), 2,000 to 2,190 were determined to be newer, and the age of the remaining 530 to 560 was not determined. The upper range of these values incorporates Plateau's 2012 analysis which was updated for this study to include about 30 additional homes not previously listed by the assessor. The lower range of values also reflects the new assessor data but includes refinements to the service area boundaries previously used by Plateau.<sup>5</sup>

**Tables 3** and **4** list interior and exterior water use rates for the homes that Plateau identified outside of the service areas. For indoor purposes, the older homes are estimated to use 0.19 acre-feet per year (AFA) and the younger homes 0.13 AFA. Records from four SVS water providers suggest that the percentage of total residential water demand for exterior use is typically about 27%. Combining these estimates of interior and exterior use, **Table 5** indicates that SVS homes built before 1997 use a total of approximately 0.26 AFA and newer homes in the area use about 0.18 AFA. These estimates compare favorably to metered residential water uses in the SVS. **Table 6** lists recent residential delivery data from 14 SVS water providers plus data from eight domestic wells metered by Water Wise staff. The average water use per home served by these providers ranged from 0.14 to 0.41 AFA with a mean and median use of 0.24 AFA.

Using the per household water use rates in **Table 5**, Plateau multiplied these rates by the number of older and newer homes it determined were located outside of the service areas. When home ages were not readily available, a range of 0.18 to 0.26 AFA was used. The results are listed in **Table 2** and indicate that residential SVS well use outside of the water provider service areas totals from 975.4 to 1,122.2 AFA.

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<sup>5</sup> It was noted during field investigations for this study that some homes located near but outside the original service area boundary used by Plateau were actually being served by a water provider. To address this potential error, all SVS service area boundaries were adjusted outward by 1/8 of a mile (about 1 city block) and the housing counts reanalyzed accordingly.

**TABLE 2. UNMETERED RESIDENTIAL SVS WELL USE DURING 2012<sup>a</sup>**

CATEGORY	ESTIMATED NUMBER IN STUDY AREA	USE COEFFICIENT		ESTIMATED QUANTITY OF USE (AFA)
		Value <sup>h</sup>	Units	
<b>Outside Water Provider Service Areas</b>				
Older (pre-1997) homes	1,970 to 2,200 <sup>b</sup>	0.26	AFA/home	512.2 to 572.0
Newer homes	1,970 to 2,160 <sup>b</sup>	0.18		354.6 to 388.8
Unimproved parcel with apparent home but no well date information <sup>c</sup>	140 to 170 <sup>d</sup>	0.18 to 0.26		25.2 to 44.2
Unimproved parcel with apparent home and older (pre-1997) well in area <sup>c</sup>	30 to 40 <sup>e</sup>	0.26		7.8 to 10.4
Unimproved parcel with apparent home and newer well in area <sup>c</sup>	30 <sup>e</sup>	0.18		5.4
Homes in Santa Cruz and Pima counties <sup>f</sup>	390	0.18 to 0.26		70.2 to 101.4
<b>Subtotal</b>	<b>4,530 to 4,990</b>			<b>975.4 to 1,122.2</b>
<b>Savings from County toilet retrofit program<sup>j</sup></b>				<b>-30.0</b>
<b>Inside Water Provider Service Areas</b>				
Well supplies water to one home for both indoor and outdoor purposes	622 <sup>g</sup>	0.18 to 0.26	AFA/well	112.0 to 161.7
Well not in use	275 <sup>g</sup>	0.0		0.0
Well supplies water to one home but only for outdoor purposes	82 <sup>g</sup>	0.05 to 0.07		4.1 to 5.7
Well supplies multiple homes	41 <sup>g</sup>	1.8 to 2.6 <sup>i</sup>		73.4 to 106.6
<b>Subtotal</b>	<b>1,020</b>			<b>189.5 to 274.0</b>
<b>Total</b>		<b>5,550 to 6,010</b>		<b>1,134.9 to 1,366.2</b>

Notes:

- <sup>a</sup> Assumes all houses are occupied; 2010 US Census data indicate that vacancy rates in the study area have ranged from about 7% to over 15% (World Media Group, 2013). See **Table 9** for an estimate of unmetered non-residential well use in the SVS.
- <sup>b</sup> Home construction dates are from the Cochise County (2013) assessor cost file. The upper range reflects Plateau's prior (2012) analysis which has been updated to include about 30 additional homes not previously listed by the assessor. The lower range reflects the new assessor data plus refinements to the original service area boundary used by Plateau.
- <sup>c</sup> Apparent homes were identified using 2010 aerial imagery on Cochise County parcels listed by the assessor as unimproved.
- <sup>d</sup> Dates of well construction were not readily available as a surrogate for home age either due to multiple wells on or near the parcel, the construction date was not listed in the ADWR (2013b) wells database, or no registered well was found in the area. The range of values reflects refinements to the service area boundary described in Note b.
- <sup>e</sup> Dates of well construction were available as a surrogate for home age. The range of values reflects refinements to the service area boundary described in Note b.
- <sup>f</sup> Homes identified through visual analysis of 2010 aerial imagery.
- <sup>g</sup> Approximately 1,020 potential residential wells were identified in the service areas using the original service area boundary and ADWR's well database. To determine whether these wells were actually in use, and if so how, the survey results listed in **Table 7** were considered representative of residential wells in the service areas. Percentages from the survey were multiplied by the total number of potential residential wells.
- <sup>h</sup> Residential use rates are from **Table 5**. Ranges are used when home ages were not readily available.
- <sup>i</sup> Two well shares were identified during our survey - one serves 3 homes and the other serves about 20 homes. Based on this information and the requirement that wells serving 15 or more homes be considered a community water supply and its uses reported to ADWR, it was assumed for this study that each well share serves approximately 10 homes. The estimated per household residential use rate was, therefore, multiplied by 10 to represent the total use by each well share.
- <sup>j</sup> Estimated annual savings reported during 2009; savings from Sierra Vista program of about 74 AFA in August 2011 are not included here since most of these retrofits probably occurred within the service areas (Plateau, 2012).

**TABLE 3. ESTIMATED RATE OF INTERIOR WATER USE BY RESIDENTIAL SVS WELL OWNERS**

HOME AGE	AVERAGE DAILY INTERIOR WATER USE (gallons per home) <sup>a</sup>									Annual Interior Water Use (AFA) <sup>b</sup>
	Toilets	Clothes Washer	Showers	Faucets	Leaks	Other	Bathtubs	Dish Washer	Total	
Before 1997	44.4	36.0	27.8	26.2	22.8	3.8	2.9	2.4	166.3	0.19
1997 to present	22.6	23.8	24.6	20.7	16.2	2.5	2.9	1.6	114.9	0.13

Notes:

<sup>a</sup> Assumes 2.4 people per home based on U.S. Census (2011) data for the study area. Fixture rates taken from AWWA (1999) for pre-1997 homes and from Aquacraft (2011a,b) for newer homes.

<sup>b</sup> Calculated by multiplying the total average daily interior water use by 365 and converting to acre-feet per year (AFA).

**TABLE 4. ESTIMATED PERCENTAGE OF EXTERIOR WATER USE BY SVS HOMES SERVED BY FOUR SVS WATER PROVIDERS<sup>a</sup>**

<b>WATER PROVIDER</b>	<b>YEAR</b>	<b>NUMBER OF RESIDENTIAL CONNECTIONS</b>	<b>LOWEST WATER USE MONTH</b>	<b>PERCENTAGE OF RESIDENTIAL WATER DEMAND FOR EXTERIOR USE<sup>b</sup></b>
Bella Vista	2007	7,452	March	30
	2008	7,566	February	25
	2009	NA		22
	2010	8,022	March	24
Northern Sunrise	2007	339	December	27
	2008	345	March	30
	2009	NA		32
	2010	333		24
Pueblo del Sol	2011	5,239	December	28
	2012	5,301	March	24
Southern Sunrise	2007	784	December	30
	2008	798	January	24
	2009	NA	February	27
	2010	799	March	28
			<b>Minimum</b>	<b>22</b>
			<b>Median</b>	<b>27</b>
			<b>Mean</b>	<b>27</b>
			<b>Maximum</b>	<b>32</b>

NA = Data not available

Notes:

<sup>a</sup> Data from water providers (Stitzer, 2011) and Community Water System Reports filed with the Arizona Department of Water Resources (2013a).

<sup>b</sup> Estimated by assuming that water is only used for interior purposes during the lowest water use month. Uses above this base during other months therefore represent exterior use. Percentages were calculated by adding all monthly residential water deliveries above the base and dividing by the total annual residential water delivery.



**TABLE 5. ESTIMATED RATE OF TOTAL RESIDENTIAL WATER USE BY SVS WELL OWNERS**

HOME AGE	ANNUAL WATER USE PER HOME (AFA) <sup>a</sup>		
	Interior <sup>b</sup>	Exterior <sup>c</sup>	Total
Before 1997	0.19	0.07	0.26
1997 to present	0.13	0.05	0.18

Notes:

- <sup>a</sup> Assumes 2.4 people per home based on U.S. Census (2011) data for the study area; AFA = acre-feet per year.
- <sup>b</sup> See **Table 3** for further information on interior residential water use rates.
- <sup>c</sup> Exterior water use rates were calculated by assuming that 27% of the total annual residential water demand is for outdoor purposes. See **Table 4** for further information on the percentage of exterior water use by SVS-area homes.

**TABLE 6. METERED SVS RESIDENTIAL WATER USE<sup>a</sup>**

<b>WATER PROVIDER</b>	<b>YEAR</b>	<b>NUMBER OF RESIDENTIAL CONNECTIONS</b>	<b>AVERAGE USE PER HOME (AFA)<sup>c,d</sup></b>
Antelope Run	2010	168	0.41
Arizona Water Company - Bisbee	2010	3,107	0.19
Arizona Water Company - Sierra Vista	2010	2,794	0.30
Bella Vista	2008, 2010	7,514	0.24
East Slope	2010	705	0.31
Holiday	2008	157	0.29
Homes with domestic wells metered by Water Wise staff <sup>b</sup>	2005-2007	8	0.24
Indiada	2010	53	0.29
Naco Water Company	2010	230	0.19
Naco Water Company LLC	2010	48	0.22
Northern Sunrise	2010	333	0.20
Pueblo del Sol	2010	5,558	0.20
Southern Sunrise	2010	799	0.21
Southland Utilities	2010	572	0.24
Tombstone	2008	793	0.14
		<b>Minimum</b>	<b>0.14</b>
		<b>Median</b>	<b>0.24</b>
		<b>Mean</b>	<b>0.24</b>
		<b>Maximum</b>	<b>0.41</b>

Notes:

<sup>a</sup> Data from ADWR (2013a).

<sup>b</sup> Data from Daily (2011).

<sup>c</sup> Calculated by dividing the total residential water delivery by the number of residential connections; AFA = acre-feet/year.

<sup>d</sup> Assumes that the number of residential connections equals the number of homes. However, some water providers do not list single family and multi-family connections separately. Since the latter can serve several homes/units, these results are probably conservative (i.e. the average water use per home may actually be lower in some cases).

### **3.2 Inside Service Areas**

A somewhat different approach was used to estimate unmetered residential well uses inside the SVS water provider service areas. Unlike homes located outside of the service areas, which have no alternative water supply, homeowners with private wells inside these areas do not necessarily have to use their wells. Plateau contacted three of the larger water providers (Arizona Water Company (2013), Liberty Utilities (2013), and Pueblo del Sol Water Company (2013)) and confirmed that they did not have records of the number and/or location of residential wells in use within their service areas.

Assuming that such information would also be unavailable from the other SVS water providers, Plateau relied on ADWR well registry records to initially identify sites of potential residential well use inside the service areas. As discussed below, an important next step was to conduct a survey to determine how many of the wells were actually in use, and if so, how they were being used.<sup>6</sup> It was then assumed that the residential water use rates estimated in **Table 5** apply equally to residential wells inside and outside of the service areas. Finally, total water use was calculated by multiplying residential use rates by the estimated number of operating residential wells in the service area.

#### Methodology

Plateau identified approximately 1,020 potential residential wells inside the service areas using ADWR's current well registry. Non-residential wells were removed from consideration based on well owner name and/or reported well use (e.g. industrial, commercial, etc.) and only completed water supply wells were evaluated. The remaining residential well owners were matched, if possible, to parcel owners in the area using assessor records.<sup>7</sup> To verify their well use, matched parcel owners were contacted using phone numbers listed on-line. For the non-exempt (>35 gallon per minute) residential wells identified in the service areas, each well registration form (total of about 50) was

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<sup>6</sup> As determined from our survey, some residential wells inside the service areas are being used for both indoor and outdoor purposes, some are only being used for outdoor purposes, and some are not being used at all.

<sup>7</sup> All water provider service areas were in Cochise County.

reviewed separately and any parcel and/or phone number listed on the form was used to try to contact the well owner.

Plateau conducted its phone survey of residential well owners within the service areas during June and July 2013. Several well/parcel owners were not successfully contacted, either because no phone number was found on-line, the number found was no longer active, or no one answered the call. Active numbers were tried at least twice on different days if unsuccessful the first time. Results from the survey were considered representative of residential wells throughout the service areas and applied to the total number of potential wells.<sup>8</sup>

### Results

**Table 7** lists the results from Plateau's 2013 phone survey. A total of 52 residential well owners in the service areas were successfully contacted and responded to the survey. Of the respondents, 32 (61%) indicated that their well currently supplies water to one home and is used for both indoor and outdoor purposes; 14 (27%) indicated that their well was not in use; 4 (8%) indicated that their well supplies water to one home, but it is only used for outdoor purposes; and 2 (4%) indicated that their well supplies multiple homes. The latter included one shared well that serves 3 homes and a second shared well that serves about 20 homes.

As indicated above, Plateau assumed that these survey results are representative of residential wells throughout the service areas. The associated percentages could, therefore, be multiplied by the total number of potential residential wells (1,020). **Table 2** lists the resulting estimates of the number of residential wells inside the water provider service areas and how they are currently being used. To determine the quantity of use associated with these wells, the rates listed in **Table 5** were applied. Note that since the age of the homes served by these wells was not readily known, Plateau used a range of

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<sup>8</sup> This was not a truly random sample and further analysis would be required to confirm our findings.

**TABLE 7. RESULTS FROM 2013 PHONE SURVEY OF RESIDENTIAL WELL OWNERS WITHIN SVS WATER PROVIDER SERVICE AREAS<sup>a</sup>**

WELL USE CATEGORY	RESPONDENTS <sup>b,c</sup>	
	Number	Percentage
Well supplies water to one home for both indoor and outdoor purposes	32	61%
Well not in use	14	27%
Well supplies water to one home but only for outdoor purposes	4	8%
Well supplies multiple homes <sup>d</sup>	2	4%
<b>Total</b>	<b>52</b>	<b>100%</b>

Notes:

- <sup>a</sup> Plateau conducted its survey during June and July 2013 by first locating all completed water supply wells in the service areas using current ADWR well registration records and removing the non-residential wells based on well owner name and/or reported well use. The remaining residential well owners were then matched, if possible, to parcel owners in the area using current assessor records. Finally, any matched parcel owners were contacted using phone numbers listed on-line. For the non-exempt (>35 gpm) residential wells identified in the service areas, each well registration form was reviewed individually and any parcels and/or phone numbers listed were used.
- <sup>b</sup> Does not include three well owners who were successfully contacted but refused to answer the survey.
- <sup>c</sup> Several well/parcel owners were not successfully contacted, either because no phone number was found on-line, the number found was longer active, or no one answered the call. Active numbers were tried at least twice on different days if unsuccessful the first time.
- <sup>d</sup> Includes one shared well that serves 3 homes and a second shared well that serves about 20 homes.

rates.<sup>9</sup> For example, for wells supplying one home for both indoor and outdoor purposes, a rate of 0.18 to 0.26 AFA was assumed. For wells supplying one home but only for outdoor purposes, a rate of 0.05 to 0.07 AFA was used. To estimate the rate of use by the well shares, Plateau assumed that each well serves approximately 10 homes with a resulting rate of 1.8 to 2.6 AFA. This well share use rate is consistent with results from the phone survey and the requirement that a well serving 15 or more homes is considered a CWS. The latter were not evaluated in this study since their use is reported to ADWR.

The quantity of water used by unmetered residential wells inside the water provider service areas is listed in **Table 2** and estimated to total between 189.5 to 274.0 AFA. Combined with the quantity of water used by unmetered residential wells outside of the water provider service areas, the total unmetered residential SVS well use during 2012 is estimated to range from 1,134.9 to 1,366.2 AFA. Note that this total was reduced by 30 AFA to account for potential savings from Cochise County's toilet retrofit program. As described in Plateau (2012), the county reported the savings through 2009; more recent data were unavailable. In August 2011, the City of Sierra Vista reported an additional 74 AFA of savings from its toilet retrofit program. These savings are not accounted for here since most of the city retrofits likely occurred in homes served by water providers.

Also unaccounted for here are potential home vacancies. It was assumed when estimating unmetered residential well uses in the study area that all homes were occupied. However, U.S. Census data indicates that vacancy rates for the area ranged from about 7% to over 15% in 2010. Current vacancy rates are not known but are expected to have declined somewhat as the economy has recovered in recent years.

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<sup>9</sup> To avoid using a range, it may be possible to determine typical home ages in each service area through parcel records and then relate these to the residential wells. The process was not attempted for this study but it could be tried in the future.

## **4.0 UNMETERED NON-RESIDENTIAL WELL USE**

This section presents Plateau's estimate of unmetered non-residential well use outside of SVS water provider service areas (Section 4.1) and inside of those areas (Section 4.2). Each subsection describes the methodologies used followed by a brief discussion of our results. Also presented in Section 4.1 is an analysis of large exterior water uses identified outside of the service areas.

### **4.1 Outside Service Areas**

To estimate unmetered non-residential well use outside of SVS service areas, Plateau relied on assessor and Arizona Department of Environmental Quality (ADEQ, 2013) public water system records to identify commercial, industrial and institutional (CII) facilities. After verifying which of these facilities were still in operation, Plateau applied various metrics to estimate their water use.

#### Methodology

As indicated above, assessor and public water system records were used to first identify potential non-residential well uses outside of the water provider service areas. Use of these facilities was then verified through field visits, phone calls and/or internet research. If an operation was found to be inactive or no longer in business, it was not further considered in this study.<sup>10</sup>

To estimate the quantity of CII water use, Plateau consulted the U.S. Geological Survey (USGS) who has tracked large non-residential water uses in Arizona's ground water basins for decades. After receiving what USGS data were available for the SVS, the remaining non-residential uses were estimated by identifying water use metrics based on the category of use.

As an example, four churches were identified outside of the SVS service areas. Their water use was estimated based on the heated square footage of each church. Square

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<sup>10</sup> Also not considered in this study are potential unmetered non-residential wells on state and federal lands. These may include livestock and mineral exploration/development wells, but was not verified by Plateau.

footages for these and other facilities came from the county assessor and/or were verified using Google images and heated areas were calculated using an adjustment factor (Morales and Heaney, 2010). Other water use metrics were based on the reported head of livestock (cattle ranch), estimated number of families per unit (duplexes), average number of vehicles (RV park), advertised number of rooms (hotels/motels), and reported number of students (schools). Two operations (a waste disposal service company and a fire district) were not easily categorized. Plateau visited the former and, after discussions with the manager, decided to use a car wash as a surrogate category since the facility primarily uses its water well for washing out trash bins and containers. Water use by the fire district was estimated by a current employee who Plateau interviewed.

## Results

**Table 8** lists the data that USGS provided for large non-residential water users in the SVS. Sand and gravel operations were noted outside of the service areas. However, the operators did not respond to USGS requests for pumpage records so their well use in 2012 is unknown.<sup>11</sup>

**Table 9** lists the other non-residential water users in the SVS that Plateau identified were not currently served by a water provider. Eighteen categories of non-residential water use were identified outside of the service areas, ranging from auto sales to schools. Using water use metrics for each category, these operations are estimated to use from 61.5 to 66.6 AFA.

### **4.1.1 Large Exterior Water Uses**

Plateau identified several large exterior water uses outside of the SVS service areas and evaluated each use separately. For purposes of this study, an exterior water use was considered large if it covered at least 0.3 acres. In its prior SVS study, Plateau (2012) found that about 90% of the exterior water uses that it could identify on aerial photography were smaller than this and probably incidental. These smaller uses are

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<sup>11</sup> USGS (2012) reported that total ground-water pumpage for mining in the Upper San Pedro Basin, which covers the study area, totaled less than 300 acre-feet in 2011. Over 20 years earlier, in 1989, ADWR (1991) reported that four operating sand and gravel mines in the SVS pumped 204.7 acre-feet.



**TABLE 8. LARGE NON-RESIDENTIAL SVS WATER USERS NOT SERVED BY WATER PROVIDERS<sup>a</sup>**

CATEGORY	NAME	REPORTED WELL USE DURING 2012 (AFA) <sup>b</sup>
<b><i>Outside Water Provider Service Areas</i></b>		
Mines	---	Not provided <sup>c</sup>
<b><i>Inside Water Provider Service Areas</i></b>		
Golf Course <sup>d</sup>	Pueblo del Sol Country Club	478
	Turquoise Valley Golf Course	288
Municipality	City of Sierra Vista	214

Notes:

**980**

- <sup>a</sup> Other non-residential water users not served by SVS water providers are listed in Table 9.
- <sup>b</sup> These values were reported to the USGS (2013) by the water users; AFA = acre-feet per year.
- <sup>c</sup> USGS requested well pumpage records from sand and gravel operations in the area but did not receive a response.
- <sup>d</sup> Fort Huachuca's Mountain View Golf Course is not listed here since it uses effluent for irrigation.

**TABLE 9. UNMETERED NON-RESIDENTIAL SVS WELL USE DURING 2012<sup>a</sup>**

TYPE OF USE <sup>b</sup>		USE METRIC			UNIT TOTAL <sup>d,e</sup>	ESTIMATED QUANTITY OF USE (AFA)
Category	Number in Study Area	Value	Units	Source <sup>c</sup>		
<b>Outside Water Provider Service Areas</b>						
Auto Sales	1	3.84	gal/ft <sup>2</sup> /mo	I	5,904 heated square feet	0.8
Bar <sup>k</sup>	7	8.19	gal/ft <sup>2</sup> /mo	I	6,580 heated square feet	2.0
Café	1	25.52	gal/ft <sup>2</sup> /mo	I	4800 heated square feet	4.5
Car Wash <sup>f</sup>	1	4.78	gal/ft <sup>2</sup> /day	II	2,120 square ft	11.4
Cattle Ranch	1	12	gal/head/day	III	900 head	12.1
Church	4	1.26	gal/ft <sup>2</sup> /mo	I	17,955 heated square ft	0.8
Convenience Store	1	7.92	gal/ft <sup>2</sup> /mo	I	3,269 heated square ft	1.0
Duplex	2	0.22	acre-ft/family/yr	IV	5 families	1.1
Fire District	1	20,000	gallons/facility/yr	X	1 facility	0.1
Light Manufacturing	1	0.87	gal/ft <sup>2</sup> /mo	I	3,718 heated square ft	0.1
Lodge	2	5.16	gal/ft <sup>2</sup> /mo	I	8,487 heated square ft	1.6
Medical	3	0.62	gal/ft <sup>2</sup> /day	II	12,366 square ft	8.6
RV Park	2	50	gal/vehicle/day	V	60 vehicles	3.4
Hotel/Motel <sup>g</sup>	8	30.2 - 39.5	Kgal/room/yr	VI	49 rooms	4.5 to 5.9
Office Building	1	5.39	gal/ft <sup>2</sup> /mo	I	553 heated square ft	0.1
Retail	1	0.11	gal/ft <sup>2</sup> /day	II	2,400 square ft	0.3
Service Shop	2	12.47	gal/ft <sup>2</sup> /mo	I	6,386 heated square ft	2.9
School	4	1.7 - 2.7	Kgal/student/yr	VI	1,190 students	6.2 to 9.9
<b>Subtotal</b>						<b>61.5 to 66.6</b>
<b>Inside Water Provider Service Areas</b>						
Cemetery	1	3.25 <sup>i</sup>	acre-feet/acre/yr	VII	1.2 acres	3.9
Fast Food Restaurant	1	20.95	gal/ft <sup>2</sup> /mo	I	2,352 heated square feet	1.8
Fire Training Center	1	0.50	acre-feet/facility/yr	VIII	1 facility	0.5
Municipality (Bisbee) <sup>h</sup>	1	5.39	gal/ft <sup>2</sup> /mo	IX	2,500 heated square ft	0.5
Office Building	1	5.39	gal/ft <sup>2</sup> /mo	I	7,680 heated square ft	1.5
School (outdoor only)	2	3.25 <sup>i</sup>	acre-feet/acre/yr	VII	4.8 acres <sup>j</sup>	15.6
<b>Subtotal</b>						<b>23.8</b>
<b>Total</b>						<b>85.3 to 90.4</b>

Notes:

- <sup>a</sup> Does not include state and federal lands. See **Table 8** for large non-residential water uses not served by SVS water providers.
- <sup>b</sup> Identified by assessor parcel records if outside service areas or ADWR well records if inside service areas; also identified via Internet searches and ADEQ (2013) public water system records. Uses verified through field visits and/or phone calls. Not listed in table if found to be out of business.
- <sup>c</sup> I = Morales and Heaney (2011); II = AWWA (2000); III = ADWR (2013c); IV = **Table 4** of this report; V = USFS (2007); VI = North Carolina Department of Environment (2009); VII = **Table 9** of this report; VIII = Plateau estimate based on conversation with operator; IX = City of Bisbee (2013); and X = employee estimate.
- <sup>d</sup> Square footage from county assessor and/or verified using Google images; head of cattle from conversation with ranch manager; number of families estimated by duplex size; number of hotel/motel rooms determined through phone calls; number of students listed by GreatSchools (2012); irrigated acreage based on field visits and/or aerial photography; and number of vehicles averaged from recent Google images.
- <sup>e</sup> Heated square footage calculated by applying an adjustment factor in Morales and Heaney (2011) to assessor data.
- <sup>f</sup> Waste disposal service company that primarily uses its well for washing trash bins and containers; car wash used as a surrogate category.
- <sup>g</sup> Includes rooms at guest ranches and bed and breakfasts.
- <sup>h</sup> Includes use of wells owned and operated by the municipality; other municipal water uses are served by local water companies and not counted here.
- <sup>i</sup> Estimated local irrigation requirement for warm season grass using a sprinkler system with an 80% efficiency.
- <sup>j</sup> Actual acreage reduced by 50% to account for observed deficit/incomplete irrigation.
- <sup>k</sup> All of the vineyards near Elgin have tasting rooms associated with their winery; each was assumed to cover 1,000 square feet.

assumed to be incorporated into the residential use rates described in Section 3 and likely include the small irrigated areas, pools and fountains seen in the imagery as well as evaporative coolers, livestock watering, car and equipment washing, dust control, and cleaning of hardscapes that could not be readily seen.

The large exterior water uses evaluated here are considered non-residential and represent the largest 10% of the exterior water uses that Plateau identified in its prior study. This cutoff between residential and non-residential outdoor water use seems reasonable and is not inconsistent with ADWR guidelines on quantifying domestic water use. ADWR (2013c) considers lawns and gardens around homes to be part of domestic use if they cover less than 0.5 acres.

#### Methodology

Plateau used June 2010 aerial photography to initially identify the areas of large exterior water use and then field verified these areas in December 2011, May 2013, June 2013 and September 2013. Some new irrigated areas were observed during the field visits and other, previously identified areas were found to be either fallowed or discontinued. Information collected in the field included crop type, irrigation method, and plant vigor (full vs. deficit irrigation). The area of irrigation was digitized from the aerial photography.

Exterior water uses were quantified by multiplying the irrigated area by its water demand. The latter was estimated by dividing the watering requirement for each crop type by the efficiency of the various irrigation methods that were observed. Representative values for irrigation efficiency and watering requirements were previously derived by Plateau (2012) or from USGS (2013).

#### Results

**Tables 10** and **11** list the large exterior water uses that Plateau mapped outside of SVS water provider service areas during 2011 and 2013. Six categories of use were identified

**TABLE 10. AGRICULTURAL WATER USES MAPPED OUTSIDE OF SVS WATER PROVIDER SERVICE AREAS DURING 2011 AND 2013<sup>a,b</sup>**

TYPE OF USE				USE COEFFICIENTS			ESTIMATED TOTAL EXTERIOR WATER USE (AFA) <sup>e</sup>
Category	Irrigation Method	Number of Areas Mapped	Total Irrigated Area (acres)	Watering Requirement (ft/yr) <sup>c</sup>	Irrigation Efficiency <sup>c</sup>	Water Demand (ft/yr) <sup>d</sup>	
Orchards	Drip	3	12.96 <sup>f</sup>	1.3 to 2.8	90%	1.4 to 3.1	19.6 to 43.4
	Flood	1	7.88		70 to 75%	1.9 to 3.7	15.0 to 29.2
Pasture	Flood	6	73.17	2.3 to 3.3	70 to 75%	3.1 to 4.7	226.8 to 343.9
	Sprinkler	1	4.6 (fallow)		80 to 85%	2.7 to 4.1	12.4 to 18.9 (fallow)
Vineyards	Drip	7 <sup>g</sup>	138.5 <sup>g</sup>	1	90%	1.1	152.3
<b>Totals</b>		<b>11</b>	<b>237.1</b>				<b>424.7 to 584.4</b>

Notes:

- <sup>a</sup> Plateau initially identified using 2010 aerial photography and then field verified in December 2011, May 2013, June 2013 and/or September 2013. Does not include previously irrigated areas that appeared on the aerial photography and/or in the field to be discontinued.
- <sup>b</sup> Includes areas of exterior water use that each cover at least 2.0 acres. One pasture covering 1.7 acres is included here since it was immediately adjacent to other, larger fields and is part of the same farming operation.
- <sup>c</sup> Watering requirement and irrigation efficiency values from Plateau (2012); USGS (2013) provided use coefficients for the vineyards.
- <sup>d</sup> Calculated by dividing the watering requirement by the irrigation efficiency.
- <sup>e</sup> Calculated by multiplying the total irrigated area by its water demand.
- <sup>f</sup> About 3.8 acres of the orchards consisted of young trees that likely have a lower watering requirement than listed here for more mature trees.
- <sup>g</sup> Plateau contacted each of the seven active vineyards in the Elgin area during September 2013 for their current planted acreage. Limited field verification was performed that same month.

**TABLE 11. OTHER LARGE EXTERIOR WATER USES MAPPED OUTSIDE OF SVS WATER PROVIDER SERVICE AREAS DURING 2011 AND 2013<sup>a,b</sup>**

TYPE OF USE				USE COEFFICIENTS			ESTIMATED TOTAL EXTERIOR WATER USE (AFA) <sup>f</sup>
Category	Irrigation Method <sup>c</sup>	Number of Areas Mapped	Total Irrigated Area (acres)	Watering Requirement (ft/yr) <sup>d</sup>	Irrigation Efficiency <sup>d</sup>	Water Demand (ft/yr) <sup>e</sup>	
Landscape Trees	Drip	10	4.52	0.3 to 2.2	80 to 95%	0.3 to 2.8	1.4 to 12.7
	Flood	3	1.53		70 to 75%	0.4 to 3.1	0.6 to 4.7
	Unknown	2	1.08		70 to 95%	0.3 to 3.1	0.3 to 3.3
Orchards	Drip	2	0.89 <sup>g</sup>	1.3 to 2.8	90%	1.4 to 3.1	1.2 to 2.8
	Flood/Sprinkler	1	0.58		70 to 85%	1.5 to 4.0	0.9 to 2.3
Ponds	NA	3	2.63	4.2	near 100%	4	10.5
Turf	Flood	1	0.54	2.6 <sup>h</sup>	70 to 75%	3.5 to 3.7	1.9 to 2.0
	Spray/Rotor	9	4.05		40 to 75%	3.5 to 6.5	14.2 to 26.3
	Unknown	8	6.28		40 to 75%	3.5 to 6.5	22.0 to 40.8
<b>Totals</b>		<b>39</b>	<b>22.1</b>				<b>53.0 to 105.5</b>

Notes:

- <sup>a</sup> Plateau initially identified using 2010 aerial photography and then field verified in December 2011, May 2013, June 2013 and/or September 2013. Does not include previously irrigated areas that appeared on the aerial photography and/or in the field to be discontinued.
- <sup>b</sup> Includes areas of exterior water use that each cover at least 0.3 acres. About 90% of the exterior water uses initially identified by Plateau were smaller than this and are considered incidental exterior uses. Agricultural water uses covering at least 2 acres are listed in Table 10.
- <sup>c</sup> The irrigation method is listed as unknown if it could not be readily determined in the field or if an area was not visited. Large exterior water uses not visited for this study include three areas of turf covering a total of about 3.3 acres and one area of landscape trees covering about 0.7 acres.
- <sup>d</sup> Watering requirement and irrigation efficiency values from Plateau (2012).
- <sup>e</sup> Calculated by dividing the watering requirement by the irrigation efficiency.
- <sup>f</sup> Calculated by multiplying the total irrigated area by its water demand.
- <sup>g</sup> About 0.9 acres of the orchards on drips consisted of young trees that likely have a lower watering requirement than listed here for more mature trees.
- <sup>h</sup> Turf was assumed to be warm season grass based on field observations and historic aerial photography.

(landscape trees, orchards, pasture, ponds, turf<sup>12</sup> and vineyards) and four irrigation methods were observed (drip, flood, spray/rotor and sprinkler). Irrigation method is listed as unknown for a few areas if it could not be readily determined in the field or if the area was not visited. Large exterior water uses not field visited during this study include three areas of turf covering a total of about 3.3 acres and one area of landscape trees covering about 0.7 acres. Plateau field verified all of the other large exterior water uses it identified or, in the case of the vineyards near Elgin, contacted each owner for current cropped acreage.

A total of 50 areas of large exterior water use were mapped covering a total irrigated area of approximately 259.2 acres. The pastures, orchards and vineyards by far covered the greatest area and those at least two acres in size are listed separately in **Table 10** as ‘agricultural’ water use.<sup>13</sup> These larger exterior water uses covered a total of 237.1 acres including a 4.6-acre pasture that appeared fallow when visited in June 2013. Plateau spoke with the landowner in December 2011 and was told that the field was still in use and had not been abandoned. This total also includes about 3.8 acres of orchards with young trees on drip that likely have a lower watering requirement than was assumed for more mature trees. **Table 11** lists the remaining 22.1 acres of ‘non-agricultural’ large exterior water use that Plateau mapped outside of the service area including landscape trees, one small orchard, ponds and turf.

Plateau estimates that the total water use associated with these large irrigated areas ranges from 477.7 to 689.9 AFA including 424.7 to 584.4 AFA for agricultural use and 53.0 to 105.5 AFA for non-agricultural use. The relatively wide range of values reflects the uncertainty in the watering requirements of the observed crop types and reported irrigation efficiencies. The totals do not include potential large exterior water uses located

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<sup>12</sup> Turf was assumed to be warm season grass based on field observations and analysis of historic aerial photography on Google Earth.

<sup>13</sup> In Arizona’s Groundwater Code (ARS 45-402), application of water to two or more acres of land to produce plants or parts of plants for sale or human consumption, or for use as feed for livestock, range livestock or poultry is considered irrigation. This seemed a reasonable cutoff for distinguishing agricultural from non-agricultural water use in the SVS.

within the service areas. It was assumed that large irrigated areas inside the service areas are either served by a water provider or, as described below, supplied by a CII well.

## **4.2 Inside Service Areas**

Similar to its methodology for identifying unmetered residential well use inside SVS service areas, Plateau estimated unmetered non-residential water use in these areas by relying on ADWR's well registry to initially locate potential CII well sites. Once it was verified which wells were in use, their pumpage was estimated using metrics similar to those developed for the unmetered non-residential wells located outside of the service areas.

### Methodology

Plateau identified over 150 potential non-residential wells inside the SVS service areas based on well owner name and/or reported use. Only completed water supply wells were evaluated and, to avoid double counting, all water company wells were excluded. To determine which of the remaining wells were actually in use, Plateau searched on-line for company information and contacted some businesses for confirmation. ADEQ's public water system records were also reviewed. Operations found or thought to be out of business were not further considered.

Various metrics were used to estimate how much water the active, unmetered CII wells were pumping. For three buildings supplied by non-residential wells, well use was estimated based on building square footage. For turf at a cemetery and at two schools, well use was estimated based on the local watering requirement for warm season grass using a sprinkler system with an 80% efficiency.<sup>14</sup> Plateau estimated well use at another facility (a fire training center) based on a conversation with the operator. Data from the USGS on large non-residential water users in the service areas was also utilized.

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<sup>14</sup> To account for deficit/incomplete irrigation observed on recent aerial photography, the actual irrigated acreage at the two schools was reduced by 50%.

Results

**Table 8** lists three large non-residential water users that the USGS identified inside the SVS service areas. Included are a municipality (City of Sierra Vista) and two golf courses (Pueblo del Sol and Turquoise Valley). Each reported to the USGS how much water they pumped from their wells in 2012. The quantity of pumpage was significant and totaled approximately 980 acre-feet.

**Table 9** lists Plateau's estimate of the remaining, unmetered non-residential well use inside the SVS service area. During 2012, that use was estimated at about 23.8 AFA. Combined with the 61.5 to 66.6 AFA for areas outside of the service areas, the total unmetered non-residential well use in the SVS was estimated at 85.3 to 90.4 AFA.



## **5.0 STUDY LIMITATIONS**

As described in Sections 3 and 4, a variety of methods and data sources were employed to estimate unmetered residential and non-residential well use in the SVS. Plateau used local data where available and/or practical and avoided broad assumptions regarding water use rates and the number of unmetered wells in operation.

Nevertheless, Plateau made several assumptions in this study that can result in uncertainty. Some of this uncertainty is reflected in the range of well use values that are presented. Other uncertainties are more difficult to quantify but should not be ignored. A list of these uncertainties and other study limitations follow:

- Plateau generally assumed that the service area map provided by the county was correct. As discussed in Sections 2 and 3.1, some errors were noted in the map and adjustments were made to the boundaries, both to correct the errors and perform sensitivity analyses on their accuracy. The range in the number of homes identified outside of the water provider service area reflects this uncertainty in the service area boundaries.
- It was generally also assumed by Plateau that assessor records used to identify parcel owners and improvements in Cochise County were complete and accurate. As described in Section 3.1, several parcels outside of the service areas were coded by the assessor as unimproved but appear to have homes when viewed on aerial photography. Plateau attempted to correct this error by checking all unimproved parcels for potential homes, but assumed that the other parcels listed with improvements were properly coded.
- Plateau also assumed that ADWR's well registry was relatively complete and accurate. However, ADWR rarely verifies that the well owner and/or driller have filled out the required registration forms accurately and not all of the information that does get filed is necessarily entered into the WELLS 55 database. Moreover, although all water supply wells in the state are required to be registered with ADWR, it is likely that some wells, particularly those drilled before the 1980s, are not registered. As a result, some residential and non-residential wells inside the

service areas may have been missed or not properly located and some well dates used as a proxy for home age may be incorrect.

- Although the residential use rates estimated in **Table 5** for older and newer homes in the study area seem reasonable and compare favorably to metered homes in the service areas, these rates were based in part on research conducted in areas outside of the SVS that related home age to indoor fixture efficiency. The rates were also based on differences in the monthly residential demands reported by local water providers that Plateau assumed reflect exterior residential water uses across the study area.
- Since it was not feasible to contact all residential well owners inside the SVS service areas regarding their well use, Plateau conducted a phone survey and assumed that the results were representative of the group as a whole. It is unknown how the survey results might have changed if more well owners had been successfully contacted. The number of respondents (52) was about 5% of the total number of well owners in the area.
- Plateau assumed that all homes it identified with private wells, both inside and outside of the service areas, were occupied. However, recent (2010) U.S. Census data show that vacancy rates in the area have ranged from about 7% to over 15%. It is unknown if and how much these rates have declined during the recent economic recovery. Nevertheless, some percentage of homes is still vacant and not using water.
- Plateau utilized several metrics to estimate non-residential well use in the SVS. Since many of these metrics were developed using data collected outside of the study area, it was assumed that any differences with the SVS were minor. Detailed water audits, as performed by local Water Wise staff from the University of Arizona, would be necessary to develop more local metrics.
- Plateau assumed that exterior SVS water uses greater than 0.3 acres are not typical, outdoor residential water uses and, for purposes of this study, were considered a non-residential use. Plateau did not separately evaluate outdoor water uses in the study area smaller than 0.3 acres since it accounted for these in its residential use rates. These assumptions seem reasonable considering that

about 90% of the exterior water uses that Plateau noted outside of the service areas on aerial photography consisted of pools, fountains and small irrigated areas less than 0.3 acres. For this study, large exterior water uses were only evaluated outside of the service areas unless they were associated with CII wells located inside the service areas.

- Finally, this study did not address potential non-residential wells located on state and federal lands within the study area. Since the agencies that manage these lands are members of the USPP, it was assumed that they can provide an estimate of well use on their lands.

## 6.0 SUMMARY OF FINDINGS

Utilizing a variety of methods and data sources, Plateau estimates the following unmetered well use in the SVS during 2012:

### Unmetered Residential Wells –

- 945.4 to 1,092.2 acre-feet (outside water provider service areas)
- 189.5 to 274.0 acre-feet (inside service areas)
- *1,134.9 to 1,366.2 acre-feet (total)*

### Unmetered Non-Residential Wells –

- 61.5 to 66.6 acre-feet (CII wells outside service areas)
- 23.8 acre-feet (CII wells inside service areas)
- 424.7 to 584.4 acre-feet (agriculture use outside service areas)
- 53.0 to 105.5 acre-feet (other large exterior water uses outside service areas)
- *563.0 to 780.3 acre-feet (total)*

In addition to these estimates, USGS (2013) reports that another *980 acre-feet* was pumped during 2012 by a municipality (City of Sierra Vista) and two golf courses (Pueblo del Sol and Turquoise Valley) based on records provided by those water users. Combined with Plateau's estimates, the total ground-water demand in 2012 not served by local water providers therefore ranged from *2,677.9 to 3,126.5 acre-feet*. Not included in this total is well pumpage by sand and gravel operations in the area and potential non-residential well use on state and federal lands. Water use on public lands may include livestock and mineral exploration/development wells but were not evaluated by Plateau.

Plateau's estimates of unmetered well use in the SVS integrate the review of thousands of parcel and well records, interviews with nearly 100 home and business owners, analysis of annual reports from over 20 local water providers, and four field visits (see Sections 3 and 4). Although several assumptions were made (see Section 5), we believe that our study provides a more rigorous estimation of unmetered well use than is typically provided in demand estimates and water budgets. The latter often assume what percentage of the population is not served by water providers and apply a uniform per

capita consumption rate or estimate well use by the number of registered wells. Plateau's approach started with the number of homes and businesses in the area and was built up from there. Hopefully our findings provide a fuller picture of this component of the SVS ground-water budget and are viewed together with prior estimates.

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