

Report on Civano Water Use, 2003*

Prepared for the Community of Civano LLC

Al Nichols Engineering, Inc.
Monday, September 08, 2003



Conversions rates, measures and costs

- ~326,000 gallons/acre foot
- 748 gallons/ccf
- ~\$.17/ccf energy cost to deliver potable water
- ~5.21 lbs. CO₂/ccf emissions for potable water
- 0.34 lbs. CO₂/ccf emissions for reclaimed water

Table of Contents

1. Introduction
 - Purpose of the Study
 - Methods
2. Civano Water Use Compared to Tucson Water Use
3. Costs, Energy Savings and CO₂ Reduction
4. Lessons Learned— Community Acceptable Practices

Appendices

- A. Background: Potable and Reclaimed Water
- B. Summary Data from spreadsheet

* ANE, Inc. would like to thank the City of Tucson Water Department, especially Tom Arnold, for graciously providing water data for Civano and averaged water data for residences in Tucson. ANE, Inc. would also like to thank Linda Douglass of TEP. For research, writing and analysis, ANE, Inc. is grateful to Cari Spring, Ph.D.

1. Introduction: Purpose of the Study and Methods

Purpose of the Study

The Civano IMPACT System Memorandum of Understanding on Implementation and Monitoring Process (signed June 26, 1998) specifies reclaimed and potable water to be used at Civano (Section 5.0, *Specific Procedures for Implementation*):

5.1.3. Impact (MOU) Establish exterior water budgets, monitor water consumption, and develop a contingency program to achieve compliance with the budgets if water conservation targets are not met, which utilize City-provided reclaimed water in landscaping for individual residential properties not to exceed 28 gallons per capita per day.

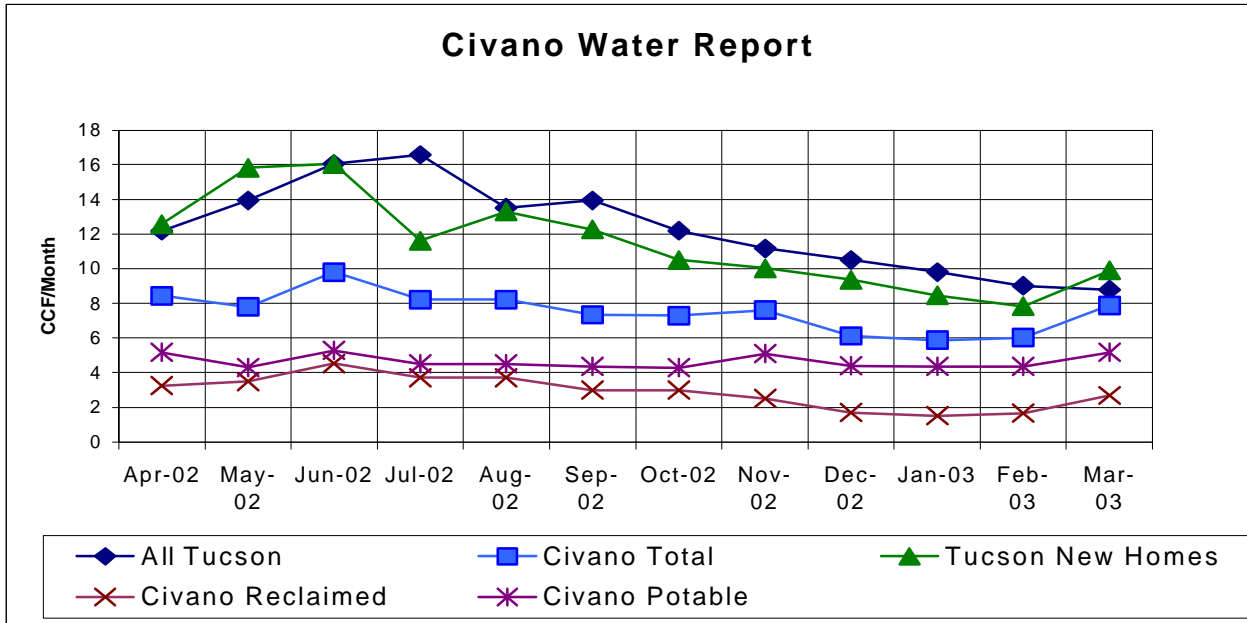
5.1.5 Establish interior water budgets, monitor water consumption and develop a contingency program to advance compliance with the budgets if water consumption targets are not met for each building, and design the plumbing systems accordingly that will reduce the interior use of water in residential structures to 53 gallons per person per day and to 15 gallons per person per day in non-residential structures. The guidelines shall specify the manner in which water use has been calculated and the principal measures to be taken to meet these budgets.

The goal of the Memorandum of Understanding is to confirm the strategies for sustainable development and to implement and monitor the Civano IMPACT System. ‘*Subsequent monitoring of performance*’ will provide the basis for determining the success in meeting the IMPACT System Standards, and as well, will serve as the basis for improving future conservation and sustainability strategies and standards (Civano IMPACT MOU, Sections 1-3). This report details the water data and provides continuing analysis for 2002-2003.

Methods

Potable and reclaimed water are metered separately at individual Civano homes. Data from water use by 60 individual Civano residences were supplied by Tucson Water from a random list provided by Tucson Electric Power (energy and fuel studies are also ongoing). Of the 60 homes sampled, 10 do not use reclaimed water (installation of water harvesting cisterns comprise an alternative to reclaimed water use). Data from a matched sample of 60 randomly selected homes in the greater Tucson area built between 1997 to 2001 (averaging 1998) were supplied by Tucson Electric Power. These data provide a similar sample by which to compare Civano homes—which are also built between 1997-2001. The City of Tucson supplied water data from Tucson single family residences (built any year). Comparison of these three samples was undertaken in order to clarify whether and where water savings might be due to contemporary design and building practices (e.g., modern plumbing and fixtures) and when such might result from other water-saving

strategies (for example, xeriscape landscaping and reclaimed water use). These averages were plotted using Microsoft Excel and the results graphed below.



2. Civano Water Use Compared to Tucson At-Large Water Use

The Civano IMPACT System Memorandum of Understanding on Implementation and Monitoring Process (June 26, 1998) specifies maximum potable and reclaimed water to be used at Civano. The goal for water use at Civano is that no more than 53 gallons potable water shall be used per person daily and reclaimed water is stipulated not to exceed 28 gallons per capita per day. The current study reports on potable and reclaimed water use at Civano from April 2002-March 2003, an evaluation required by the Civano IMPACT System MOU.

Assuming 2.25 people per residence at Civano results in a daily per capita potable water use of 50.83 gallons (maximum 53 gallons required) and daily reclaimed water use of 31.63 gallons (maximum 28 gallons required). Total per capita water use for Civano is approx. 82.46 gallons/day (81 gallons total water use maximum specified). This compares with 134.41 gallons per capita daily (assuming the same 2.25 people/residence) for Tucson houses, and 125.33 gallons per capita daily for newer Tucson homes.

Civano reclaimed water use reported during 2002 was 25 gallons per capita per day. The daily use increase shown this year may be due to new homes watering to establish exterior plantings or to increased plantings by homeowners. The current study is also based on a larger sample than the 2002 study, which may have influenced findings. It is generally believed that reclaimed water use should diminish over time as native plants become established.

Total Civano water use is approximately 61% that of Tucson at-large homes and is 66% that of newer Tucson homes, representing an approximate 39% and 34% savings, respectively, of total water use. Additionally, reclaimed water use for residential landscaping at Civano provides for a 62% reduction in potable water use over Tucson homes (i.e., Civano uses 38% of the potable water that Tucson homes at-large use) and results in a potable water savings of 59% over newer Tucson homes (Civano homes use 41% of the potable water that newer homes use). This overall water savings is likely a result of strict landscape standards, while reduction in potable water use results directly from use of reclaimed water for landscape needs.

As an alternative to using reclaimed water, homeowners can install rainwater harvesting cisterns. No investigation of landscape water use has occurred in conjunction with this practice.

Civano homes also use water saving plumbing fixtures that meet the usage requirements of the Tucson code, as do the newer Tucson homes.

Water use for common-area landscaping at Civano uses strictly reclaimed water and accounts for 8,326 ccf/yr, or approximately 19 acre feet/year. As the project builds out, landscape water use is expected to decline as the landscape matures. This further reduces the need for potable water and is recommended for any commercial venture within reach of reclaimed water lines.

The pilot study performed last year (2001-2002) by ANE, Inc. analyzing Civano water use showed residential potable water use per home at 39% that of Tucson (at-large) use (since Tucson at-large homes do not systemically use reclaimed water, this result is found by comparing Civano potable water use to total water use of Tucson at-large homes). Last year's study reflected an avoided potable water use of 61% by Civano homes as compared to Tucson homes at-large. The results are similar to this year's study.

While the water data are good news, an existing barrier to sustainability is that current metering methods for reclaimed water provide a financial disincentive to use reclaimed water (details are given in the 2002 report, and see section 4 below).

3. Costs, Energy Savings and CO2 Reduction

As of this date, there are approximately 300 occupied homes in Civano. Extending the results of this sample to the Civano-wide individual water use, annual total and potable water savings, as compared to the Tucson at-large averages, are approximated below. Also indicated is the reduction in CO2 given total and potable water-use reductions: as a result of reduced water use, energy used to drill, store and transport water is reduced. Hence, CO2 reductions follow from reduced water use:

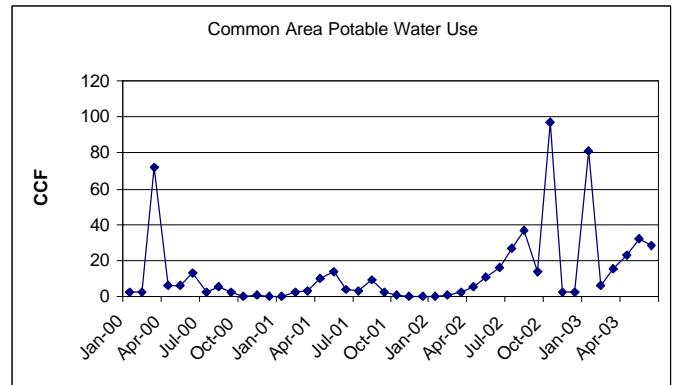
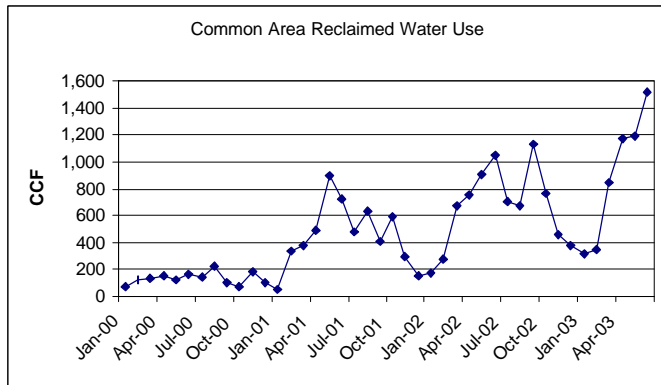
Total Water Use

Savings for 300 homes 12,816,980 gallons/yr.
39.34 acre feet/yr.
CO2 Avoided - 140,072 lbs./yr.
70 tons/yr.

Potable Water Use

Savings for 300 homes 20,619,368 gallons/yr.
63.28 acre feet/yr.
CO2 avoided - 143,343 lbs./yr.
71.7 tons/yr.

Potable water is used in common areas only for the existing and new pools. Spikes in water use (right graph) indicate annual cleaning and filling of the pools. In addition to the individual residential total and potable water savings shown here, the common area landscaping uses xeriscape and reclaimed water, which further decreases potable water and energy use and avoids CO2, while successfully providing shade and grass spaces in the community. The increasing reclaimed water use (left graph) indicates landscaping of areas in advance of residential build out/occupancy of those areas. As such, the data are not at present useful for an overall per capita water use analysis associated with common areas. See the 2002 report for such analysis, and for indications of the substantive contributions from this practice.



4. Lessons Learned—Community Acceptable Practices

The Civano MOU (signed June 26, 1998) specifies maximum per-residence use of reclaimed and potable water at Civano and provides that *subsequent monitoring of performance* will provide the basis for determining the success in meeting the IMPACT System Standards, and as well, will serve as the basis for improving future conservation and sustainability strategies and standards (Civano IMPACT MOU, Sections 1-3). While

specific language for design change is not indicated, the MOU demands intelligent change given lessons learned from experience. It falls to the stakeholders to develop the particulars constraining any evolution of the standards.

In meeting with 70 Civano neighbors who have lived with xeriscape and reclamation, consensus demonstrated that the reclaimed water requirement should not be extended into the new Civano neighborhoods. The primary reasons given indicate prohibitive financial burden for individual residential use of reclaimed water: the cost of the additional meter, backflow preventer and expansion tanks add considerable start-up financial burden to the homeowner. Moreover, the on-going cost-of-use is at issue since most homes use potable water at the lowest cost—about \$1.03 per ccf—while reclaimed water costs about \$1.31/ccf. Additionally, high water pressure caused some drip systems to fail and high maintenance of the drip systems results from the mineral content of the reclaimed water. The city added a pressure-reducing valve to the project at a cost reportedly near \$25,000.

The 10 residences without reclaimed water in the sample were analyzed for average water use and the following results obtained: homes in the study without reclaimed water use consumed 57.0 ccf/year potable water (3,553 gal/mo., ~52 gal/day/person) compared to 55.9 ccf/yr (3,484 gal/mo., ~51 gal/day/person), or only ~2% more potable water. This indicates that these 10 homes have very small lots, are judicious with water use and/or are effectively utilizing rainwater harvesting. (Note that these homes serve as a pilot comparison of homes without reclaimed water, do not comprise a statistically valid sample, and were not evaluated for move-in date nor otherwise controlled. See ANE, Inc.'s report on Civano water 2002 for discussion of the relevance of this point.) If these data are representative of some lots at Civano, the value of reclaimed water for such residences, given its start-up and on-going costs, and given the xeriscape and lot-size contributions, arguably undermines the investment. As an alternative, neighbors currently have the option of avoiding the reclaimed water system by installing rainwater harvesting cisterns.

In terms of community-acceptable practices, the xeriscape requirement is working, should continue and would greatly benefit Tucson were it applied systemically as a code requirement. Use of reclaimed water for common spaces, where professional landscape personnel are responsible for handling the water system and where a per-residence financial burden does not exist, is recommended for further expansion at Civano; reclaimed water use for common-areas provides for a significant savings in potable water use, energy use and CO2 production. Effectiveness, economics and satisfaction of water harvesting practices remain for further investigation.

To conclude, the reduction in total and potable water use at Civano over Tucson homes is likely due in some measure to landscape requirements, small lot sizes, and xeriscape landscaping requirements, given the 34% to 39% total water savings indicated and the 38-41% potable water savings. Contrasting total water use in new homes (125.33 gal/person/day) with water use in Tucson homes at-large (134.41 gal/person/day) suggests

that new homes use only an approximate 7% water savings a day due to contemporary design/build practices.

Appendices

A. Background: Potable and Reclaimed Water

The City of Tucson Water Department provides potable water to Civano and to Tucson. Potable water is purified to a degree optimal for drinking and bathing/washing as per the State of Arizona's standard of "full-body" contact. Cost-to-supply potable water in Tucson includes drilling of groundwater, cost for CAP water, pumping and distribution, and metering and monitoring costs. Supply of potable water uses energy at a cost of approximately \$0.17 per ccf in Tucson, with approximately 5.21 pounds of CO₂ per CCF released into the atmosphere. Reclaimed water use cost of pumping creates 0.34 lbs. of CO₂ per ccf.

Reclaimed water is supplied to Civano and to the City of Tucson by Pima County Wastewater Management. Reclaimed water is the final product of a multiple-stage treatment that cleans wastewater. This process produces water suitable for irrigation but not for full-body contact. Using reclaimed water matches water quality with water use to conserve groundwater resources. High quality water is reserved for drinking and bathing, while reclaimed water is ideal for irrigation.

At Civano, reclaimed water is used at the individual home site and in common-areas (for landscaping, such as walkway foliage, trees, etc.). Because it is not drilled and extracted from depths determined by the level of the groundwater table, nor is it pressurized (to the same degree as potable water), the energy needed to supply reclaimed water is somewhat less than that for potable water; therefore, CO₂ production/release is also somewhat less for reclaimed water than potable water.

Homeowners at Civano use reclaimed water for landscaping. They are served reclaimed water at their homes; this water is metered through a separate meter at each home. Or the homeowner may install water harvesting devices (collection devices which claim rain or runoff water) rather than using City-supplied reclaimed water for home landscaping needs. The impact of reclaimed water use at Civano is reported here, while water harvesting at Civano is not.

B. Summary Data from spreadsheet

Summary
Data

	Mar, 2003	Feb, 2003	Jan, 2003	Dec, 2002	Nov, 2002	Oct, 2002	Sep, 2002	Aug, 2002	Jul, 2002	Jun, 2002	May, 2002	Apr, 2002
--	--------------	--------------	--------------	--------------	--------------	--------------	--------------	--------------	--------------	--------------	--------------	--------------

Totals

Totals for all homes in Tucson	147.77	8.79	9.01	9.8	10.51	11.19	12.21	13.93	13.52	16.59	16.07	13.95	12.2
Totals for new homes in Tucson	137.78	9.92	7.85	8.47	9.35	10.03	10.52	12.27	13.30	11.62	16.07	15.83	12.57
Civano Potable Water	55.88	5.18	4.37	4.37	4.42	5.10	4.28	4.35	4.52	4.52	5.28	4.32	5.18
Civano Reclaimed Water	34.77	2.70	1.67	1.52	1.70	2.52	3.00	3.00	3.70	3.70	4.53	3.48	3.25
Civano Total	94.50	7.88	6.04	5.89	6.12	7.62	7.28	7.35	8.22	8.22	9.81	7.80	8.43

Savings

Civano vs Tucson (all) Total	36.05%
Civano vs Tucson (new) Total	31.41%
Civano vs Tucson(all) Potable	62.18%
Civano vs Tucson (new) Potable	59.44%

Common Area Water Use

RECLAIMED WATER CCF

Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02	Oct-02	Nov-02	Dec-02	Jan-03	Feb-03	Mar-03
752	902	1050	707	670	1135	765	459	379	315	350	842
Total yr 8,326 Apr 02 to Mar 03											

POTABLE WATER USE (POOLS)

Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02	Oct-02	Nov-02	Dec-02	Jan-03	Feb-03	Mar-03
5	11	16	27	37	14	97	2	2	81	6	15
Total yr 313 Apr 02 to Mar 03											