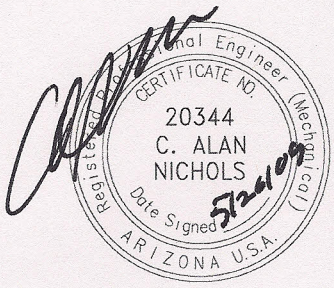
ANE Job #00609



Energy and Water Use in Tucson
January 2008 – December 2008

Civano Residences Compared to Tucson's Pre and Post Energy code Homes.

Prepared for the Pulte Corporation and the City of Tucson

By:

Al Nichols Engineering, Inc.

Tuesday, May 26, 2009

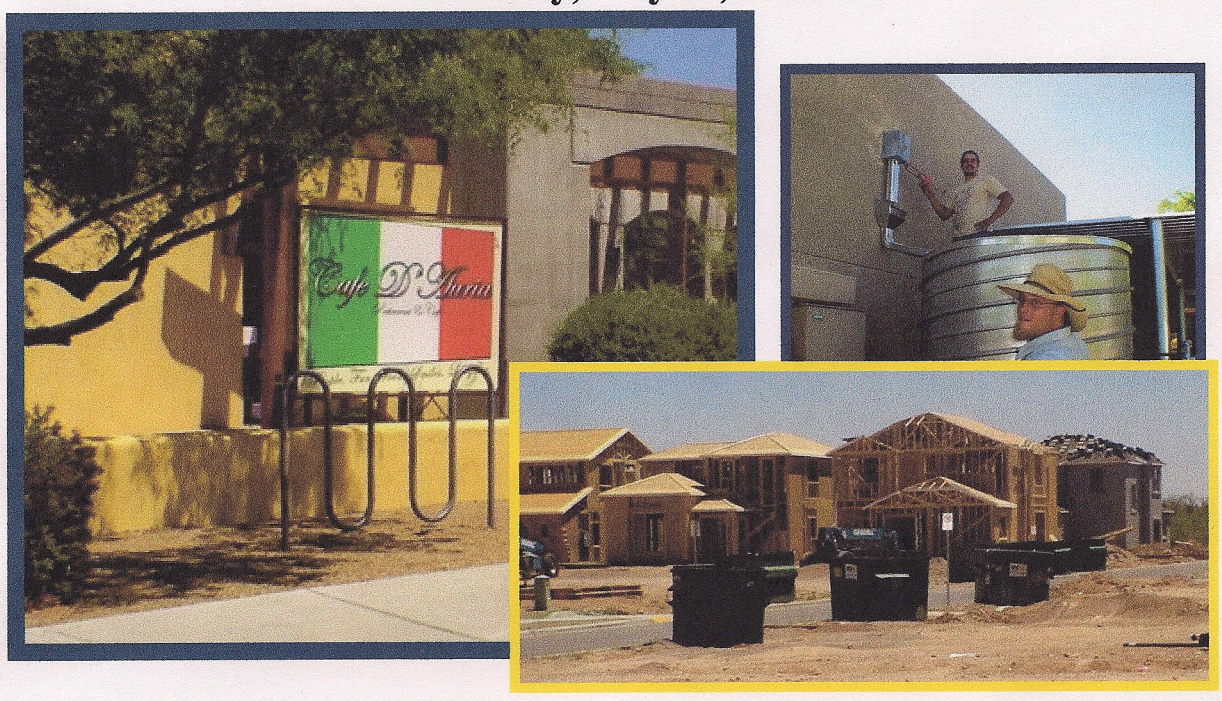


Photo 1 – Newly Opened *Café D Auria* in the Civano Neighborhood Center, HIM Rain Water Cistern Upgrade for Civano's "Greenest" School, Pulte Construction Still in Progress.

See previous ANE Inc. Civano Energy and Water Audit reports at: www.civanoneighbors.com

Energy and Water Use in Tucson, January 2008 – December 2008

ANE, Inc. would like to thank Southwest Gas and Tucson Electric Power for providing data for Tucson, and participating residents of the City of Tucson and the Civano neighborhood for permission to use utility data in this study. ANE, Inc. thanks the City of Tucson Water Department [add other thanks].

Table of Contents

A. Changes Made to the Civano Study Report dated

1. Font sizes were reduced and the report was printed double sided, saving printed pages.
2. An Executive Summary has been added with highlights of the latest year's study.
3. Information from consecutive studies about the significance and goals of the Sustainable Energy Standard (SES), the Civano Memorandum of Understanding (MOU), and Tucson's Model Energy Code have been moved into the report Appendix.

B. Executive Summary

Civano homes as a group perform at a significantly higher level than homes built before energy codes were enforced in Tucson, as well as most homes built in the Tucson region today. Based on the housing sample used for the 2008 study year, Civano average total energy use per year, per home in 2008 was approximately 31% over non energy-code homes and 27% better than the energy code group. Civano's heating and cooling energy reduction over non energy-code homes was approximately 42% and was 38% better than energy code homes. Overall potable water use reductions in sample Civano homes compared to city-at-large homes are also significant. Development practices, technology and social convention in Civano have yielded an approximate reduction of overall water use per year, per household of 41%. Potable water consumption has been cut approximately 55%.

The International Energy Conservation Code (IECC) is closing the gap on Civano's Sustainable Energy Standard (SES). *If* local jurisdictions adopt the full 2009 IECC, homes built by approximately 2011 could start closing the efficiency gap between 'standard' housing and Civano by half. As projected, the 2012 IECC could produce homes by 2015 which are all on par or measurably better performers than Civano homes with regards to energy consumption. Other forces, such as the US Green Building Council's Leadership in Energy and Environmental Design (LEED) program my close the gap much more quickly for some builders and/or consumers who insist to build to LEED, or other high-performance standards. **Changes in the IECC** have resulted in the adaptation of a cooling degree day standard whereas previously the standard only recognized heating degree standards to determine target values for code-compliant insulation r-values and HVAC system efficiency ratings. This development is part of an ongoing trend to recognize the vast variations of climate zones found in the United States, including places like Tucson: An arid desert known to also essentially be sub-tropical for approximately six weeks out of a year. The cooling/dehumidifying season is a much more considerable energy and water consumption concern in Tucson than the heating requirement found in more of the heavily populated regions of the country where many building codes originally developed.

Civano's development slowed significantly in 2008 and 2009, but did not stop. Even during the worst times there were buildings being finished and even several foundations being poured. Concurrently, the older parts of the neighborhood, approaching their 10^{th} year anniversary as a community, are welcoming in a wealth of new businesses and a growing number of on-site services. These are a long awaited, and key component of the village design originally intended by Civano's planners and proponents. It would be beneficial to study what happens to Civano's energy and water consumption as the community develops and integrates further.

1. Characteristics of the 2008-sample Energy Use Study

The 12 month study period is January 2008 to December 2008. Data collected is matched with all utilities and discounts annual weather functions that might otherwise alter the comparative results. Data for Civano and Tucson-at-large homes was collected from Tucson Electric Power, Southwest Gas and Tucson Water based on voluntary participation in the study by Civano and Tucson homeowners. Participation in Civano's energy audit is always on a voluntary basis as required by law and utility restrictions to personal access to data. Previous releases plus new releases from respondents who replied to postings around Civano resulted in 106 participants contributing to the current study; homes averaged 1,850 square feet, down 127 feet from the 2007 study sample.

As neighborhoods expand, the sample size was expected to increase, and that is what happened overall in the sample. Of the 106 current Civano participants, 66 are from Phase II development (Pulte's Sierra Morado) and 40 are from Civano Phase I. This year there was a marked decrease in valid release forms for Tucson at large homes. As a result, after an analysis of weather data yielded mild 0.74 F difference in average temperature difference between 2007 and 2008, much of the data from the 2007 baseline was carried into the 2008 study. This method yields data adequate for the purposes of this study as it pertains to finding averages. Given a wide range of behaviors of people in their homes, we are unable to draw solid conclusions about the variations between energy audit years. 12 out of 35 homes in the pre energy-code homes had new data for 2008 and the remainder used data from 2007. 3 out of 16 homes from the post energy-code era in Tucson had new data for 2008 while 13 did not.

Homes for the Tucson sample included those built before the first energy codes were enacted (pre-1998 City homes), and homes built immediately after the first energy codes were enacted (1998 to 2005 City homes). Names and addresses were obtained from Pima County tax records. The reported average Tucson home square footage from this sample is 1,856 square feet, ranging between 1,028 and 2,900 square feet.

Energy bills were examined by month, and energy use evaluated and reported in source kBtu/sf/yr/home (see Appendix for conversions). The cooling/heating energy was determined by averaging the "base" (or "plug") loads for each month. The calculated base loads were then eliminated to reveal the heating or cooling energy for the month. Base loads come from those devices such as televisions, refrigerators and computers that use energy throughout the year, not on a seasonal basis. The base load is assumed to be consistent throughout the year.

Base loads are calculated using Tucson Electric Power Company's method for base calculation: the lowest monthly energy use found during March/April is averaged together with the lowest of the two months October/November. The resulting number is utilized as the base calculation for the sample.

Base use is difficult to measure and the method followed here is a good approximation. This procedure will always produce at least one month with negative numbers. As an evaluation measure, this procedure assumes little or no heating and cooling for the selected base months of the year, March/April, October/November, whereas it might be that *both* heating and cooling take place. In the latter case, some of the energy attributed to base load would therefore actually be heating and/or cooling energy.

Average square footage for Civano Phase I electric homes was 1,594 sf; for Civano Phase I dual fuel homes (use of gas and electric) was 1,902 sf; for Civano Phase II electric homes was 1,495 sf; for Civano Phase II dual fuel homes was 2,411 sf; for City, pre-98 homes was 2,013 sf; and for City 1998-2005 homes was 1,700 sf.

B. Evaluation of 2007 Energy Use

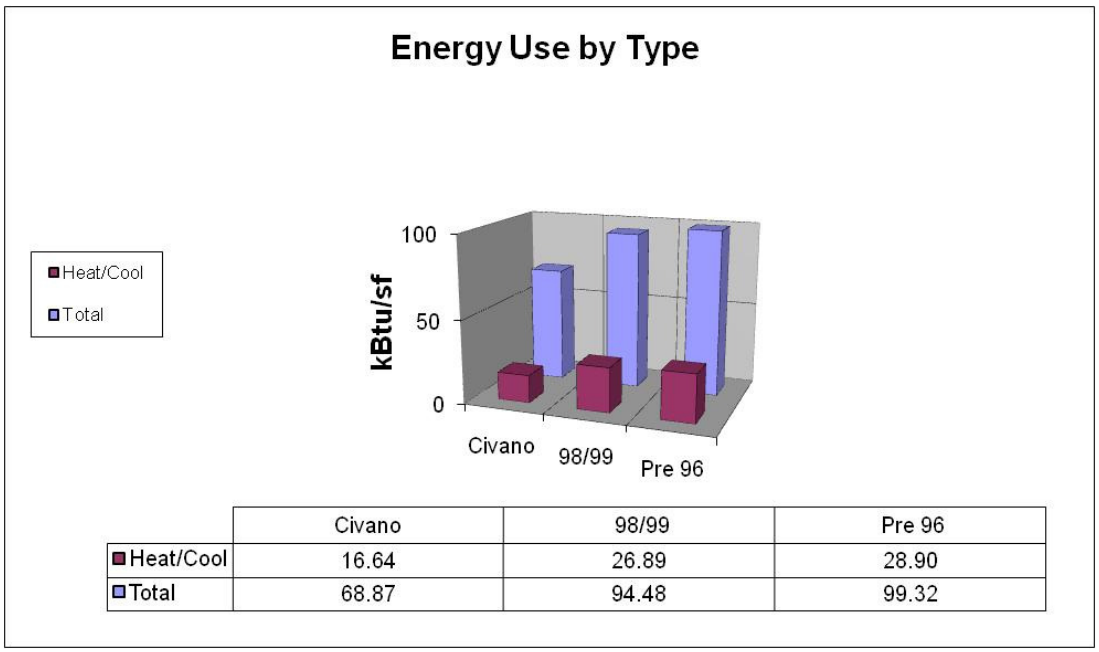
To measure improvement in energy use between the different sample sections of this study, Civano Phase I homes, Civano Phase II homes and 1998-2004 Tucson homes were compared to the baseline of Pre 1998 Tucson homes. Results for cooling and heating energy use reduction and total energy use reduction by percentage for 2008 are given in Table 2.

2008 CIVANO ENERGY SAVINGS

Savings over post 96 homes HEAT/COOL	
GROUP	PERCENT SAVINGS
Civano 1	0.29
Civano 2	0.44
Civano All	0.38
Savings over pre 98 homes HEAT/COOL	
GROUP	PERCENT SAVINGS
Civano 1	0.34
Civano 2	0.48
Civano All	0.42
Savings over post 98 homes TOTAL	
GROUP	PERCENT SAVINGS
Civano 1	0.31
Civano 2	0.25
Civano All	0.27
Savings over pre 98 homes TOTAL	
GROUP	PERCENT SAVINGS
Civano 1	0.34
Civano 2	0.28
Civano All	0.31

Table 1: Percent of improvement performance in Civano by percent

The results are that homes built under the IECC (1998-2005) used 3% less energy for heating and cooling and 4% less energy total when compared to homes built before the Model Energy Code was in force, given homes in this study sample. Civano Phase I homes (Civano I), built to the Sustainable Energy Standard, performs better, reducing heating and cooling consumption over non energy code homes by 34% and overall energy consumption by 31% over homes built before the inception of the IECC in Tucson. The most recent Civano homes, Phase II being built by Pulte Homes, are showing increased performance in heating and cooling over pre energy-code homes at 48% savings with an overall 38% improvement in energy consumption. Compared to the post energy code Tucson home, Pulte's homes are coming in at approximately 44% more efficient for heating and cooling and 31 % more efficient in total energy use. Although some sub-groups of these sample homes are pulling the average of the group down approximately 10% shy of the SES energy goals, the homes are operating at a substantially increased efficiency. The best way to determine the reasons for fluctuations in energy consumption is to conduct more, deeper study. For the parameters of this study, it is acknowledged that the performance of Civano is not perfectly on target, although it exudes massive successes in energy consumption efficiency performance.



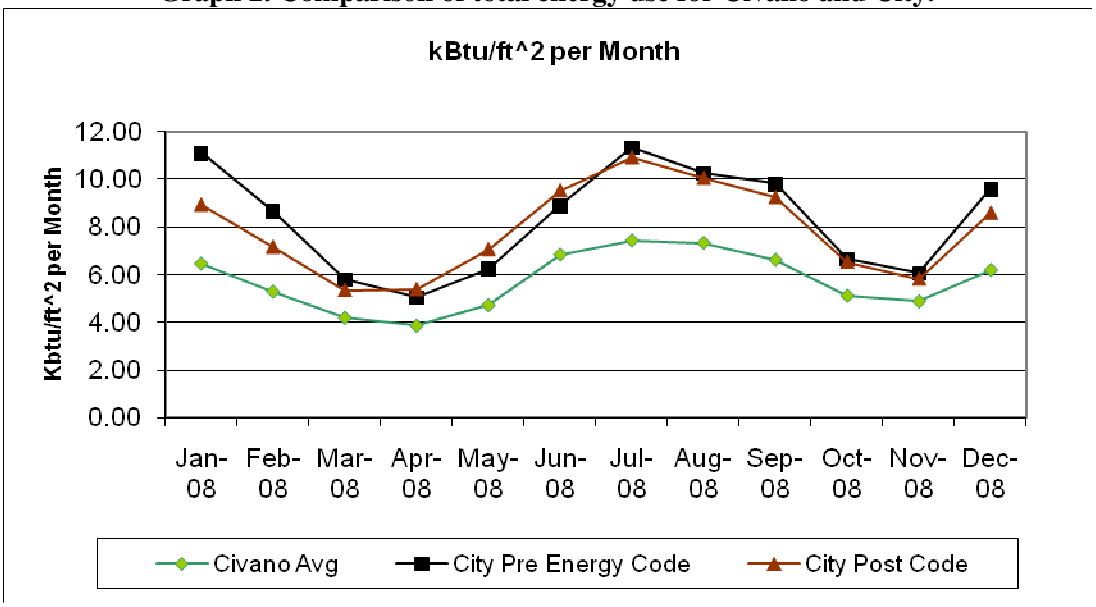
	Civano	98/99	Pre 96
Heat/Cool	16.64	26.89	28.90
Total	68.87	94.48	99.32

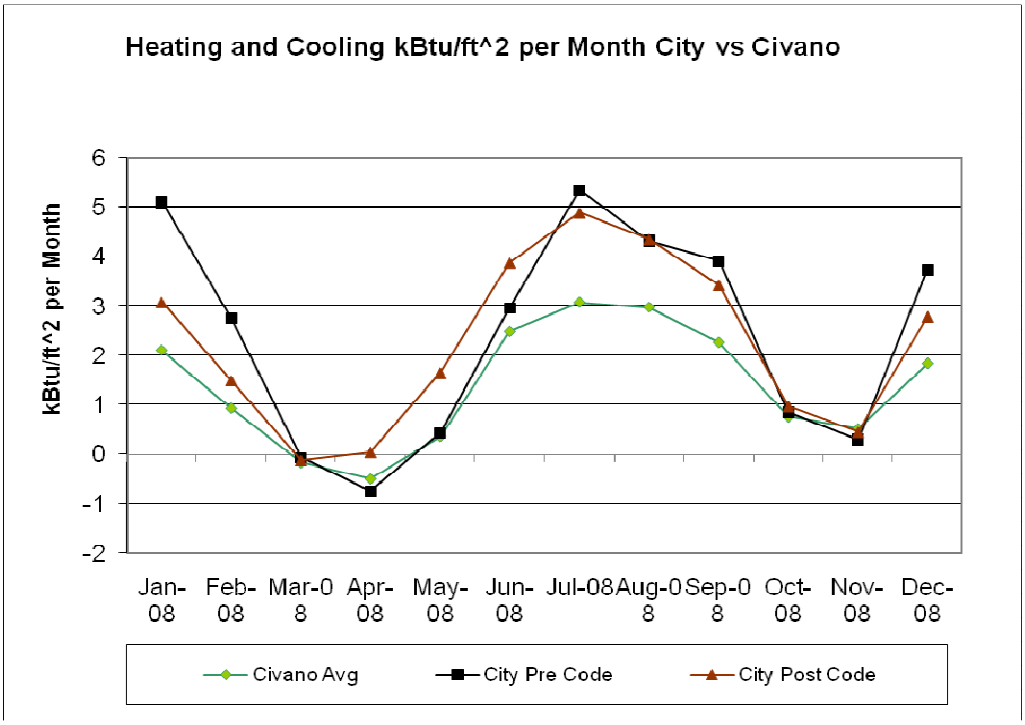
Graph 1: Total, heating and cooling energy for all sample homes

Graph 1 gives a total representation of total, heating and cooling energy consumption for all Civano homes (in our sample), IECC homes and pre energy code homes. Civano homes (Phases I and II) use an average of 24% of their energy on heating and cooling and 76% on base loads. Energy homes in our sample also use an average of 28% of their energy on heating and cooling and 72% on base loads. However, pre energy code homes use an average of 29% of their energy on heating and cooling and 71% on base loads.

Graph 2 shows total and heating and cooling energy (respectively) as average energy use in kBtu/ square foot/month and shows the two peaks of use arising from seasonal energy use for heating and cooling.

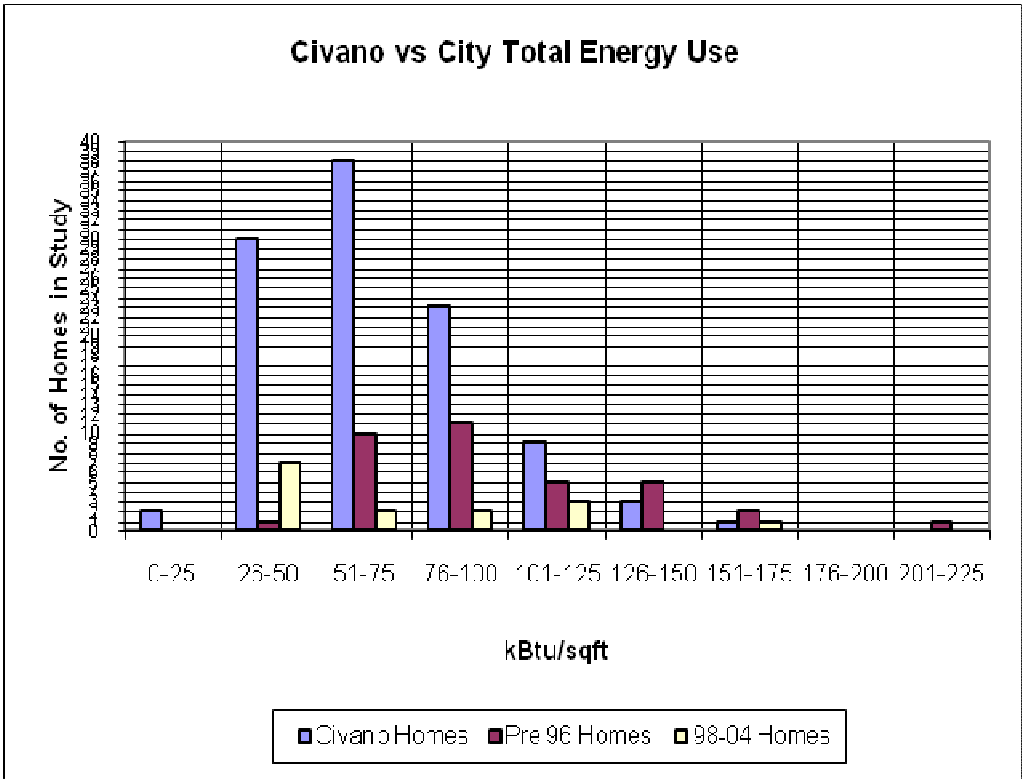
Graph 2. Comparison of total energy use for Civano and City.





Graph 3. Comparison of heating and cooling energy for City and Civano.

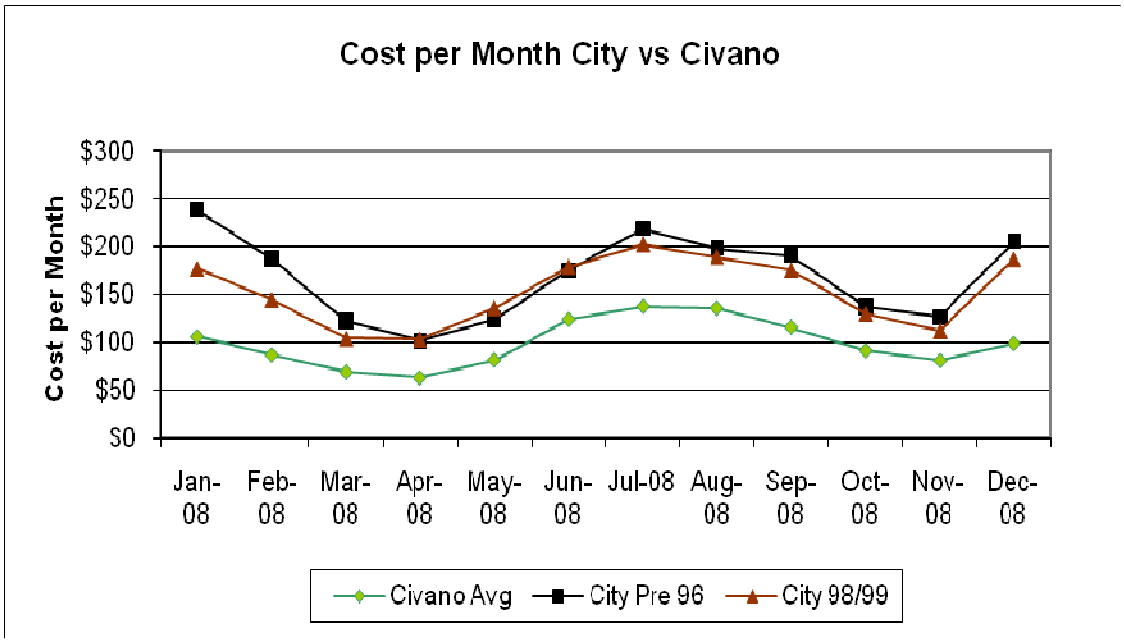
Graph 3 illustrates that the daily habits of Civano residents (relating to base loads) are very similar to those of the general population and indicates that the consistently lower use of kBtu/ft^2 is due to increased efficiency of the building envelope and the use of solar energy. Behavioral differences may also play a role, though that cannot be corroborated within the parameters of this study. Graph 4 illustrates this wide difference in behaviors. Even within one group, Civano homes, energy use varies from less than 25 kbtu/ft2 to over 126 kbtu/ft2.



Graph 4. Histogram of energy use for homes with complete data.

C. Cost and Energy Savings for City and Civano

Cost for utilities per year and cost for heating and cooling per year is averaged as seen in Graph 5. Cost savings are generally tied to energy savings, but different utility rate structures can slightly alter this relationship. Additionally, behavior and even home design affect the relationship between savings and rate structure.



Graph 5. Utility costs for Civano and the City.

3. Conclusions for the 2006 Energy Use Study

The results show a significant improvement in energy conservation under the SES as applied in Civano homes compared to other homes across the City. The SES design certification (REScheck) and the observed post-occupancy home performance correlate very well; indicating that the 7000 heating degree simulation was an adequate tool for designing to the SES standards in the Tucson climate in spite of the fact that cooling degree days are now becoming acknowledged more in the energy code language. Furthermore, this study has shown that the requirements that achieve these savings are both financially and mechanically feasible for both the homeowners and the builders.

Photo 2: (Group) Doucette, and Two Civano Community Businesses: Home Improvement and Maintenance and the Yoga House.

FOR A LISTING OF CIVANO BUSINESSES: www.civanoneighbors.com

II. Water Use

A. Introduction: Civano and Sustainable Water Use Standards

1. Purpose of the Study

Civano (per MOU) adopted the 1998 Sustainable Energy Standard (SES) for energy and water use as 28 gallons per day per capita exterior and 53 gallons per day, per capita interior.

2. Characteristics of the 2007 Water Use Study

Potable and reclaimed water are metered individually for Civano residences. Data from potable water use by 88 individual Civano residences and from reclaimed water use by 31 residences were supplied by Tucson Water Company. The 57 Phase II homes in the water study do not have reclaimed water as an option on their homes (section III, A, 2).

B. Evaluation of 2006 Water Use

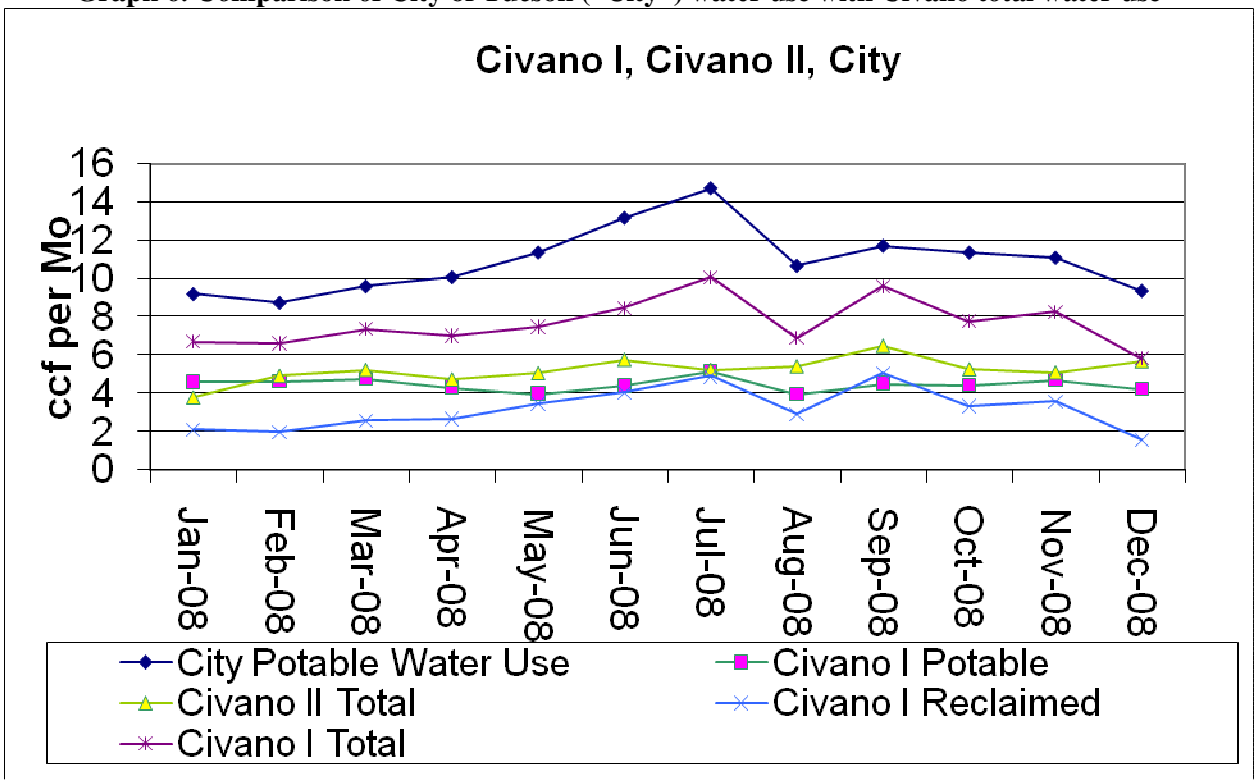
One year of water data was reported by Tucson Water Company for the City vs. the Civano average. Samples returned indicate an overall average monthly potable water use as shown in table 4 below. These totals *do not* include the 15 Civano Phase II homes that did not have a complete year of data.

CIVANO PERCENT WATER SAVINGS				
GROUP	SERVICE	TOTAL CCF		SAVINGS
Civano II	WA	62.9		52%
Civano I	WA	53.9		59%
Civano I	RC	38.3		N/A
Civano I	Total	92.2		30%
Civano ALL		77.6		41%
Civano Potable		58.4		55%
Average Usage City		**131.0**		**(Baseline)**

Table 3 Water use and savings by percent

Tucson Water Company provided data from the total Tucson population of residential water users as 131 ccf per year compared to 92.16 per year (total water) for Civano I homes and 62.9 for Civano II homes. Civano I used an average of only 54 ccf/residence per year of potable water whereas Civano II's overall use is all potable. Thus, total Civano potable water use is significantly lower than Tucson homes. Overall water savings is likely a result of strict landscape standards, small lot sizes, use of cisterns, reclaimed water and community awareness.

Graph 6. Comparison of City of Tucson ("City") water use with Civano total water use



As seen in graph 6, the City's average water use is higher overall than Civano, and the peak water use (June-July) is more pronounced in City homes as well.

C. Civano, Phase I Water Use in Common Areas

Potable water is used in common areas only for the existing and pools. Elsewhere, reclaimed water is used for common area landscaping needs. 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 while successfully providing shade and grass spaces in the community. See the ANE, Inc. 2001- 2002 report for indications of the substantive contributions from use of reclaimed water for common areas (not computed this year as build out continues). A larger effort can be made to reduce water to native trees that are now established and stable.

Pepper Viner Homes in Civano Neighborhood I did not receive the same reclaimed water infrastructure as the earlier homes in Phase I. However, they did get enough reclaimed service to irrigate community landscaped areas without using potable water.

Pulte Homes has made large strides in reducing potable water use at each home by aggressively employing xeriscape techniques and only using city reclaimed water for common landscaped areas. Furthermore, medians and front yards in Sierra Morado are contoured with swales and berms to help slow and collect the water on sight rather than releasing it as runoff.

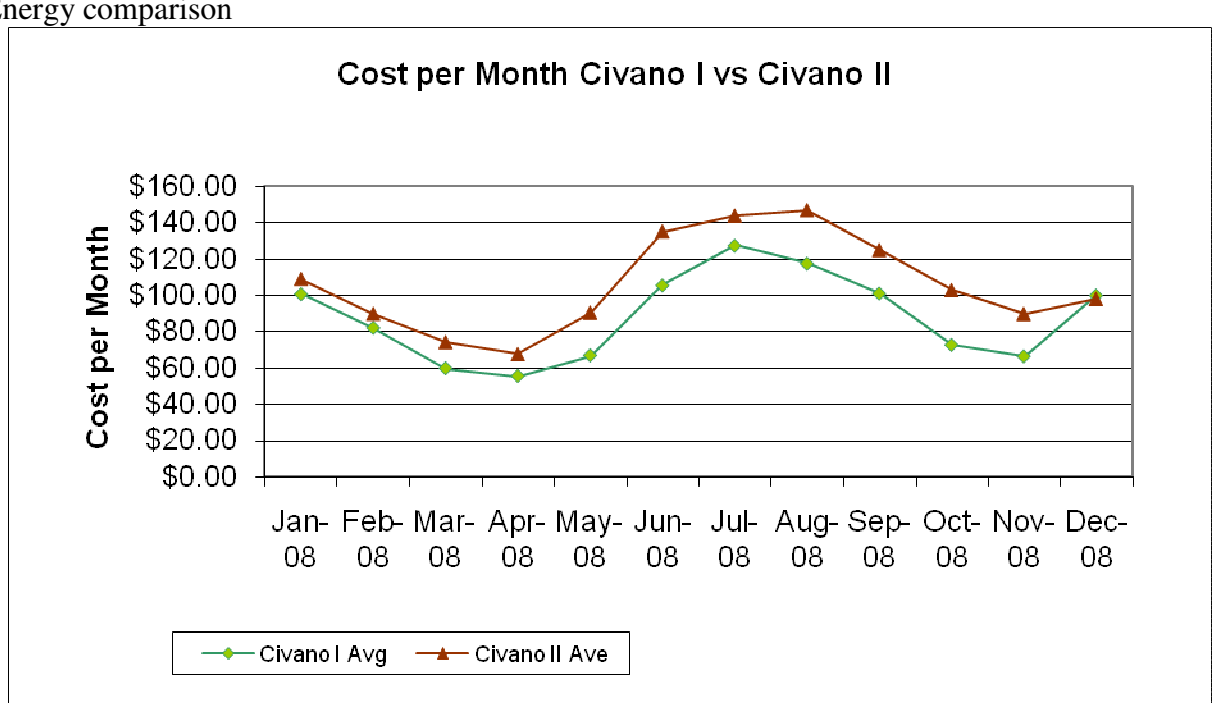
III. Civano, Phase I vs. Phase II Comparison

The mandates for performance in Civano are intended to cover the entire community. However, it is interesting to compare different builder's successes in Civano to help us better understand which

processes, practices and technologies lend themselves well to creating high-performance production housing products. Pulte Homes uses consistent methodologies, materials and designs in a very streamlined production process whereas the Phase I Civano housing stock consists of the work of many different builders, materials and configurations.

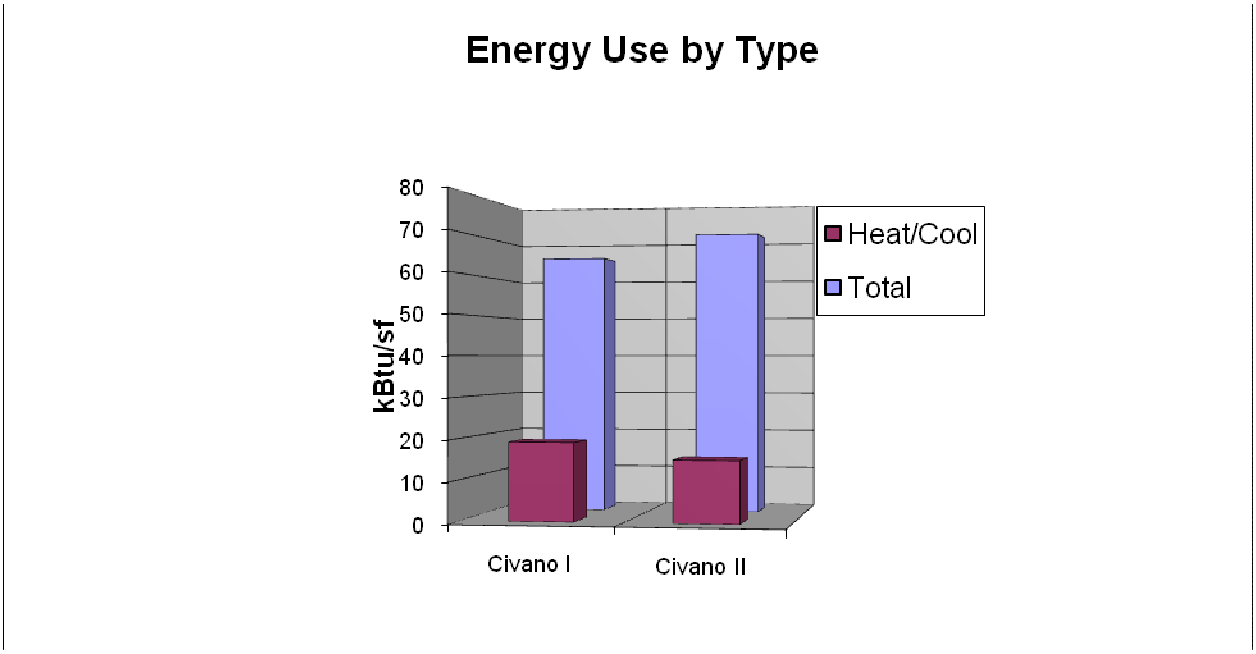
B. Comparison of Water and Energy Use

1. Energy comparison



Graph 8. Total Energy Use of Civano Phase I and Civano Phase II Homes

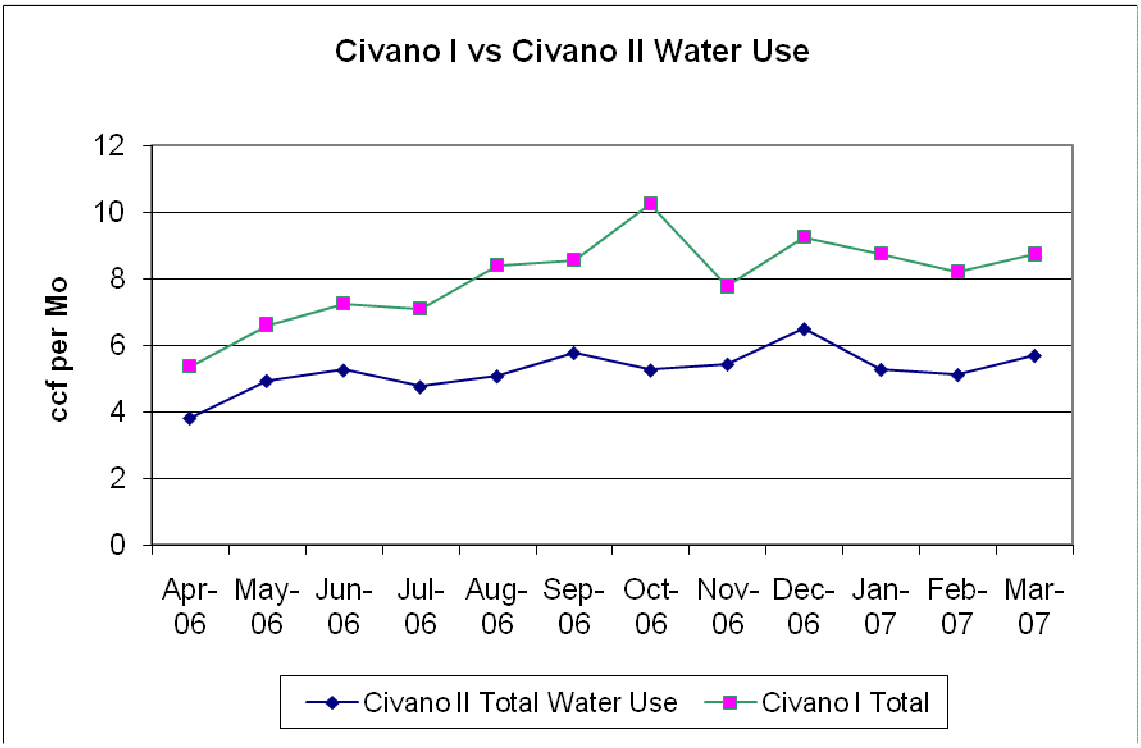
Overall energy consumption in Phase II housing (Pulte) has increased over Phase I. This may be due to the small size of the Phase I sample, behavior, building quality, or sampling methods—but for now this difference is non-conclusive. Pulte includes the release form for this utility study in their signing documents which presents a difference in *who* signs up for this study. All other releases are solicited in a 'cold sale' fashion and it *may be* that the individuals responding are more apt to be aware of the effects of their behavior on energy and water consumption than those who are agreeing to the study as a matter of course to completing their home purchase. In the end, human behavior is the missing link to this study and perhaps the key to becoming a more sustainable society. It would be extremely advantageous to conduct a social-science study to bolster the findings of this (and any other) residential energy/water audit.



Graph 9. Heating/Cooling and Total Energy Use for Civano Phase I and Civano Phase II Homes

2. Water comparison

Phase II does not gain potable water savings from the use of city reclaimed water because those houses are not connected to the city reclaimed system. Therefore, Phase II uses more potable water than Phase I. However, the *overall* water consumption in Phase II homes in the 2008 data-year sample is lower than Phase I by nearly 32%. Homes use low water use landscaping with berms and swales to enhance growth. Phase II (Unit 1) has 12.45 acres of landscaped common area and Phase III (Unit 2) will build out with 17.23 acres of landscaped common area, all of which is irrigated with reclaimed water.



Graph 10. Civano Phase I (potable & reclaimed) and Civano Phase II Water Use

Using inexpensive and uncomplicated rainwater harvesting systems may be an excellent way to reduce potable water usage in future Civano homes. These systems only cost approximately $1000 less than the connection fee for city reclaimed water, are nearly free to operate and do not require the extensive infrastructure that is needed to redistribute reclaimed water. Using grey water is possible, but more problematic, requiring excellent homeowner education and willingness to maintain the system. It is very inexpensive to incorporate grey water stub-outs into each home during design so that grey water may be utilized by interested home owners.

The comparisons between the performance of Civano Phase I homes and Pulte's Phase II homes show that the Pulte-built group is operating at a higher level of efficiency than Phase I homes, in general. Phase II showed an overall decrease in water usage over the Phase I homes. Phase II homes use more *potable* water than Phase I homes because Phase II is not connected to city reclaimed water at the individual home level. Phase I landscape also has much more foliage and a larger overall landscaping water budget.

Photo 1 - Sierra Morado, Phase II Construction

Photo 2 – Pepper Viner, Civano Phase I

APPENDIX 'A'

I. Energy Use

1. Purpose of Study: Civano MOU, Tucson's Model Energy Code and the Sustainable Energy Standard

Per the Civano MOU 1998, Civano adopted the 1998 Sustainable Energy Standard (SES) for design and construction of all buildings in Civano. The code was substantially updated in 2005. The SES identifies beneficial use of solar energy and a maximum use for hot water, cooling, and heating energy as 50% of the local standard as paramount to attaining a high performance level of energy use. Water use was also restricted to (see Part II: Water Use). The MOU is adaptable by design and the current revisions to the SES approved by mayor and council on October 1, 2005 identify beneficial use of solar energy as a minimum of 5% while keeping the 50% heating and cooling energy reduction standard. The solar requirement has been met in most Civano homes with solar hot water heaters.

2005 Sustainable Energy Standard

> The 2005 Sustainable Energy Standard: The calculated target annual energy consumption of the building shell and mechanical system and domestic hot water heating shall be less than the energy required by the present Tucson/Pima County Model Energy Code by 50 percent. (Sustainable Energy Standard, Chapter 1, Section 101.4.)

The Model Energy Code (MEC) thereafter became the IECC when International Standards were adopted; in this report, the Model Energy Code is referred to as the IECC.[1]

Cooling and heating energy use by homes built to the 1995 MEC was assumed to be approximately 36-54 kBtu/sq ft/year source energy. (Source energy is computed as the energy produced at the power utility to support the end-use; see the Appendix for conversions assumed.) The 2005 SES proposed that energy use for homes built to the SES be 50% of the MEC as specified in Table 1, and therefore between 18-27 kBtu/sf/yr depending on the square footage of the home. Evaluation of energy use was then to be evaluated yearly during the initial build out, as determined through energy audit of actual use. Small houses have more wall area per square foot than large houses, thus small houses tend to use more energy *per square foot* for heating and cooling than large houses.

Table 2. 1998 Sustainable Energy Standard: Prescriptive Compliance Summary

Building	kBtu/sq. ft./year/home as source consumption in kBtu		
Sq. Ft. Range	Heating	Cooling	Total
<1000	5	22	27
1000-1399	4	18	22
1400-1799	4	16	20
1800-2199	4	15	19
>2199	4	14	18

[1] ANE, Inc. reports on Civano Energy use for 2001-2002, 2002-2003 and 2003-2004 provide a history of the development of the 1998/2005 SES and its basis.

The 1998 SES also described a need for “beneficial use of solar energy" but provided no parameters. Solar hot water was most commonly provided by builders, but others relied on less rigorous criteria to meet this requirement which prompted the upgrading of the standard. The 2005 SES (October 1, 2005; Attachment B to Ordinance 10178) specifies the use of solar energy as 550 kBtu/yr/bedroom for residences and is prescriptively met using typical solar thermal hot water systems that have a rating of 2000 kWh/year or more for up to four bedrooms. Other means include PV or other methods allowed by the standard. Commercial buildings are to demonstrate a 5% utilization of solar energy.

SES compliance is determined by using a free DOE simulation program, REScheck, to model Tucson residence designs at 7,000 heating degree days—the same number of heating degree days that is used for normal compliance in home designs to be built on top of Mt. Lemmon. This standard was determined by Kent Engineering by modeling homes in a more sophisticated program, CALPass, to achieve the 50% reduction in heating and cooling energy, and then putting the resulting home design parameters into REScheck and running simulations at different heating degree days until the same result (50% reduction in heating and cooling) was achieved. The DOE then modified REScheck to include a SES option that simulates designs at 7000 heating degree days, specifically for modeling the SES in the Tucson valley. During simulation, Kent Engineering also determined that once a building envelope is designed to the SES standard, building orientation and aspect ratio have much less effect on energy performance (5%). The end result is a free, easy to use program that any contractor or home designer can download and use to determine if their buildings will pass the SES standard, without the more complicated concerns about home orientation or aspect ratio. REScheck also provides an inspectors checklist for the solar requirements with each compliance report.

Energy evaluation of homes built in different years and per different energy standards potentially allows evaluation of the effects of codes and standards on real energy use. These results are important to stakeholders of Civano and to the City of Tucson. Broadly, evaluation of the SES and its methods helps to evolve conceptions and methods in sustainability. It aids the evolution of adequate (complete and correct) evaluation methods. The latter goal is explicit in Civano’s Memorandum of Understanding.

> 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 as well as the basis for improving future conservation and sustainability strategies and standards** (Civano IMPACT MOU 1998, Sections 1-3; bold added).

A. Introduction: New Standards and a New Master Developer

Photo 3 - Entrance to Pulte's Civano Sierra Morado

Phase II of Civano is called Sierra Morado—designed and (being) built by Pulte Homes as the new master developer of the Civano Project to meet the requirements of the SES and MOU. Pulte’s vertically integrated company uses mostly in-house architects, planners, engineers, craftsman, mortgage brokers and salespeople. Pulte is truly integrated to provide production homes. Phase I neighborhood design was master-planned by out of state and local architects and sold in small pieces to many different home builders. Thus, the way Phase II is being developed differs enough from Phase I to warrant direct comparisons of building pricing and performance. Although Phase II lacks some of the character of Phase I, it provides much more affordable housing that matches and exceeds the performance of Phase I homes.

1. MOU Adaptation

Phase I included connections at every home for city reclaimed water. This proved to be a large expense to the city and homeowners alike. In addition to an approximate $3,500 total cost to connect to the system (for the homeowner, including a backflow protector that has to be certified every year) the reclaimed water costs more than the lowest tier potable water cost that most Civano homeowners in our study pay. Reclaimed water is lower quality than potable and requires yearly maintenance of backflow protectors. This added cost and maintenance has created an incentive for homeowners to abandon or not use the city reclaimed system in favor of other methods such as rain water collection. Considering the huge cost of the added infrastructure and low incentives to use the system, city reclaimed water is not appropriate for use on the residential scale unless it is made more financially attractive.

With these new lessons learned, the neighborhood decided to drop the requirement for City reclaimed water in Phase II and III at the individual home level; however, common areas must use reclaimed water for landscape. Homes will use low water use landscaping with berms and swales to enhance growth. Phase II (Unit 1) has 12.45 acres of landscaped common area and Phase III (Unit 2) will build out with 17.23 acres of landscaped common area, all of which is irrigated with reclaimed water. The homes on traditional lots don't have reclaimed stubbed to their property, but the high density product, the landscaped right of ways, the community center landscaping, and the common areas are all served by reclaimed water. The results of water consumption between Phase I and Phase II will be explored in Section III, B, 2.

APPENDIX 'B'

Multipliers

The Sustainable Energy Standard evaluates compliance with target energy goals using *source energy*. *Point-of-use* energy refers to amount of energy used at a location, in this case, home energy use (indicated on a utility bill). *Source energy* is the total amount of energy used to produce and transport energy to its point-of-use. The SES specifies multipliers to assess source energy use: point-of-use *electrical* energy is multiplied by 3.1 to calculate source energy, and point-of-use *gas energy* is multiplied by 1.11 to assess source gas.

Correlations

In Tucson

- Approximately 2.3 pounds of CO2 are released per kWh of electrical energy (charts appear in *Benchmarking Air Emissions of Electric Utility Generators in the United States*, National Resource Defense Council, 1996);
- Approximately 1 pound of coal and approximately 0.65 gallons of water are used per kWh of electricity**.**
- 67.39 pounds of CO2 are released per therm of coal powered electrical energy.

National Average

11 pounds of CO2 released per therm of natural gas.

Conversions

kilowatt-hour (kWh): 1,000 watt hours
kilo British thermal units (kBtu): 1,000 Btu; 3.41 kBtu per kWh
Therm: 100,000 Btu or 100 kBtu; 29.3 kWh per therm
~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

Pulte Homes

Trail System
Civano - Sierra Morado

Tucson, Arizona

LEGEND

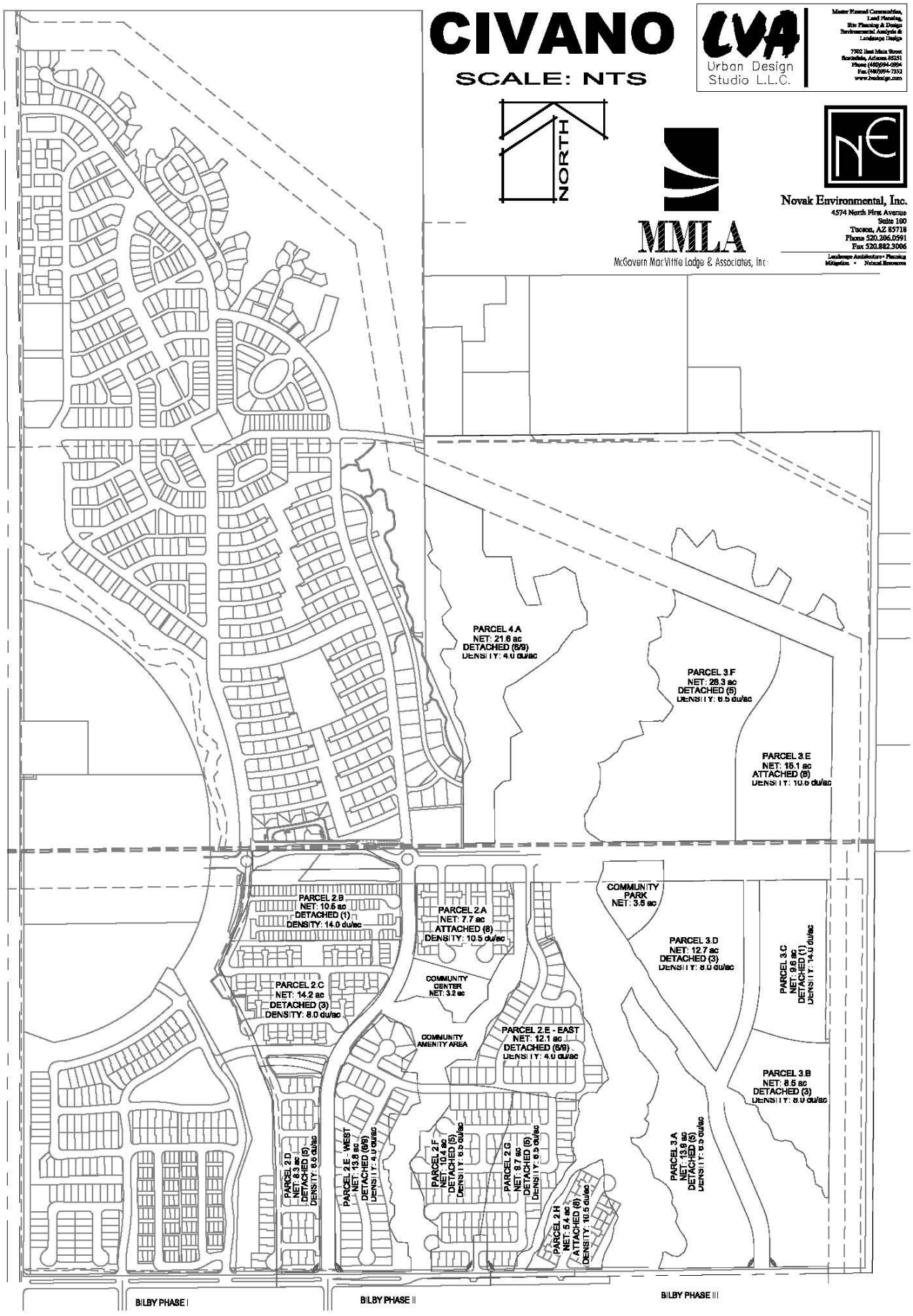
- Trail System
- Multi-use Path (asphalt or earth)
- La Colinas
- La Meseta
- Tierra Calida
- El Paseo
- La Mesa
- Las Haciendas

Planning and Landscape Group
201 N. Bonita Ave.
Tucson, Arizona 85745
Tel: (520) 750-7474
Fax: (520) 750-7475
www.stantec.com
Stantec

NORTH

200 0 200 400
SCALE IN FEET

185625700


CIVANO
SCALE: NTS
NORTH
LVA Urban Design Studio L.L.C.
MMLA
McGovern MacVittie Lodge & Associates, Inc.
Novak Environmental, Inc.
4574 North First Avenue
Suite 100
Tucson, AZ 85718
Phone 520.206.0591
Fax 520.882.3006
PARCEL 4.A
NET: 21.6 ac
DETACHED (5/9)
DENSITY: 4.0 du/ac
PARCEL 3.F
NET: 28.3 ac
DETACHED (5)
DENSITY: 5.5 du/ac
PARCEL 3.E
NET: 16.1 ac
ATTACHED (8)
DENSITY: 10.5 du/ac
PARCEL 2.B
NET: 10.6 ac
DETACHED (1)
DENSITY: 14.0 du/ac
PARCEL 2.A
NET: 7.7 ac
ATTACHED (8)
DENSITY: 10.5 du/ac
COMMUNITY PARK
NET: 3.5 ac
PARCEL 2.C
NET: 14.2 ac
DETACHED (3)
DENSITY: 8.0 du/ac
COMMUNITY CENTER
NET: 3.2 ac
PARCEL 3.D
NET: 12.7 ac
DETACHED (3)
DENSITY: 8.0 du/ac
PARCEL 3.C
NET: 9.6 ac
DETACHED (1)
DENSITY: 14.0 du/ac
COMMUNITY AMENITY AREA
PARCEL 2.E - EAST
NET: 12.1 ac
DETACHED (5/9)
DENSITY: 4.0 du/ac
PARCEL 3.B
NET: 8.5 ac
DETACHED (3)
DENSITY: 8.0 du/ac
PARCEL 2.D
NET: 8.3 ac
DETACHED (5)
DENSITY: 6.6 du/ac
PARCEL 2.E - WEST
NET: 13.8 ac
DETACHED (5/9)
DENSITY: 4.0 du/ac
PARCEL 2.F
NET: 4.6 ac
DETACHED (5)
DENSITY: 6.5 du/ac
PARCEL 2.G
NET: 8.7 ac
DETACHED (5)
DENSITY: 6.3 du/ac
PARCEL 2.H
NET: 5.4 ac
ATTACHED (8)
DENSITY: 10.5 du/ac
PARCEL 3.A
NET: 13.0 ac
DETACHED (5)
DENSITY: 6.5 du/ac
BILBY PHASE I
BILBY PHASE II
BILBY PHASE III