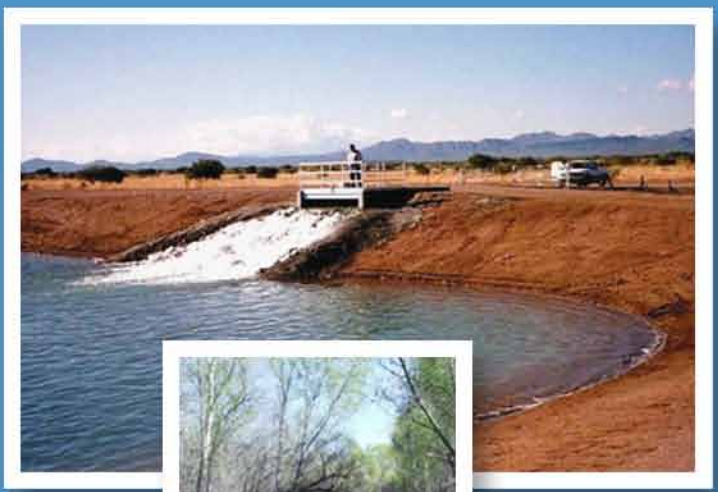
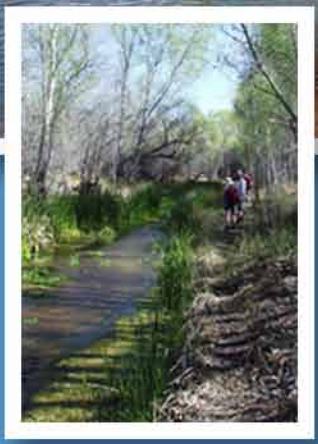
A City of Tucson
and Pima County
Cooperative Project

Water & Wastewater

Infrastructure, Supply & Planning Study





Chapter 3

May 2009

CHAPTER 3: CRITICAL FACTORS ASSOCIATED WITH WATER SUSTAINABILITY

This section responds to item C from the Scope of Work approved by Mayor and Council and the Board of Supervisors, as reproduced below:
What is the Sustainable Water Population of the City/County Service area- A number of studies and analyses have estimated the sustainable future population based on present, known water supplies. These studies and population ranges should be summarized to determine, under the present forecast, the most likely sustainable population of the joint City/County service area, given known City and County water supplies. This initial inventory and assessment should determine the near-term critical factors associated with sharing a stable and sustainable water supply, as well as the investments that may be needed in water, wastewater, and reclaimed water infrastructure systems to meet the service demands and needs of our existing population, as well as the sustainable future water population. This work can again be completed by the City and County staff in consultation with University and State technical resources.

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3.1 Water Resources Assessments for the Tucson AMA Municipal Sector

3.1.1 Tucson AMA Municipal Sector Perspective

Sharon Megdal, Director of the Water Resources Research Center (WRRC) at the University of Arizona completed a study in 2006 that looked at water resource availability for the Tucson Metropolitan Area. The study was funded by a consortium of business groups led by the Metropolitan Pima Alliance. The following text is taken from the executive summary of the report, which is available on the WRRC website.

Groundwater has long been a significant water source for many areas in Arizona. In 1980 Arizona adopted the Groundwater Management Act (Act) to address the serious groundwater overdraft that was occurring in Tucson and several other regions of the state by the municipal, industrial and agricultural sectors. The Act, through the goal of "safe-yield," forced the municipal sector within the Tucson Active Management Areas (AMA) to utilize alternative, renewable sources of water. This report focuses on the municipal sector of the Tucson AMA and explains how water management is accomplished and the manner in which municipal water providers – the suppliers of water to the Tucson region's residents and businesses – are likely to meet the future water demands of their service areas.

The institutions that are used to carry out water management in the Tucson AMA are complex. A key set of rules in the water management universe is the Assured Water Supply (AWS) rules. AWS rules establish that new municipal growth must utilize renewable water supplies. The AWS rules provide flexibility; they allow new growth to be served with groundwater, should sufficient groundwater be available for pumping, but most groundwater use must be replenished with other water supplies, such as Central Arizona Project (CAP) water or effluent. Not all water providers in the AMAs, however, have access to CAP water or effluent. To ensure that these water providers could continue to grow, yet meet the standards of the AWS rules, the Central Arizona Groundwater Replenishment District (CAGRD) was created. Current laws allow areas to continue to grow through contracts where the CAGRD is statutorily obligated to replenish groundwater used by new subdivisions in excess of that allowed per the provisions of the AWS rules. The projections provided by the CAGRD show rapid growth in the agency's replenishment obligations, even though they are based on projected membership only through 2015.

Each agency or city that plans for water demands must consider important questions such as: What are the region's dependable (or "firm") water supplies? Where might the region find other sources of water? How many people can those supplies support? Will sufficient supplies be available to support future population growth?

There have been efforts to quantify the population that can be served by the Tucson AMA's renewable water supplies. This is a challenging exercise since it depends on many assumptions, as well as the complex interaction of rules, regulations and institutions. Arriving at a population figure that current supplies can support is complicated by a number of factors. For example, the rate at which effluent will be utilized has significant uncertainties. Membership in the CAGRD allows growth in some areas based on the expectation that it will find the water supplies needed for replenishment rather than a guarantee based on water supplies under contract for the full 100 years. The rate of water consumption is a key determinant, and there are many complexities associated with forecasting water use on a per capita basis.

The worksheet below is included in the report with several illustrative "Scenario Populations" that could be served with existing water resources in the year 2030.

Assumptions of Scenario Spreadsheet

*These calculations are meant to be illustrative only. They are assumptions and are not intended to be forecasts or projections. The spreadsheet scenarios do not quantify the public investments required to actually utilize the identified water resources. Additional public investments may be required to utilize the resources.

[1]The population projections are for Pima County and are based on Pima Association of Government (PAG) Projections. PAG estimated population for 2005 was 916, 026. The Tucson AMA has different boundaries but includes metropolitan Pima County.

[2]The projected replenishment obligations are from November 2004 CAGRD Plan of Operation. The CAGRD projections do not include replenishment for Tucson, but it is assumed that Tucson will need 12,500 af of replenishment for its Assured

Scenarios Spreadsheet

2030 Scenarios Worksheet*	M&I + DOI Effluent + Higher GPCD	Half (M&I + DOI) Effluent + Higher GPCD		M&I + DOI Effluent + Lower GPCD	Half (M&I + DOI) Effluent + Lower GPCD
See Notes for Assumptions	Year 2030	Year 2030		Year 2030	Year 2030
PAG Pima County Population Projection[1]	1,496,045	1,496,045		1,496,045	1,496,045
Estimated 2005 Population = 916,026					
Water Supplies/Sources in Acre Feet					
CAGRD with Tucson Water[2]	35,600	35,600		35,600	35,600
Allowable GW[3]	41,100	41,100		41,100	41,100
Exempt Well GW[4]	4,000	4,000		4,000	4,000
Undesignated GW[5]	22,000	22,000		22,000	22,000
Effluent[6]	67,409	33,705		67,409	33,705
Effluent DOI[7]	28,200	14,100		28,200	14,100
Municipal & Industrial CAP[8]	195,810	195,810		195,810	195,810
Total Annual Supply in Acre Feet[9]	394,119	346,315		394,119	346,315
Total Annual Supply in Gallons[10]	128,424,070,269	112,846,926,140		128,424,070,269	112,846,926,140
Assumed Total GPCD[11]	165	165		150	150
Water Per Person per annum[12]	60225	60225		54750	54750
Scenario Population[13]	2,132,405	1,873,756		2,345,645	2,061,131
Scenario Population less Projected Population[14]	636,360	377,711		849,600	565,086
Ratio of Scenario Population to Projected Pop[15]	1.43	1.25		1.57	1.38

Figure 123-Sharon Megdal's Scenarios Spreadsheet

Water Supply (AWS). The figure shown has added 12,500 replenishment for Tucson Water, added Plan's projection for the Tucson AMA.

[3]Allowable groundwater is an estimate of the groundwater pumping that is allowable under the AWS Rules, annualized, according to Arizona Department of Water Resources estimates (ADWR Est.).

[4]Some pumping is going to occur through exempt wells. This is an estimate of the annual pumping based on a 1999 Tucson AMA Task Force Report.

[5]Some water providers are undesignated and allowed to pump groundwater to serve pre-AWS Rules population solely using groundwater (ADWR Est.)

[6]The amount of effluent available to the region based on Brown and Caldwell's 2006 Metropolitan Area Facility Plan Update Pima County Wastewater Management Projection, accessed from http: on March 21, 2006. It includes the projected outputs of the three metropolitan treatment plants (95,286 af) plus outputs of the non-metropolitan treatment plants (10,323 af) less the 10,000 af effluent set aside for conservation pool less the 28,200 af of effluent held in trust for the Tohono O'odham Nation by the Department of the Interior. There are many uncertainties regarding the amount of effluent that will be utilized. They relate to the return flows from municipal uses, the manner in which the effluent is utilized (e.g. managed recharge at 50% credits or constructed recharge or direct utilization through the reclaim system). The extent of future use of effluent to meet municipal demands may depend on technological innovations as well.

[7]There is effluent that is regulated by the Department of the Interior (DOI). The manner in which the 28,2000 af of effluent

held by the Secretary of the Interior for the benefit of the Tohono O'odham Nation will likely be used by municipal users in the Tucson AMA, but many uncertainties surround this utilization. In addition, the CAGRD may use some of this effluent for its replenishment. There could be double counting involved.

[8]The Municipal and Industrial (M&I) CAP figure represents the subcontracts held by Tucson AMA M&I water providers and the Arizona State Land Department (14,000af) and pending M&I reallocations. The Tohono O'odham Nation hold rights to 37,800 af, with another 28,200 non-Indian priority water associated with the recent federal water settlement. The scenarios assume no leasing of Indian CAP water for non-Indian municipal purposes.

[9] An acre foot of water is 325,851 gallons.

[10] Total Supply times 325,851.

[11]Gallons per capita per day are an assumed number that includes all customers and all water sources served by municipal water providers. It includes, for example, golf course use of effluent or reclaimed water provided through a municipal water system. The value of this number for the region will depend on the level of conservation across water using sectors, the mix of newer and older housing stock, the amount of outdoor water use and other factors.

[12]Annual water per year, equal to the assumed GPCD times 365.

[13]The Scenario Population is the number of people that can be served by the Total Annual Supply, based on assumptions. It equals "total annual supply in gallons" divided by "water per person per annum."

[14]This is the difference between the population that the scenario assumptions show can be supported by the assumed water supplies less the PAG projected population. A positive number demonstrates that the identified water supplies can serve more than the PAG projected population.

[15] A ratio greater than one indicates that the scenario population is greater than the projected population.

For each scenario, the Scenario Population is the number of people that can be served by the Total Annual Supply, based on the assumptions. The scenarios show that the water supplies identified are more than sufficient to accommodate growth as projected by the PAG. How robust this finding is clearly depends on the assumptions. Should the population projections be too low, water use rates per capita too low, or water supply assumptions too high, additional water supplies will have to be identified sooner. The spreadsheet is designed to be a tool or framework that can be adjusted over time as information is updated or assumptions change.

The red arrows point to the key numbers in the spreadsheet that affect the output. The PAG population projection is very important. There are a lot of uncertainties about effluent utilization and two scenarios are considered. Gallons-per-capita-per-day figures include all customers, household and commercial/industrial, and are heavily dependent on future conservation trends and again two scenarios are considered. The available water supplies were taken from various reports from the Arizona Department of Water Resources (ADWR). It is important to note that the scenario analysis does not quantify the public investments required to actually utilize the identified water sources and it assumes that we figure out a way to use all of our CAP water, which we are currently not doing as a region.

The scenarios are for 2030 and only consider municipal water needs. They do not tell us how close we are to meeting the Groundwater Management Act's (Act) safe-yield goal. How close or far away we are from achieving a balance between groundwater withdrawals and natural and artificial recharge depends primarily on the water use of the agricultural and industrial sectors. Water use in the municipal sector is strictly regulated by the Act which for most large water providers in the region requires the use of renewable water resources as opposed to non-renewable groundwater. In contrast, agricultural and industrial uses in the region are largely reliant on pre-1980 grandfathered groundwater rights. The Act set a 2025 date for meeting the safe-yield goal. In 1980, 2025 was 45 years away; now it is less than 20 years away. The Act called for the development of Fourth and Fifth Management Plans. It will likely be through the development of these regulatory documents, as well as the next CAGRD Plan of Operation, that the Tucson region will begin to consider collectively what its future water picture is likely to look like.

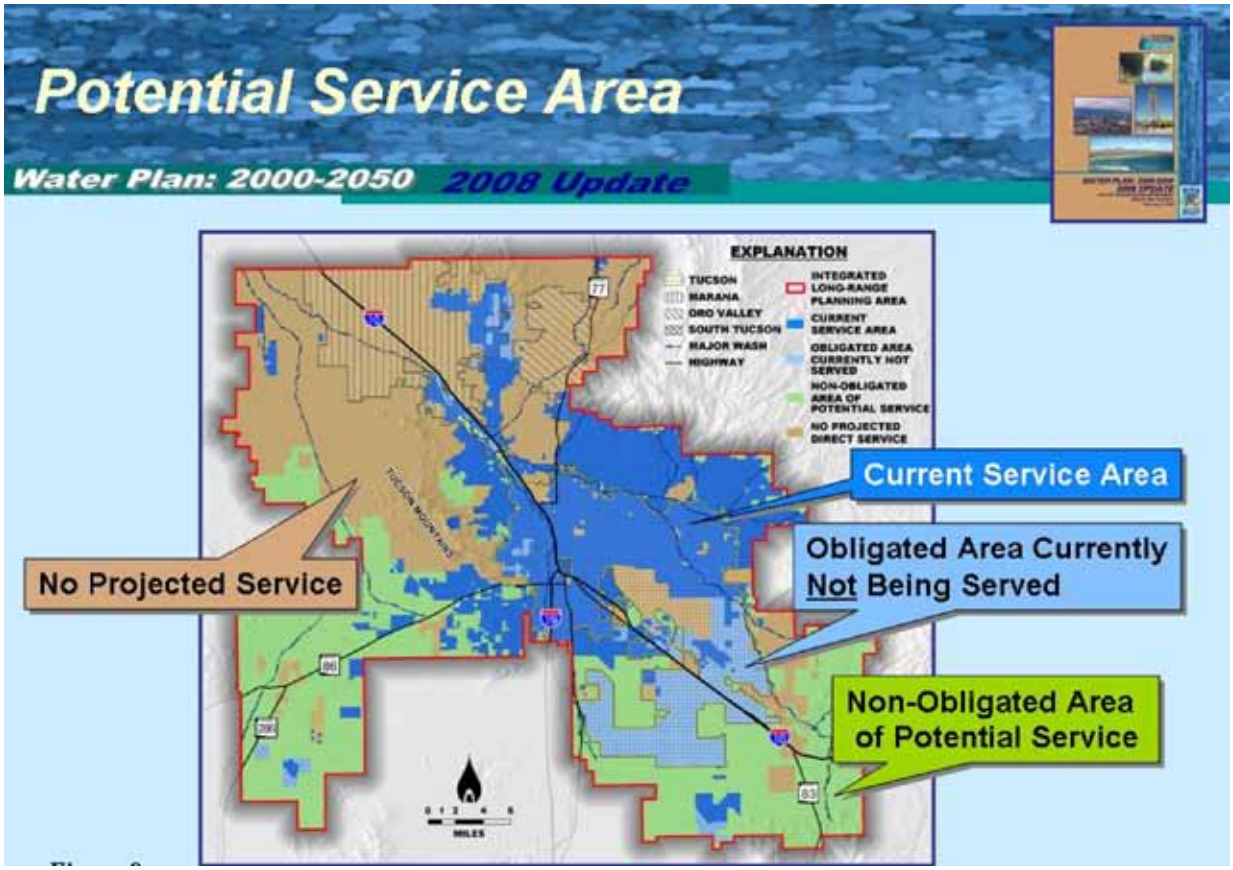

Figure 124-Potential Service Area

Many of the suggested actions are associated with participation in collaborative, broad-based efforts. Understanding of the nature of the region's water supply challenges requires looking toward the long-term. Water management is not just the concern of water managers. The coalition of business interests that participated in the development of this report should continue to work with the public sector and others in the private sector to ensure that the Tucson region continues to have sufficient water supplies.

3.1.2 Tucson Water 2050 Plan Update

Tucson Water issued Water Plan: 2000-2050 in 2004 to initiate a dialogue between the Utility and the community about the water-resource challenges which need to be addressed in the coming years. In 2008, an update to the plan was published incorporating a renewed view of the community's water-resource future. [38]

It is important to note that the 2050 Plan and the 2008 Update to the plan were completed prior to the initiation of the City/ County Water and Wastewater Study. It is anticipated that information and recommendations coming out of the Study (related to planning for growth, environmental needs for water, sustainability, climate-related uncertainties, etc.) will help shape Tucson Water's future updates to the Plan.

Although the substantive issues and challenges remain largely the same, the planning timeframes within which to address them have changed. The Update also accounts for revised population projections that have since been developed, an increase in the City's Central Arizona Project allocation, and changed planning assumptions and priorities which have evolved in the three years since Water Plan: 2000-2050 was issued.

Both Water Plan: 2000-2050 and the 2008 Update demonstrate that Tucson Water has adequate water resources available for Tucson Water's current customers (approximately 733,000) and for an estimated additional 370,000 people. Tucson Water's rate payers have already invested in developing the Utility's water-resource portfolio and its extensive water distribution

[38] *Both reports can be found on the Tucson Water website at http://www.tucsonaz.gov/water/pubs-gi.htm.*

systems. As a result, the community's remaining water-resource challenges primarily involve increasing system reliability and securing sustainable water supplies for our existing service area population as well as for additional growth beyond that described above should that occur.

Both Water Plan: 2000-2050 and the Update emphasize the need for the Utility to continue pursuing three general initiatives:

1. Utilize fully the renewable water resources the City of Tucson currently has available;
2. Achieve more efficient water use through expanded conservation programming; and
3. Acquire additional water supplies to increase reliability and meet future demand.

Long Range Planning Area

The Long Range Planning Area, shown on **Figure 124**, includes areas currently served by Tucson Water (dark blue) and undeveloped areas that the Utility is obligated to serve (light blue). These two areas are collectively referred to as the "Obligated Area", and represent areas within the City limits or areas where the utility is currently contracted to serve. The remaining geographic areas (shown in green) are non-obligated areas of potential service. The Obligated Area and the non-obligated areas of potential service are collectively referred to as the Utility's "Potential Service Area." Areas shown in brown are those where Tucson Water has no plans to provide direct service.

Regional Cooperation within the Long Range Planning Area

Even though Tucson Water has no plans to provide direct service to areas shown in brown, the Utility continues to evaluate local water management issues and to work cooperatively with water providers that serve these areas. Over the years, Tucson Water has been an active participant in many formal and informal local groups, such as the Southern Arizona Water Users Association (SAWUA), discussing various water management issues. In 2004 Tucson Water began discussions about regional cooperation on water resource issues with the largest water providers in the area. Those discussions resulted in a 2006 proposal from SAWUA for a cooperative water supply organization.

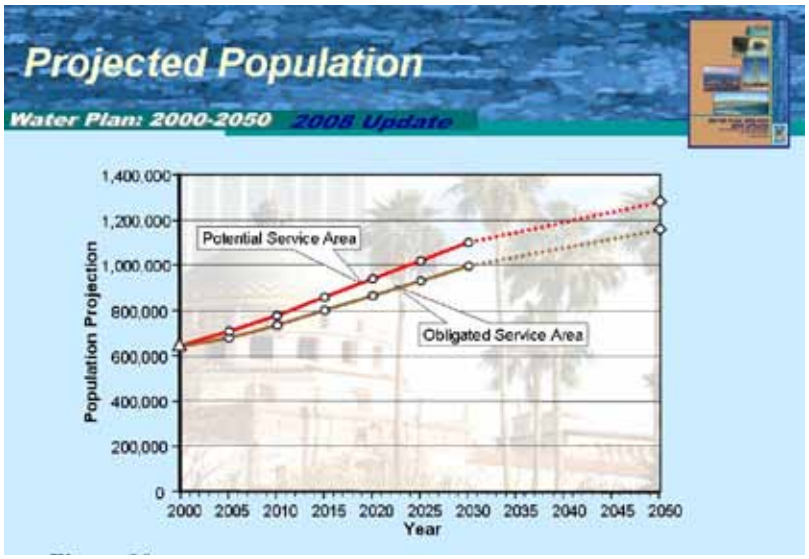

Figure 125-Projected Population

At approximately the same time, the Central Arizona Water Conservation District (CAWCD) Board developed a strategic plan that included the goal of acquiring additional water resources on the behalf of all water providers within its three-county service area. In effect, CAWCD proposed to perform the same functions as envisioned under the SAWUA proposal but on a much larger and far reaching scale. In addition, Pima County has proposed the establishment of a countywide water-and-wastewater authority which would include all public and private water and wastewater providers within the county.

As these alternative proposals have been discussed, local water providers have also continued to discuss potential cooperative projects related to water supply and management. The discussions have included concepts such as joint projects for delivering renewable water supplies to areas of need, common issues and concerns for coordinated lobbying at the State level, and consideration of water credit transfers to reduce costs to ratepayers and meet water management goals.

Figure 126-Demand Scenario Matrix

Population Projections
Revised projections were used to develop population estimates for Tucson Water's Obligated Area and its Potential Service Area; these projections are graphically shown on **Figure-125**. The Obligated Area population is estimated to increase from 638,936 in 2000 to approximately 990,000 in 2030 and to just over 1.1 million by 2050. The Potential Service Area population is estimated to be about 1.1 million in 2030 and almost 1.3 million in 2050.

Projecting Water Demand
Two significant issues have arisen since the development of Water Plan: 2000-2050 regarding the extent of the City's future water service area and the extent to which additional water demand-management (i.e., water conservation) measures are implemented. The 2008 Update addresses these emerging issues by presenting four future demand scenarios **(Figure 127)**.

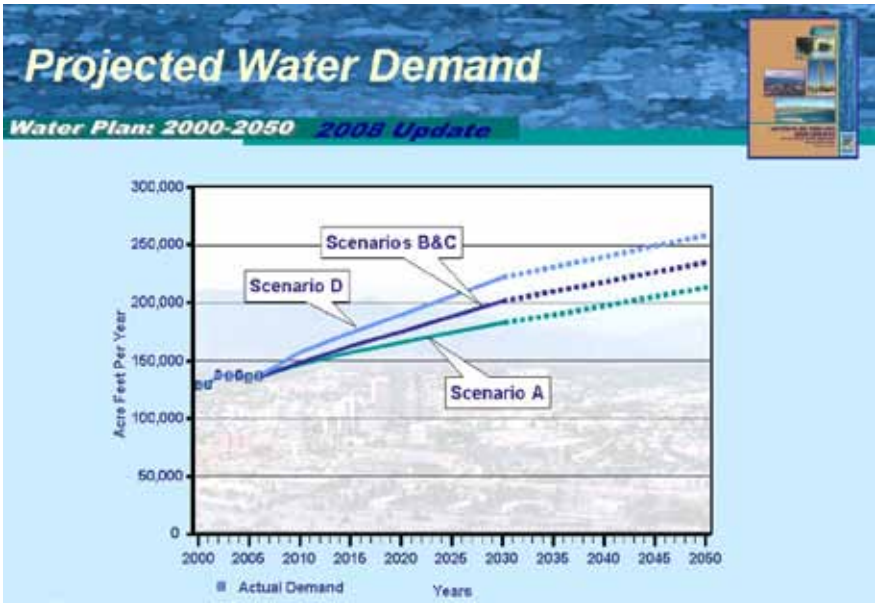

Figure 127-Projected Water Demand

First, the City of Tucson historically has provided water service throughout the area characterized in this Update as the Potential Service Area; the City's willingness to serve within this area typically has been limited only by the availability of infrastructure to serve proposed new development. On December 11, 2007, the City Manager announced a new interim policy under which the City will not agree to serve any new developments outside its Obligated Area until such time as the Mayor and Council adopt a comprehensive policy regarding the City's future water service area. This new policy, if adopted by Mayor and Council, could significantly change demand projections and the timing of resource utilization for the Tucson Water service area.

Second, the Community Conservation Task Force recommendations have been developed but the extent to which these recommendations will be implemented has not yet been determined. Additional water conservation measures over and above what was recommended by the Community Conservation Task Force have also been recommended. However, expanding existing programs and implementing new, more aggressive conservation measures will require additional investment and community support. In combination with a potential new policy on service area expansion, decisions regarding the future level of water conservation efforts will also impact future demand and resource utilization in the Tucson Water service area. As a result of these new developments, four water demand projections based on the combinations of two variables were developed for the Update. The two variables are service area size and level of demand management (see below). Demand management for the Update involves increased conservation measures and increased distribution system efficiencies that result in fewer system losses.

Variable #1: Service Area Size - Reduce (or increase) the size of the potential area that will be directly served by Tucson Water. In this analysis, the future service area size is projected to be either the Obligated Area or the Potential Projected Service Area.

Variable #2: Level of Demand Management - Invest (or not invest) in implementing additional, more aggressive water demand management measures to reduce potable Gallons Per Capita Per Day. In this analysis, additional demand-management is assumed to be a ten percent reduction in potable demand (i.e. potable GPCD) by 2030. This reduction is based on information generated by the Community Conservation Task Force and by the Utility's Water Loss Control Program. These two variables combine into four unique sets of assumptions each of which is represented in one of the demand scenarios. The results of a resource-demand analysis of the resultant four scenarios illustrate how changes in two planning variables could impact water resource utilization and the City's Assured Water Supply (AWS) designation in future years.

Scenarios A and C approximate futures which assume additional investment in more aggressive programs will occur. For comparative purposes, Scenarios B and D represent futures which assume there would not be additional investment in such demand-management measures. Projected water demand, as represented by each of the four scenarios, is highly sensitive to the size of the area to be served and whether the Utility invests in more aggressive demand-management measures. As seen in **Figure 127**, Scenario A has the smallest increase in projected water demand through 2050. This projection represents future water supply needs within the smaller Obligated Area and assumes that more aggressive demand-management strategies can be successfully implemented with the support of the community. Under this scenario, the Utility's total water demand is projected to increase from 128,141 AF in 2000 to approximately 180,000 AF in 2030 and to about 215,000 AF by 2050.

The demand scenario which approximates the largest projected increase in demand is represented by Scenario D. This worst-case demand projection represents the most conservative portrayal of the Utility's future water supply needs. It assumes that the larger Potential Service Area would be served solely by Tucson Water and that additional demand-management programs would not be implemented above and beyond those already in place. Under this scenario, the Utility's total water demand is projected to increase to approximately 220,000 AF per year by 2030 and about 255,000 AF by 2050. Scenarios B and C are indistinguishable in terms of projected water demand and represent a mid-range increase in water demand through 2050.

Balancing Projected Demand with Available Resources

Success in implementing the resource utilization plan and in addressing the critical water management choices to be made in 2008 and later will help determine how the Utility's water resources portfolio will be utilized in future years. These actions will determine to a considerable degree how quickly Tucson Water will use its available water supplies, when additional water supplies will need to be developed or acquired, and how demand may be managed in the future. For purposes of illustration, four demand-resource projections are presented which correspond to Scenarios A, B, C, and D. These demand-resource projections approximate potential resource utilization possibilities and demonstrate how future changes in the planning assumptions could impact resource planning decisions and the City's AWS designation. Scenarios A and D and discussed in detail in this summary as the two end point perspectives on the critical planning assumptions analyzed.

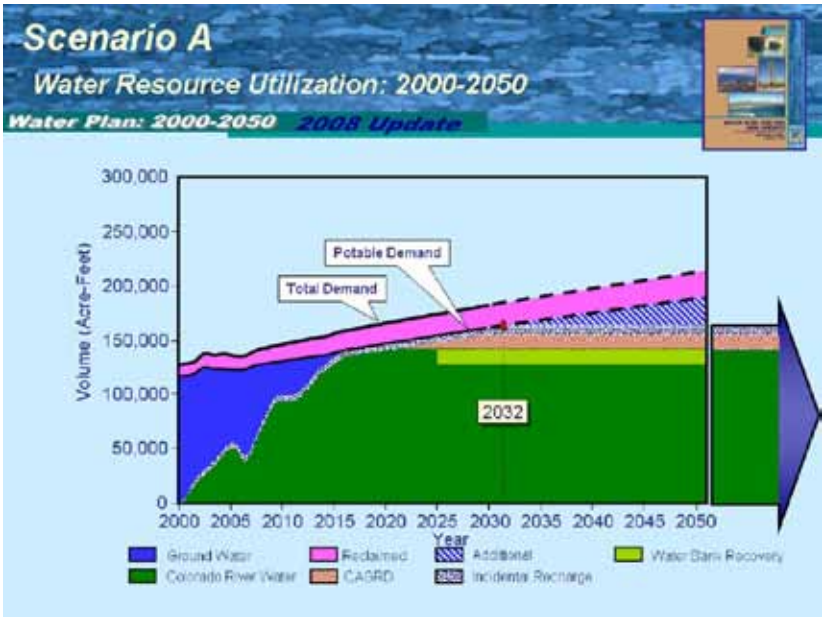

Figure 128-Scenario A

Scenario A – Increased Demand Management in the Obligated Area

In addition to decreasing future demand by limiting the Utility's service area expansion to the smaller Obligated Area, this scenario is predicated under the assumption that the Utility's potable Gallons Per Capita Per Day would gradually be reduced by ten percent by 2030. The latter would be achieved by implementing more aggressive demand-management measures beyond those already in place.

Figure 128 provides a view of how the Utility's resource utilization is projected to occur under Scenario A. The Utility's total water demand is projected to increase from 128,141 AF in 2000 to approximately 180,000 AF in 2030 and to about 215,000 AF by 2050. This projected increase in water demand over time is the smallest of the four scenarios. Under this scenario, projected potable demand would exceed the sum of the City's annual Central Arizona Project allocation, its Incidental Ground-Water Recharge increment, and its annual Central Arizona Ground Water Replenishment District contracted volume by about year 2032. However, Tucson Water would still have available the balance of its renewable effluent resources not committed to the Utility's reclaimed water system and its reserve of non-renewable ground-water credits.

The City could extend its AWS designation to about 2050 by depleting its reserve of ground-water credits; instead, Tucson

Water recommends these credits be preserved as long as possible to provide planning flexibility for the future. It is more prudent to use these credits as short-term transitional supplies while additional renewable supplies are being acquired and/or developed.

Tucson Water recommends that the resource planning priority be placed on developing additional renewable resources such as the City's effluent supplies, additional imported supplies or a combination of both. In this manner, new growth after 2032 would become more hydrologically sustainable and the City's AWS designation could be extended well beyond 2050. Of the four future scenarios analyzed, Scenario A delays the need to develop or acquire additional renewable supplies furthest into the future and maximizes planning flexibility to deal with future uncertainties.

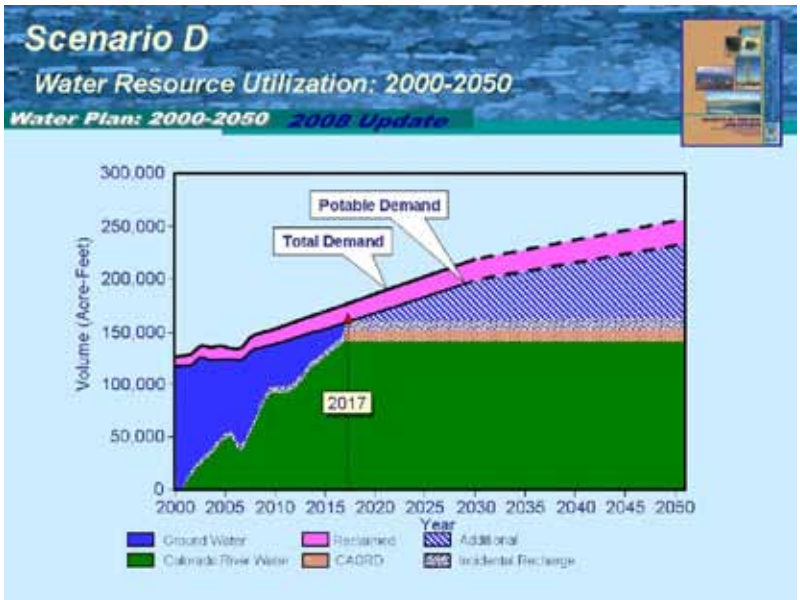

Figure 129-Scenario D

Scenario D – Without Additional Demand Management in the Potential Service Area, Scenario D is based on the conservative demand assumptions used in Water Plan: 2000-2050. The Utility's total water demand is projected to increase to approximately 220,000 AF per year by 2030 and about 255,000 AF by 2050. It differs from Scenario A by assuming that the entire Potential Service Area would be served by Tucson Water (an area twice as large as the Obligated Area) and no additional demand-management measures would be implemented within the 50-year planning horizon.

Projected potable demand would exceed the sum of the City's annual Central Arizona Project allocation, its Incidental Ground-Water Recharge increment, and its annual Central Arizona Ground Water Replenishment District contracted volume by about 2017. Tucson Water would still have available beyond 2017 the balance of its renewable effluent resources and its reserve of non-renewable ground-water credits.

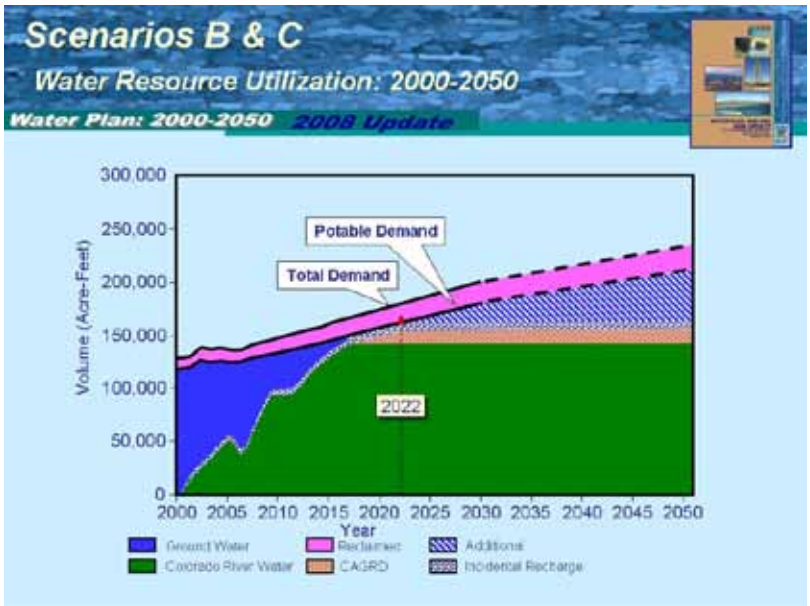

Figure 130-Scenario B & C

The City could extend its AWS designation to about 2025 by depleting its reserve of groundwater credits; as with Scenario A, Tucson Water recommends these credits be preserved as long as possible to provide planning flexibility for the future. Tucson Water recommends that the resource planning priority be placed on developing additional renewable resources such as the City's effluent supplies, additional imported supplies or a combination of both. In this manner, new growth after 2017 would become more hydrologically sustainable and the City's AWS designation could be extended further out in time. Of the four future scenarios analyzed, Scenario D is the least able to delay the need to develop or acquire additional renewable supplies and provides the least planning flexibility with which to deal with future uncertainties.

The demand-resource projections associated with Scenario B and Scenario C are equivalent and would fall in between those shown for Scenario A and Scenario D.

Conclusions of the 2050 Plan and 2008 Update

- Emphasize "Wet" Water Management Strategies: The community's sustainable future ultimately depends on maintaining a physical hydrologic link between renewable water sources and the infrastructure needed to convey those waters to customers within the projected service area.
- Utilize Renewable Ground Water: Tucson Water plans to limit its ground water withdrawals at or below this hydrologically sustainable level in order to ensure the long-term viability of the aquifer within the Utility's service area.
- Preserve City's Ground-Water Credits for Longer Term: The City could extend its AWS designation under any future scenario by depleting its reserve of non-renewable groundwater credits in the near or mid terms. Instead, Tucson Water recommends that these credits be preserved as long as possible to provide planning flexibility for the future. It is more prudent to use these credits as short-term transitional supplies while additional renewable supplies are being acquired and/or developed. This would ensure that the water resources needed to support new growth will be hydrologically sustainable.
- Reassess the Water-Quality Target for Colorado River Water: Customer preferences are being reassessed through the on-going Decision H20 program by linking costs and environmental sustainability issues with potential mineral level targets. The goal is to finalize this aesthetic water-quality management decision in 2009.
- Fully Utilize Colorado River Water: Between CAVSARP, SAVSARP, and the Pima Mine Road Recharge Project, the Utility will have sufficient recharge capacity in place to fully use its Central Arizona Project allocation as early as 2009.
- Fully Utilize Effluent for Future Supply: Tucson Water recommends that the resource management goal should be to maximize the future use of the City's effluent through additional treatment and recharge in order to augment the aquifer within Tucson Water's service area.
- Acquire Additional Water Supplies: The City of Tucson is exploring opportunities to acquire potentially available supplies to augment its water-resource portfolio. The availability of additional water resources will become increasingly competitive and costly both locally and statewide.
- Manage Water Demand: Tucson Water is taking a number of actions to further manage demand including expanded conservation programming, reducing lost and unaccounted for water, encouraging the practice of water harvesting, and providing public information programs. Additional demand management efforts have been evaluated and recommended by the Community Conservation Task Force to further reduce per capita potable water use.
- Adjust Development Fees to Shift the Cost of Growth to New Customers: Tucson Water has developed a financial plan that continues to shift the cost burden of growth to new customers as they are added to the system. The Utility recommends that in the future, development fees be adjusted to ensure that existing customers do not bear the cost of growth.
- Continue to Expand Regional Cooperation: Tucson Water has taken steps to initiate new cooperative efforts and expand existing ones with local providers. These cooperative actions focus on acquiring additional sources of water supply, developing resource credit banking agreements, and exploring potential win-win arrangements to wheel renewable resources within the region.

3.1.3 Environmental Needs for Water

The Committee recognizes environmental needs for water in addition to municipal needs. Historically, water necessary to meet environmental needs was not recognized and instead, diverted for human use. This model has resulted in the destruction of river systems and riparian habitat throughout the southwest. In models focusing on sustainability, environmental water needs are recognized, valued, and allocated by the community to ensure that riparian and groundwater-dependent ecosystems remain healthy.

River and Riparian Systems

River and riparian systems provide a number of ecological and economic functions to communities such as the provision of drinking water, water to irrigate our agricultural crops, purification of wetlands and drinking water and groundwater recharge. Riparian systems also sequester carbon, provide oxygen, filter the air and provide recreational opportunities. Although riparian areas are very small acreage-wise, they harbor a disproportionate share of the State's wildlife. Riparian vegetation conditions respond to changing surface and groundwater levels, over both short time frames and longer time frames. It doesn't take much groundwater pumping before water tables are lowered and affect the river flows.

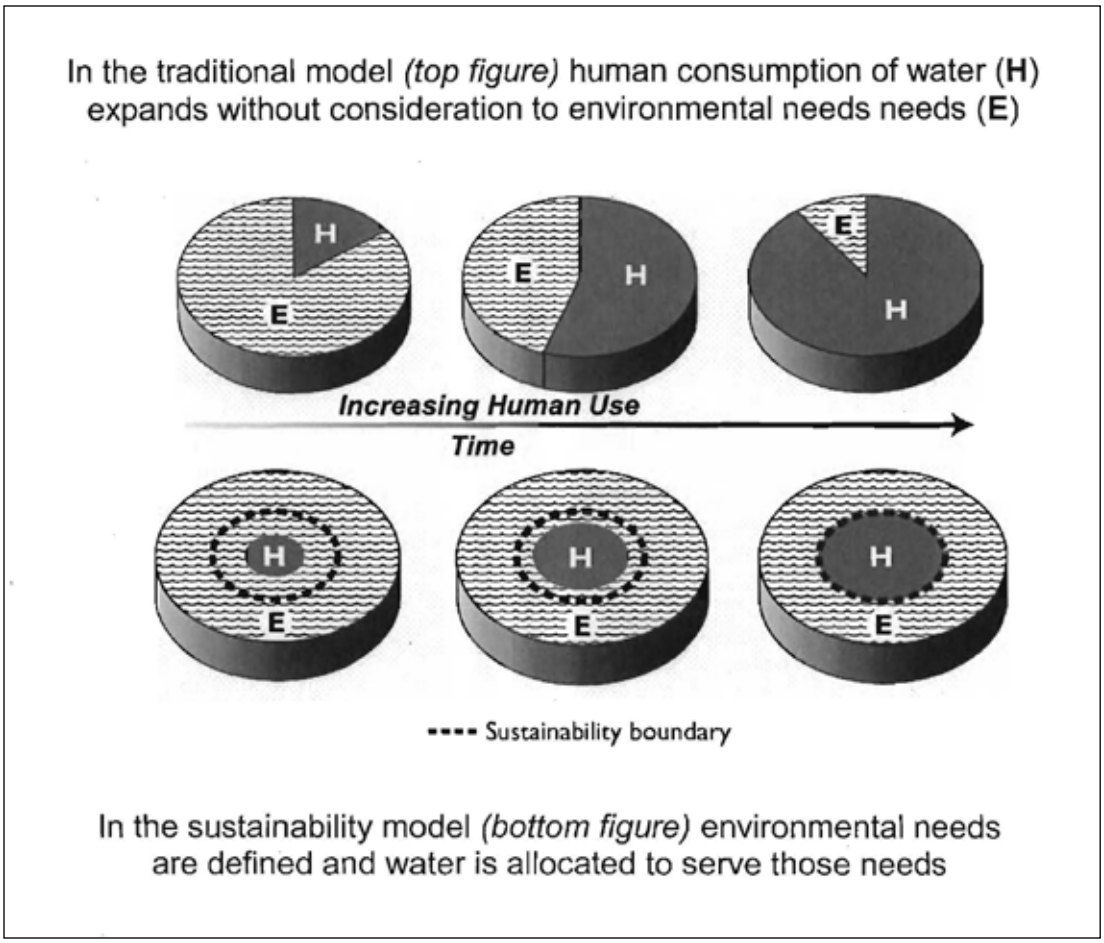

Figure 131-Water Managment Models

This is the challenge of moving forward with growth in areas that rely primarily on groundwater supplies.

The Department of Economic Security growth projections show that Arizona is slated to double its population by 2050 to over 12 million people. This raises the question of what water will supply that future growth. The U.S. Geological Survey has mapped 17 groundwater basins that still give rise to rivers. The groundwater in these basins discharge to form the State's remaining perennial streams or an estimated 1,000 miles of groundwater-dependent rivers.

Thirty six percent of perennial flow in Arizona has been lost over time due to diversions, dams, and groundwater pumping. Maps of the growth footprint at 2050 viewed in conjunction with these groundwater basins reveals that a lot of the growth projected to occur in the Maricopa/Pinal County area will not draw from groundwater dependent river basins. However, a lot of growth in the Prescott/Kingman, in eastern Tucson and in the lower San Pedro Basin will potentially be in conflict with the river and riparian resources that currently exist.

The San Pedro River, Sonoita Creek and Cienega Creek are key areas in Arizona where perennial flow still exists. Colorado River water supplies are not available in the San Pedro River and in eastern Pima County areas.

In those 17 groundwater basins statewide, there are already 73 imperiled species that inhabit those areas. The potential loss of biodiversity has economic implications as well in terms of recreational opportunities and the potential to lose nature-based tourism. Another potential impact is for litigation from surface water right-holders affected by groundwater pumping. Litigation leads to higher project costs and societal conflicts between groundwater and surface water users. This scenario is already happening in between Prescott and Phoenix over the water supplies in the Upper Verde.

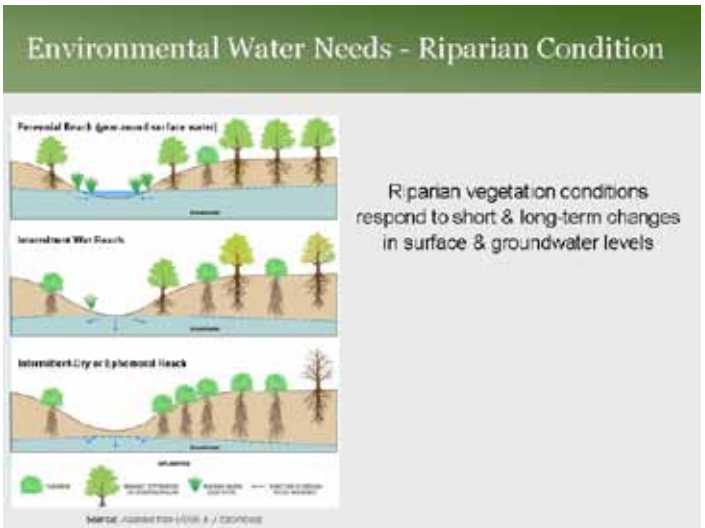

Figure 132-Riparian Condition

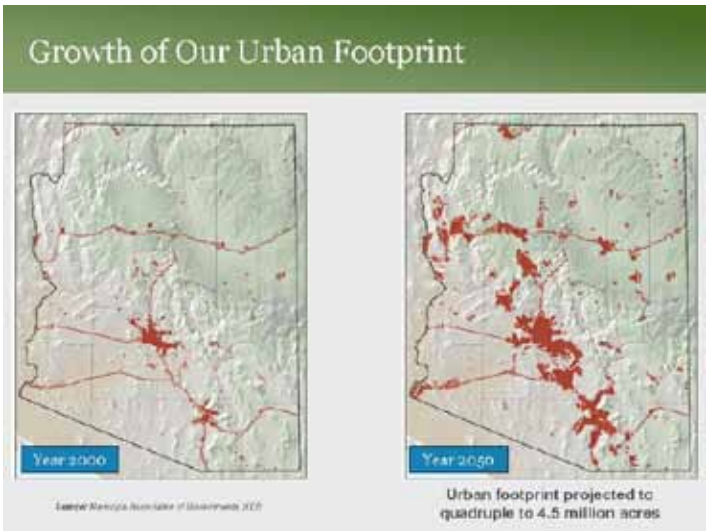

Figure 133-Urban Footprint

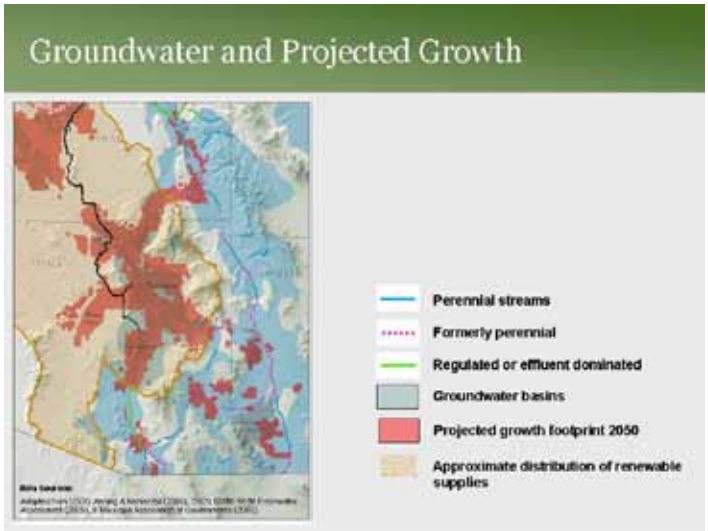

Figure 134-Projected Growth

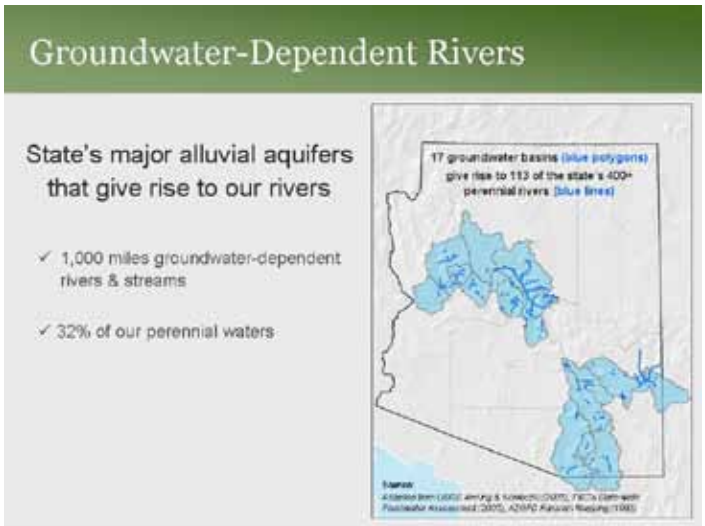

Figure 135-Groundwater Dependent Rivers

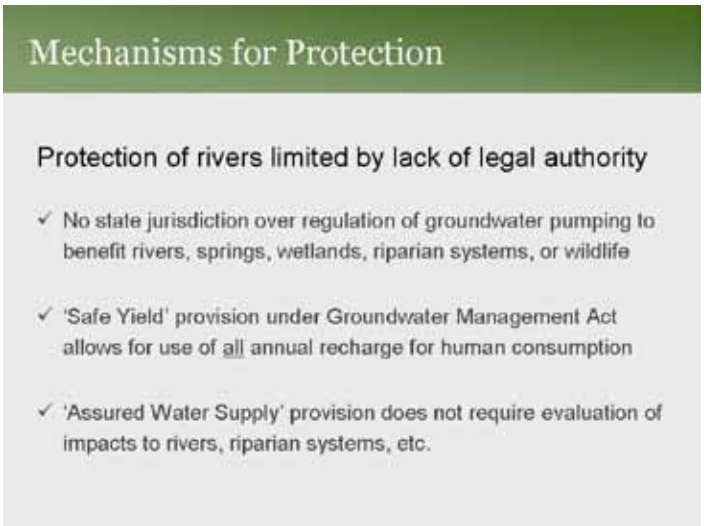

Figure 136-Mechanisms for Protection

No.	Restoration Project	Source of Water	Actual Demand in 2007 (afa)	Estimated Future Demand (afa)
1	Avra Riparian Restoration and Groundwater Replenishment**	Effluent	2.1	225
2	Swan Wetlands	Reclaimed	15.0	340
3	Kino Environmental Restoration Project (KERP)	Reclaimed	159.3	180
4	Marana High Plains Environmental Restoration and Groundwater Replenishment	Effluent	4.9	4.9
5	Marana Cottonwoods**	Effluent	25.3	80
6	Santa Cruz River- Ina to Trico***	Effluent	139.1	139.1
7	Pantano Jungle Revegetation	Storm water and groundwater	-	-
8	Cortaro Mesquite Bosque*	CMID groundwater	-	-
9	Cienega Creek Stream Flow Restoration	Surface water and groundwater	-	-
10	Bingham Cienega	Surface water and groundwater	-	-
11	Oxbow at Santa Cruz River	Effluent and surface water	-	-

Table 6- Pima County Existing Restoration Projects

afa: acre feet annually
*The 120 afa identified as estimated future water is for vegetative establishment (3-5 years). It is anticipated that once the plans are established they will be gradually taken off irrigation.
** Effluent for these projects are not part of the Metropolitan system (i.e. Ina, Roger and Randolph Facilities).
***This is only one segment for which evapotranspiration numbers are calculated. The actual flow begins at Roger Road and extends beyond the AMA boundary. The effluent being discharged into the channel is incidentally supporting a riparian habitat. If this effluent were no longer to be discharged, this habitat would not be sustained.

No.	***Restoration Project***	***Potential Source of Water***	***Estimated Future Demand (afa)***
1	Santa Cruz In-channel, Prince to Sanders	Conservation Effluent Pool	4,600
2	Santa Cruz, Confluence & Dybig Property	Conservation Effluent Pool	400
3	Santa Cruz, Ajo to Silverlake	Conservation Effluent Pool	600
4	Cortaro Mesquite Bosque	Effluent	100
5	Canoa Ranch*	Effluent	225

Table 7-Future Restoration Projects

* The 225 afa identified is not part of the Metropolitan system.

Mechanisms for Protection
State law does not fully address the protection of river and riparian systems. The prior appropriation laws were set up for beneficial use. Beneficial use is agriculture and mining, domestic consumption, etc. Provisions, such as in-stream flow, are not enough in light of current and projected population growth patterns. Safe Yield and the Assured Water Supply provisions of the Groundwater Management Code are mechanisms for managing human water supplies, not for managing water for the environment. There is no requirement for an evaluation of impacts to rivers, streams, riparian systems, etc.

Given the data showing that a fair amount of our population growth is projected to occur in areas that do not have renewable water supplies, the challenge is to determine how to manage growth so that resource use and the current quality of life in the region are sustainable.

The Sonoran Desert Conservation Plan (SDCP) was adopted following a large public process that included 600 public meetings to define goals for protecting the cultural and natural heritage in Pima County. The process also involved 150 contributing scientists and produced 200 specific studies. As such, the Sonoran Desert Conservation Plan (SDCP) reflects a lengthy public debate and is informed by significant contributions from the scientific community about where we should go and how we should get there from an ecosystem perspective.

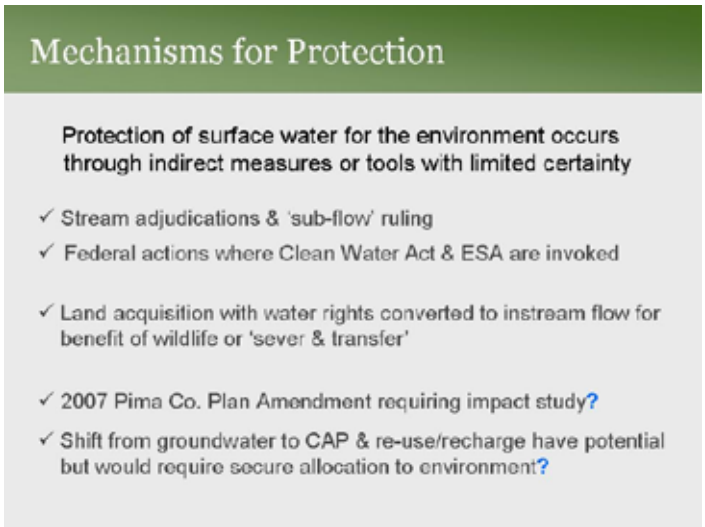

Figure 137- Mechanisms for Protection

The SDCP has implications for the City/County Water and Wastewater Study, including: (1) The importance of floodplain functions and the need to pursue a more integrated management approach among various floodplain management programs and agencies, land use planning agencies and across jurisdictions; (2) A great deal of inventory work was completed helping expand understanding of where some of the remaining stream ecosystems are that can be affected by groundwater pumping, hydro-geology, and the distribution of species and water supplies in eastern Pima County. The inventory shows, for example, that in Avra Valley there is an absence of groundwater-dependent ecosystems whereas the Tucson Basin is different. Historically, there was groundwater discharge along the Santa Cruz River, downtown Tucson, San Xavier del Bac, along the Pantano Wash, and the Rillito Creek. There is no longer groundwater discharge in these areas.

Figure 138-SDCP Riparian Goals

But there are still quite a few other areas in eastern Pima County where groundwater pumping can make a difference in terms of riparian ecosystems, such as the northeast Tucson Basin. In 1989, the Tucson Mayor and Council passed a Resolution restricting the increase of groundwater pumping in this area to protect the riparian ecosystem. Simultaneously, they directed Staff to develop a conservation program for the Tucson Water Service Area, private water companies and private users in the area. In 1990 and around 2000, a review of the water table and the condition of the riparian areas resulted in recommendations for additional measures to reduce groundwater pumping and to import reclaimed water to the area. Tucson Water has since built a reclaimed water line to the 49ers Golf Course which has reduced the stress to the aquifer in that uppermost part of the Tanque Verde Valley.

However, the area farther downstream along lower Sabino Creek is in stress. The water table is still very low although the ability to reduce the stress is limited. There are two water providers serving the area: Metro (Hub) Water Company and Tucson Water. Metro (Hub) is reliant on groundwater to serve its customers in the area. Alternative, renewable water resources are available to Tucson Water (i.e. CAP water), however, Tucson Water is currently doing some groundwater pumping in the area to meet peak summer localized demand and maintain these wells as a back up source of supply. However Tucson Water primarily uses CAP water to serve the area. Options for reducing the problem include reducing potable water consumption, inter-ties between Metro Hub and Tucson Water to use CAP water, and well-head casings that limit the entry of shallow groundwater in older wells.

Cienega Creek is another example of an ecological treasure with a number of rare and endangered species. The Cienega also recharges the Tucson Basin. A major concern with the Cienega is that surface flows are diverted for use on the Del Lago Golf Course, pursuant to a historic surface water right. Because it is considered a renewable supply, this consumption

is not subject to all of the restrictions that would apply if groundwater were used. Consistant with previously developed plans to build a reclaimed line to serve the Vail community and golf course, the County recently identified a potential funding source for a pipeline to serve this area. Other options exist and need to be explored as well.

The Santa Cruz River is another area where there are significant issues associated with maintaining flows and associated ecosystem benefits. The flows in the Santa Cruz River downstream of Roger and Ina Road Wastewater Facilities come solely from effluent discharge, except when it's mixed briefly with storm water, making it the County's largest, longest perennial stream with the second largest cottonwood-willow forest, second only to Cienega Creek. As such, it is another important riparian ecosystem in Pima County and also one of the areas that's richest in bird life and particularly, migratory water fowl. Notably, the Santa Cruz is also drought-proof in comparison to other streams and springs in Pima County which dry up during times of drought.

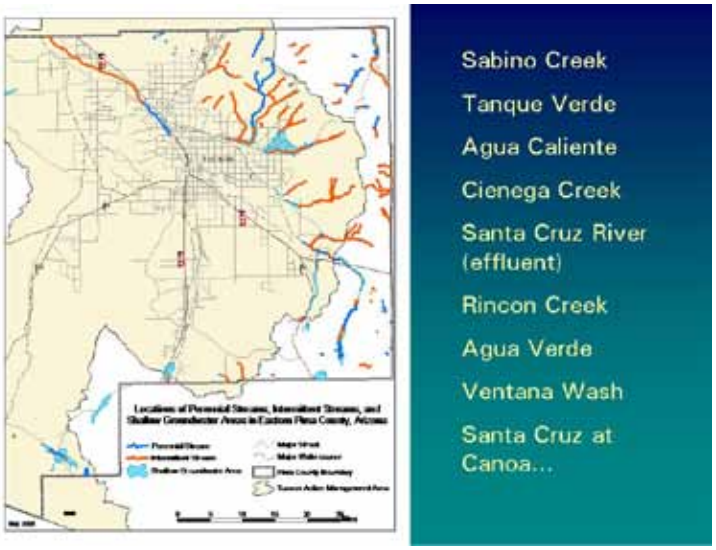

Figure 139-Streams & Shallow Groundwater

Although the effluent dependent portion of the Santa Cruz River supports a relatively healthy riparian ecosystem, the aquatic ecosystem is quite poor. However, the scheduled upgrades to the Roger and Ina Wastewater facilities will improve the quality of effluent and will have very important riparian and aquatic ecosystem benefits because it will improve the aquatic conditions that support the base of the food chain.
A key issue with the Santa Cruz River is that despite the upcoming water quality improvements, there is no effluent

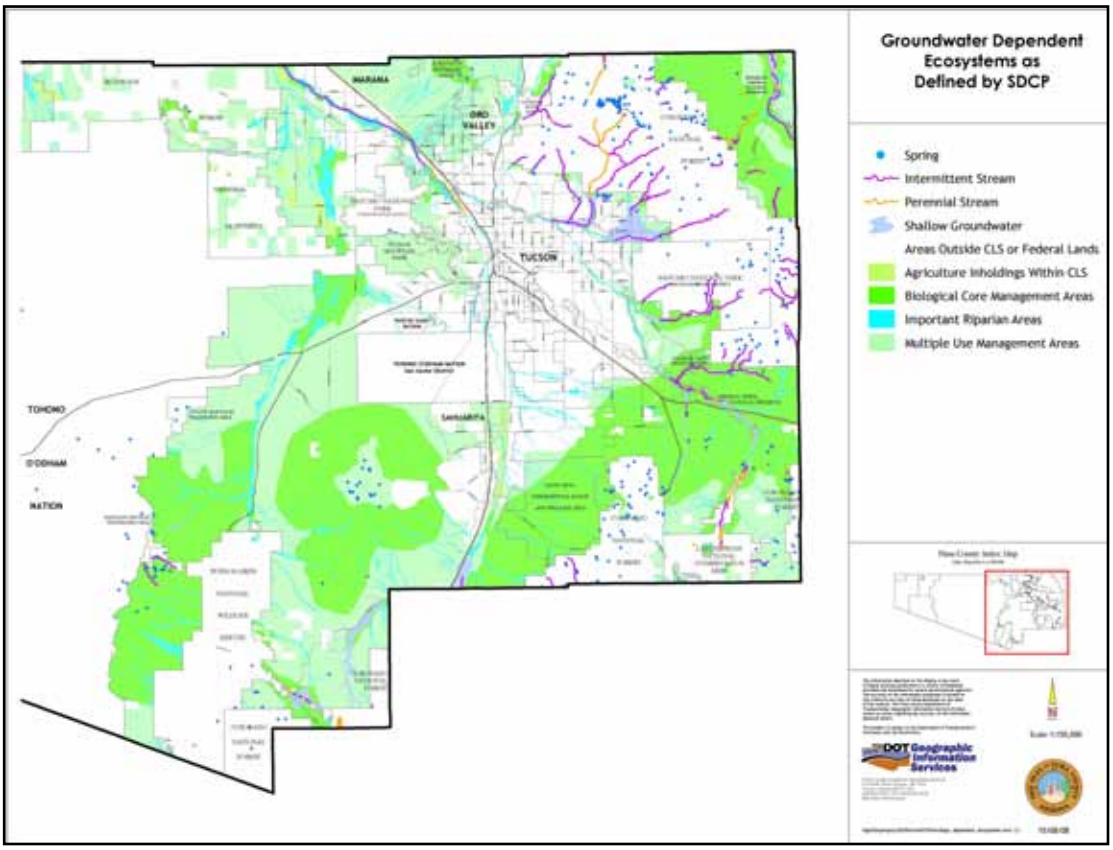

Figure 140-Groundwater Dependent Ecosystems

allocated to the river. It is currently being discharged and acquiring credits. The "Conservation Effluent Pool" (CEP) is an agreement between the City and the County that is dedicated to environmental uses. Currently, the CEP has not been officially drawn upon for designated environmental projects. Negotiations are underway between the City and County to establish a decision-making process for developing projects and committing this water for its intended purpose of restoring riparian habitat. The decision making process will be defined in a new IGA.

The Science Team that helped develop the ecological component of The Sonoran Desert Conservation Plan recommended that effluent being discharged into the Santa Cruz be maintained at current levels. It is important to note that this would have implications on the region's water supply portfolio and there are opportunity costs for using the effluent in this way. It is also important to consider that although efforts to re-vegetate riparian areas are beneficial, off-channel drip-irrigated, riparian vegetation and created ponds do not provide ecosystem function that having a flowing stream provides – these approaches are not equivalent. The focus therefore needs to be on some of these stream flow issues.

In conclusion, mechanisms to relieve stress on aquifers and protect important, sensitive ecosystems include land acquisition and the allocation of effluent, groundwater and surface water to maintain ecosystem functions. Additionally, water conservation in targeted areas could positively impact groundwater-dependent ecosystems (GDEs) as could expansion of the reclaimed water infrastructure, and potable water interconnections.

Figure 141-Santa Cruz River Today

Figure 142-Santa Cruz River Future

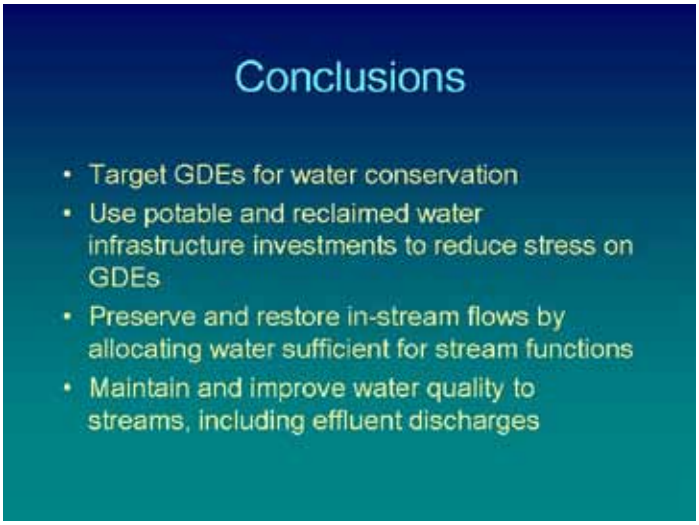

Figure 143-Conclusions

3.2 Three Variables Involved in Projecting a Sustainable Water Future

3.2.1 Population Growth and Urban Form

Population trends and projections are critical variables for assessing how long our current water resources will last. The Committee acknowledges that different levels of uncertainty are inherent in population estimating and projecting and that estimates and projections are only as good as the soundness of the methodology and assumptions used by those who make estimates and projections.

For the Committee, population projections (how many people will be here in the future) is a more critical issue than populations estimates (how many people are here now) and members have different levels of confidence in available projections.

Population Estimates
Estimating current population in Arizona is done by the Department of Commerce, which the Governor empowered to produce population estimates annually for the state, its 15 counties, and 99 incorporated entities. The Department of Commerce uses two methods to estimate current population: the Housing Unit Method and the Composite Method. The Housing Unit Method starts with the last census and adjusts the numbers using building permit data. These estimates are considered reliable. The Composite Method breaks the population into age groups and uses various administrative records including birth and death records, school registration, driver licenses, etc. to track population.

Once these estimates are established, all state agencies must use these numbers. They are used to establish expenditure limits for cities and counties and state revenue sharing proportions. At the state level, they are used for capital planning including for things like water and roads.

Population Projections
Projecting population, on the other hand is about making assumptions and looking at the outcomes of those assumptions. There are two projections available, from the Department of Commerce and the University of Arizona. At the state level, the Department of Commerce makes population projections based on the Cohort Survival method, reviewing demographic trends, such as gender, age, birth and death rates. The trend in this country and for other maturing countries is that over time, the population gets older and fewer babies are born. Department of Commerce projections for Arizona however take this trend too far and fail to account for Hispanic migration. Their death rate is likely too high and birth rate too low, which explains why their population projections for later years are low compared with the projections done by the University.

The University of Arizona also makes population projections, using an econometric model that factors in economic trend data to project population.

There are no statutes requiring that either the state or University of Arizona projections be used for local population projections and planning purposes. PAG and local jurisdictions commonly rely on the University of Arizona projections rather than the official Department of Commerce state numbers.

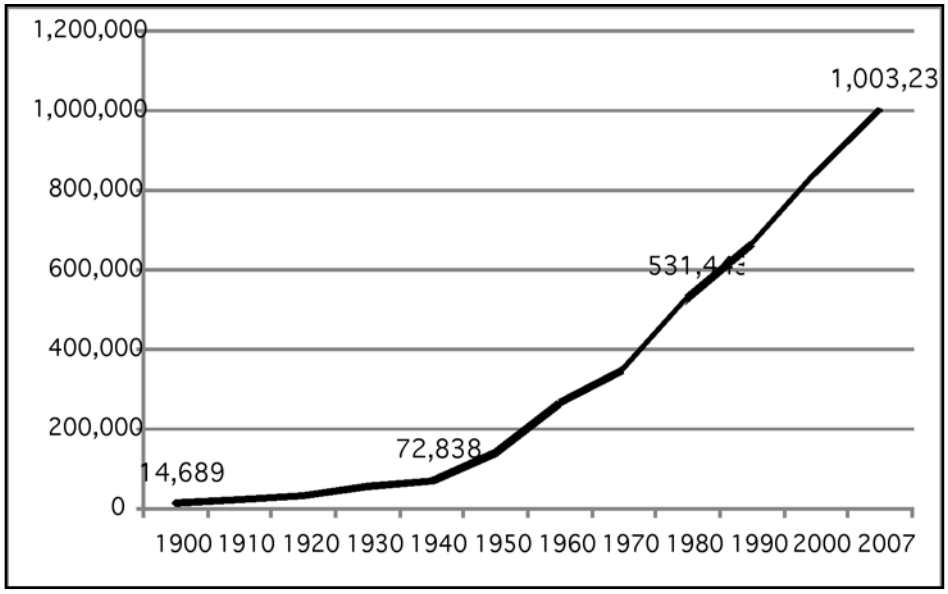

Figure 144-Pima County Population: 1900-2007

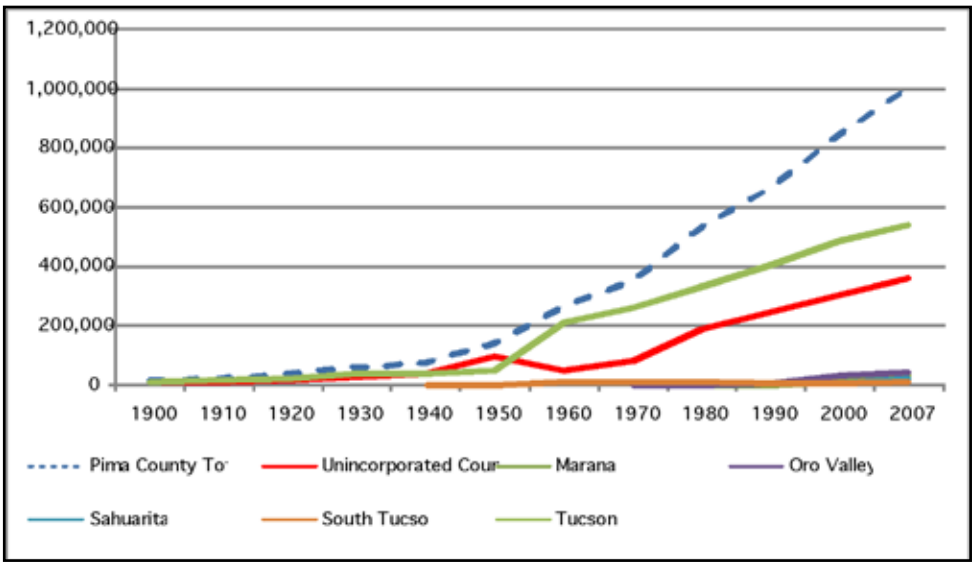

Figure 145-Population Growth by Jurisdiction: 1900-2007

POPULATION GROWTH: 1900 TO PRESENT

Pima County's population growth began in earnest in the Post WW II era **(Figure 144)**.Between 1900 and 1940, Pima County grew from 14,689 people to 72,838, an increase of 58,149 (almost 400%). Forty years later, in 1980 Pima County had a population of 531,443, an increase of 458,605, 8 times larger than the increase between 1900 and 1940. In the 27 years between 1980 and 2007, Pima County grew by another 471,792, again an increase 8 times greater than the 1900 to 1940 increase.

- Between 1900 and 1940, approximately 60 percent of the county population lived within the incorporated boundaries of the City of Tucson. By the end of the 1940s, at the start of the area's dynamic population growth, approximately 2/3 of the county population lived in the unincorporated county.
- During the 1950s, Tucson accomplished large scale annexations, with the result that, in 1960, 80.1 percent of the county population lived within the Tucson corporate boundaries. The Unincorporated County population stood at 17.2 percent, and the Other Incorporated Jurisdictions (South Tucson) was 2.6%.
- By 2007, Tucson's share of total county population declined to 53.9 percent, while the Unincorporated County share rose to 35.9 percent and the Other Incorporated Jurisdictions share to 10.1 percent.

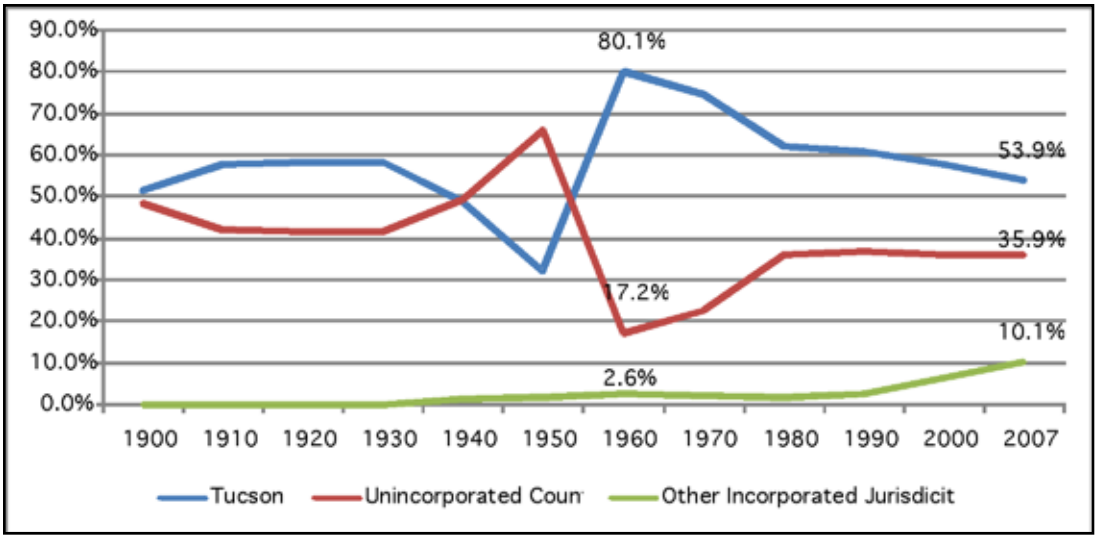

Figure 146-Percent of Pima County Population by Jurisdiction, 1900 to 2007

Figures 146 and 147 chart the pace of population growth in Pima County from two perspectives – absolute numbers of net new population and the average percent annual net increase in population.

Figure 147 shows a trend line of steadily larger annual net increases in population in the decades from 1900 to 2007. There were dips in the average annual net increase in the 1960s and 1980s, but in every other decade the net actual increase was higher than the previous decade. In the first seven years of the 2000s, the net annual increase was almost 22,400.

Figures 148 and 149, however, show a different dynamic, based on a measure of the percent annual net increase in population. As **Figure 148** shows, on an annual basis, between 1940 and 2007, net population increase, as a percent of total population, has trended steadily downward. Annual population increase, as a percent, was the highest in the immediate post-war years, at 12.2 percent in 1947 and 13.6 percent in 1948. By 2007, net annual population increase had declined to 2.4 percent.

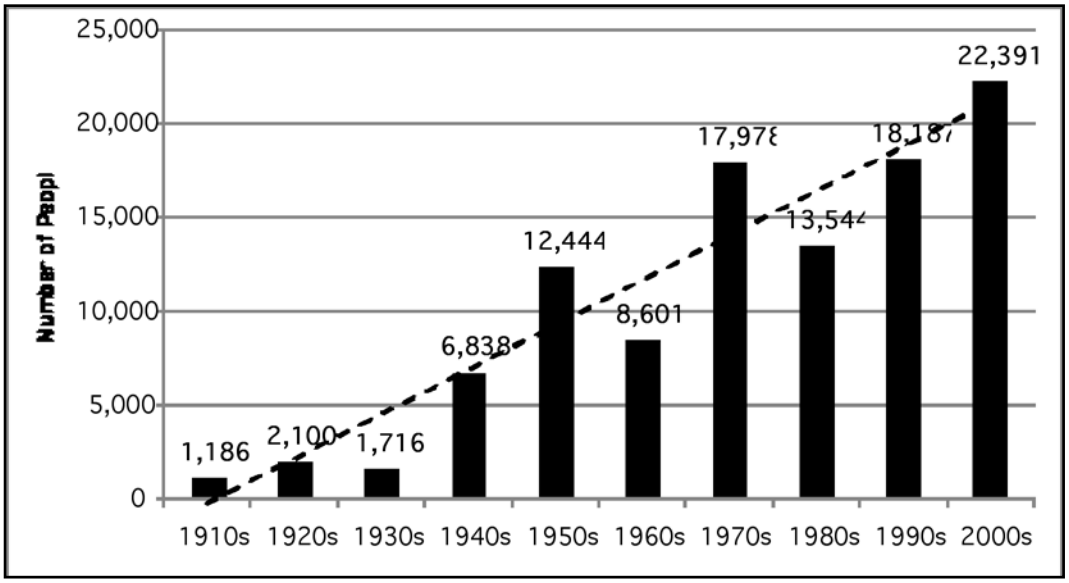

Figure 147- Annual Increase in Population, 1910 to 2007

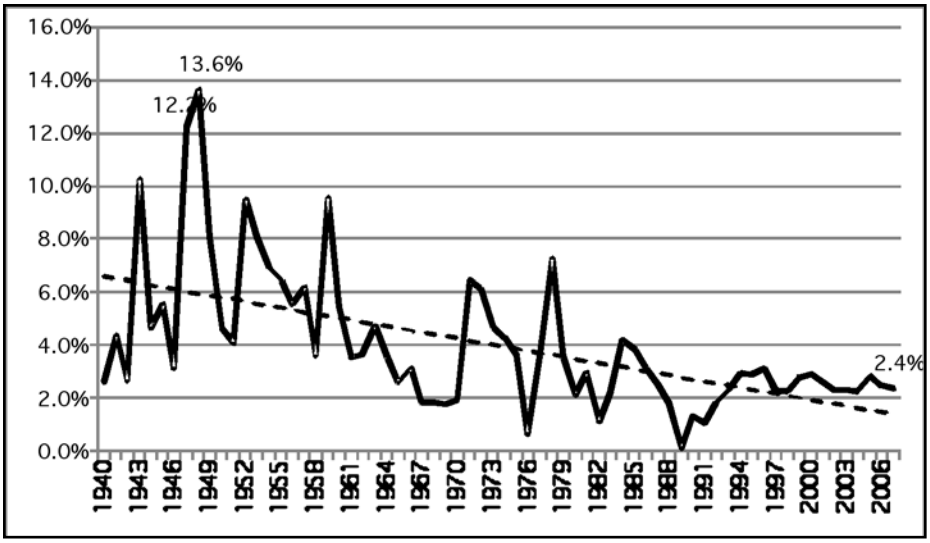

Figure 148-Percent Population Increase by Decade, 1940 to 2007

Figure 149 shows the same decline in the proportional net increase of population, by decade. In the 1940s, the net population increase was 93.9 percent, followed by 88.1 percent in the 1950s.Except for a spike in the 1970s, decadal net population increase declined from 32.4 percent in the 1960s to 18.9 percent in the first seven years of the 2000s.

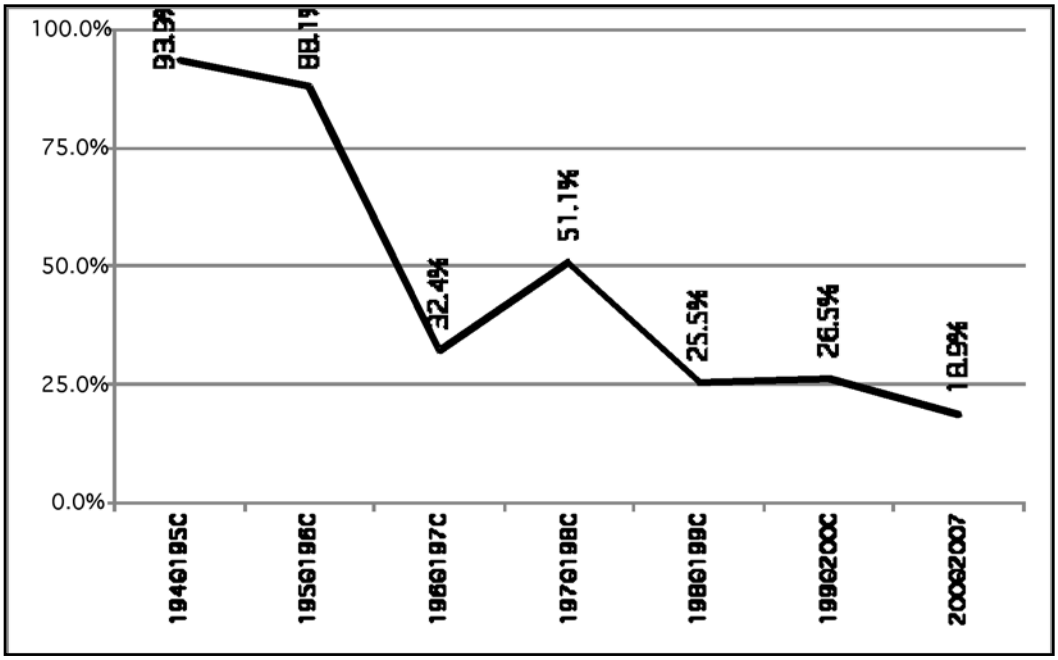

Figure 149-Percent Population change

COMPONENTS OF GROWTH

The components of population change include in-migration, out-migration, births, and deaths. For example, from 2005-2006, Pima County's population grew by 23,645 people **(Figure 150)**. Almost 68,000 people came here in that year, while just over 50,000 moved away, for a net increase of 17,601 people. In addition, there were almost 14,000 births matched by almost 8,000 deaths, for a net increase of 6,044. Combining net in-migration with net natural increase results in a total net population increase of 23,646.

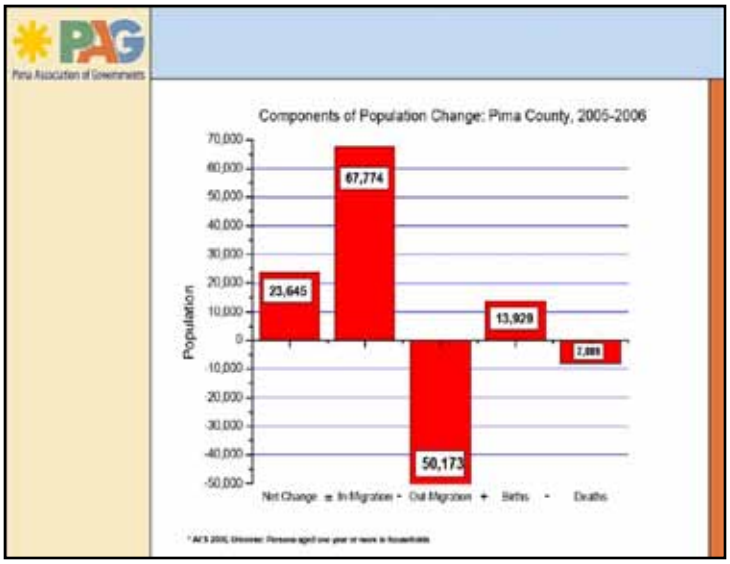

Figure 150-Components of Population Change, Pima County, 2005 - 2006

In 2005 to 2006, net in-migration (17,601) accounted for three-quarters of the net increase of 23,645. **Figure 151** shows a similar pattern of net in-migration as the preponderant component of net population growth in Pima County.

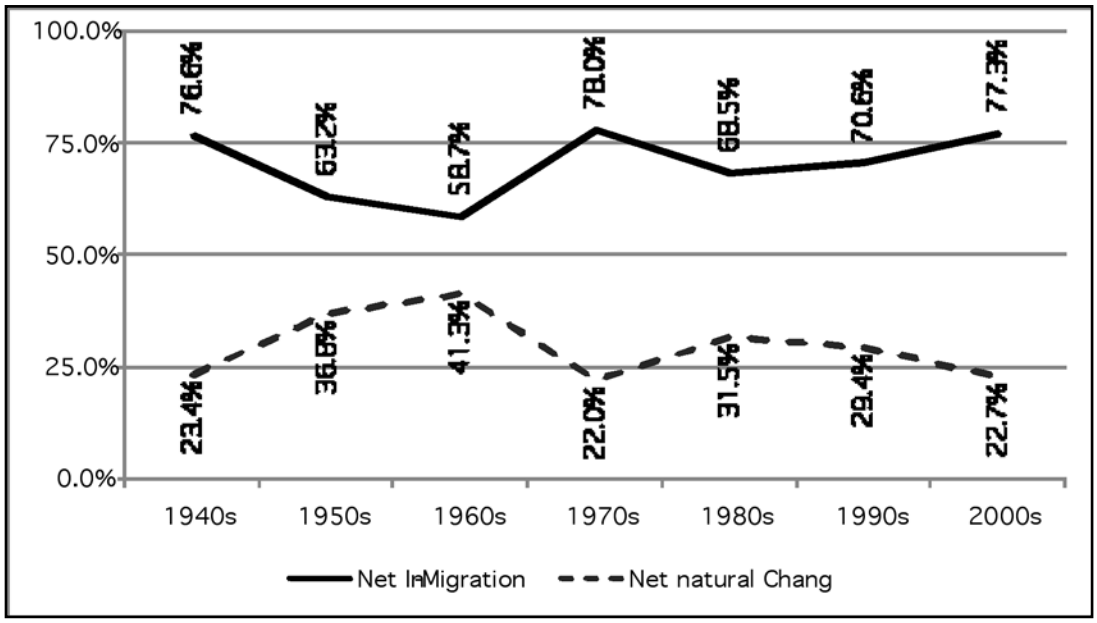

Figure 151-Components of Pima County Growth by Decade, 1940 to 2007

The impact of net in-migration on Pima County can be seen from the 2005 to 2007 American Community Survey data. Approximately one-third of Arizona residents in 2005 to 2007 were born in Arizona, while slightly higher percentages of the Pima County (37.4%) and Tucson (40.1%) residents were born in the state.

Almost one-half of statewide residents were born in another state (48.4%), while 16.1% were born outside of the United States. Locally, 46.6% of Pima County residents were born in another state, while a lower percent of Tucson residents (41.6%) were born in another state. On the other hand, a higher percentage of Tucson residents (18.3%) were born outside of the United States than was true of Pima County residents as a whole (15%).

	Arizona	Pima County	Tucson
Born in Arizona	35.4%	37.4%	40.1%
Born In Another State	48.4%	46.6%	41.6%
Born Outside the U.S.	16.1%	15.0%	18.3%

Figure 152-Place of Birth for Arizona, Pima County, and Tucson Residents, 2005 - 2007

Pima County's growth is a product of larger national and regional patterns, which saw, especially in the post-WWII era, a tremendous redistribution of economic activity and population to the South and West. According to the U.S. Census, "The population of the West grew faster than the population in each of the other three regions of the Country in every decade of the 20th Century." Furthermore, according to the Census, "From 1900 to 2000, Florida's ranking in population size increased more than any other state, from 33rd to 4th, **followed by Arizona's, from 48th to 20th."** Recent data shows Arizona as the second fastest growing state (after Utah) as measured by percent growth rate.

According to the Census, "most social scientists agree there are a combination of economic and non-economic reasons for moving," but that "Generally, the distance of the move is related to whether the move is motivated by employment or housing reasons. Interregional moves are more likely to be job-related, while intraurban moves are more likely to be housing related." It would seem likely that job opportunities associated with an expanding economy drew many of in-migrant population to the state and the county.

Retirees have been another major source of in-migration, which can also be seen as an economic decision: maximizing retirement income to achieve a desired standard of living.

PROJECTING POPULATION GROWTH

Figure 153 presents three population projections for Pima County: in 2007 from the Tucson Planning Department and the University of Arizona and in 2006 from the State Department of Economic Security. The University of Arizona projections go through 2035, while the Tucson Planning projections continue through 2050.

All three projections track each other closely through approximately 2015. After that year, the Tucson Planning and University of Arizona follow a similar trajectory, while the Department of Economic Security projection line diverges after that year, producing consistently lower estimates.

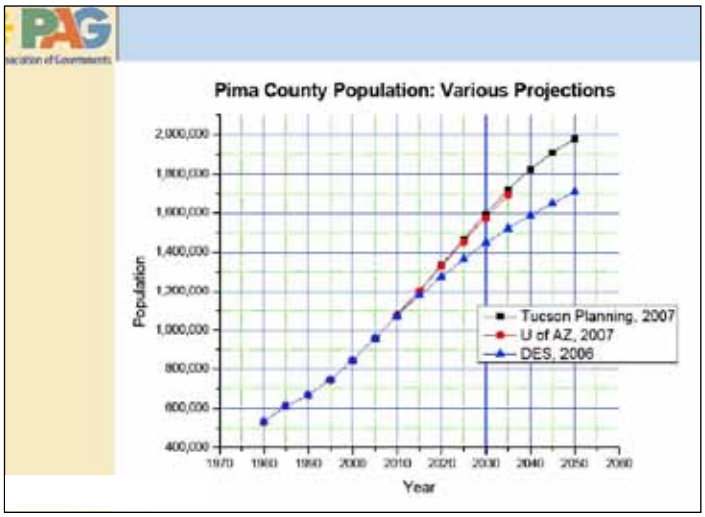

Figure 153-Pima County Population Projections

In 2030, the Tucson Planning/University of Arizona projections are for approximately 1.7 million compared to a Department of Economic Security projection of approximately 1.4 million. In 2040, the respective projections are approximately 1.8 million versus 1.6 million and in 2050, the comparative projections are almost 2 million versus 1.7 million.

Regarding the Department of Economic Security projections, the Pima Association of Governments web page carries the following statement:

> "The Arizona Department of Economic Security has published its official population projections for the State and all counties: 2006 – 2055.
>
> The links at right show the most widely used tables of these projections. Members of Pima Association of Governments (as well as those in the Phoenix Metro area) do not support the adoption and use of these projections.
>
> It is our belief that these projections are unacceptably low, especially in the later periods. We believe that the population growth portrayed here does not reflect the more youthful forces of migration from foreign sources and makes Pima County appear too "old," with too few births and too many deaths."

Regardless of the differences in two "official" population projections, however, it is clear the "official" forecast is for continued, and substantial, population increases in Pima County. As is noted below, not all Committee members believe these "official" projections as "facts." Most Committee members acknowledge that any population projections, including these for Pima County, are inherently uncertain, especially the further out into the future they go. Some members accept the Tucson Planning/University of Arizona projections as a starting point, assuming that there will be continued, substantial, growth. Other members would cast doubt on the projections, maintaining either that the projected levels of population are either not attainable and will not occur or that they are unsustainable and should not be allowed to occur.

Despite these differences, an informal poll of members at a Committee meeting revealed substantial, if not unanimous, agreement with the statement that there are inherent limits to how large Pima County will grow. For example, Dave Taylor from PAG noted that we absorb approximately 5,300 acres of vacant land per year. Based on this trend, assuming horizontal development at current densities, there is enough private and state land (subtracting out environmentally sensitive lands identified in the County's Sonoran Desert Protection Plan), to accommodate an upper limit of 2.2 million and that limit would be reached by the year 2061.

There is a theory in demography that human settlements tend to follow an S-curve in development: a period of rapid population growth followed by a period when the growth curve flattens out with the population achieving a relative stable or steady state. The Committee did not predict exactly when population growth might level out or what would be the drivers of that leveling out, but the Committee does believe it will happen in Pima County.

Mr. Dave Taylor told the Committee that rapid growth followed by a leveling off was "typical" of cities, presenting anecdotal evidence of the trend in the United States **(Figure 154)**.

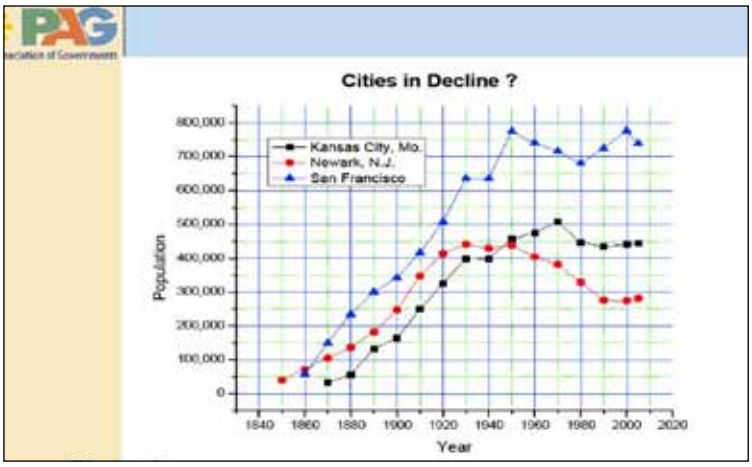

Figure 154-The S-Curve of Population growth in Three American Cities

Mr. Taylor noted that "maxing out" of population is related to the care and capacity of the place – characteristics like charm, culture, livability, affordability, schools and the availability of good jobs as well as available land and other resources to serve new population. In the western United States, rapid population growth is a relatively new phenomenon and it could be forty years or more before growth curves start leveling off.

Pima County is not an isolated entity, an island unto itself. The county is part of larger economic reality commonly referred to as the Sun Corridor, a swath that extends from Nogales to Prescott. This area is and will continue to be economically interconnected. According to the Morrison Institute, Metro Phoenix (Maricopa and Pinal County) generates 75 percent of the Arizona Gross Metropolitan Product, a share of state economic productivity that is 6 times larger than Metro Tucson's share of 13 percent. According to Dave Taylor, Metro Tucson will share water, transportation energy and other resources, including economic growth, within the Sun Corridor context.

Issues with Population Projections

Our decisions about infrastructure investments are closely linked to our projections about future population growth. Therefore, it is important to get these numbers right. There are questions about the assumptions behind current growth projections by PAG and the State. We need to make those assumptions transparent and discuss them.

Population growth has been a prime driver of Arizona's economy historically. In fact population growth and economic prosperity seem to go hand in hand. There is some suspicion that the numbers we've been using in the last few years don't really match reality and that could spell problems in the future. What's going to happen when population growth slows down? We have a precedent for this happening in Tucson - 1990 when IBM left town.

It isn't likely that future growth will be an extrapolation of the past because we face unprecedented challenges and uncertainties:

- Infrastructure - our population in Arizona has been doubling approximately every 20 years, but we have not kept up with the investments in infrastructure to serve this growth. We have a backlog of infrastructure needs competing for very limited resources. We must get more aggressive about calculating cost of growth based on true needs.
- Water quality and cost – what are the implications for water quality and the costs of bringing new water to this area? What about the affect climate change will have on the Colorado River and our need for water resources in a hotter, drier climate?
- Energy – this is the biggest uncertainty we face now. Oil prices have a significant effect on our energy and construction costs. We've seen this in road construction costs increasing exponentially in the last several years. For example, the budgets projected for RTA projects are way too low now.
- Climate change – we're not including carbon taxes in any of our energy planning right now. As we become hotter and drier, quality of life will be effected which will likely decrease growth.
- Jobs - we're caught in a tautology of jobs driving growth and growth driving jobs and if one falters, we're in trouble. We need to diversify our economy toward sustainability so we're not reliant on growth to drive our economy.
- Car dependence - We continue to assume that vehicle miles travelled will increase and there is evidence to the contrary. We are a car dependent, sprawling Southwestern city but it is becoming clear that this is not sustainable. Our relationship with the car and how we've built our city around it is going to need to change.

We need a cooperative regional process to come up with population estimates and projections that we feel are most accurate because these numbers are going to drive our decisions and investments. There are a number of things changing in the world right now that indicate future growth will not be an extrapolation of the past. We need new ways of thinking about our future and new tools to deal with these uncertainties. We need to serve the people who live here well and appropriately allocate new infrastructure costs to new population.

Land Use and Planning for Growth

Arizona Planning History Highlights

To understand local land use planning it is important to understand the historical context and the role the federal and state government play in enabling planning and zoning by cities and counties.

1920s
In the 1920s the Secretary of Commerce, Herbert Hoover, developed legislation that established a model zoning code. Arizona was one of the first eleven states to adopt the legislation. In 1925 the City of Tucson attempted to create a Commission on Planning but failed. In 1927 the Tucson Zoning Commission was created and presented the first city zoning ordinance that was subsequently passed by the City Council in 1930. The zoning ordinance zoned for existing uses of the land.

1930s
The City Zoning Commission that had been appointed in 1930 contracted for a Regional Plan Report to be done. Due to budget constraints during this time the City Council refused the Commission's request for funding. In 1937 the Tucson Regional Plan, Inc. was formed to look at regional planning and development with the major area of concern at the time being unregulated development outside of the city limits.

1940s
In the 1940s growth slowed compared to the 1930s. During this decade the Arizona Legislature passed legislation giving authority to local governments to create Planning Boards. Both the City of Tucson and Pima County formed boards and the City Planning and Zoning Commission was established. The City adopted a new zoning ordinance during this time. In 1943 the County prepared the first Comprehensive Plan. The plan focused on Land Use, Transportation and Public Facilities with water and sewer being addressed as infrastructure. The City adopted many of the provisions of the Comprehensive Plan, though not all of them. The County did not have authority from the state to adopt the plan at this time. The City and County cooperated to form a Planning Office. This joint effort was unique to many jurisdictions. In 1949 the County was given authority to plan and zone.

1950s
In 1953 legislation was passed by the voters to allow County zoning and the Joint City and County Planning Office became the City/ County Planning Department. The department focused primarily on school and neighborhood planning but was criticized for missing the big picture. During this time the County population began to rise in the unincorporated areas.

1960s
The City/ County General Land Use Plan was adopted in the 1960s. This was considered to be a land use plan, not a comprehensive plan and it was assumed that area and neighborhood plans would be developed and implemented following the land use guidelines. In 1964 the City/ County Planning Department was disbanded.

1970s
Continued growth occurred in the city and county in the 1970s. Satellite communities developed during this time that included Green Valley, Rincon Valley and Avra Valley. In 1972 the City and County cooperated to begin work on a Joint Comprehensive Plan. The Urban Environmental Management Act was passed by the state in 1973. This act provided the framework for general planning in cities and towns, which is still effect today in Arizona. In 1974 legislation was passed that made zoning mandatory for counties and gave counties subdivision authority. During this time Oro Valley and Marana incorporated.

1980s
In the 1980s there were more efforts made toward regional planning. The County adopted the Conceptual Land Use Element of the Comprehensive Plan that used PAG population projections for 2015 to be under 1.1 million for the county with 453,000 in the unincorporated area. During this time the City was still working on area and neighborhood plans and in 1984 adopted the Major Streets and Routes Plan. The Groundwater Management Act of 1980 was passed. The County adopted a new zoning code in 1989.

1990s
In 1993 the Eastern Pima County Comprehensive Plan was adopted. Most of the area plans that existed in the county as well as the 1960 general land use plan were repealed. The City replaced their Zoning Code in 1995 with the City Land- Use Code. The Arizona Growing Smarter Act passed in 1998 that made planning mandatory for incorporated areas. The Act included plan elements, public participation and municipal general plan election.

2000s
The Growing Smarter Plus Act of 2000 expanded on planning and growth management requirements in the State of Arizona and brought in the water element. Growing Smarter legislation caused the City and County to adopted new plans

and for the first time required that the plans address the issue of water. However, critics of the plans point out that neither one of these plans had a strong implementation element to them. Voters ratified the City's 10 year General Plan in 2001. In 2006 voters passed Proposition 207 which requires the government to reimburse land owners when regulations result in a decrease in the property's value, and also prevents government from exercising eminent domain on behalf of a private party.

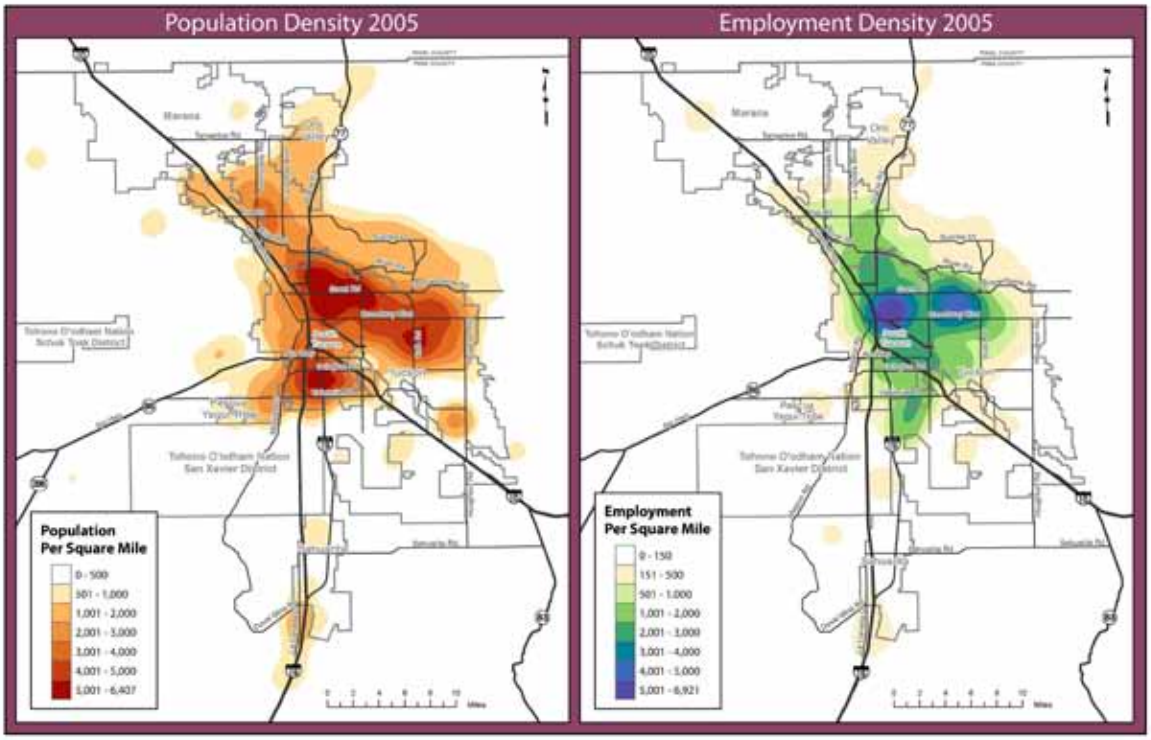

Figure 155-Population vs. Employment Density

How Has Tucson Grown?

Tucson has seen rapid and consistent growth since World War II. The typical development pattern has been suburban in nature due to many factors including the preference of the population for single-family housing, few constraints on development, and the availability of cheap land. Despite all the plans, there has been a lack of regional coordination with respect to land use planning. Development at the urban edges has also occurred due to the complexity and time necessary to build near existing neighborhoods, the abundance of cheap land in unincorporated areas, and the location of state lands which, because they have not been released for development, have encouraged "leap frog" development. Over time, this has left vacant or underdeveloped land throughout the City's urban core and insufficient infrastructure to serve growing populations.

Tucson and Pima County are seen as being primarily reactive to growth and development and ineffective at steering development to desired locations. The local jurisdictions are criticized for making growth and development decisions that have regional impacts without coordinating with each other.

Drivers and Effects of Growth

There are positive and negative aspects of growth just as there are positive and negative aspects to a lack of growth. Looking at the history in Pima County and comparing it to other cities in the western U.S., it is important to acknowledge that some amount of growth will continue to happen in Tucson. In light of that, it behooves community and local governments need to direct where the new growth will go, what it should look like, and how to pay for the necessary infrastructure.

The major drivers of growth are the desirability/livability of the location/city (climate, affordability, available housing, cheap land, schools, public services, mobility, natural beauty, access to recreation, entertainment, cultural assets, and institutions of higher education) and the economy (good paying jobs and opportunities for businesses). Growth is affected by the availability and affordability of land and water, cost of infrastructure and government regulations. Uncertainty about

any of these things can have negative impacts on growth. Decisions made by voters and elected officials affect growth in terms of time, process, money and investment in capital improvements.

Prosperity and stability in a community often happens as the economy of the area grows. Tax revenues paid to the government help pay for infrastructure, facilities and public services. Positive aspects of growth are a vibrant economy, strong tax revenues and meaningful job opportunities.

Negative aspects of growth can be a lowering of the quality of life that attracted people to the location in the first place, including congestion, degradation of air and water quality, and destructions of the natural environment. The demand for public services and infrastructure can become greater than the community's ability to provide them or the ability to provide them in a timely manner.

Shrinking or stagnant communities are marked by high unemployment rates, low wages, failing schools, crumbling infrastructure, public services that fall short of need, abandoned homes and neighborhoods, and closing businesses. Some of that can be attributed to a loss of population and a depressed economy but some of it is also caused by a lack of proper planning and an inability to adapt to changing economies. The goal of most cities is to have a diverse population with a robust economy and a desirable quality of life.

Planning for Growth

Smart Growth is a contemporary urban planning approach that tries to move beyond the traditional pro-growth/no growth debate and instead directs where growth goes, what it should look like, and how it should be paid for. Smart growth steers growth to existing communities to avoid urban sprawl. The concept advocates compact, transit-oriented, walkable, and bicycle friendly land use. Smart Growth values long-range regional considerations of sustainability and aims to achieve a unique sense of community and place by preserving and enhancing natural and cultural resources.

Smart Growth principles include promoting mixed land use and taking advantage of compact building design. Smart Growth strives to offer more housing choices to people of all incomes and lifestyles. Smart Growth also supports the preservation of open space, farmland, natural beauty and critical environmental areas. Smart Growth values making development decisions predictable, fair and cost-effective and encourages community and stakeholder collaboration in development decisions.

Growth Management Tools

There are a variety of tools that cities and counties use to manage growth and regulate development. The County Comprehensive Plan and the City General Plan provide broad policy guidance for managing growth in the community. Regional, sub-regional, neighborhood, and specific plans provide more policy direction for particular areas. One of the functions of these plans is to inform land use regulation decisions. Zoning legally establishes on a parcel by parcel basis what type of development can be built where. Property owners who request to rezone property must go through a public process to do so. Rezonings must be in compliance with applicable plans; if they are not, a plan amendment is needed prior to rezoning.

Impact fees are a tool that governments use to pay for infrastructure needed to serve new development. The legal framework for how municipalities and counties set impact fees is set by state law. Both Tucson and Pima County have guidance and impact fee programs. The City recently initiated impact fees for transportation, parks, police, fire and public facilities. The County has impact fees for transportation only. Impact fees apply to all new developments and have specific benefit areas, for example, the Southwest Infrastructure Plan (SWIP) and the Houghton Area Master Plan (HAMP).

Key Issues for Planning Going Forward

To be successful in planning for the future the entire region needs to be engaged in a comprehensive regional planning process that cuts across jurisdictional boundaries. Aligning local land use policies, codes, and processes with the region's public policy objectives is important. Codes are needed that facilitate achieving the goals of a community. Choices need to be made about which costs the region will pay to secure the economic growth and quality of life desired.

Ideally land near existing infrastructure should be developed first. Development that is compact and contiguous to existing development should be encouraged. Building a community wisely, with logical infrastructure expansions and conservation of natural resources is ideal community. A diversity of housing is needed to create a healthy community. In order to preserve the quality of life a community-wide consensus needs to be developed regarding the future for the region.

3.2.2 Trends in Per Capita Demand for Water

Water demand and per capita usage rates are critical variables for assessing how long our current water resources will last. In recent years use per service account has dropped noticeably. In 2007 total gallons per capita per day (GPCD) was 166. From 1997 to 2007, the total number of service accounts in the Tucson Water service area grew from 150,000 to 230,000. In the same time period there was a 17 percent drop in water use per service. On average that amounts to a 15 to 20 percent decrease in demand over the last ten years on a per- account measurement. There are three rate classes, single family, commercial, and multi-family. All three rate classes have shown some reduction in use since 1997. Both single and multi-family accounts have dropped in per-service use by about 17 percent in the 10 years shown here. Even commercial accounts, which tend to have fewer options for conservation, have dropped about eight percent in the same time period. A lower per capita use has important implications for future water supplies. Present supplies would last longer, or future needs would be reduced, leaving Tucson Water in an even better position than it is now concerning water supply

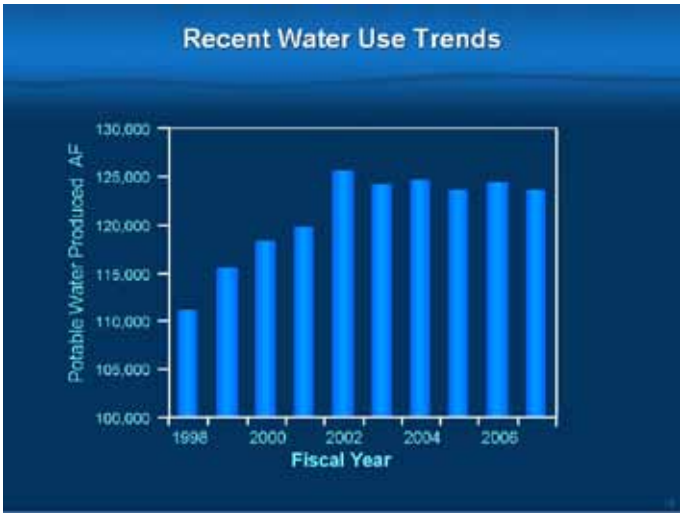

Figure 156-Use Trends

Tucson Water produced a combined 136,561 acre-feet of potable and reclaimed water in 2007. GPCD represents the average total volume of water produced in a year divided by the total population served during the year. The total GPCD water usage rate for Tucson Water's customer base averaged about 177 GPCD for many years, but recent years have shown a trend toward lower usage. At the long-term average of 177, the components of total GPCD include about 14 GPCD to meet reclaimed water demand and approximately 163 GPCD for all potable deliveries. Per capita potable water usage can be further broken down into total residential use at 110 GPCD, commercial and industrial water use at 35 GPCD, and water loss at 18 GPCD. Except for the past few years, the Utility's total GPCD has been relatively consistent for almost 25 years although the relative contributions of reclaimed and potable demand have changed over time.

Changes in water sources will mean big changes in the Utility's water resource portfolio, as well as in energy use. As late as the year 2000, the service area water supply for the 128,000 AF demand came from only two sources, groundwater and reclaimed water. In 2007 total demand had already grown to 136,000 acre-feet, but groundwater was supplying less than half the total potable demand. By 2020, total demand is projected to be about 175,000 AF, but groundwater will only make up a fraction of total supply. At that time Tucson Water will be using its full allocation of 144,000 AF of Central Arizona Project water.

3.2.3 Costs of Water and Wastewater Infrastructure Constraints

The ability and willingness of the population to pay for much needed, increasingly expensive infrastructure investments in our water and wastewater systems is a critical variable that will affect our ability to create a sustainable water future. There are significant costs looming for both water and wastewater ratepayers and the degree to which the population can and is willing to pay will affect our ability to create a sustainable water future. Both utilities face increasing need for investment in maintenance, rehabilitation, and replacement of infrastructure. In the near future, investment in the maintenance and rehabilitation of our water and wastewater systems will need to increase to address aging infrastructure and to meet increasingly stringent water and wastewater quality standards. Both water and wastewater rates have

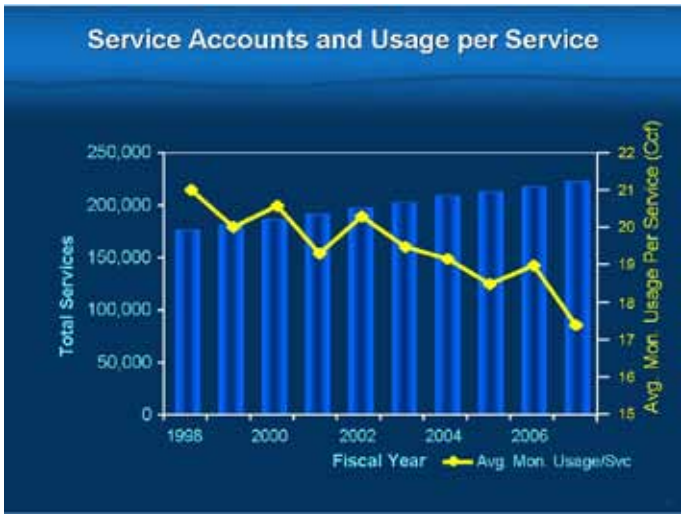

Figure 157-Usage per Service Accounts

traditionally been maintained at relatively low levels and rates must increase in the future to fund much needed investments.

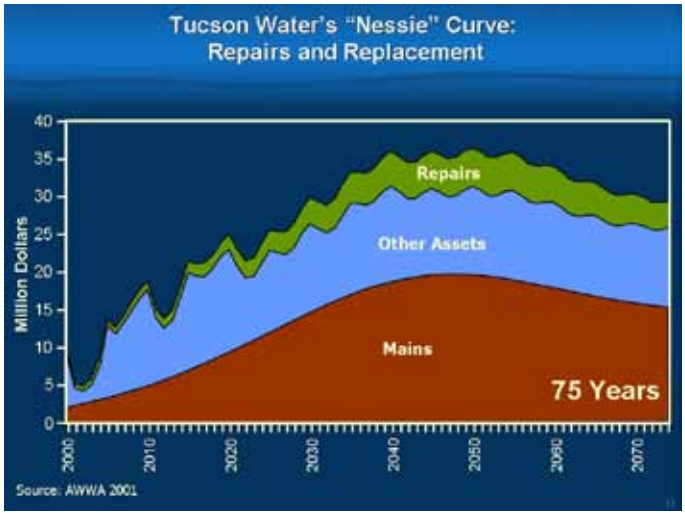

Figure 158-Nessie Curve

Tucson Water has invested heavily during the past decade in developing infrastructure to reduce dependence on groundwater pumping and increase use of renewable CAP water. To meet critical aging points that will be coming up in the future, funding must increase to maintain and replace aging mains, pipes and other delivery infrastructure. Currently, lost water exceeds 10 percent of total water delivered by the utility – an indication of the growing need to address issues of rehabilitation and system maintenance. By addressing rehabilitation there is a potential to prevent the loss of about half of this lost and unaccounted for water.

Pima County Wastewater is facing a huge investment in replacing its Roger Rd. and upgrading and expanding its Ina Rd. regional reclamation facilities through the ROMP (Regional Optimization Master Plan). This is primarily the result of the need to meet more stringent wastewater quality regulations, but is also a result of the age of the current facilities and the need to expand capacity. Wastewater rates will need to increase significantly to pay for ROMP. The wastewater system in the central Tucson area is projected to approach capacity in the future. The ROMP program will resolve this issue by the construction of the Plant Interconnect. There may also be a need for new cross-town interceptors or upstream facilities to address this. Determining the right balance of investing in centralized versus de-centralized wastewater treatment facilities will be important as new areas develop. Another concern that needs to be addressed is that as conservation efforts increase, there could be less liquid in the wastewater system which could increase the need for system flushing. This would be at cross-purposes with the conservation goals we are trying to achieve.

In terms of the reclaimed water system, all significant turf irrigation users that can be reached in a cost effective manner have already been joined to the reclaimed system. To expand the system further, study will be needed to establish priorities for use of reclaimed and how to fund these extensions. In some cases, the general public may be asked to pay for extensions to fund projects with a public good.

Other factors driving up costs for water and wastewater include energy costs of transporting and treating water and wastewater. As energy costs increase rates will be affected. Renewable energy sources will need to be pursued and funded to help offset cost and make the systems more sustainable. New water resources will be much more expensive than current water resources and current ratepayers may be unwilling to pay the higher rates. How to pay for growth and expansions to systems and ensuring that growth is paying its "fair share" will be an ongoing issue.

Figure 159-ROMP