PATCHING THE HOLES IN THE BUCKET: SAFE YIELD AND THE FUTURE OF WATER MANAGEMENT IN ARIZONA

Rita Pearson Maguire, Esq.*

I. SETTING THE STAGE

For the past twenty-six years, Arizona's elected officials and water managers have heralded the passage of the state's Groundwater Management Act ("GMA" or "Groundwater Code") and its concomitant goal of safe yield. In 1986, the Ford Foundation even recognized the GMA as one of the ten most innovative programs in state and local government. Critical acclaim for the GMA noted that it put the most populated areas of Arizona on a path toward adequate supplies by requiring the "safe yield" of diminishing groundwater supplies stored in underground aquifers in designated Active Management Areas ("AMAs") by 2025. The GMA defines safe yield as "a groundwater management goal which attempts to achieve and thereafter maintain a long-term balance between the annual amount of groundwater withdrawn in an [AMA] and the annual amount of natural and artificial recharge in the [AMA]."[1] Safe yield is a crucial aspect of a long-term goal of sustainability, which means that resource availability will not diminish in the future despite growing demands.

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* Rita Maguire is a founding member of the law firm of Maguire & Pearce, PLLC. Her legal areas of concentration include water law, environmental law, public utilities law, and administrative law. Before establishing Maguire & Pearce, Ms. Maguire was the founding President of the Arizona Center for Public Policy, a nonpartisan research organization dedicated to providing objective analyses of the major policy issues in Arizona. Ms. Maguire was appointed the Director of the Arizona Department of Water Resources in 1993 and served as its director until 2001. During her tenure, the Arizona Water Bank Authority and the Arizona Water Protection Fund were created, the Assured Water Supply Rules were promulgated, and the Third Management Plan was adopted. Ms. Maguire has written and lectured extensively on the topic of water management in Arizona and the Colorado River Basin. This Article is a revised version of a paper originally presented at the Water Law and Policy Conference hosted by the University of Arizona James E. Rogers College of Law in Tucson, Arizona, on October 6–7, 2006. Articles from the Conference are collected in this symposium issue, Volume 49 Number 2, of the *Arizona Law Review*. The author would like to thank Elizabeth Dreeland, who contributed significantly to the completion of this article.

1. ARIZ. REV. STAT. ANN. § 45-561(12) (2006).

Four of the state's five AMAs[2] use safe yield as the principal means for determining how groundwater is managed within their boundaries. The GMA established the Arizona Department of Water Resources ("ADWR") as the state agency directly responsible for ensuring that safe yield is achieved. ADWR has since promulgated two regulatory programs to promote safe yield: the Assured Water Supply Rules ("AWS Rules") and mandatory water conservation practices that apply to all persons withdrawing, distributing, or using groundwater in the AMAs. Both programs are designed to preserve groundwater, maximize efficient use of water, and promote long-term water supply planning.

Careful management of the state's scarce water resources has been the mantra of community leaders since the 1920s when Arizona was concerned about its ability to divert water from the Colorado River due to the rapid growth of agriculture in California's Imperial Valley. Fortunately, Arizona was successful in securing a large allocation of water that has since been used to support the rapid population growth in the central parts of the state. But between the time of the river's allocation in 1928[3] and the completion in 1993 of the Central Arizona Project ("CAP"), which delivers Colorado River water to Maricopa, Pinal, and Pima counties, significant groundwater mining occurred in the metropolitan areas of Phoenix and Tucson.

Starting in the 1930s, groundwater was pumped in these areas at a faster rate than it was naturally or artificially replenished, creating a hydrologic condition known as "overdraft."[4] Concern about the rapid depletion of the aquifers was one of the main reasons for the passage of the GMA in 1980 with the Legislature declaring that:

> [The] withdrawal of groundwater is greatly in excess of the safe annual yield and that this . . . is threatening to do substantial injury to the general economy and welfare of this state and its citizens. . . . It is therefore declared to be the public policy of this state . . . to provide a framework for the comprehensive management and regulation of . . . groundwater in this state.[5]

Passage of the Groundwater Code signaled the extent to which the state's leaders were willing to ensure that adequate water supplies were available beyond the present generation of Arizonans.

Development of surface water supplies delivered by the CAP and the Salt River Project ("SRP"), water conservation, and increased use of effluent have helped to reduce reliance on groundwater in the Phoenix and Tucson AMAs. Nevertheless, continued agricultural activity and dramatically growing populations have increased the demand for water. Moreover, despite concerted efforts through

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2. The Groundwater Management Act established four AMAs: the Phoenix, Prescott, Tucson, and Pinal AMAs. In 1994, the Santa Cruz AMA was created. Only the Pinal AMA does not have a Safe Yield management goal for its aquifers.

3. Boulder Canyon Project Act, 43 U.S.C. §§ 617-617t (1928); *see also* Arizona v. California, 373 U.S. 546, 560 (1963).

4. ARIZ. GROUNDWATER MGMT. STUDY COMM'N, FINAL REPORT I-4 (1980).

5. ARIZ. REV. STAT. ANN. § 45-401(A)-(B).

the GMA to promote the use of renewable surface water supplies rather than the use of finite groundwater supplies, groundwater pumping continues to drain the aquifers beneath Phoenix and Tucson.

Although much progress has been made toward achieving safe yield since the GMA's passage, the Phoenix and Tucson AMAs still appear to be a long way from reaching this goal. More importantly, the Groundwater Code is vague about what happens after 2025.[6]

This article examines the current and projected water budgets in the two AMAs, the reasons why safe yield is not being met, the consequences of failing to achieve safe yield by 2025, and whether safe yield will continue to be the best measure of water management success in the future.

Water management is often analogized to turning the Queen Mary: takes a lot of time and careful planning. Now is the time to revisit our commitment to achieving safe yield. It will take strong political leadership with the technical support of water managers and providers alike to make the changes necessary to ensure safe yield is achieved. Now is also the time to begin talking about the next generation of water management in Arizona. The conversation begins with an understanding of the value of water to the state's communities and its ecosystems. It must also include a regional evaluation of the water needs of the major metropolitan areas within the Colorado River Basin. The futures of Los Angeles, San Diego, Las Vegas, and Denver are now inextricably linked to Phoenix and Tucson through the Colorado River system. How this system is managed will have a direct impact on the stability of the water supplies in Arizona.

II. WHY SAFE YIELD?

The effort toward sustainable use of finite groundwater supplies is widely viewed as crucial to maintaining growth and a high quality of life throughout the state. Today, groundwater makes up approximately 40% of the state's water budget, surface water about 58%, and effluent the remaining 2%.[7] Because surface water is a renewable supply, water managers promote the use of surface water over groundwater and advocate saving groundwater for times when surface water availability is reduced due to drought conditions. By examining the tree rings of native species dating back more than 500 years, dendrohydrologists at the University of Arizona and elsewhere have recently concluded that extended dry/wet cycles of approximately twenty to thirty years may be a normal climatic condition in the southwest.[8] As the state's population grows, droughts will have

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6. The statutory definition of safe yield says not only that it is to be achieved by 2025, but "thereafter maintain[ed]," suggesting a permanent standard for how the aquifers are to be managed in safe yield AMAs. ARIZ. REV. STAT. ANN. § 45-561(12).

7. ARIZ. DEP'T OF WATER RES., SECURING ARIZONA'S WATER FUTURE, *available at* http://www.azwater.gov/dwr/Content/Publications/files/supplydemand.pdf (last visited Apr. 2, 2007).

8. JENNA MCPHEE, ANDREW COMRIE & GREGG GARFIN, DROUGHT AND CLIMATE IN ARIZONA: TOP TEN QUESTIONS AND ANSWERS 20 (2004), *available at* http://www.ispe.arizona.edu/climas/learn/drought/DroughtQ&A.pdf.

the potential for immediate and devastating impacts, particularly in our cities, unless steps are taken to mitigate their effects.

The drafters of the Groundwater Code thought that safe yield of the aquifers in the AMAs was the best way to reduce the uncertainty associated with fluctuating water supplies in a desert environment. They believed sustainable use could be achieved through the adoption of a series of water management programs that includes imposing progressively stringent conservation requirements on most groundwater users, replacing groundwater pumping with the delivery of surface water, encouraging the use of effluent and other reclaimed supplies, implementing artificial recharge programs, and the gradual retirement of agriculture through the urbanization of farmland and the purchase of irrigation rights. By achieving a balanced approach to pumping and recharging the aquifer, safe yield of the resource is assured.

There has been a great deal of speculation about how the key benchmarks of the GMA were selected. For example, why did the drafters choose 2025 as the deadline to achieve safe yield? Why is groundwater pumping permitted to a depth of 1,000 feet below land surface under the GMA-authorized AWS Rules? And why is an adequate municipal water supply defined as 100 years of water? Interviews with the original staff of the Groundwater Management Study Commission ("Commission"), who prepared the report leading to the GMA's adoption, suggest that these benchmarks are somewhat arbitrary: they were certainly not driven by hydrologic considerations. For example, 2025 was not the original date selected to achieve safe yield. The first of the Commission's hydrologic studies, the Baseline Conditions Report, recommended 2020. According to Wesley Steiner, State Engineer and the first Director of ADWR, 2020 was chosen in recognition of how much time it would take to reduce the estimated annual statewide overdraft from two million acre-feet to zero.[9] The date was later changed to 2025 to allow sufficient time to write the first management plan under the GMA.[10] The 1,000-foot depth for allowable groundwater pumping was less than the water mining permitted under the state's adequacy statute, which applies to basins outside the AMAs.[11] Allowable groundwater mining under the adequacy statute is 1,200 feet and was based on the depth of the deepest well in the state in 1973, the year of its enactment.[12] Finally, 100 years "seemed" like a sufficient period of time to ensure adequate supplies for cities in a semi-arid environment and was considerably longer than any other regulatory program in effect in the country at the time.[13]

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9. Telephone Interview with Wesley Steiner, former Director, Ariz. Dep't of Water Res. (Aug. 2, 2006).

10. Desmond D. Connall, Jr., *A History of the Arizona Groundwater Act*, 1982 ARIZ. ST. L.J. 313, 325.

11. *See* ARIZ. DEP'T OF WATER RES., WATER ADEQUACY PROGRAM SUMMARY 2 (2001), *available at* http://www.azwater.gov/WaterManagement_2005/Content/Forms/WADSumm.pdf.

12. Telephone Interview with Phil Briggs, former Chief Hydrologist, Ariz. Dep't of Water Res. (Aug. 2, 2006).

13. Telephone Interview with Wesley Steiner, *supra* note 9.

If the central components of the safe yield goal are not hydrologically driven, does it matter if we reach our goal? What happens if we do not, and what will be the significance of failure?

III. WHAT IF WE FAIL TO ACHIEVE SAFE YIELD?

Without question, there are serious physical consequences associated with failing to achieve safe yield, some of which are already occurring in the Phoenix and Tucson areas. As an aquifer is depleted, it compacts, which can lead to permanently diminished groundwater storage capacity. Groundwater can be more difficult to access as the water table declines, making it more costly to extract. Greater depths are often associated with diminished water quality as mineral and salt deposits become more concentrated. Groundwater overdraft can also lead to land subsidence, in which land sinks as an aquifer compacts, leading to fissures in the earth's surface that can be very damaging to roads, building foundations, even airport runways.[14] Earth fissures and subsidence can be extremely expensive to repair. Environmental damage can also be severe; riparian areas throughout Arizona are already imperiled by dropping groundwater tables.

Public opinion can also become a problem with the failure to meet safe yield, especially in places like Tucson, where major efforts have been made to create public awareness of the need for water stewardship. Overall confidence in the state's ability to do what it sets out to do will likely be significantly undermined in the minds of the voting public.

A more immediate risk is to the state's credibility with the federal government and the six basin states who, along with Arizona, share rights to supplies from the Colorado River and its tributaries. Funding for the CAP was predicated on the state's passage of the GMA in 1980.[15] Since then, Arizona has held up the Groundwater Code as the definitive guide to successful groundwater management in the southwest. Arizona's representatives were even able to convince the Bureau of Reclamation in the mid-1990s that CAP irrigation districts should not be subject to proposed federal conservation requirements on Colorado River water use because of the conservation requirements contained in the GMA.[16] The state is currently negotiating the parameters for how shortages in the Lower

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14. Telephone Interview with Phil Briggs, *supra* note 12. Examples of subsidence causing major problems in the Phoenix area include earth fissures in Mesa where the Loop 202 is scheduled to meet the U.S. 60 in 2008, *see* NCS Consultants, LLC, Projects—Red Mountain Freeway (202L), http://www.ncsconsultants.com/projects/redmountain.php (last visited Feb. 27, 2007), significant property damage in Queen Creek, *see* ARIZ. DEP'T OF WATER RES., EARTH FISSURES IN ARIZONA 3, http://www.azwater.gov/dwr/Content/Hot_Topics/Earth_Fissures_in_Arizona/fissuretest.pdf, and concerns about subsidence near the Luke Air Force Base, *see* Ariz. Geological Survey, Center for Land Subsidence and Earth Fissure Information, http://www.azgs.state.az.us/CLASEFI.htm (last visited Feb. 27, 2007).

15. Connall, *supra* note 10, at 329.

16. Letter from Rita P. Maguire, Director, Ariz. Dep't of Water Res., to Ronald J. Schuster, U.S. Bureau of Reclamation (June 1, 1995) (on file with Ariz. Dep't of Water Res.); *see also* Letter from Rita P. Maguire, Director, Ariz. Dep't of Water Res., to Senator Jon Kyl (Aug. 8, 1995) (on file with Ariz. Dep't of Water Res.).

Colorado River Basin will impact CAP deliveries in the future. How will Arizona convince its neighboring states to make the additional financial investments necessary to reduce the risk of shortage and thereby protect CAP deliveries if we fail to achieve the fundamental tenet of the GMA?

Ultimately, failure to meet safe yield could impinge upon future growth as investors avoid Arizona for fear of inadequate water supplies, or municipal bond ratings are lowered to reflect the long-term uncertainty about water availability and sufficiency.

But if the defining goals of safe yield—that is, its achievement by 2025, allocation of groundwater to a depth of 1,000 feet, and a 100-year assured water supply for municipal uses—are arbitrary, why not modify the definition and declare success when success is assured? This question is likely to be asked of elected officials and water managers as 2025 draws near and it becomes clear that safe yield will not be achieved. Declaring victory under a new definition might address the statutory dilemma, but it will not fix the physical problems and other consequences of overdrafting groundwater.

The first official indication that the Phoenix and Tucson AMAs were not going to achieve safe yield of their groundwater supplies by 2025 came in ADWR's Third Management Plan ("TMP"), published in 1999.[17] The Department provided the following table to illustrate the groundwater overdraft they projected would exist in 2025.

Anticipated Overdraft in 2025 in Acre Feet[18]

	1990	**1998**	**2025**
Phoenix AMA	(776,000) [19]	(251,000)	(430,000 - 471,000)
Tucson AMA	(135,000)	(159,000)	(50,400 - 53,300)

In December 2001, Governor Hull's Water Management Commission reached a similar conclusion, stating in its Final Report, "[c]urrent data indicate the Phoenix, Prescott, and Tucson AMAs may not reach their goal of safe-yield by 2025."[20]

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17. Every 10 years, ADWR writes a new management plan for each of the AMAs. The Third Management Plan is in effect from 2000–2010.

18. ARIZ. DEP'T OF WATER RES., THIRD MANAGEMENT PLAN FOR PHOENIX ACTIVE MANAGEMENT AREA 11-21 (1999) [hereinafter THIRD MANAGEMENT PLAN FOR PHOENIX AMA]; ARIZ. DEP'T OF WATER RES., THIRD MANAGEMENT PLAN FOR TUCSON ACTIVE MANAGEMENT AREA 11-23 to 11-24 (1999) [hereinafter THIRD MANAGEMENT PLAN FOR TUCSON AMA].

19. ARIZ. DEP'T OF WATER RES., 1 ARIZONA WATER RESOURCES ASSESSMENT 76, 93 (1994).

20. GOVERNOR'S WATER MGMT. COMM'N, FINAL REPORT vi (2001), *available at* http://www.azwater.gov/dwr/Content/Publications/files/FinalReport.pdf.

Most recently, ADWR's 2005 Annual Report concludes that in the Phoenix AMA, "all credible predictions for the year 2025 show continued overdraft conditions."[21] The ADWR is somewhat more circumspect about the Tucson AMA stating, "[p]rojections . . . show greatly reduced overdraft in 2025, but the use of CAP water must increase."[22] We are less than twenty years away from 2025, and those tasked with protecting and managing the state's water supplies believe that we will fail to achieve safe yield in three of the state's four AMAs required by state law to do so. Is there time to reverse the apparent trend towards failure? What will have to be done to reduce the continuing overdraft conditions in the Phoenix and Tucson AMAs? Does the political will exist to make the necessary adjustments, and what will be the consequences of changing the existing regulations?

IV. THE CURRENT GMA REGULATORY FRAMEWORK IN THE PHOENIX AND TUCSON AMAS

A. A Demographic Description of the Phoenix and Tucson AMAs

Active management area boundaries are based on the hydro-geography of groundwater basins, not on political boundaries.[23] The result is that the Phoenix AMA includes seven sub-basins, covers 5,600 square miles, and takes in portions of three counties (Maricopa, Pinal, and Yavapai Counties), although it is predominantly located in Maricopa County. Today, the Phoenix AMA has a population of approximately 3.7 million people,[24] but by 2025, its population is projected to be about 5.8 million people.[25] Three Native American reservations are located wholly, or partially, in the Phoenix AMA: the Salt River Pima-Maricopa Indian Community, the Gila River Indian Community, and the Fort McDowell Yavapai Nation. The Ak-Chin Indian Community is located in the Pinal AMA but it is adjacent to the Phoenix metropolitan area.

The Tucson AMA includes two sub-basins and portions of Pinal and Santa Cruz counties, but the majority of the AMA is located in Pima County. It covers approximately 3,900 square miles and has a population of over 900,000 people. By 2025, it is projected that more than 1.4 million people will live and

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21. ARIZ. DEP'T OF WATER RES., ANNUAL REPORT 51 (2005), *available at* http://www.azwater.gov/dwr/Content/Find_by_Category/About_ADWR/ADWR_Annual_Report_2005_Final.pdf.

22. *Id.* Although not the subject of this article, ADWR's predictions about the safe yield status of the Prescott AMA are quite specific and dire, stating, "[C]urrent uses and commitments to serve new subdivisions will result in groundwater demands that are *more than double* the long-term sustainable supply of groundwater." *Id.* (emphasis added).

23. A notable exception is the groundwater basin beneath the Santa Cruz AMA that crosses Arizona's border with Mexico.

24. THIRD MANAGEMENT PLAN FOR PHOENIX AMA, *supra* note 18, at 11-4 tbl.11-2.

25. ARIZ. DEP'T OF ECON. SECURITY, ARIZONA POPULATION PROJECTIONS 2006–2055 (2006) [hereinafter POPULATION PROJECTIONS], *available at* http://www.workforce.az.gov/admin/uploadedPublications/1995_2006-2055AZProjectionSummary.xls. Note that these population projections are based upon the political, not AMA, boundaries.

work in the Tucson AMA.[26] Portions of the Tohono O'Odham Nation and all of the Pasqua Yaqui tribal lands are located within the Tucson AMA.

The state's total population is projected to be 9.6 million people by 2025, with the residents of these two AMAs making up well over 70% of the state's population.[27] The Phoenix and Tucson AMAs are also critical economic centers for the state, providing 83%[28] of the jobs today and a slightly lower percentage in 2025 due to rapidly growing communities in the Prescott AMA and elsewhere. There is no doubt that the Phoenix and Tucson AMAs are the backbone of the state's economic vibrancy and will continue to be so in the future.

B. Current and Projected Water Demand in the Phoenix and Tucson AMAs

In addition to the number of residents, the amount of water used in an AMA is determined by the mix of business activities and the amount of water necessary to sustain them. As the urban sectors continue to grow in the AMAs, greater percentages of the water budgets will be dedicated to meeting residential needs. Households use about two-thirds of all municipal supplies, and unlike agriculture and some industrial users that can be paid not to use water during drought periods, most municipal uses are constant regardless of the climatic cycle. Maintaining sufficient supplies of groundwater can minimize the detrimental impacts of future droughts on our municipalities by replacing drought-reduced surface supplies when necessary.

In the Phoenix AMA, municipal and agricultural demands each make up about 46% of the water budget and industrial uses make up about 8%.[29] Between now and 2025, municipal demand is projected to grow, reflecting a rapidly growing urban population and a decline in agricultural activity throughout the AMA.

Municipal demands in the Tucson AMA today make up about 53% of the overall demand, while agricultural use accounts for just 32% of the water budget. However, industrial uses in the Tucson AMA make up a larger percentage of the water demand, 14% versus 8% in Phoenix, due to the presence of metal mining activities within the AMA.[30] Municipal demands in the AMA are expected to grow, but not as rapidly as in the Phoenix AMA. Agricultural uses are expected to decline, while industrial demand is expected to remain constant.

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26. ARIZ. DEP'T OF ECON. SECURITY, PIMA COUNTY POPULATION PROJECTIONS 2006–2055 (2006), http://www.workforce.az.gov/admin/uploadedPublications/1989_2006PimaProjections.xls.

27. *See* POPULATION PROJECTIONS, *supra* note 24.

28. *See* Arizona Workforce Informer, http://www.workforce.az.gov/?PAGEID=67&SUBID=142 (last visited Mar. 30, 2007) (providing links to Excel spreadsheets of employment data for Arizona as a whole and for the Phoenix and Tucson metropolitan areas individually).

29. Interview with Mark Frank, Area Director, Phoenix Active Mgmt. Area, in Phoenix, Ariz. (June 1, 2006).

30. Interview with Ken Seasholes, Area Director, Tucson Active Mgmt. Area, in Phoenix, Ariz. (June 2, 2006).

An important consideration when evaluating the security of municipal water supplies in the Phoenix and Tucson AMAs is the heavy reliance on Colorado River water delivered through the CAP. The CAP is the lowest priority user among those entities with rights to the Colorado River in the Lower Basin. Consequently, water deliveries from the CAP are likely to be reduced when supplies are limited by drought conditions. When CAP supplies are cut back, subcontracts for non-Indian agriculture will be reduced first. Any additional shortfalls will be applied equally to CAP municipal and industrial subcontracts and Indian contracts.[31]

No one knows for certain how deep or how long the cuts in CAP supplies could be in the future. For this reason, it is critical that sufficient supplies of groundwater are available to replace shorted municipal CAP supplies. The cushion created by groundwater and the presence of agriculture provide important assurances that an extended drought on the state's surface water supplies will not have devastating economic impacts on cities in the near term. As time passes, however, there will be fewer and fewer acres in agricultural production due to the growing municipal populations in both AMAs. Moreover, the farmland that remains will likely be pumping groundwater rather than irrigating with renewable supplies from the CAP or SRP systems, thereby reducing available groundwater supplies when droughts occur.

C. Key Historic Differences Between the Phoenix and Tucson AMAs

There are several important differences between the Phoenix and Tucson AMAs that account for the dramatic differences in how close the two regions are to achieving safe yield. Historically, Phoenix's principal industry was agriculture. Farming was the basis for growth and development in the Phoenix AMA until settlement patterns started changing following World War II. Irrigation canals delivering water from the Salt, Verde, Gila, and Agua Fria Rivers along with access to inexpensive and extensive groundwater supplies made the Phoenix area an extremely attractive place to farm. Only recently has agriculture accounted for less than a majority of the water use in the Phoenix AMA. As Phoenix urbanized and farmland was retired, irrigation canals began delivering water to homes instead of fields. Residential neighborhoods in Phoenix and the surrounding cities developed in old citrus groves with lush landscaping and little recognition of the surrounding desert environment.

Tucson was almost exclusively dependent on groundwater until the CAP began delivering Colorado River water in 1992. Until the early 1980s, agriculture was the largest water user in the Tucson AMA. However, because the agriculture there is groundwater-dependent, Tucson's water infrastructure is smaller and more decentralized than the dams and canals found in Phoenix. Consequently, few of

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31. In exchange for receiving CAP water at subsidized rates through 2030 from the Central Arizona Water Conservation District ("CAWCD"), irrigation districts holding CAP non-Indian agricultural subcontracts relinquished their subcontract rights. After 2030, there is no guarantee that CAP water will be available to agriculture at subsidized rates. CAP supplies with the non-Indian agriculture priority will be used in the future to meet municipal demands and will be the first supplies reduced when Colorado River deliveries are reduced due to drought conditions.

Tucson's residential neighborhoods have developed on farmland; instead, they developed on raw desert relying heavily on native desert vegetation for landscaping. The large-scale metal mining operations in and around Tucson have also been large users of groundwater and a driving force in the economy. Although mining productivity has ebbed and flowed over time in response to competition from foreign markets and increased domestic environmental regulations, technological advancements have allowed mines to overcome these obstacles and expand their operations. The result is that these mines are using more water today than they were in 1980.

Finally, Tucson's over-dependence on groundwater caused substantial groundwater level declines and subsidence in certain areas of the downtown. This has made the community much more sensitive to its need to conserve water and grow on renewable supplies.[32]

The Phoenix AMA is larger in area, population, and economy than the Tucson AMA. Moreover, the rapid pace of growth in the Phoenix AMA is expected to continue in the future. The continued presence of agriculture at higher rates than in the Tucson AMA and unreplenished groundwater pumping are the two principal reasons that the size of groundwater overdraft is substantially larger in the Phoenix AMA. It also means that any adjustments to the Groundwater Code to reduce access to groundwater will have greater economic and visual impacts in the Phoenix AMA.

D. Key Regulatory Differences Between the Phoenix and Tucson AMAs

The Phoenix and Tucson AMAs have similar, but not identical, criteria for satisfying the GMA's requirement to eliminate groundwater mining. Differences include the mined groundwater allowance for new Certificates of Assured Water Supply, which is 4% of a post-1995 subdivision's annual water supply in Phoenix and 8% in the Tucson AMA.[33] This is because there are significantly more surface water and effluent options available to a water provider in Phoenix than in Tucson. The percentages shrink with every GMA Management Plan, thus the percentages will drop to 2% and 4%, respectively, in the Fourth Management Period and will shrink to zero in the Fifth Management Period. The balance of a provider's water budget must come from renewable supplies like Colorado, Salt, or Verde River supplies as well as from effluent.

In addition, the conservation requirements placed on water providers are different in the two AMAs. For example, the current gallons per capita per day ("GPCD") model for new single-family development in the Phoenix AMA is 235 GPCD, while in Tucson, the model is 175 GPCD.[34] The difference in criteria reflects some basic climatic and character differences between the two communities: the interior-use models for both AMAs are the same (57 GPCD), but

32. Interview with Kathy Jacobs, Executive Director, Ariz. Water Inst., in Phoenix, Ariz. (June 28, 2006).

33. Interview with Doug Dunham, Office Manager, Office of Assured/Adequate Water Supply, in Phoenix, Ariz. (June 30, 2006).

34. *See* THIRD MANAGEMENT PLAN FOR PHOENIX AMA, *supra* note 18, 5-17 to 5-18; THIRD MANAGEMENT PLAN FOR TUCSON AMA, *supra* note 18, 5-15 to 5-16.

exterior-use assumptions vary significantly due to temperature, elevation, and landscape differences. The higher exterior-use rate in Phoenix allows Phoenix to reduce residential water use during drought periods without impacting interior uses. It also permits more gradual restrictions on domestic water use than in Tucson, where residential demand is firmer and makes up a much larger percentage of the city's overall water budget.

V. HOW DID THE PHOENIX AND TUCSON AMAS GET OFF-TRACK FROM THE GOAL OF SAFE YIELD?

When the GMA was adopted in 1980, it contained a number of "holes in the bucket" that crippled the state's efforts to achieve safe yield from the outset. These holes were a necessary part of getting the ambitious requirements of the GMA passed at the time. In order to gain the support of the mines, for example, they were given an absolute right to dewatering permits—the right to obtain mineral extraction permits that allow groundwater mining—and were exempted from any replenishment obligation for pumped groundwater.[35] Many believe that elimination of one or more of the holes in the GMA bucket would go a long way toward reducing the demand for groundwater and move us closer to eliminating the overdraft in the Phoenix and Tucson AMAs.

A. Agriculture

Water use is organized and managed under the GMA by the three largest use sectors: agriculture, municipal, and industrial users. Determining who may pump groundwater and how much they may pump is a key to managing groundwater. When the GMA was passed, it contained exemptions for certain types of groundwater uses within each sector. Some of the most significant exemptions pertain to agriculture due to its heavy reliance on groundwater at the time of the Act's passage.

Prior to 1980, Arizona case law gave landowners an unlimited right to pump groundwater as long as it was put to reasonable use and was not transported away from the land from which it was pumped.[36] With the Act's passage, however, groundwater was deemed a public resource governed by ADWR. In order to gain agriculture's support for this concept, the GMA grandfathered existing pumping rights at a rate prescribed by the director of ADWR based on specific plots of land that had been irrigated with groundwater between 1975 and 1980.[37] This rate, known as a "water duty," is reduced by the director with each ten-year management period consistent with the GMA's conservation principles.[38] The GMA permits a farmer to exceed the water duty in a given year provided the excess use is paid back in subsequent years by using less water. These "flex" accounts are designed to address the needs of the farmer, whose groundwater use

35. Connall, *supra* note 10, at 337.

36. Town of Chino Valley v. State Land Dep't, 580 P.2d 704, 709 (Ariz. 1978); Farmers Inv. Co. v. Bettwy, 558 P.2d 14, 19 (Ariz. 1976); Bristor v. Cheatham, 255 P.2d 173, 175 (Ariz. 1953).

37. ARIZ. REV. STAT. ANN. § 45-465(B) (2006).

38. ARIZ. REV. STAT. ANN. § 45-565(A)(2) (2006).

can vary from year to year, depending on local climate conditions and marketplace demands. Unfortunately, experience has shown that, in many cases, the water duty was set too high, allowing farmers to accumulate substantial amounts of flex credits (6.6 million acre-feet in the Phoenix AMA and 12.8 million acre-feet in all the AMAs as of 2000) that can be used to pump additional groundwater in the future.[39] Farmers accrue credits even when their land is fallowed and can sell unused flex credits, with some restrictions, to other farmers in the AMA. These outstanding claims create a future liability for the aquifer and undermine the achievement of safe yield.

A critical assumption of the GMA was that, over time, urban development in the AMAs would occur on retired agricultural lands.[40] Believing that, in general, urban users use less water per acre than farmers, the GMA's drafters sought to encourage development on farmland, particularly in the Phoenix AMA.[41] It was also clear to the drafters that the state's existing water supplies were insufficient to sustain the combination of large agricultural and municipal water demands from the same basins.[42]

To some extent, this effort succeeded. For example, in 1981, SRP delivered about 440,000 acre-feet of water to agriculture within its service area, all of which is located in the Phoenix AMA. By 2004, SRP water deliveries to agriculture had dropped to 87,000 acre-feet delivered to less than 30,000 acres of cultivated land. SRP is now predicting "in the next five to ten years there will be virtually no large agriculture within the SRP boundaries."[43]

SRP has gone from being predominantly an agricultural water provider to a municipal water provider with 80% of its water deliveries for municipal uses.[44] Urbanization within the SRP service area, however, is not so much a function of the GMA as it is a function of the location of SRP's lands. And although the land within its service area is urbanizing, sizeable residential development in the Phoenix AMA still occurs on raw desert.[45]

The GMA's main incentive to develop on farmland was the ability to convert Irrigation Grandfathered Rights ("IGFRs")[46] to Non-Irrigation Type 1

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39. Interview with Mark Frank, *supra* note 29.

40. *See* Connall, *supra* note 10, at 324.

41. "A medium-density residential development (four to six houses per acre) with a moderate level of landscaping and a golf course for every 2,000–3,000 homes uses approximately the same quantity of water as the cotton farm it replaced." James M. Holway, *Urban Growth and Water* Supply, *in* ARIZONA WATER POLICY 157, 159 (Bonnie G. Colby & Kathy L. Jacobs eds., 2007).

42. Telephone Interview with Wesley Steiner, *supra* note 9.

43. JOHN SULLIVAN, COLORADO RIVER SYMPOSIUM PROCEEDINGS (2005) (on file with author).

44. SALT RIVER PROJECT, 2005 ANNUAL REPORT: A WATERSHED YEAR (2005), *available at* http://www.srpnet.com/about/financial/ar/pdfx/pdf05/EntireReport.pdf.

45. In 1980, SRP-irrigated lands accounted for 29% of the irrigated acreage (98,000 acres) in the Phoenix AMA. Telephone interview with Mark Frank, Area Director, Phoenix Active Mgmt. Area (Nov. 22, 2006).

46. Irrigation Grandfathered Rights are described in ARIZ. REV. STAT. ANN. § 45-465 (2006). The GMA allocates three acre-feet of groundwater for every acre of

rights. IGFRs can also be extinguished for municipal assured water supply purposes, but neither of these incentives has been very effective. Because the GMA lacks an effective incentive to purchase expensive farmland, the cost of land rather than access to water has driven municipal development. Large master-planned communities in north Scottsdale and the north Phoenix area were built on raw desert, resulting in additional water use without a commensurate reduction in agriculture.

Moreover, regulatory efforts to reduce agriculture's pumping of groundwater are limited to progressively more stringent conservation requirements capped by the assigned water duties in the Third Management Plan.[47] Unlike the municipal sector, agriculture is not required to use renewable supplies and has no replenishment obligation for pumping groundwater. Fortunately, municipal water users have been willing to heavily subsidize the cost of renewable CAP supplies and thereby artificially reduce agriculture's demand for groundwater. They did this for two reasons: to maximize the state's use of its Colorado River allocation at a time when interests in California and Nevada sought to increase their allocations from the River at Arizona's expense, and to give the cities future rights to recover groundwater based on accumulated storage credits without having to replenish the aquifer.

Agriculture is not required to use renewable supplies because the drafters of the GMA believed that agriculture's demand for water would decline with urbanization. However, farmland has not urbanized at the rate originally anticipated, and groundwater pumping will resume if CAP water is not available to farmers at subsidized rates. ADWR indicated in its Third Management Plan that the agricultural sector pumps more than one-half million acre-feet of groundwater annually in the Phoenix AMA alone.[48]

One mitigating factor to agriculture's groundwater use is the incidental recharge that occurs on farmland.[49] In addition, there is growing sentiment that some level of agricultural production in the AMAs has important benefits including: providing drought-replacement supplies through land fallowing programs; promoting a diversified economy; ensuring open space in an urban environment; and reducing nighttime temperatures in adjacent communities, which in turn, lowers evaporative losses of water and generally makes these areas more pleasant places to live.

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retired farmland under ARIZ. REV. STAT. ANN. § 45-462. Until recently, there were sufficient alternate supplies of water available for development that made these water rights of limited value.

47. Section 45-566 of the Arizona Revised Statutes was modified to set the factor at 80%, replacing the original (GMA) language of "maximum conservation consistent with prudent long-term farm management practices . . . ." 2002 Ariz. Sess. Laws ch. 5, § 4. The Fourth Management Plan statute, ARIZ. REV. STAT. ANN. § 45-567, was also modified to reference the TMP standard. 2002 Ariz. Sess. Laws ch. 5, § 6.

48. THIRD MANAGEMENT PLAN FOR PHOENIX AMA, *supra* note 18, at 12-5.

49. For planning purposes, ADWR assumes that between 20% and 26% of the water applied to crops is recharged to the aquifer depending upon the AMA. Telephone interview with Mark Frank, *supra* note 29.

Each of these benefits has value, but at what cost? It may be appropriate to reevaluate the treatment and role of agricultural water uses under the GMA if these are to continue to exist in the AMAs in the future. One approach might be to impose a replenishment obligation on agriculture; the financial impact could be lessened by allowing accumulated flex credits to satisfy a portion of that obligation.

B. Municipal Use

Water supply reliability is the principal concern of most municipal water providers. To that end, several water management tools have been created under state law including the Assured Water Supply Rules, the Central Arizona Groundwater Replenishment District ("CAGRD"), and the Arizona Water Banking Authority. Each is designed to promote long-term, secure water supplies for municipalities using renewable supplies. While all three programs are clearly assets in the state's water management portfolio, each program has vulnerabilities that, at a minimum, should be carefully monitored to ensure that they are able to fulfill their missions and assist in achieving the goal of safe yield.

1. The Assured Water Supply Program ("AWS")

The AWS provisions of the GMA and the subsequent AWS Rules promulgated by ADWR in 1995 require all new subdivisions in an AMA to demonstrate that sufficient water supplies of adequate quality are physically, legally, and continuously available for 100 years. In addition to these consumer protections, the AWS Rules require substantial use of renewable supplies, such as CAP water and effluent, and permit only minimal use of mined groundwater in order to achieve safe yield.

Two types of permits are issued to municipal water providers pursuant to the AWS Rules, and there are two significant differences between them. First, Certificates of Assured Water Supply ("Certificates") only cover the demands of subdivided land, which may not include ancillary commercial growth. ADWR typically issues a Certificate to a developer/builder who must demonstrate an assured water supply before plats can be recorded or parcels sold. Second, once the Certificate is issued and lots sold, it is irrevocable regardless of changes in the available water supply.

Designations of Assured Water Supply ("Designations") encompass a water provider's entire service area demand and are typically issued to cities. Very few private water companies elect to become designated because of the Arizona Corporation Commission's ("ACC") cost recovery policy for renewable water supplies—a key component of a designated provider's portfolio. Unlike certificated providers, designated providers are subject to a rolling review of their water budgets. In other words, ADWR reviews the designated provider's needs over the next 100-year period every three to fifteen years depending on the requirements of the individual Designation. This allows ADWR to check on the viability of the designated provider's long-term water budget and provides an important protection to the water provider's customers. Designated providers must also submit an annual report to ADWR to maintain their Designation. If, at any

time during the projected life of a Designation, demand outstrips supply, ADWR may suspend or revoke the Designation.[50]

When the AWS Rules were enacted, it was envisioned that as a city's service area expanded, designated providers would eventually serve the subdivision development initially served under Certificates. This would result in most municipal demand being met with renewable supplies that were regularly reviewed by ADWR, thereby ensuring that adequate supplies were always available. However, due to significant leapfrog-type residential development in the Phoenix AMA,[51] large residential areas will probably never be served by a designated water provider because they are built beyond existing service area boundaries.[52] Moreover, the ACC's policy of denying cost recovery to private water companies until renewable water supplies are "used and useful" continues to discourage private water companies from seeking Designation.

Limiting ADWR's review to a single snapshot of the water supplies available to a certificated subdivision means ADWR is not monitoring the impacts of development in the surrounding area. In north Phoenix, for example, construction of "wildcat" subdivisions will likely reduce the amount of groundwater available to certificated subdivisions in the area because groundwater pumping by these unregulated subdivisions reduces the supplies of all the nearby communities.[53] Unfortunately, current law provides no protection from these unregulated pumpers and no mechanism for reevaluating the available water supplies for a subdivision under a Certificate of Assured Water Supply.

2. Central Arizona Groundwater Replenishment District ("CAGRD")[54]

While the AWS Rules were being drafted in 1993, the Arizona Legislature authorized the Central Arizona Water Conservation District to replenish excess groundwater pumping within the CAP service area through an entity known as the Central Arizona Groundwater Replenishment District ("CAGRD").[55] This authority was granted in response to concerns that access to renewable water supplies, as well as affordability, would limit future residential growth in the Phoenix and Tucson AMAs or, at a minimum, substantially raise the cost of development. The CAGRD allows developers/builders to build subdivisions dependent on excess groundwater pumping as long as they enroll the

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50. ARIZ. ADMIN. CODE § 12-15-709 (1995).

51. Tucson's situation is different because almost 90% of the AMA's residents are served by a single designated provider.

52. Interview with Doug Dunham, Office Manager, Office of Assured/Adequate Water Supply, in Phoenix, Ariz. (June 30, 2006).

53. *Id.* The term "wildcat" subdivision refers to parcels of land split into five or fewer lots that are not subject to local zoning requirements, including those pertaining to adequate water supplies.

54. This section is based on RITA P. MAGUIRE, HERB DISHLIP & MICHAEL J. PEARCE, THINKAZ, AN ANALYSIS OF THE WATER BUDGETS OF BUCKEYE, PAYSON, AND PRESCOTT VALLEY 12 (2005), *available at* http://www.thinkaz.org/documents/AnAnalysisoftheWaterBudgets.pdf.

55. ARIZ. REV. STAT. ANN. § 48-3774 (2006).

subdivision's lands (known as "Member Lands") in the CAGRD.[56] Water providers may obtain a Designation by enrolling their entire service area into the CAGRD as a Member Service Area.[57]

Enrollment in the CAGRD satisfies a key requirement of the AWS program: that groundwater use will be consistent with the goal of safe yield. Once enrolled and the remaining elements of the AWS program proven, a developer/builder can obtain a Certificate, allowing the subdivision to move forward to final platting and issuance of the Public Subdivision Report by the Arizona Department of Real Estate. Municipalities can also receive a Designation by enrolling in the CAGRD; examples of cities that have done so include Tucson, Peoria, and Scottsdale.

Enrollment of Member Lands in the CAGRD allows mined groundwater to be served to a subdivision, but it carries a corresponding replenishment obligation that must be met by the CAGRD within three years of the member's use. The ability to engage in large-scale groundwater use could undermine the safe yield goal unless the CAGRD performs its functions in a timely and complete manner. Yet, the corresponding obligation of the CAGRD to acquire scarce renewable water supplies raises issues about where such supplies will be found in the future and at what cost.

There are, and will be, many entities in the market looking for long-term renewable water supplies. These entities include private and public water utilities, and even cities and towns. Limited supplies and rapidly increasing demand guarantee that the price of these supplies will escalate in the future. It also means that the CAGRD will be in direct competition with other municipal water providers that will be seeking additional water to meet the needs of their growing populations.

3. Arizona Water Banking Authority ("AWBA")

The AWBA was created in 1996 to store the state's unused Colorado River entitlement underground. Between the time of the AWBA's creation and 2030, it is estimated that up to 14 million acre-feet could be stored in aquifers within the CAP service area, which includes Maricopa, Pima and Pinal counties.[58]

This innovative water management tool serves a number of purposes, but perhaps its most important role is to provide back-up supplies to cities that rely on CAP water. Water deliveries under CAP subcontracts can be reduced by the Secretary of Interior during drought periods when there is inadequate storage in Lakes Mead and Powell to meet all the demands in the three Lower Colorado River Basin States (Arizona, California, and Nevada). Projections by the AWBA indicate that after 2030, the probability of shortage in the Lower Basin in any

56. *Id.*

57. ARIZ. REV. STAT. ANN. § 48-3780.

58. Ariz. Water Banking Auth., Executive Summary, http://www.awba.state.az.us/backgrnd/exec_sum.html (last visited Mar. 14, 2007).

given year could be over 30%.[59] Thus, it is imperative that a sizeable amount of water be stored in advance to ensure that cities with CAP subcontracts do not experience significant water shortages in the future.

The AWBA is required to store the state's unused Colorado River entitlement in all three counties. However, the bulk of its water has been stored in Pinal County through indirect recharge projects. By the close of 2006, more than one million acre-feet will be stored there.[60] This amount represents slightly less than half of the total supplies stored by the bank since its inception and is a key source of supplies for cities with CAP subcontracts in Pinal County and for the state of Nevada, which has contracted with the Bank to store unused Colorado River water for its future use.

Although the Pinal AMA is not the subject of this article, management of its groundwater supplies can and does have an impact on the stability of the water supply for the region, which includes the Phoenix and Tucson AMAs. Pinal County is currently "the fastest growing county in the state of Arizona and one of the fastest in the country."[61] Moreover, economic forecasters are projecting that the Phoenix and Tucson metropolitan areas will continue to grow along Interstate 10, merging in Pinal County within a decade.[62] Referred to as the "Arizona Sun Corridor," this regional metropolitan area is expected to have a population of more than ten million by 2040.[63] But unlike the Phoenix and Tucson AMAs, the Pinal AMA aquifer is not managed for safe yield. Instead, its management goal is to "allow development of non-irrigation uses . . . and to preserve existing agricultural economies in the active management area for as long as feasible, consistent with the necessity to preserve future water supplies for non-irrigation uses."[64] The result is that access to groundwater is relatively unrestricted for municipal and industrial uses, and little or no groundwater replenishment is required for new subdivisions in the AMA. Consequently, ADWR predicts that groundwater demands in the Pinal AMA will exceed the AMA's renewable groundwater supplies within the next two to three years.[65]

In response to concerns about the long-term security of groundwater supplies, ADWR and a local citizen advisory council have recommended that the Pinal AMA's AWS Rules be modified to incorporate the safe yield goal for municipal development. These modifications were recommended to occur no later

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59. Ariz. Water Banking Auth., Availability of Excess CAP Water, *available at* http://www.awba.state.az.us/annc (follow "CAP—Availability of Excess CAP Water" hyperlink to PowerPoint presentation) (last visited Apr. 12, 2007).

60. ARIZ. WATER BANKING AUTH., ANNUAL PLAN OF OPERATION (2006), *available at* http://www.awba.state.az.us/annc/2006/2006_Plan_of_Operation1.doc.

61. Alan Levine, *Pinal Planning for Future*, CASA GRANDE DISPATCH, Aug. 20, 2005, at A1 (quoting Ken Buchanan, Assistant Pinal County Manager).

62. Marshall Vest, Univ. of Ariz. Eller College of Mgmt., Forecast Update, 3rd Quarter 2006 (Aug. 30, 2006).

63. *Id.*

64. ARIZ. REV. STAT. ANN. § 45-562 (2006).

65. PINAL ACTIVE MGMT. AREA GROUNDWATER USERS ADVISORY COMM., FINAL SUBCOMMITTEE REPORT: ASSURED WATER SUPPLY RULES MODIFICATION CONCEPTS 3 (2006).

than January 1, 2007 to minimize the potential for a permanent groundwater mining condition in the municipal sector.[66] Failure to adopt, or even a delay in the adoption of the proposed rule change, poses a serious threat to the groundwater supplies there, including the storage credits held by the AWBA.

Another threat to the groundwater supply in the Pinal AMA is the presence of three Indian reservations located there: the Gila River, Ak-Chin, and Tohono O'odham Indian communities. Indian reservations were established by the federal government and are not subject to state laws and regulations. This means that current and future restrictions on access to groundwater in the AMA do not apply to these tribes. Each of the tribes has a water rights settlement with the federal government and with other interested parties, which provides among other things, federal funding to build infrastructure on the reservations for the purpose of placing large tracts of land into agricultural production.[67] Thus, even if urbanization in the Pinal AMA retires most of the existing non-Indian agriculture, Indian farming is likely to continue in the AMA.

Today, the Pinal AMA is facing the same challenges that threatened the groundwater supplies in the Phoenix and Tucson AMAs 25 years ago. As a result, the community is considering adopting the safe yield goal for the municipal sector. While this is a step in the right direction, non-Indian agriculture will still be allowed to pump significant quantities of groundwater without the limitations of safe yield. There is little doubt that the combination of rapid urban development, future recovery of groundwater by the AWBA, and continued agricultural activity on Indian and non-Indian land will place a significant strain on the groundwater supplies in the Pinal AMA.

C. Industrial Use

Industrial use is defined as a non-irrigation use of water not served by a municipal water provider.[68] Industrial users generally have their own wells and withdraw groundwater pursuant to Type 1 or Type 2 Non-Irrigation Grandfathered Rights, General Industrial Use (GUI) permits, and Mineral Extraction permits. They include resorts, golf courses, cemeteries, sand and gravel operations, large-scale power plants, and mines.

Like agriculture, the industrial sector is not required by the GMA to use renewable water supplies, nor does it have a groundwater replenishment requirement. In contrast to agriculture, the industrial sector was always expected to grow with the population. Thus, industrial use now accounts for about 8% of all groundwater pumping in the Phoenix AMA and is projected to grow to 10% by

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66. *Id.* at 5.

67. *See, e.g.*, Arizona Water Settlements Act, Pub. Law 108-451, 118 Stat. 3478 (2004); Ak Chin Indian Water Rights Settlement Act, Pub. Law 95-328, 92 Stat. 409 (1978).

68. ARIZ. REV. STAT. ANN. § 45-561.5 (2006).

2025.[69] In the Tucson AMA, industry uses about 25% of the groundwater, a figure that is projected to grow to 37% in 2025.[70]

The Governor's Groundwater Management Commission initially recommended in 2001 that all municipal and industrial users not covered by the AWS Rules use renewable supplies or be subject to a 100% replenishment obligation for all mined groundwater. This recommendation was later amended to recommend that certain groundwater pumpers pay an annual groundwater mining tax instead. To date, the legislature has not adopted either recommendation, and groundwater mining continues.

Industrial use of groundwater is projected by ADWR to continue to grow beyond 2025. In 1998, groundwater made up 76% of the water budgets of the industrial users in the Phoenix AMA. In contrast, in the Tucson AMA, groundwater accounted for 99% of the industrial water use largely due to the mining operations in the area.[71] Any evaluation of the AMAs' ability to reach safe yield must address the problem of allowable groundwater pumping by industrial users under the GMA. Options to consider include limitations on the issuance of GIU permits, restrictions on the ability of new industrial users to rely on groundwater supplies, and imposition of a replenishment obligation for pumped groundwater.

D. Exempt Wells

Exempt wells present a significant threat to groundwater in areas outside the Phoenix and Tucson AMAs. Inside the two AMAs, exempt wells create other problems. No one is exactly sure how extensively exempt wells affect the aquifers they tap. It is, however, clear that they have begun damaging underground water sources for rivers and that they are draining sensitive aquifers and damaging riparian habitats dependent on subsurface flows.[72] In addition, because exempt wells are not subject to a replenishment obligation, they do not contribute to the safe-yield goal.

An exempt well is defined as any well pumping groundwater for non-irrigation use with a maximum pump capacity of 35 gallons per minute.[73] Over a year, this could equal up to 56 acre-feet, yet a single acre-foot of water can easily meet the annual needs of a family of five. Most exempt wells use much less groundwater than the maximum allowed, but because they are not metered or subject to annual reporting requirements, no one knows how much water they actually pump.

Despite the protections offered by the AMA structure, exempt wells are a problem in the Phoenix and Tucson AMAs for several reasons. One of the biggest problems is a lack of information—ADWR does not know how many wells are

69. THIRD MANAGEMENT PLAN FOR PHOENIX AMA, *supra* note 18, at 11-21.
70. THIRD MANAGEMENT PLAN FOR TUCSON AMA, *supra* note 18, at 11-23.
71. *Id.*
72. This statement is based on notes of the Statewide Water Advisory Group Meeting in Phoenix on August 18, 2006.
73. ARIZ. REV. STAT. ANN. § 45-402.8 (2006).

actually in operation, how much water each well pumps, or how many people each well serves. Exempt wells are typically located outside a municipal water provider's service area in wildcat or dry lot subdivisions. High densities of exempt wells can cause problems in sub-areas of an aquifer where supplies are limited and groundwater tables are particularly sensitive to pumping.

Exempt wells can also adversely impact adjacent wells, both regulated and unregulated, by drawing limited groundwater from the same aquifer. Furthermore, before a non-exempt well can be drilled, a hydrologic impact analysis must be completed and submitted to ADWR to make sure that the proposed well does not impact existing wells, including exempt wells. This means that a replacement well in a new location must consider impacts on exempt wells not in existence at the time the original well was drilled. Conversely, when an exempt well is drilled, its impact on adjacent wells is not a limitation. This inequity in well treatment will only be exacerbated as more development occurs.

In the Prescott AMA, over 7,000 exempt wells are estimated to be in use, accounting for as much as 10% of the AMA's municipal water use.[74] In the Phoenix AMA, however, exempt wells currently account for just 1% of the groundwater pumped, or 12,000 acre-feet annually.[75] The Tucson AMA currently has around 6,500 exempt wells, accounting for approximately 2% of the AMA's groundwater pumping.[76] Although the volume of groundwater pumped by exempt wells in the Phoenix and Tucson AMAs is not large, their locations in sensitive areas of the aquifer, where pumping can significantly impact adjacent wells or riparian habitats dependent upon subsurface flows, present a significant threat.

VI. WHAT HAPPENS AFTER 2025?

There is no doubt that central Arizona has changed dramatically since the passage of the GMA in 1980. The dramatic influx of new residents has expanded municipal boundaries in all directions within the Phoenix and Tucson AMAs. The expansion has even spread to cities in the Pinal AMA, creating a contiguous municipal region between Phoenix and Tucson and beyond, referred to by urban planners as a "megapolitan area." Megapolitan areas are clustered networks of metropolitan areas with linked economies and infrastructures, including water supplies and the corresponding treatment and delivery systems.[77] Ten such areas have been identified in the U.S. In 2003, the "Arizona Sun Corridor," or "Valley of

74. GOVERNOR'S WATER MGMT. COMM'N, FINAL REPORT 32 (2001), *available at* http://www.azwater.gov/dwr/Content/Publications/files/FinalReport.pdf.

75. Email from Mark Frank, Area Director, Phoenix Active Mgmt. Area, to author (Sept. 8, 2006).

76. Ariz. Dep't of Water Res., Tucson AMA: Water Management, http://www.azwater.gov/WaterManagement_2005/Content/AMAs/TucsonAMA/TAMA_management.htm#Wells (last visited Feb. 27, 2007).

77. ROBERT LANG & DAWN DHAVALE, BEYOND MEGALOPOLIS: EXPLORING AMERICA'S NEW "MEGAPOLITAN" GEOGRAPHY 5–6 (2005), *available at* http://www.mi.vt.edu/uploads/MegaCensusReport.pdf.

the Sun" megapolitan area, had a population of slightly less than five million; by 2029, the population is projected to more than double.[78]

Water management in this complex and interconnected region will continue to be a major challenge. Unless the "holes in the bucket" are addressed by the state legislature, they will continue to exist in 2025, as will groundwater overdraft in the Phoenix and Tucson AMAs. Even if the legislature eliminates some, or all, of the existing exemptions to the GMA, the projected population growth will substantially increase the pressure on public and private water providers to find sustainable supplies of high quality, affordable water. Without a significant change in direction, our current course can only lead to an even greater gap between the overdraft and safe yield in the future.

The Groundwater Code does not address the consequences of failing to reach safe yield by 2025, nor does it address what happens if safe yield is achieved but is later undermined. Staff for the Groundwater Management Study Commission recalls that the issue of what would happen as we got closer to 2025 was something the Commission members expected to be debated and determined in the future.[79] Programs like the CAGRD and the AWBA were not contemplated at the time, but it was understood that many things would change in the years following the GMA's passage that would require attention from policymakers and water managers.

If the conclusion is that safe yield is the appropriate measure of water management success in Arizona, does it matter whether we achieve it by 2025 or at some other date in the future? Today, we know that the population in the "Sun Corridor" will continue to grow and that groundwater overdraft in this megapolitan area will continue as well. We also know that sizeable amounts of agricultural lands will remain in production for the foreseeable future in the Phoenix and Pinal AMAs. Finally, we know that there are large metropolitan areas within the Colorado Basin that need, or are projected to need, their full entitlements from the Colorado River and then some. The water needs of these communities will become particularly acute in the event of an extended drought in the Basin as forecast by climatologists.

The longer we wait to take action, the more ground we will need to cover to achieve, and thereafter maintain, safe yield. Some will argue that the eventual urbanization of the remaining farmland in the corridor will take care of most of the overdraft and that the only real concern is providing sustainable supplies to the municipal and industrial sectors.[80] But are we content to assume that agricultural pumping will not cripple efforts to provide uninterrupted supplies to a significantly larger municipal population in the future? Moreover, there is no guarantee that agricultural production will not continue, even expand, on the six Indian

78. *Id.* at 16.

79. E-mail from Kathleen Ferris, former Director, Ariz. Dep't of Water Res., to author (Sept. 4, 2006).

80. TECHNICAL ADVISORY COMM., GOVERNOR'S WATER MGMT. COMM'N, SAFE YIELD GOAL (2001).

reservations located within the corridor.[81] To date, several assumptions made by the drafters of the GMA have proven incorrect. For example, non-Indian agricultural acreage did not go out of production at the rates predicted, the metal mining industry did not succumb to foreign competition as expected, and the ability to purchase and retire IGFRs based on the amount of money set aside was inadequate. Can we afford to believe that we are making fewer errors in our current assumptions? If we are unable to get to safe yield as planned in 1980, what makes us think that we can achieve safe yield, and maintain it, after 2025?

VII. WHAT MORE CAN BE DONE TO CHANGE THE CURRENT COURSE?

In addition to patching the holes in the bucket, there are a number of water management tools that could put us closer to achieving safe yield. The expanded use of reclaimed water and wider application of conservation methods are two examples. Although these options are well known in Arizona, they will have to play larger roles in the state's water budget to move us closer to safe yield.

Historically, the majority of the wastewater produced in the metropolitan areas has been treated in centralized wastewater treatment plants and then made available as reclaimed water. Today, regional estimates of the water supply assume between 30% and 70% of the reclaimed water produced will be put to use. As the scarcity and cost of water increases, water providers will find it cost-effective to invest in integrated water and wastewater systems that can utilize up to 100% of the reclaimed water produced. This water can reduce groundwater usage by substituting reclaimed water for use in public parks, cemeteries, golf courses, and other public areas.[82] Recently, a few cities have elected to turn over the traditional responsibility of building and maintaining water and wastewater infrastructure to private water companies.[83] If done right, partnerships between local governments and the private sector have the potential to provide highly efficient use of scarce water supplies. Conversely, the failure to integrate multiple private systems serving areas within a single municipality will result in less efficient use of water and wastewater. It will also increase the likelihood that retrofitting these systems will be necessary in the future, as subdivision boundaries merge.

State and local governments, as well as the private sector, run several conservation programs intended to increase awareness of the value of water and to instill the ethic of water stewardship. These programs are designed to cut waste without sacrificing function and often have an added bonus of reducing water bills. For example, ADWR's Rinse Smart program helps restaurant owners reduce water

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81. Ak-Chin, Fort McDowell Yavapai Community, Gila River Indian Community, Pascua Yaqui, Salt River Pima-Maricopa Community, and Tohono O'odham Nation.

82. *See, e.g.*, Global Water Utility Company, http://www.gwresources.com (last visited Mar. 15, 2007).

83. Examples include the Town of Buckeye in the Phoenix AMA and the towns Maricopa and Casa Grande in the Pinal AMA.

use by using a more efficient spray nozzle when rinsing dishware.[84] ADWR encourages household-scale conservation practices such as low-flow plumbing, water-saving technology, and xeriscaping for desert-friendly yards.

Conservation and greater utilization of reclaimed water will stretch existing supplies but cannot generate enough new water to meet all long-term needs. Additional steps will require action at the state's policymaking levels. Conversations with those intimately involved with the passage of Arizona's water management programs confirm a single common thread that led to their adoption—leadership. This same element will be required of the state's political leaders in the future, as we continue to work to meet the challenge of providing adequate, high quality, affordable water to our communities, businesses, and the environment. The tradition of ensuring that secure and adequate water supplies are available for future generations of Arizonans began in the 1920s, was codified in state law in 1980, and must be revisited by the state's political and community leaders in the 21st century.

84. ARIZ. DEP'T OF WATER RES., RINSE SMART ARIZONA, *available at* http://www.azwater.gov/dwr/Content/Find_by_Program/Drought_and_Conservation/files/FutureDraftArizona_RinseSmart.pdf (last visited Apr. 16, 2007).