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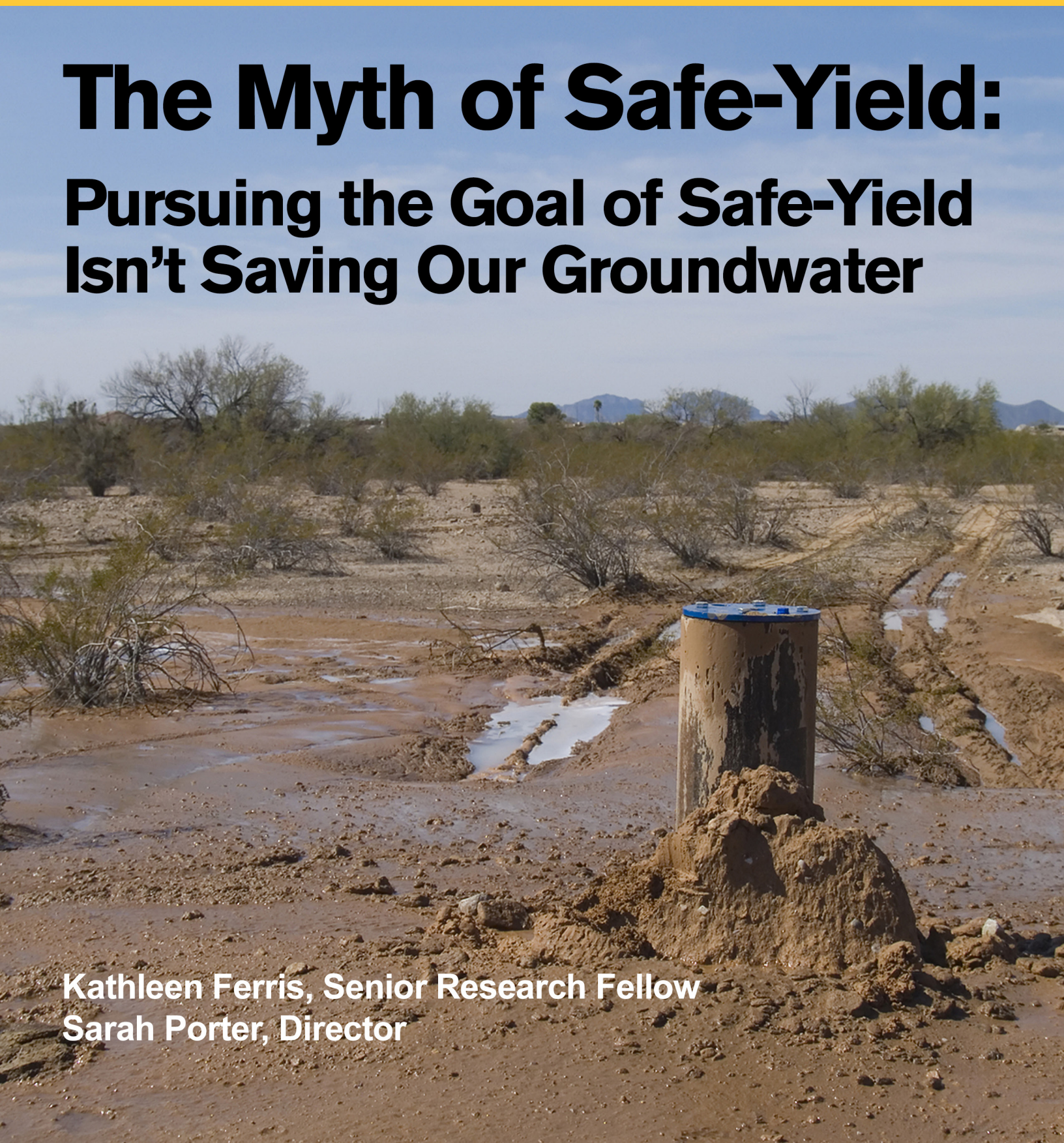
The Myth of Safe-Yield:

Pursuing the Goal of Safe-Yield Isn't Saving Our Groundwater



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Preface

The iconic images of the bathtub ring around Lake Mead caused by falling water levels have been viewed by millions around the country and the world. Lake Mead has become the symbol of what happens when climate change meets over-allocation of a fragile water supply. Seeing is believing, and there is now a near-universal belief that changes are needed to help sustain the Colorado River.

If we could see the groundwater aquifers that serve as our underground reservoirs, many of them would be showing similar signs of stress as groundwater levels fall, the aquifers collapse, land subsides, and minerals and pollutants concentrate in the diminished supply that is left. If we could see that with our own eyes, perhaps we would understand, as we do with Lake Mead, the need to manage better the use of these finite water supplies. For Arizona's Active Management Areas, we might realize the time has come to move beyond the goal of safe-yield.

To be sure, the achievement of safe-yield in these areas, a balance between the amount of groundwater withdrawn and the amount replenished by 2025, would be cause for celebration. It would mean we had reached a key milestone of the Arizona Groundwater Management Act, passed by the legislature in 1980 to protect major urban areas from the consequences of the overuse of finite groundwater.

But today, nearly 41 years later, state experts warn that we are not on track to achieve and sustain safe-yield. And current laws still allow too much groundwater to continue to be pumped in an unsustainable manner for our future water needs to be protected.

Groundwater management has been my life's work for nearly 45 years. As a young lawyer decades ago, I had the remarkable opportunity of serving as the Executive Director of the Arizona Groundwater Management Commission. My job was to help the 25-member Commission develop a comprehensive law for managing the state's groundwater. When Governor Bruce Babbitt convened the private negotiations necessary to strike the compromises needed, I sat beside him and, along with my staff, turned the negotiated principles into the legislation that became the Groundwater Management Act. I went from there to be the first Chief Legal Counsel for the newly created Arizona Department of Water Resources and, later, Director of the Department. All of this is to say that I take no pleasure in pointing out the limitations of safe-yield or the need for changes in how we regulate groundwater. But I take heart in remembering the late Arizona Senate President Stan Turley's admonition, paraphrasing Mark Twain, that "good judgment comes from experience and experience comes from bad judgment." Senator Turley's counsel gives us hope that if we can learn from our past

mistakes in this critical moment for Arizona water, we still have the opportunity to chart a better route for the future.

Sarah Porter and I based this comprehensive report on extensive research and the Department's work over the last 40 years. Our analysis shows that Arizona continues on a path of unsustainable groundwater use that threatens the health and welfare of our state. It is not too late for a course correction, but that will require that Arizonans face the truth and make bold choices. It will also demand courageous leadership.

Kathleen Ferris
Spring 2021

Executive Summary

> "The thing you have to remember is … we're pumping water that's 7- to 8,000 years old in many cases. As soon as the water's gone, we don't have another ice age to reestablish it."[1]
>
> Thomas Maddock, Professor Emeritus
> Hydrology and Atmospheric Sciences, University of Arizona

The Groundwater Management Act launched a new era of water management in the state's Active Management Areas (AMAs). For three of the AMAs, the Act set a long-term goal of safe-yield by January 1, 2025, when groundwater withdrawals in the AMA and recharge of the AMA's groundwater aquifers would ideally be in balance.

Without the Act, groundwater pumping in the AMAs over the past 40 years would have been far, far greater. More land would have been cleared for farms, new high-capacity wells would have been drilled for agricultural, municipal and industrial use, unrestrained by any limits, and the aquifers would be in critical condition. Conservation requirements have helped increase efficiency and reduce demand, and municipal water providers have invested billions of dollars in treatment plants required to use surface water and reclaimed water as alternatives to groundwater. They have also constructed projects to store these supplies underground when they could not be put to immediate use, so they can be called upon when inevitable shortages of surface water occur in the future.

But today, less than four years away from the safe-yield target date of 2025, significant weaknesses of the Groundwater Management Act are apparent, and conservation has not produced the cutbacks in groundwater use necessary to sustain this essential and limited resource. While the use of Colorado River water delivered through the Central Arizona Project (CAP) has reduced reliance on groundwater, CAP water is now fully allocated and expected to decrease as climate change and long-term drought continue. Scientists warn that due to climate change, the Colorado River flows during 2000-2018 were approximately 18% less than the average over the 20th century and are likely to continue to decline.[2] Since 2000, the water level of Lake Mead has fallen more than 130

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[1] TONY DAVIS, *Ancient Aquifers are Dropping as Suburbs Pump Groundwater*, Arizona Daily Star, November 16, 2019, https://tucson.com/ancient-aquifers-are-dropping-as-tucsons-suburbs-pump-groundwater/article_04f387d6-1ba2-11ea-b086-2b67c2b7c10c.html.

[2] CENTER FOR COLORADO RIVER STUDIES, *The Future of the Colorado River Project, White Paper No. 6,* Quinney College of Natural Resources, Utah State University at 112, https://qcnr.usu.edu/coloradoriver/files/WhitePaper6.pdf.

feet and now sits at just 39% of capacity.[3] The Bureau of Reclamation projects the lake elevation to drop below 1075 feet by the end of 2021, triggering a Tier 1 shortage of Colorado River supplies, which would result in a cut to river deliveries of 512,000 acre-feet in 2022, most of which would fall on CAP water users.

Compounding the problem, researchers are cautioning that the southwest is suffering from more than drought—that we are witnessing "a period of transition to an increasingly water scarce environment" known as "aridification."[4] While drought is temporary, scientists caution that aridification is long-term, and possibly permanent, aggravating the water scarcity issues we face.

As CAP water becomes less available, central Arizona will be forced to rely more and more on groundwater, increasing the urgency to better manage it as a savings account for a dryer future. The goal of safe-yield has been fundamental to the state's efforts to safeguard groundwater, but it is insufficient to ensure the long-term sustainability of groundwater supplies in the AMAs. In 2019, the latest year for which ADWR has compiled data, groundwater still made up nearly 40% of the total amount of water used in the CAP service area.

And so, 40 years after the passage of the Groundwater Management Act, we are at a crossroads between success and not good enough. As this report explains:

- **Conservation, while necessary, is insufficient to achieve safe-yield**. Mandatory conservation requirements have pushed citizens and businesses to use water more efficiently, but the increasing water demands of the municipal and industrial sectors will continue to outpace the limits of conservation.

- **Too many users are allowed to pump groundwater in perpetuity, while others are allowed to initiate new uses of groundwater**. The Groundwater Management Act gave "grandfathered rights" to persons who were using groundwater in the five years prior to 1980, and the Director of the Arizona Department of Water Resources (ADWR) is required to issue new permits to withdraw groundwater for many industrial uses. ADWR counsels that the amount of groundwater that may be pumped by these users far exceeds the amount

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[3] IAN JAMES, *As a Hotter, Drier Climate Grips the Colorado River, Water Risks Grow Across the Southwest,* Arizona Republic, April 23, 2021, https://www.azcentral.com/story/news/local/arizona-environment/2021/04/23/snow-and-shrinking-flows-colorado-river-shortage/7294203002/.

[4] COLORADO RIVER RESEARCH GROUP, *When is Drought not a Drought? Drought, Aridification and the "New Normal,"* River Simulator, March 2018, http://www.riversimulator.org/Resources/ClimateDocs/WhenIsDroughtNotDrought2018CRRG.pdf.

available for pumping under safe-yield conditions. In essence, like the Colorado River, groundwater is overallocated in the face of continually dwindling supplies.

- **Safe-yield has been subject to differing interpretations, complicating the assessment of meeting this goal**. While the safe-yield definition seems simple enough, the legislature did not explain what a "long-term balance" between annual withdrawals and annual recharge specifically meant. Some have argued that we must consider the cumulative overdraft since 1980 in determining whether safe-yield has been achieved. Others assert that ADWR should calculate the achievement of safe-yield by measuring rolling averages of recharge since 1980 against groundwater use. ADWR's own overdraft projections have changed considerably over the past 40 years, with the agency now saying that any projection is likely to be outdated by the time it is published. In short, the definitions and assessments of safe-yield are muddled and confused at a time when clarity and effective policy are increasingly urgent.

- **Achieving safe-yield will not prevent the lowering of groundwater levels in all areas of an AMA or the inherent consequences of long-term groundwater decline, including land subsidence, water quality degradation and aquifer compaction**. Safe-yield applies on an AMA-wide basis, but many AMAs encompass multiple subbasins, each a "relatively distinct body of groundwater."[5] So, even if safe-yield were to be attained overall for an AMA, not all areas within the AMA would benefit.

- **Legislation since 1980 has created additional challenges for the sustainability of groundwater supplies in the AMAs**. In 1993, the legislature made it possible to rely on groundwater as a 100-year assured water supply for new residential growth, even if pumping that groundwater depletes the usable supply underlying that growth. But while the Central Arizona Water Conservation District (acting as the Central Arizona Groundwater Replenishment District) is supposed to replenish most of this pumped groundwater, it is not required to put water back in the ground in all of the areas where the groundwater is withdrawn. Moreover, there are serious concerns that the District will not be able to acquire the vast amounts of water needed to meet all of its expected future replenishment obligations. Additionally, the legislature passed the Underground Water Storage Act in 1994 to encourage the underground storage of unused surface water supplies in an AMA but allowed that stored water to be pumped

[5] ARIZ. REV. STAT. ANN. § 45-402 (2021).

back out anywhere within the AMA, creating the potential for localized groundwater depletion.

In 1981, the Arizona Supreme Court ruled that the Groundwater Management Act was constitutional, holding that private property owners do not own the groundwater beneath their lands. The Court concluded, "We do not doubt but that the overdraft of groundwater in this state is a serious problem which has no chance of correcting itself, and that it is necessary for comprehensive legislation to both limit groundwater use and allocate its use among competing interests."[6]

Too many years have passed and too much groundwater has been pumped to ignore these issues any longer. It is once again time for the legislature and all Arizonans to recognize that new strategies are needed to secure the long-term sustainability of groundwater in the AMAs. Actions that should be considered include:

1. Explore mechanisms to reduce groundwater use and encourage the transition to renewable supplies by those with grandfathered rights to pump groundwater.
2. Create mechanisms to encourage new urban development on agricultural lands so that less water-intensive uses replace existing higher water uses.
3. Establish incentives for existing industrial users of groundwater to convert to renewable water supplies, such as treated wastewater, while limiting ADWR's authority to issue new industrial use permits.
4. Refine the AMA-wide safe-yield goal to reflect the hydrogeologic differences within an AMA and prevent declines of groundwater levels in each subbasin of an AMA.
5. Give ADWR the financial resources and effective tools and measures to manage groundwater at a more local level within each AMA.
6. Create incentives to store water in locations of the AMAs experiencing groundwater declines and pump stored water from areas where groundwater levels are rising.
7. Reduce the depth to which groundwater may be pumped for assured water supply purposes in each subbasin of an AMA to ensure a sustainable supply of groundwater in that subbasin indefinitely.
8. Require ADWR to deny applications for Certificates of Assured Water Supply based on groundwater in the Phoenix, Pinal or Tucson AMA if sufficient water supplies to replenish the groundwater are not realistically available or if there is no effective site to replenish the groundwater where it would be pumped.

[6] *Town of Chino Valley v. City of Prescott*, 131 Ariz. 78, 638 P2.d 1324 (1981).

Glossary of Terms

Acre-foot: 325,851 gallons of water. An acre-foot of water will cover an acre of land to a depth of one foot.

ADWR: Arizona Department of Water Resources

AMA: Active Management Area

Analysis: Analysis of Assured Water Supply, which is issued by ADWR for master-planned communities

Assured Water Supply (AWS): sufficient water of adequate quality to satisfy the water needs of the proposed use for at least one hundred years

CAGRD: Central Arizona Groundwater Replenishment District

CAP: Central Arizona Project

CAWCD: Central Arizona Water Conservation District, which operates the CAP and is responsible for CAGRD

Certificate: Certificate of Assured Water Supply, which is issued by ADWR for individual subdivisions

Designation: Designation of Assured Water Supply, which is issued by ADWR to municipal water providers

Hydrologic disconnect: the underground storage and recovery (pumping) of water supplies in hydrologically disconnected areas

Mined groundwater: groundwater pumped from aquifers and not replaced; also known as unreplenished groundwater

Municipal water provider: a city, town or private water company that provides water service

Safe-yield: an AMA management goal that attempts to achieve and maintain a long-term balance between the annual amount of groundwater withdrawn in the AMA and the annual amount of natural and artificial recharge

Subbasin: a relatively distinct body of groundwater within a groundwater basin

Subdivision: land that has been divided into six or more lots or parcels for sale or lease

Introduction

Arizona's groundwater is finite. Accumulated over thousands of years in the spaces between the fractured rock and gravel under the land surface, it is an ancient resource not easily replaced. Yet over many decades, deep wells, cheap power, and the rapid expansion of farms, industries and cities pushed the use of groundwater to unsustainable levels, and by 1977, Arizonans were literally mining 2.5 million more acre-feet of groundwater annually than was replenished.[7]

To address that crisis, on June 12, 1980, the Arizona Legislature finally embraced the regulation of groundwater pumping by approving a sweeping "Groundwater Management Act," finding that:

> "[T]he people of Arizona are dependent in whole or in part upon groundwater basins for their water supply and that in many basins and sub-basins 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**."[8]

The Act aimed to achieve a long-term balance between the amount of groundwater withdrawn and the renewal of that resource in three of the state's most populous areas by 2025.[9] It was hoped that this "safe-yield" goal would curb the decades-long overuse of finite groundwater supplies in central Arizona that threatened its economy and citizens.

The new law created hydro-geographical Active Management Areas (AMAs)[10] in which it:

- Prohibited the expansion of agriculture, the largest user of groundwater.
- Regulated the drilling of new wells.
- Prevented the sale of subdivided land that lacked a 100-year "assured" water supply.
- Set a long-term groundwater management goal for each AMA.

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[7] ARIZ. GROUNDWATER MGMT. STUDY COMM'N, *Draft Report of Tentative Recommendations,* July 1979*,* at I-2.

[8] ARIZ. REV. STAT. ANN. § 45-401 (2021) (emphasis added).

[9] In 1994, the legislature created the Santa Cruz AMA with the goal "to maintain a safe-yield condition … and to prevent local water tables from experiencing long-term declines." ARIZ. REV. STAT. ANN. §§ 45-411.03, 45-562 (2021).

[10] ARIZ. REV. STAT. ANN. § 45-411 (2021).

Figure 1. Active Management Areas in Arizona (Source: ADWR).

To implement the Act and help achieve these management goals, the legislature established a new Arizona Department of Water Resources (ADWR)[11] responsible for adopting management plans for each of five successive management periods that would include ongoing, mandatory conservation programs designed to achieve reductions in groundwater withdrawals.[12]

Today, less than four years away from the 2025 deadline to achieve safe-yield, ADWR cautions that meeting and sustaining this goal will be challenging, and perhaps impossible, under its current regulatory authority. Mined groundwater continues to be a water source for agriculture, industries and municipal providers, and mandatory conservation has not produced the needed cutbacks in groundwater use. Even if the safe-yield goal were to be achieved, groundwater management problems would still persist in parts of the AMAs.

This report explores the obstacles to safe-yield and other groundwater management challenges facing the AMAs, including the use of unsustainable groundwater supplies to support new urban growth and development. It makes several recommendations for water managers and elected officials to consider.

[11] ARIZ. REV. STAT. ANN. § 45-102 (2021).
[12] ARIZ. REV. STAT. ANN. § 45-563 (2021).

What Stands in the Way 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."[13]
>
> Rita Pearson Maguire, Esq.
> Former Director, ADWR, 1993 - 2001

Over the years since 1980, it has become clear from the management plans that it will be challenging to reach and probably impossible to sustain safe-yield under current law, at least in the Phoenix, Prescott and Santa Cruz AMAs. While the Tucson AMA is currently hovering around safe-yield, it is unlikely to maintain this status if shortages of Colorado River water reduce deliveries of CAP water to the AMA. Appendix A to this report is a more detailed description of the management plans for the Phoenix, Prescott and Tucson AMAs.[14] Since the third management period, the following themes have continued to resonate:

- Mandatory conservation will not, by itself, achieve safe-yield.
- Too many users are allowed to pump groundwater indefinitely, while others are allowed to initiate new uses of groundwater.
- Safe-yield is subject to differing interpretations, complicating the assessment of meeting and sustaining the goal on a long-term basis.

Because the Phoenix AMA is the largest AMA both in size and water use, this report includes more details on the Phoenix AMA.

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[13] RITA PEARSON MAGUIRE, *Patching the Holes in the Bucket: Safe Yield and the Future of Water Management in Arizona*, Arizona Law Review Vol. 49:361 at 371 (2007), https://arizonalawreview.org/pdf/49-2/49arizlrev361.pdf.

[14] The management goal for the Santa Cruz AMA is a unique version of safe-yield, in part because of the international nature of the Santa Cruz river basin, and ADWR has adopted only two management plans for that AMA. For these reasons, the Santa Cruz AMA is excluded from analysis in this Report.

Conservation Won't Get Us to Safe-Yield

> "Although conservation is an effective means of managing available supplies and can help move the [AMA] closer to safe-yield, it is insufficient by itself to bring the [AMA] to safe-yield."[15]
>
> Arizona Department of Water Resources

Who can argue against conserving a limited resource? Arizonans must always be mindful of how we use water and must strive to reduce our consumption so supplies can be stretched to serve our ever-increasing needs. Yet, even in the years leading up to the 1980 Groundwater Management Act, water planners did not believe that sustainable groundwater use could be accomplished through conservation alone.

That is why the Groundwater Management Study Commission, established by the legislature in 1977 to recommend groundwater management legislation, initially proposed that several options be adopted to reduce groundwater withdrawals. In addition to conservation, the Commission advised that pro-rata reduction of all groundwater uses, purchase and retirement of groundwater rights, and even eminent domain proceedings to acquire land and water rights should be authorized to reduce groundwater pumping.[16]

Agriculture, the largest user of groundwater, opposed pro-rata reduction, knowing that farmers would see the biggest cuts in their allowable groundwater use. In the end, among the compromises necessary to agree on a new management law, pro-rata reduction was dropped from the equation and conservation became the key method for reducing withdrawals, largely because it was the only measure everyone would support.

Municipal Conservation Won't Outpace Water Demands

There are currently two separate conservation programs for municipal water providers. The Groundwater Management Act originally required that each municipal water

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[15] ARIZ. DEP'T OF WATER Resources, *Fourth Management Plan Phoenix Active Management Area 2010-2020,* 1-5, https://new.azwater.gov/sites/default/files/media/FULL FINAL PHX 4MP_1.pdf; ARIZ. DEP'T OF WATER RESOURCES, *Fourth Management Plan for the Prescott Active Management Area 2010-2020,* 1-5, http://infoshare.azwater.gov/docushare/dsweb/Get/Document-10037/PrescottFourthManagementPlan.pdf; ARIZ. DEP'T OF WATER RESOURCES, *Fourth Management Plan for the Tucson Active Management Area, 2010-2020,* at 1-5, http://infoshare.azwater.gov/docushare/dsweb/Get/Document-10038/TAMA_4MP_Complete.pdf.

[16] ARIZ. GROUNDWATER MGMT. STUDY COMM'N., *supra,* note 7, at V-9.

provider reduce its daily per capita use rates[17] (the GPCD program). The legislature later amended the law to require ADWR, beginning in the second management plans, to adopt a non-per capita conservation program for municipal providers, based on the implementation of best management practices designed to achieve efficiency equivalent to the GPCD program rather than meet a specific GPCD target.[18] The non-per capita program is mandatory for all large municipal providers that have not received a Designation of Assured Water Supply (Designation) from ADWR.[19] A Designation means that the municipal provider has shown that it has sufficient water of adequate quality to meet the demands within its service area for at least 100 years. A Designation is reviewed by ADWR at least every 15 years.[20]

As of January 2019, many of the largest municipal providers, such as the cities of Phoenix, Tucson and Mesa, continue to be regulated under the GPCD program, while 61 out of 81 large municipal providers in the AMAs were regulated under the non-per capita program.[21] According to the Phoenix AMA Fourth Management Plan, the average GPCD rate for Phoenix AMA large providers has dropped by about 1.2% per year since 2000, but "multiple factors affect the GPCD rate, sometimes making it an unreliable measure of actual water conservation efforts."[22] In its 2015 Colorado River Basin *Moving Forward Report*, the U.S. Bureau of Reclamation observed that "population is one of the principal drivers influencing M&I water use," but M&I water use is affected by many other factors, such as climate, housing densities, types and age of housing, and income and employment of residents.[23]

A 2020 study finds that "many cities have been able to accommodate population increases while simultaneously reducing their volume of water use, thereby decoupling

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[17] ARIZ. REV. STAT. ANN. § 45-564 (2021).

[18] ARIZ. REV. STAT. ANN. § 565.01 (2021); *see also* ARIZ. REV. STAT. ANN. § 45-566.01 (third management period) & § 45-567.01 (fourth management period) (2021). ADWR continues to use the GPCD target to measure efficiency of the non-per capita pprogram.

[19] ARIZ. DEP'T OF WATER Resources, *Fourth Management Plan Phoenix Active Management Area* 2010-2020 5-7, https://new.azwater.gov/sites/default/files/media/FULL FINAL PHX 4MP_1.pdf.

[20] A.A.C. R12-15-711.

[21] ARIZ. DEP'T OF WATER Resources, *AMA Municipal Conservation Program Report* (2019), http://infoshare.azwater.gov/docushare/dsweb/Get/Document-11352/AMA Municipal Conservation Program Report_2019.pdf.

[22] ARIZ. DEP'T OF WATER Resources, *supra,* note 19, at 3-9.

[23] U.S. BUREAU OF RECLAMATION, *Colorado River Basin Stakeholders "Moving Forward" to Address Challenges Identified in the Colorado River Basin Water Supply and Demand Study, May 2015 at 3-7 - 3-10,* https://www.usbr.gov/lc/region/programs/crbstudy/MovingForward/Phase1Report.html.

growth from water use."[24] Arizona economist Gary Woodard flatly states, "There is just no tie anymore between population and water demand."[25]

A complicating factor is that conservation is often confused with efficiency. The *Moving Forward Report* defines water conservation as "programs and practices that provide for sustained reductions in water use, loss or waste."[26] Water use efficiency, however, "accomplishes more with less by using the best available technology and using water in smarter and more innovative ways."[27] The use of water-saving appliances is an example of water use efficiency, which can build resiliency for existing water supplies and delay the need to acquire new water supplies.

The conservation requirements of the Groundwater Management Act are not intended to reduce the total amount of water used by the municipal sector but rather to reduce groundwater withdrawals[28] and improve the efficiency of water use so that the same amount of water is used to do more. As the Third Management Plan for the Phoenix AMA plainly stated, "the municipal sector is allowed to grow and increase its water use over time."[29] This is evidenced by the fact that municipal water providers have "service area rights" allowing them to withdraw and transport groundwater within their service areas,[30] and that those service areas may be extended and new wells drilled to serve new uses.[31]

Each municipal water provider has a different portfolio of water rights. The cities of Phoenix, Mesa, Scottsdale, Tempe, Chandler, Gilbert, Glendale, Peoria, Avondale and Tolleson serve lands with rights to Salt and Verde River water delivered by the Salt River Project (SRP). This water must be used on lands within each city holding rights to water from the SRP and may not be delivered to other lands. Similarly, not all municipal water providers have rights to Colorado River water delivered by the Central Arizona Project, and there are contractual limitations on where CAP water may be used. As a

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[24] BRIAN D. RICHTER, ET AL, *Decoupling Urban Water use and Growth in Response to Water Scarcity,* Water 2020, at 1.
[25] Sara E. Pratt, *Declining U.S. Water Use a Challenge for Models*, EARTH (September 17, 2015), https://www.earthmagazine.org/article/declining-us-water-use-challenge-models.
[26] U.S. BUREAU OF RECLAMATION, *supra,* note 23, at 3-6.
[27] AMERICAN RIVERS, *Water Efficiency and Conservation,* https://www.americanrivers.org/threats-solutions/clean-water/efficiency-conservation/.
[28] ARIZ. REV. STAT. ANN. § 45-563 (2021).
[29] ARIZ. DEP'T OF WATER RESOURCES, *Third Management Plan for the Phoenix Active Management Area, 2000-2010,* 12-2; http://infoshare.azwater.gov/docushare/dsweb/Get/Document-10007/PhoenixAMA_3MP.pdf.
[30] ARIZ. REV. STAT. ANN. § 45-492 (2021).
[31] ARIZ. REV. STAT. ANN. § 45-493 (2021).

result, more efficient use of SRP or CAP water does not result in the availability of these sources for other municipal providers who do not have rights to those water sources.

The Phoenix AMA Fourth Management Plan shows that between 1985 and 2017, the annual municipal water demand in the Phoenix AMA grew from 633,501 acre-feet to 1,081,451 acre-feet, an increase of 70%.[32] During that same period, however, the population in the AMA has more than doubled (adding 2.3 million people), an increase of more than 120%.[33] The proportion of the Phoenix AMA demand met with groundwater has decreased as the use of Colorado River water and treated effluent have increased,[34] but the population of the Greater Phoenix area is expected to grow by another one million people over the next ten years, putting even greater strain on groundwater and other available water supplies.[35] Clearly, the same amount of water cannot be stretched to meet the needs of current customers and one million more.

Agricultural Efficiency is Not Reducing Groundwater Use

Unlike with the municipal sector, the Groundwater Management Act intended that the use of groundwater for agricultural purposes would decline over time. The Act precludes the irrigation of acres of land that were not irrigated at some time from January 1, 1975, through January 1, 1980.[36] Additionally, agricultural water users were initially required to comply with a water duty limit set by ADWR for each farm unit that would be reduced with each management period. For the first management period, the Director was required to calculate the water duty "as the quantity of water reasonably required to irrigate the crops historically grown in a farm unit" assuming "conservation methods … which would be **reasonable** for the farm unit including lined ditches, pump-back systems, land leveling and efficient application practices, but not including a change from flood irrigation to drip irrigation or sprinkler irrigation."[37] In setting the water duties for the second management period, the Director was required to "assume the **maximum** conservation consistent with prudent long-term farm management practices within areas of similar farming conditions, considering the time required to amortize

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[32] ARIZ. DEP'T OF WATER RESOURCES, AMA Annual Water Supply & Demand Dashboard, https://new.azwater.gov/ama/ama-data (last consulted 05-12-21).
[33] ARIZ. DEP'T OF WATER RESOURCES, *supra*, note 19, at 5-3.
[34] *Id.* at 3-3.
[35] CATHERINE REAGOR, *1 Million More People in Metro Phoenix in the Next Decade? Where Will We Put Them?,* Arizona Republic, January 26, 2020, https://www.azcentral.com/story/money/real-estate/catherine-reagor/2020/01/26/metro-phoenix-population-growth-million-people-2030-where-they-live/4551466002/.
[36] ARIZ. REV. STAT. ANN. § 45-452 (2021).
[37] ARIZ. REV. STAT. ANN. § 45-564 (2021) (emphasis added).

conservation investments and financing costs."[38] And for the third management period, the Director was mandated to assume an irrigation **efficiency of 80%** in setting the water duties.[39] ADWR refers to the water duty program as the "base program."

The Groundwater Management Act was later amended to require ADWR, beginning in the third management period, to include a best management practices (BMP) program for agricultural users as an alternative to the base program. The amendment required that the BMP program must achieve "conservation that is at least equivalent to that required" by the base program.[40] As of 2017, 172 irrigation grandfathered rights, with approximately 27,000 acres, were enrolled in the BMP program in the Phoenix AMA,[41] compared to about 131,000 acres enrolled in the base program.[42]

In the Fourth Management Plan for the Phoenix AMA, however, ADWR concluded that "BMP farms in the PhxAMA generally apply about 18 percent more water per irrigation acre than non-BMP farms," likely due to crop type, double-cropping or bringing more fallow land into production.[43] Accordingly, the agency has determined that the BMP program "is not currently achieving conservation at least equivalent to the base program."[44] Several agricultural water users and organizations have pushed back against ADWR's findings by challenging, among other things, ADWR's interpretation of "conservation."[45] But ADWR has rightly concluded that under the Groundwater Management Act, its conservation programs must be "designed to achieve reductions in withdrawals of groundwater."[46] Here again, there seems to be confusion between conservation and efficiency. Improved efficiency could mean growing twice as much alfalfa with the same amount of water, but that practice doesn't conserve any water. As a 2018 University of Arizona publication reported:

> "The irrigation efficiency of an agricultural operation may be defined as the ratio of water beneficially used to the total amount of water applied. As more of the applied water goes to beneficial uses rather than non-

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[38] ARIZ. REV. STAT. ANN. § 45-565 (2021) (emphasis added).
[39] ARIZ. REV. STAT. ANN. § 45-566 (2021).
[40] ARIZ. REV. STAT. ANN. § 45-45-566.02.F (2021).
[41] ARIZ. DEP'T OF WATER RESOURCES, *supra,* note 19, at 4-8.
[42] *Id*. at 3-14, Table 3-5 shows the total irrigation acres in 2017 to be 158,164.
[43] *Id.* at 4-8.
[44] ARIZ. DEP'T OF WATER RESOURCES, 5th Management Plans Work Group Agricultural Subgroup Meeting, May 18, 2020, https://new.azwater.gov/sites/default/files/media/2020-05-18_Ag_Data2.pdf.
[45] LETTER TO TOM BUSCHATZKE, Sept. 2, 2020 at 3 (on file with authors).
[46] ARIZ. REV. STAT. ANN. § 45-563 (2021).

> beneficial uses, efficiency increases. … **Conservation means a reduction in the amount of water consumed**."[47]

In short, the last 40 years have confirmed that conservation alone is not enough to ensure the sustainability of our groundwater supplies. While conservation and increased efficiency are necessary and important to stretch supplies, demand for water in the AMAs will continue to increase in the municipal and industrial sectors. And climate change and reduced supplies of surface water will put greater stress on groundwater. Central Arizona is growing, and with that growth will come increased water supply needs and even greater water management challenges, further attenuating the link between conservation and safe-yield. Yet aside from conservation requirements, ADWR has virtually no authority to mandate reductions of groundwater use. ADWR urgently needs additional tools to manage groundwater withdrawals. The following sections suggest several that might be considered.

Long-Term Rights to Pump Groundwater Hinder the Achievement of Safe-Yield

> "Several categories of water users, both existing and potential new users, may legally withdraw groundwater without replenishing or replacing that volume back into the aquifer. These uses contribute to overdraft and, under the current regulatory framework, may continue or increase over time."[48]
>
> Arizona Department of Water Resources

The Groundwater Management Act protected uses of groundwater that were in existence as of January 1, 1980. Farmers received irrigation grandfathered groundwater rights, allowing them to continue to pump groundwater to irrigate land that was farmed in the five years prior to January 1, 1980. Industrial users of groundwater were eligible

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[47] WATER RESOURCES RESEARCH CENTER, *Water and Irrigated Agriculture in Arizona,* Arroyo, June 27, 2018 at 11, (emphasis added), https://wrrc.arizona.edu/sites/wrrc.arizona.edu/files/attachment/Arroyo-2018-revised.pdf.

[48] ARIZ. DEPT. OF WATER RESOURCES, *supra,* note 19 at 11-3; ARIZ. DEP'T OF WATER RESOURCES, *Fourth Management Plan for the Prescott Active Management Area 2010-2020* at 12-1, http://infoshare.azwater.gov/docushare/dsweb/Get/Document-10037/PrescottFourthManagementPlan.pdf;
ARIZ. DEP'T OF WATER RESOURCES, *Fourth Management Plan for the Tucson Active Management Area, 2010-2020* at 12-1, http://infoshare.azwater.gov/docushare/dsweb/Get/Document-10038/TAMA_4MP_Complete.pdf.

for Type 2 non-irrigation grandfathered rights enabling them to withdraw historically pumped amounts of groundwater indefinitely. Cities, towns and private water companies received service area rights authorizing them to continue to pump and serve groundwater within their service areas. Additionally, the Act requires ADWR to issue new permits to withdraw groundwater to certain industrial users. ADWR collectively refers to groundwater pumping pursuant to these rights and permits as "residual pumping" or "unreplenished groundwater withdrawals."[49] **Residual pumpers have no obligation to substitute renewable water supplies or to replenish the groundwater they pump**. Only the municipal sector, through the Assured Water Supply (AWS) rules, is required to use renewable water supplies to sustain its future growth.[50]

As shown in Figure 2, the agricultural sector is the largest contributor to unreplenished groundwater use in the Phoenix, Pinal and Tucson AMAs.

[49] For a detailed discussion of unreplenished groundwater withdrawals, see ARIZ. DEP'T OF WATER RESOURCES, GOVERNOR'S WATER AUGMENTATION, INNOVATION AND CONSERVATION COUNCIL POST-2025 AMAS COMMITTEE, *Issue Brief #3, Unreplenished Groundwater Withdrawals,* https://new.azwater.gov/sites/default/files/Post-2025%20AMAs%20Committee%20Executive%20Summary%20%26%20Issue%20Briefs.pdf.

[50] ARIZ. DEP'T OF WATER RESOURCES, *supra* note 29, at 12-2.

	Active Management Area				
Sector and Type	**Prescott**	**Phoenix**	**Pinal**	**Tucson**	**Santa Cruz**
GROUNDWATER DEMAND 5-Year Average (2012-2016)					
Agricultural Sector	**1,939**	**623,307**	**611,059**	**101,784**	**10,134**
Groundwater	1,939	350,586	422,694	76,666	10,134
GSF Accounting	-	179,935	124,841	24,909	-
Tribal	-	92,786	63,524	209	-
Municipal Sector	**12,970**	**226,061**	**30,996**	**36,345**	**6,448**
Large Designated Providers	4,584	54,040	9,671	12,290	3,121
Large Undesignated Providers	5,098	89,468	16,290	16,560	2,845
Small Providers	1,062	3,688	1,521	4,046	313
Large Untreated Providers/Urban Irrigation	-	68,690	21	-	-
Domestic Exempt Well Demand	2,227	10,175	3,494	3,450	170
Industrial Sector	**1,592**	**107,024**	**18,273**	**57,107**	**1,161**
Sand & Gravel	316	11,311	570	3,855	150
Mining	-	30	-	35,995	-
Turf	976	58,972	4,016	10,773	886
Electric Power	-	11,617	-	1,591	-
Dairy	-	11,216	9,414	131	-
Cattle Feedlots	-	85	1,755	-	-
Other	300	13,793	2,518	4,762	125
TOTAL All Sectors	**16,501**	**956,392**	**660,329**	**195,236**	**17,743**
OFFSETS TO GROUNDWATER DEMAND					
Agricultural Sector					
Incidental Recharge	1,419	467,183	250,668	22,036	2,375
Municipal Sector					
Replenishment (CAGRD)	-	35,942	394	2,796	-
Incidental Recharge	-	67,968	1,461	6,401	-
Industrial Sector					
Incidental Recharge	238	9,149	786	5,322	148
TOTAL All Sectors	**1,657**	**580,241**	**253,308**	**36,555**	**2,524**
UNREPLENISHED GROUNDWATER DEMAND*					
Agricultural Sector	520	156,125	360,391	79,748	7,758
Municipal Sector	12,970	122,151	29,142	27,148	6,448
Industrial Sector	1,354	97,875	17,487	51,785	1,013
TOTAL All Sectors	**14,844**	**376,150**	**407,021**	**158,681**	**15,219**
*Average Unreplenished Demands are not the same as average Overdraft because they do not include natural recharge components.					

Figure 2. Unreplenished Groundwater Withdrawals in the AMAs (Source: ADWR[51]).

Recognizing that the agricultural sector could continue to mine groundwater indefinitely pursuant to irrigation grandfathered rights, the Groundwater Management Act authorized ADWR, beginning in 2006, to implement a program to purchase and retire

[51] ARIZ. DEP'T OF WATER RESOURCES, GOVERNOR'S WATER AUGMENTATION, INNOVATION AND CONSERVATION COUNCIL POST-2025 AMAS COMMITTEE, *supra,* note 49, at 15.

grandfathered rights[52] and to impose a withdrawal fee in the Phoenix, Pinal and Tucson AMAs of up to $2 per acre-foot of groundwater withdrawn in the AMA to pay for the program.[53] ADWR analyzed the potential value of such a program in the Third Management Plan for the Phoenix AMA. Assuming a 20-year program and no change in the price of farmland, ADWR estimated that over the 20-year period it could purchase a total of 11,560 acres, resulting in a groundwater savings of 24,276 acre-feet per year at an average cost of $71.43 per acre-foot.[54] However, if the price of farmland doubled, the average groundwater savings would drop to 12,138 acre-feet per year at a cost of $142 per acre-foot.[55]

ADWR cautioned that before implementing a purchase and retirement program it would need to address land management and maintenance issues. It noted staffing needs, control of noxious weeds and dust, potential liability and the impact of removing the land from the local property tax base.[56] ADWR concluded that such a program would have limited success in the Phoenix AMA, especially if it included land purchases and not simply agreements to retire grandfathered rights to pump groundwater.[57]

Clearly, a significant amount of acreage cannot be purchased with the revenue produced by a fee of $2 per acre-foot of groundwater pumped. To put this fee in context, the highly- subsidized rate of CAP water for agricultural uses in 2021 is $56 per acre-foot,[58] and tap water delivered by municipal utilities can cost upward of $1,700 an acre-foot.[59]

Back in 1980, a larger fee to retire agricultural land was not thought to be necessary by the drafters of the Groundwater Management Act, who believed that by the third management period more agriculture would have been replaced by urban uses.

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[52] ARIZ. REV. STAT. ANN. § 45-566(A)(9) (2021) (authorizing purchase and retirement of grandfathered rights during Third Management Period); § 45-567(A)(8) (2021) (authorizing purchase and retirement of grandfathered rights during Fourth Management Period).

[53] ARIZ. REV. STAT. ANN. § 45-611 (2021) (authorizing levy of $2 per acre-foot per year groundwater withdrawal fees for purchasing and retiring grandfathered rights).

[54] ARIZ. DEP'T OF WATER RESOURCES, *supra* note 29, at 8-41.

[55] *Id.*

[56] *Id.* at 8-42.

[57] *Id.*

[58] CENTRAL ARIZ. WATER CONSERVATION DIST., *Central Arizona Project Final 2021-2026 Rate Schedule,* https://www.cap-az.com/documents/departments/finance/Final-CAWCD-2021-2026-Water-Rate-Schedule.pdf.

[59] The City of Phoenix's summer price is currently $1,782 per acre-foot. CITY OF PHOENIX, *Water Rate Schedule Effective Feb. 1. 2020,* https://www.phoenix.gov/waterservicessite/Documents/wsdwatrates20.pdf.

> "**A key assumption of the Code was that urban growth would largely occur on retired agricultural land**, with the water no longer needed by farms being available to serve new houses and industries. In fact, much of the new growth is occurring on native desert land rather than on retired farmland. **Development on desert land does not result in one type of demand replacing another; it results in a new demand being added to existing demands, resulting in significantly greater demands than originally assumed**."[60]

Some context here is important. The dominant crops historically grown in the Phoenix AMA are alfalfa, cotton and wheat.[61] Irrigation water duties are based on the crops historically grown in a farm unit. Alfalfa, for example, has a high consumptive use of 5 acre-feet per acre.[62] Residential uses of water are much less per acre, with ADWR recently concluding that an acre-foot of water will supply an average of three single-family homes in an AMA for a year.[63]

With growth occurring primarily on desert land rather than replacing farms, groundwater pumping for agriculture continues to be an obstacle to safe-yield, especially in the Phoenix AMA. ADWR reports that in the Phoenix AMA about 192,000 acres have been retired from irrigation since 1985, yet agricultural demand has remained stable since 2005,[64] most likely because of bringing more fallow land into production, so pumping for irrigation grandfathered rights continues to put pressure on groundwater.

Municipal water providers also contribute to unreplenished groundwater withdrawals. As shown in Figure 2, groundwater mining by the municipal sector, particularly in the Phoenix AMA, is substantial, accounting for an average of more than 122,000 acre-feet per year between 2012 and 2016. A municipal provider that is not designated as having an assured water supply may continue to pump groundwater to serve subdivisions that were platted before 1995, when ADWR adopted the Assured Water Supply Rules, without any obligation to replenish that groundwater.[65] Such a provider may also serve groundwater to water users not located on subdivided land, such high water-use data centers, which could greatly increase groundwater mining by the municipal sector. Additionally, the assured water supply rules gave many designated municipal water

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[60] ARIZ. DEP'T OF WATER RESOURCES, *supra,* note 19, at 11-6, 11-7 (emphasis added).
[61] *Id.* at 4-5.
[62] *Id.* at 4-33.
[63] ARIZ. DEP'T OF WATER RESOURCES, *How Many Homes in Arizona, On Average Share an Acre-Foot of Water Each Year,* https://new.azwater.gov/news/articles/2021-19-04.
[64] ARIZ. DEP'T. OF WATER RESOURCES, *supra,* note 19 at 11-3.
[65] ARIZ. DEP'T OF WATER RESOURCES, GOVERNOR'S WATER AUGMENTATION, INNOVATION AND CONSERVATION COUNCIL POST-2025 AMAS COMMITTEE, *supra,* note 49, at 12.

providers a predetermined "groundwater allowance," which allows the municipal provider to pump a set amount of groundwater without replenishing it.[66]

Compounding the problem of residual groundwater pumping, industrial users with grandfathered rights and withdrawal permits issued by ADWR are also not required to replenish the groundwater they pump. These industrial users include copper mining, sand and gravel operations, some power generating stations, golf courses, dairies, and cattle feedlots that are not served by a municipal water provider. As shown in Figure 2, unreplenished groundwater withdrawals by industrial users are especially high in the Phoenix and Tucson AMAs, averaging almost 98,000 acre-feet per year between 2012 and 2016 in the Phoenix AMA and 52,000 acre-feet per year in the Tucson AMA. Designated municipal providers could serve some industrial users with treated wastewater or surface water, but industrial users can pump groundwater at a fraction of the cost of municipally delivered water.

In the Third Management Plan for the Phoenix AMA, ADWR offered proposals to address increasingly troubling residual pumping that would have required new legislative authority, including:

- Requiring applicants for general industrial use permits to first use available renewable water supplies;
- Establishing replenishment requirements for municipal water providers that are not designated as having an assured water supply; and
- Implementing programs to reduce agricultural groundwater use.[67]

A Governor's Water Management Commission recommended in 2001 that, among other things, ADWR be given additional statutory authority to address the issue of unreplenished groundwater withdrawals.[68] This authority included limiting the duration of certain non-irrigation grandfathered rights and requiring that some groundwater pumpers pay an annual groundwater mining tax.[69] But legislation introduced in the 2002 legislative session to implement these recommendations failed.[70]

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[66] *Id.*

[67] ARIZ. DEP'T OF WATER RESOURCES, *supra,* note 29, at 12-8.

[68] GOVERNOR'S WATER MGMT. COMM'N., *Final Report*, Dec. 2001, https://azmemory.azlibrary.gov/digital/collection/statepubs/id/2941/.

[69] RITA PEARSON MAGUIRE, *supra,* note 13 at 379.

[70] ARIZ. STATE LEGISLATURE, 2002 Forty-fifth Legislature-Second Regular Session, Senate Bill 1344, https://www.azleg.gov/legtext/45leg/2R/bills/sb1344p.pdf; ARIZ. STATE LEGISLATURE, 2002 Forty-fifth Legislature-Second Regular Session, House Bill 2582, https://www.azleg.gov/legtext/45leg/2R/bills/hb2582p.pdf.

In the Fourth Management Plan for the Phoenix AMA, ADWR once again acknowledged that the amount of groundwater that may be pumped pursuant to grandfathered rights **"far exceeds the amount of groundwater available for pumping under safe-yield conditions**."[71] But the plan did not propose any additional programs or measures to address this issue.

It has been clear for at least 20 years that unreplenished pumping is the Achilles heel of the ability to reach safe-yield, but Arizona has been unwilling to take the steps needed to address this fundamental flaw in our formula to protect groundwater. Between 2012 and 2016, unreplenished pumping contributed over 376,000 acre-feet per year to the groundwater overdraft in the Phoenix AMA and nearly 159,000 acre-feet per year to the groundwater overdraft in the Tucson AMA. Mined groundwater is lost to the AMAs and water users forever, but under current law, that steady drain of unreplenished groundwater will likely continue indefinitely.

Recommendations to Address Long-Term Rights to Pump Groundwater

- Explore methods to reduce pumping by residual groundwater users, such as:
  - A 5% reduction in groundwater use over a five-year period;
  - A "mined groundwater" fee to make the value of groundwater more comparable to renewable water; and
  - A maximum annual allowable groundwater decline rate for wells used by residual pumpers.
- Investigate mechanisms to encourage new urban development on agricultural lands, especially lands in proximity to existing municipal providers that have access to renewable supplies and infrastructure that could be used to serve the urban development.
- Develop incentives to encourage existing industrial users to convert to renewable water supplies, such as treated wastewater, and curtail ADWR's authority to issue new industrial groundwater use permits.

[71] ARIZ. DEP'T OF WATER RESOURCES, *supra,* note 19, at 1-4 (emphasis added).

Safe-Yield Confusion Impedes Groundwater Management

> "Safe-yield is complicated, it's complex. There's not a good way of saying this AMA is this many acre-feet away from safe-yield because it's kind of a moving target. There are a lot of different ways we can look at this to better understand it, but there are also a lot of interconnected components and factors that might influence the story we might want to tell about each AMA."[72]
>
> Natalie Mast, AMA Director, Management Plans

Safe-yield is a goal, not a mandate. It is defined as a "**long-term balance** between the **annual** amount of groundwater withdrawn in the active management area and the **annual** amount of natural and artificial recharge in the active management area."[73] This definition seems straightforward enough but calculating how close we are to safe-yield is more difficult than that simple definition implies.

ADWR's capability (and desire) to project the annual overdraft in 2025 has changed over the management periods. For the Phoenix AMA, ADWR's projections of the annual overdraft in 2025 have ranged from 365,000 acre-feet in the First Management Plan[74] to 431,000 acre-feet in the Third Management Plan.[75] In the Fourth Management Plan, ADWR refrained from projecting the 2025 overdraft, concluding that "the range of potential variables and changes to policies have made it so that any projection is likely to be outdated by the time it is published."[76]

Additionally, ADWR's calculations of the components of safe-yield have varied significantly over the years. In the first, second and third management plans for the Phoenix AMA, ADWR estimated the average amount of natural recharge to be quite small, from 10,000 acre-feet annually in the First Management Plan[77] to 24,100 acre-feet in the Third Management Plan.[78] But in the Fourth Management Plan, based on hydrologic modeling, ADWR calculated that stream channel recharge in the Phoenix

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[72] ARIZ. DEP'T. OF WATER RESOURCES, Meeting of the Fifth Management Plans Safe-Yield Technical Sub-group, September 23, 2019; https://new.azwater.gov/5MP/meetings.
[73] ARIZ. REV. STAT. ANN. § 45-561 (2021) (emphasis added).
[74] ARIZ. DEP'T OF WATER RESOURCES, *Management Plan for the First Management Period Phoenix Active Management Area 1980-1990* at 23, http://infoshare.azwater.gov/docushare/dsweb/Get/Document-10006/1MP%201980-1990%20Dec.1984.pdf.
[75] ARIZ. DEP'T OF WATER RESOURCES, *supra,* note 29, at 8-41.
[76] ARIZ. DEP'T OF WATER RESOURCES, *supra*, note 19, at 11-1.
[77] ARIZ. DEP'T OF WATER RESOURCES, *supra,* note 74, at 20.
[78] ARIZ. DEP'T OF WATER RESOURCES, *supra,* note 29, at 11-15.

AMA has varied from a high of 310,031 acre-feet in 1990 to a low of 89,675 acre-feet in 1999.[79] To ADWR's credit, it is considering the responses it has received to these numbers and plans to update these figures again in the months ahead.

Similarly, in the short time since ADWR adopted the Fourth Management Plan for the Phoenix AMA in 2020, its calculation of canal seepage has changed significantly. In that published plan, canal seepage between 1985 and 2017 varied from a high of 246,247 acre-feet to a low of 73,909 acre-feet.[80] However, these numbers included some double-counting, which ADWR discovered and corrected on its online dashboard, which now shows the range of canal seepage over this period as a high of 88,002 acre-feet to a low of 70,213.[81] Less seepage means less recharge, and these new numbers that estimate significantly reduced canal seepage *more than triple* the cumulative overdraft in the AMA between 1985 and 2017, shooting up from 1,243,877 acre-feet to 3,774,474 acre-feet.

ADWR's figures for stream channel recharge and canal seepage are generated by ADWR's regional groundwater models, which have evolved and continue to evolve over time. It's certainly a good thing to have better technology and use better science, but this changing data is hard to track and can confuse all but the most intrepid followers of hydrologic modeling and safe-yield groundwater management.

Adding to the confusion of changing data, ADWR has pointed out that "there is disagreement on the appropriate time-scales for analyzing long-term overdraft."[82]

Recognizing these challenges, ADWR established a Fifth Management Plans Safe-Yield Technical Subgroup in 2019, with the goals of developing a consensus on the methodology for assessing the components of safe-yield and evaluating the long-term status of safe-yield for each AMA in a way that could be clearly communicated.[83]

ADWR's water budgets include "inflows" and "outflows" of water for each AMA.[84] Figure 3 lists the components of inflows and outflows and describes the data source for each

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[79] ARIZ. DEP'T OF WATER RESOURCES, *supra,* note 19, at 2-19, 2-20.
[80] *Id.*
[81] ARIZ. DEP'T OF WATER RESOURCES, *supra*, note 32.
[82] ARIZ. DEP'T OF WATER RESOURCES, *supra,* note 19, at 1-4.
[83] ARIZ. DEP'T OF WATER RESOURCES, Presentation to 5th Management Plans Work Group Safe-Yield Technical Subgroup Meeting, September 23, 2019, https://new.azwater.gov/sites/default/files/media/2019.09.23_SY_Subgroup_Kickoff_0.pdf.
[84] ARIZ. DEP'T OF WATER RESOURCES, Presentation to 5th Management Plans Work Group Safe-Yield Technical Subgroup Meeting, February 24, 2020, https://new.azwater.gov/sites/default/files/media/2020-02-24_SY_Components_Outflows.pdf.

component. As noted in Figure 3, the values for some of these components, including groundwater use, are based on annual reports filed by water users, while the values for other components, such as natural recharge, are derived from ADWR's regional groundwater models.

Components of ADWR's Safe-Yield Water Budget Calculation	
INFLOWS	**OUTFLOWS**
Natural	**Natural**
Groundwater Inflow[1]	Groundwater Outflow[1]
Streambed Recharge[1]	Riparian Demand[1]
Mountain-Front recharge[1]	
Artificial	**Artificial**
Incidental Recharge by Sector[2]	Groundwater Demands by Sector[2]
Canal Seepage[1]	Remediated Groundwater Use[2]
Cut to the Aquifer[2]	Poor Quality Groundwater Use[2]
CAGRD Replenishment	

[1] Derived from ADWR's Regional Groundwater models

[2] Complied from AMA Annual Reports

Figure 3. Groundwater Inflows and Outflows Data Sources.

Working through the Safe-Yield Technical Subgroup, ADWR has proposed a new method for the "long-term analysis of safe-yield" that would use a 20-year running average for the "natural components" of its water budget, such as natural recharge, and a three-year running average for the "artificial components," such as groundwater withdrawals and incidental recharge from water uses and canal seepage.[85] ADWR explains that it is proposing this new method for analyzing safe-yield because some components of its water budgets, such as stream channel recharge, vary greatly from year to year, and this new methodology would help to "smooth" the variability between wet and dry years.[86]

Not everyone supports ADWR's proposed new method for analyzing safe-yield. Some believe that the calculation of safe-yield should take into account, or at least not ignore,

[85] ARIZ. DEP'T OF WATER RESOURCES, Presentation to 5th Management Plans Work Group Safe-Yield Technical Subgroup Meeting, September 30, 2020, https://new.azwater.gov/sites/default/files/media/2020-09-30_SY_Subgroup.pdf.

[86] ARIZ. DEP'T OF WATER RESOURCES, Presentation to 5th Management Plans Work Group Safe-Yield Technical Subgroup Meeting, July 7, 2020, https://new.azwater.gov/sites/default/files/media/2020-07-07_SY_Presentation.pdf.

the cumulative overdraft that has occurred since 1980,[87] which the ADWR dashboard now shows to be 3,774,474 acre-feet for the Phoenix AMA,[88] factoring in net natural recharge, incidental recharge, and other components that reduce the overdraft.

Others would like to assess the achievement of safe-yield over an even longer period of time than that proposed by ADWR, by using a 40-year rolling average of the natural components and a five-year rolling average of the artificial components, so as to "avoid premature relaxation of conservation requirements during wet periods and over-zealous regulation during temporary dry periods."[89] It's difficult to imagine how ADWR could relax or toughen conservation requirements on a sporadic basis, given the cumbersome and time-consuming process the law requires for developing and adopting management plans. Plus, ADWR's statutory mission to reduce groundwater withdrawals does not contemplate the loosening of conservation requirements. It's also unclear whether a rolling average approach might mask the chronic lowering of groundwater levels and whether dry periods are still temporary in this time of climate change and aridification.

The debate over how to calculate safe-yield illustrates the difficulty of showing the progress made since 1980 while acknowledging that we have a long way to go. That is why the most helpful idea to come out of the Safe-Yield Technical Subgroup is ADWR's proposal for communicating to the general public its assessment of progress towards achieving the management goals. ADWR's metrics table shown in Figure 4 makes it clear that the Phoenix, Prescott and Santa Cruz AMAs are unlikely to achieve safe-yield with current practices and that the Tucson AMA is unlikely to maintain safe-yield under Colorado River shortage conditions.

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[87] PETER KROOPNICK, Hydrogeologist, Citizens Water Advisory Group, speaking at Fifth Management Plans Safe-Yield Technical Subgroup meeting, September 23, 2019.
[88] ARIZ. DEP'T OF WATER RESOURCES, *supra*, note 32.
[89] DAVID C. ROBERTS, Associate General Manager of Salt River Project, Letter to Thomas Buschatzke, Director, ADWR, November 25, 2020.

Safe- Yield Metric	Definition	AMA				
		Prescott	Phoenix	Pinal**	Tucson	Santa Cruz
Annual	Proportion of years in overdraft	✗	✗	✗	✗	✗
Long-Term Status	Overdraft status of the most recent year of long-term analysis	✗	✗	✗	✓	✗
Long-Term Direction	Direction of overdraft in the most recent 3 years of the long-term analysis	✗	✗	✓	✓	✓
Single Year Overdraft	Amount of overdraft in the most recent year of the long-term analysis	12,154	151,136	166,077	-721	9,488
% Overdraft (by Total Demand)	Single year overdraft, using the most recent year of the long-term analysis, as a percent of total water demand	35.8%	6.5%	15.3%	-0.2%	17.1%
% Overdraft (by Groundwater Demand)	Single year overdraft, using the most recent year of the long-term analysis, as a percent of groundwater demand	77.3%	16.2%	26.1%	-0.4%	56.3%
Outlook	Narrative about potential future issues that may impact the achievement or maintenance of safe-yield	°Absence of imported water supplies	°Shortage of Colorado River Water °Uncertainty re surface water supplies °Difficulty achieving goal with existing tools	°Cuts to Agricultural Pool °Shortage of Colorado River Water	°Shortage of Colorado River Water	°Sensitivity to Drought °Shallow Basins °Adjudications °IOI Agreement
Long-Term Status	What does this all mean?	Not at Safe-Yield, unlikely to achieve with current practices	Not at Safe-Yield, unlikely to achieve with current practices	Safe-Yield is not the goal	Currently at or around Safe-Yield, unlikely to maintain in Colorado River shortage conditions	Not at Safe-Yield, status is significantly impacted by drought conditions

** Safe-yield is not the goal for the Pinal AMA

Figure 4. AMA Metrics Table (Source: ADWR[90]).

It's prudent for ADWR to prepare annual water budgets and to carefully track the components of safe-yield. But with clear threats to our water supplies increasing, we cannot afford to let debates over methods of calculating safe-yield distract us from the real work at hand. As the agency responsible for interpreting safe-yield, ADWR should do so quickly and move on to the core issue of preventing unsustainable groundwater level declines.

Subbasin Groundwater Conditions Differ Substantially Within an AMA

Disagreements over how safe-yield is calculated aside, the management goal and all of the proposed calculation methods fail to address the fact that the AMAs are not internally uniform. As shown in Figure 5, there are three distinct water-bearing units in the Phoenix AMA: the upper, middle and lower alluvial units.

[90] ARIZ. DEP'T OF WATER RESOURCES, Safe-Yield Metrics Table, https://new.azwater.gov/sites/default/files/media/SYTable_1.pdf.

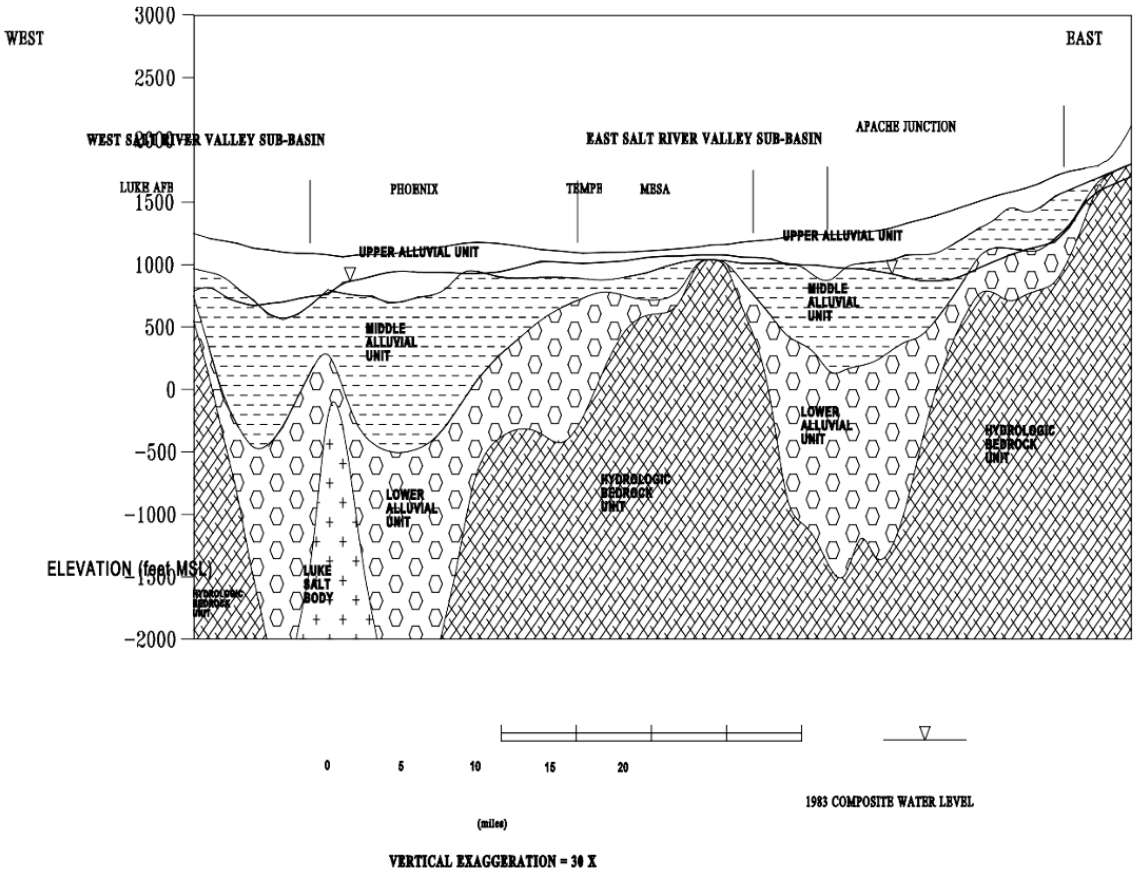

Figure 5. Hydrogeologic cross-section, Phoenix AMA (Source: ADWR[91]).

According to ADWR, most of the groundwater withdrawn in the Phoenix AMA is from wells in the middle alluvial unit.[92] It seems essential then to determine if the water budget inflows, including natural streambed recharge and incidental recharge from agriculture (the largest source of recharge), benefit the middle portions of the alluvial groundwater basins in the AMA from which most of the groundwater gets pumped. It also seems prudent to consider whether megadroughts, which Ian James of the *Arizona Republic* reports "have been supercharged by humanity's heating of the planet,"[93] will further reduce the amount of streambed recharge. As reported by Tony Davis of the *Arizona Daily Star*, a new study by the Bureau of Reclamation "warns that the hottest

[91] ARIZ. DEP'T OF WATER RESOURCES, *supra,* note 19, at 2-8.
[92] *Id.* at 2-7.
[93] IAN JAMES, *Supercharged by Climate Change, 'Megadrought' Points to a Drier Future in the West*, Arizona Republic*,* May 6, 2020, https://www.azcentral.com/story/news/local/arizona-environment/2020/05/06/western-megadrought-centuries-worsened-climate-change-global-warming/3036460001/.

weather Tucson is likely to get in the future would reduce natural replenishment of the aquifer by rainfall and runoff down our streams and washes."[94]

Depths to groundwater within the Phoenix AMA also vary greatly. As shown in Figure 6, depth to groundwater in 2014 varied from 100 feet near the Salt River bed to as much as 1,000 feet in the Carefree area.

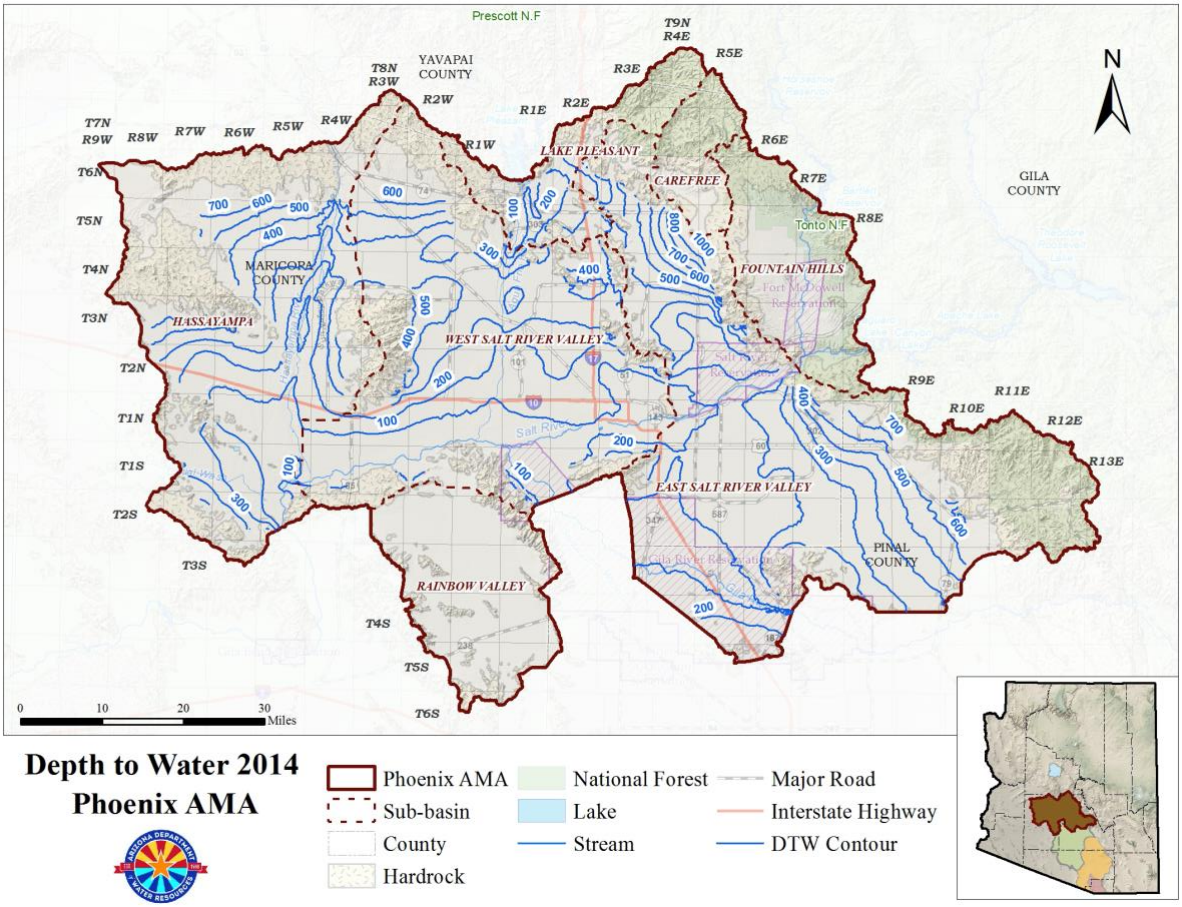

Figure 6. Depth to Water 2014, Phoenix AMA (Source: ADWR[95]).

Based on a recent report by ADWR,[96] the Kyl Center for Water Policy has developed an interactive, web-based map to visualize depth to water level changes within Arizona's

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[94] TONY DAVIS, *Climate Change Could Reduce Tucson Groundwater Supplies New Study Finds,* Arizona Daily Star, March 20, 2021, https://tucson.com/news/local/climate-change-could-reduce-tucson-groundwater-supplies-new-study-finds/article_bcfa05dd-57f4-58be-ad52-1c685a43114d.html.

[95] ARIZ. DEP'T OF WATER RESOURCES, *supra,* note 19, at 2-12.

[96] ARIZ. DEP'T OF WATER RESOURCES, *Statewide Groundwater Level Changes in Arizona,* Report No. 18, December 2020; https://new.azwater.gov/sites/default/files/2018WLCR_Final_0.pdf.

groundwater basins and AMAs.[97] Utilizing ADWR's automated groundwater site inventory and index wells, the map reinforces the conclusion that depths to groundwater vary significantly across the Phoenix AMA. Not surprisingly, as shown in Figure 7, depths to groundwater are shallower in wells near the Salt River channel but increase in wells farther away from that channel, further confirming that recharge in one area doesn't benefit the entire AMA.

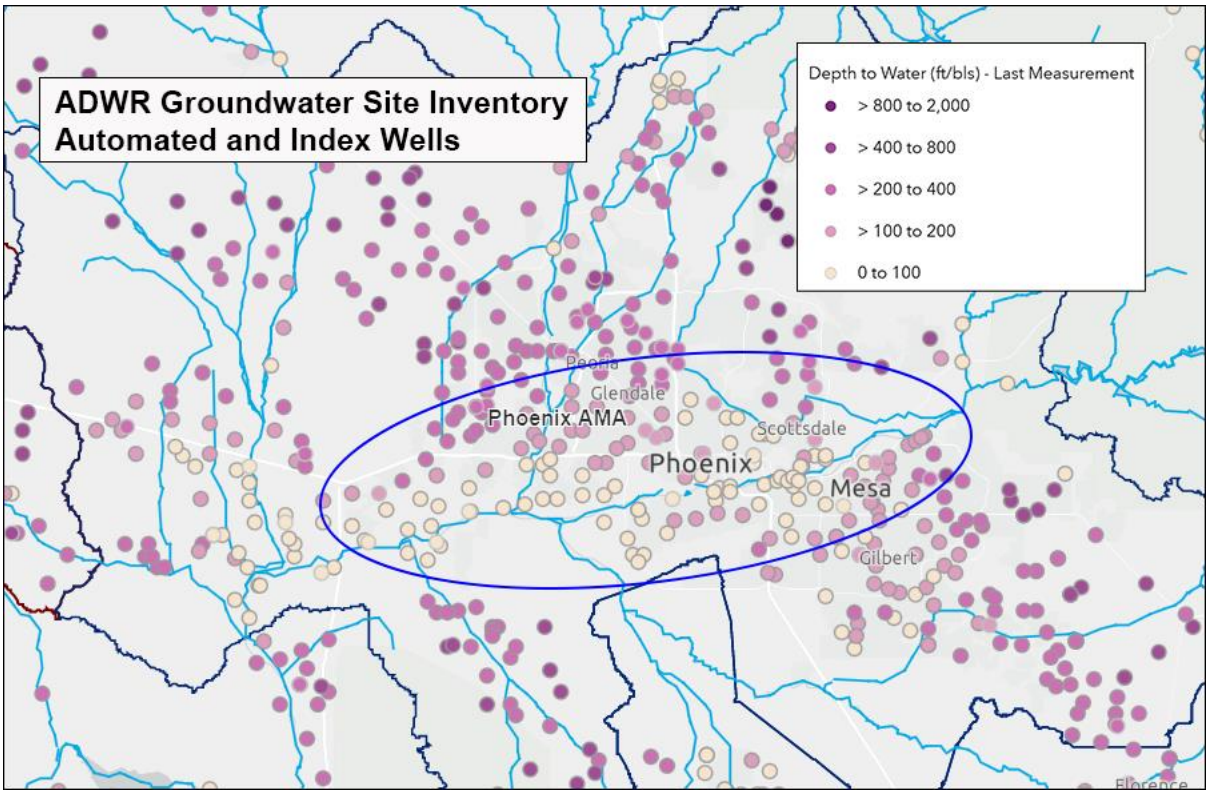

Figure 7. ADWR Groundwater Site Inventory Automated and Index Wells (Source: Arizona Water Blueprint; ADWR Data).

The map also illustrates that groundwater conditions differ considerably across an AMA and the AMA-wide safe-yield goal does not address areas where groundwater levels are declining. A groundwater aquifer is not like a sponge. If a sponge dries out, it will still absorb water later. If an aquifer is dewatered, however, the spaces between the rock and gravel collapse, leading to aquifer compaction, the inability of the aquifer to accept water in the future, and land subsidence and earth fissures.

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[97] ASU KYL CENTER FOR WATER POLICY AT MORRISON INST., *Arizona Water Blueprint, Groundwater Level Changes in Arizona Subbasins,* https://asu.maps.arcgis.com/apps/webappviewer/index.html?id=ba1b9f091a4c42669a8d36c2e966c11.

Meanwhile, the municipal sector continues to grow. In the Phoenix AMA, it is expected to be responsible for 58% of the AMA's water demand by 2040.[98] So, even if some calculation of safe-yield is eventually reached, is it possible to maintain it as growth continues, urban demands for water increase and Colorado River water supplies decline? Scientists at Utah State University have warned, "The ongoing Millennium Drought may not be a drought at all, but instead may represent the 'new abnormal' to which the basin must adjust."[99]

Recommendations to Improve the Safe-Yield Goal

- Refine the AMA-wide safe-yield goal to:
  - Reflect the hydrogeologic differences within each AMA.
  - Consider the rate of recharge in each subbasin of the AMA.
  - Prevent declines of groundwater levels in each subbasin of the AMA, taking into account existing uses of groundwater, rates of recharge and projected declines of Colorado River water.
- Give ADWR the financial resources to manage groundwater at a more local level using a variety of methods such as:
  - More stringent well spacing requirements;
  - Limits on new wells;
  - Incentives and methods to rebuild groundwater resources.
- Require ADWR to develop a yearly metrics table to communicate what's happening in each AMA, evaluate the effectiveness of management programs, and raise awareness of problems and potential solutions.

The Limits of Safe-Yield

> "Although the specifics of calculating safe-yield are daunting, the theory of safe-yield is simple. It is closely related to the **concept of sustainability, which means that resource availability does not diminish over time**."[100]
>
> Arizona Department of Water Resources

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[98] ARIZ. DEP'T. OF WATER RESOURCES, *supra,* note 19, at 11-8.
[99] CENTER FOR COLORADO RIVER STUDIES, *supra,* note 2, at 113.
[100] ARIZ. DEP'T OF WATER RESOURCES, *Fourth Management Plan for the Tucson Active Management Area, May 13, 2016* 12-2, http://infoshare.azwater.gov/docushare/dsweb/Get/Document-10038/TAMA_4MP_Complete.pdf (emphasis added).

That statement seems so obvious, but unfortunately, the high-minded goal of safe-yield is not preventing the diminishment of groundwater resources in the AMAs. Recognizing this, under the auspices of the Governor's Water Augmentation, Innovation and Conservation Council,[101] ADWR has established a Post-2025 AMAs Committee to "identify water management challenges facing the AMAs and generate strategic solutions for 2025 and beyond."[102] The Committee Chairs, working with ADWR and engaged Committee members, have developed thoughtful issue briefs on groundwater problems not addressed by safe-yield. One of these ongoing problems is the unreplenished or residual pumping of groundwater discussed earlier in this report. Another problem discussed by the Committee is the issue of "hydrologic disconnect." Hydrologic disconnect is a short-hand way of referring to storing water underground (through artificial recharge) and pumping it back out from an area that could not have benefited hydrologically from the recharge.

Hydrologic Disconnect Leads to Groundwater Depletion

In 1986, the Arizona Legislature established a program to allow water users to "store" surface water and treated wastewater underground when those supplies could not be put to direct use. Storage occurs using constructed facilities or river channels that allow the water to percolate underground. The program was refined by the legislature in 1994 with passage of the Underground Water Storage, Savings and Replenishment Act.[103] The expanded program included the concept of "in-lieu" recharge, where surface water is delivered to irrigation districts for use by farmers, who then reduce their groundwater pumping by that amount. Through 2017, over 11 million acre-feet have been stored (or saved) underground in the AMAs through direct and in-lieu recharge.[104] Although stored in groundwater aquifers, the water is known as "stored water," which does not count as groundwater and may be "recovered" (meaning pumped) at any time by the holder of the storage credit.[105]

While this program has boosted future water supplies for municipal providers and industries, the law unfortunately allows the stored water to be recovered from any place

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[101] GOV. DOUGLAS A. DUCEY, *State of Arizona Executive Order 2019-02,* http://infoshare.azwater.gov/docushare/dsweb/Get/Document-11355/executive_order_02-2019.pdf.
[102] ARIZ. DEP'T OF WATER RESOURCES, Post-2025 AMAs Committee, https://new.azwater.gov/sites/default/files/Post%202025%20AMAs%20Committee%20Overview.pdf.
[103] Ariz. Rev. Stat. Ann., Title 45, Chapter 3.1 (2021).
[104] ARIZ. DEP'T OF WATER RESOURCES, GOVERNOR'S WATER AUGMENTATION, INNOVATION AND CONSERVATION COUNCIL POST 2025 AMAS COMMITTEE, Issue Brief #1, Hydrologic Disconnect at 1, https://new.azwater.gov/sites/default/files/ISSUE%20BRIEF%20–%20Hydrologic%20Disconnect%20-%20Final.pdf.
[105] ARIZ. REV. STAT. ANN. § 45-852.01 (2021).

within the same AMA in which it was stored. In the early years of underground storage, efforts were made to get as much water underground as possible. This led to the construction of storage sites in places where it was easiest to store water because of the storage sites' proximity to surface water canals. But these storage locations are not necessarily where the users of the stored water have their wells, and there is considerable concern that this hydrologic disconnect will lead to localized groundwater declines and related subsidence, aquifer compaction and water quality impacts. As reported in the Committee's Issue Brief:

> "There is a lack of comprehensive analysis or documentation as to the exact extent to which the hydrologic disconnect will impact groundwater conditions. … Nevertheless, there is little question that a large and persistent disconnect between recharge and recovery could lead to localized issues. Existing empirical data and modeling related to other water management efforts suggest that in certain cases there is a significant benefit to aligning the withdrawals of groundwater to the location of recharge and replenishment."[106]

In the Phoenix AMA, for example, water may be stored underground in the Hassayampa Subbasin but be pumped nearly 100 miles away from groundwater aquifers in the East Salt River Valley Subbasin that could not have benefited from the storage of that water in the Hassayampa Subbasin. Obviously, the water being pumped in this situation is groundwater, not stored water, and that pumping impacts other groundwater users in the area.

Another form of hydrologic disconnect involves the Central Arizona Groundwater Replenishment District (CAGRD), which must replenish (recharge) groundwater pumped to serve CAGRD member subdivisions and municipal water providers. A case in point can be found in the Tucson AMA, where most of CAGRD's replenishment obligations occur from groundwater pumping in the Upper Santa Cruz Subbasin, while CAGRD replenishes water for this pumping primarily in the Avra Valley Subbasin.[107] In the Green Valley-Sahuarita area located in the Upper Santa Cruz Subbasin, "groundwater levels are falling anywhere from 2 to 7 feet yearly in wells serving three private water companies that supply nearly 60 subdivisions belonging to the

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[106] ARIZ. DEP'T OF WATER RESOURCES, GOVERNOR'S WATER AUGMENTATION, INNOVATION AND CONSERVATION COUNCIL POST-2025 AMAS COMMITTEE, *supra,* note 104, at 3.

[107] https://www.cap-az.com/documents/meetings/2021-04-15/1858-041521-WEB-Final-Packet-CAGRD.pdf.

replenishment district."[108] While pumping by others may be contributing to these dropping water levels, replenishment in the areas of these wells would certainly be beneficial.

Recommendations to Limit Hydrologic Disconnect

- Create incentives to store water in locations of the AMA experiencing groundwater declines and recover the water in areas of the AMA where groundwater levels are rising.
- Create disincentives to recover stored water in areas experiencing groundwater level declines. Such disincentives might include increasing the "cut to the aquifer," which is currently 5%. The cut to the aquifer may not be pumped but must be left behind to benefit the aquifer.
- Require that before ADWR issues a Certificate or Designation of Assured Water Supply based on membership in CAGRD, CAGRD must have a replenishment facility in the area of impact where groundwater will be pumped to serve the subject development.

Groundwater as an Assured Water Supply is Not Sustainable

Ironically, one of the Groundwater Management Act's signature accomplishments, the assured water supply requirement, is becoming one of the biggest obstacles to sustainable groundwater use.

The prohibition on the sale of subdivision lots that lack a 100-year assured water supply was not only meant to protect consumers but also to influence the speed and location of urban growth.[109] The Act's drafters intended that an assured water supply would consist primarily of surface water so that new development would not aggravate already severe groundwater overdraft problems.

But when ADWR proposed Assured Water Supply rules in 1988 that would have restricted the decline of groundwater levels, they were met with fierce opposition from water providers and developers in areas that lacked access to surface water. Ultimately, in 1993, the legislature allowed groundwater to continue to be used as an assured water supply for new subdivisions if the groundwater would be replenished (recharged) later

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[108] TONY DAVIS, *Ancient Aquifers are Dropping As Tucson's Suburbs Pump Groundwater*, Arizona Daily Star, Nov. 16, 2019, https://tucson.com/news/local/ancient-aquifers-are-dropping-as-tucsons-suburbs-pump-groundwater/article_f7d43ecf-d7e5-586c-ab4a-62524d5a9427.html.

[109] ARIZ. GROUNDWATER MGMT. STUDY COMM'N., *supra,* note 7, at V-16.

by the Central Arizona Water Conservation District (CAWCD) that operates the Central Arizona Project. At the time, it was thought that subdivisions served with groundwater would eventually transition to renewable water supplies, "an important strategy in reducing the long-term reliance on groundwater."[110] The responsibility of CAWCD to purchase water supplies and replenish groundwater has become known as the Central Arizona Groundwater Replenishment District (CAGRD), although CAGRD is not a separate entity but is a responsibility of CAWCD.[111]

The establishment of CAGRD enabled development in groundwater-dependent areas of three AMAs to expand and freed ADWR to adopt new assured water supply rules in 1995. One provision of the rules has significant consequences for groundwater sustainability in the AMAs. As part of demonstrating an assured water supply, an applicant is required to show, among other things, that sufficient water is physically available to meet the applicant's estimated water demands for at least 100 years. Rule R12-15-716 explains how ADWR will determine the "physical availability" of groundwater. This rule allows the applicant to rely on groundwater to be withdrawn from depths of up to 1,000 feet below the land surface in the Phoenix, Tucson and Prescott AMAs and from up to 1,100 feet below land surface in the Pinal AMA. These numbers are not based on hydrological principles of the sustainable amount of groundwater that an aquifer can yield. Rather, they are arbitrary numbers picked because they are less than the 1,200-foot depth to groundwater that was permitted under the state's 1973 "adequate" water supply program, in which 1,200 feet was based on the deepest well in the state at the time.[112]

The potential consequences of allowing so much groundwater to be withdrawn from depths of up to 1,100 feet below land surface should be every bit as concerning as falling Lake Mead water levels. As Lake Mead's water level falls, the supply of Colorado River water that can be delivered decreases accordingly. Similarly, as groundwater levels decline, the availability of this resource for the future is severely reduced, and like the over-allocated Colorado River, Arizona's groundwater supplies are already over-committed in some areas, including the Pinal AMA.

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[110] ARIZ. DEP'T OF WATER RESOURCES, *supra,* note 29 at 8-4.

[111] A detailed analysis of CAGRD and its impact can be found in *The Elusive Concept of an Assured Water Supply, the Role of CAGRD and Replenishment,* ASU Kyl Center for Water Policy, Fall 2019, Kathleen Ferris & Sarah Porter. https://morrisoninstitute.asu.edu/sites/default/files/kyl_center_elusive_concept_101619.docx.pdf.

[112] RITA PEARSON MAGUIRE, *supra,* note 13, at 364.

The Pinal AMA Predicament

While the Pinal AMA does not have a safe-yield management goal, the assured water supply requirement still applies in that AMA. For many years, ADWR issued Analyses, Certificates and Designations of Assured Water Supply (collectively referred to as assured water supply determinations) in the Pinal AMA, just as the agency has done in other AMAs. But in 2019, after improved hydrological modeling efforts, ADWR determined that it had "overallocated" the available groundwater supplies in much of the AMA. ADWR's "2019 Pinal Model and 100-Year AWS Projection Technical Memorandum"[113] showed less groundwater is physically available than previously thought, with an "unmet demand" (a shortfall of groundwater available) of over eight million acre-feet after 100 years of pumping. Of this amount, nearly two million acre-feet are associated with assured water supply determinations for subdivisions, master-planned communities and municipal water providers.[114] As a result, new residential growth in the Pinal AMA has come to a standstill, while stakeholders and ADWR try to figure out how to solve the problem.

Even if a "work-around" were possible, what would all the increased groundwater pumping to serve new subdivisions and municipal development mean for the long-term future of the Pinal AMA and the sustainability of its groundwater supplies? ADWR calculates that the total demand for the issued determinations of assured water supply in the Pinal AMA model area is 214,491 acre-feet annually (more than 21 million acre-feet over 100 years).[115] It's unclear how much of that groundwater CAGRD would be required to replenish because the replenishment obligation is less for assured water supply determinations issued prior to October 1, 2007, when ADWR amended its rules.

In its most recent Plan of Operation, CAGRD estimated its annual replenishment obligation for the Pinal AMA to be only 5,600 acre-feet through 2034, but CAGRD estimates its replenishment obligation based on historical water use and growth projections, rather than the amount of groundwater included in assured water supply

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[113] ARIZ. DEP'T OF WATER RESOURCES, 2019 Pinal Model and 100-Year Assured Water Supply Projection Technical Memorandum (October 11, 2019), http://infoshare.azwater.gov/docushare/dsweb/Get/Document-11793/2019_Pinal_Model_and_100-Year_AWS_Projection-Technical_Memorandum.pdf.

[114] *Id.* at 29.

[115] ARIZ. DEP'T. OF WATER RESOURCES, Presentation to House Ad Hoc committee on Groundwater Supply in Pinal County, October 11, 2019, https://new.azwater.gov/sites/default/files/10.11.19%20Pinal_Ad_Hoc_Committee_presentation_FINAL.pdf.

determinations.[116] According to the Post-2025 AMAs Committee's Issue Brief, "CAGRD appears to have sufficient supplies to meet its annual replenishment obligations until 2050."[117] However, the amount of groundwater use contemplated by many of the assured water supply determinations in the Pinal AMA, as well as many assured water supply determinations in the Phoenix and Tucson AMAs, is not included in CAGRD's 2015 Plan of Operation because that plan does not cover subdivisions projected to enroll in CAGRD after 2024.[118]

The Post-2025 AMAs Committee has examined the water supplies available to CAGRD and, in its issue brief on CAGRD Replenishment and Water Supplies, the Committee reports:

> "[T]he quantity and accessibility of renewable supplies realistically available in the future are as uncertain for the CAGRD as for other water users. Fewer available water supplies for acquisition will likely lead to increased competition among the CAGRD and other entities seeking additional supplies for future use, including large industrial users and municipal and private water utilities … The difficulties of acquiring these supplies beyond 2025 are compounded by the current complexities and contention surrounding the transfer of Colorado River water from the river to Central Arizona. Opposition from On-river interests to these Colorado River mainstem transfers and the increasing cost of such water supplies may also have an impact on future CAGRD acquisition activities."[119]

If CAGRD fails to acquire or identify the near-term availability of the necessary water supplies for replenishment, the law states that the Director of ADWR may, after a complicated process involving public hearings, reject a new plan or reverse the decision approving a Plan of Operation.[120] If that happens, all Designations based on membership in CAGRD expire and no additional subdivisions may join CAGRD.[121] But that worst-case outcome would not halt subdivisions that are already members of

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[116] CENTRAL ARIZONA WATER CONSERVATION DISTRICT, CENTRAL ARIZONA GROUNDWATER REPLENISHMENT DISTRICT, 2015 Plan of Operation, 3-7 (2014), https://www.cagrd.com/documents/plan-of-operations/2015-CAGRD-Plan-of-Operation.pdf.

[117] ARIZ. DEP'T OF WATER RESOURCES, GOVERNOR'S WATER AUGMENTATION, INNOVATION AND CONSERVATION COUNCIL POST 2025 AMAS COMMITTEE, *supra,* note 103, Issue Brief #5, CAGRD Replenishment and Water Supplies at 23.

[118] CENTRAL ARIZ. WATER CONSERVATION DIST., *supra,* note 115, at 3-1, 3-2.

[119] ARIZ. DEP'T OF WATER RESOURCES, GOVERNOR'S WATER AUGMENTATION, INNOVATION AND CONSERVATION COUNCIL POST 2025 AMAS COMMITTEE, *supra,* note 117, at 23 (footnotes omitted).

[120] ARIZ. REV. STAT. ANN. §45-576.03 (2021).

[121] ARIZ. REV. STAT. ANN. §45-576.06 (2021).

CAGRD, even if homes have not been built there, and CAGRD's obligation to find water supplies to meet the replenishment obligations of those current members would still continue indefinitely.

According to CAGRD's 2015 Plan of Operation, in the Pinal AMA alone nearly 90% of the lots currently enrolled in CAGRD are unconstructed. That's 56,693 lots out of the 63,353 enrolled.[122] Meanwhile, experienced political observers question whether the Director of ADWR would be inclined to halt an industry that has historically been such a large part of Arizona's economy. Aside from the obvious unlikelihood that a political appointee would decide to shut down development based on CAGRD, why would we want this draconian result and the conflicts that would ensue? As Senator Jon Kyl has noted, shouldn't we try to stay "a step ahead of the game and confront issues before they become crises?"[123]

Up Next: The Phoenix AMA

What's happening in the Pinal AMA is a harbinger for the other AMAs. The Phoenix AMA comprises seven groundwater subbasins, each with varying hydrogeologic conditions that are influenced by a number of factors such as depth to groundwater, withdrawals and recharge, surface water, subsidence potential and groundwater quality.[124] ADWR has estimated the volume of water in storage to a depth of 1,000 feet below land surface in the Phoenix AMA to be approximately 84.5 million acre-feet, but cautions that "some portion of this volume may be physically or practically unrecoverable."[125] In the Third Management Plan for the Phoenix AMA, ADWR warned that "most groundwater is too deep to be pumped efficiently," and "manmade and natural causes have rendered much groundwater of insufficient quality for many uses without costly treatment."[126] On top of that, the amount of groundwater in storage varies significantly among the AMA subbasins, as does the quality of the groundwater. As illustrated in Figure 8, wells must be designed to account for aquifer layers to prevent the infiltration of poor quality water. But even properly designed wells may have to be redesigned to deal with changing quality as more and more groundwater is pumped.

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[122] CENTRAL ARIZONA WATER CONSERVATION DISTRICT, CENTRAL ARIZONA GROUNDWATER REPLENISHMENT DISTRICT, *supra,* note 115 at 3-1. Many of these lots may pre-date 2007, meaning they could develop on unreplenished groundwater.

[123] JOSHUA BOWLING, *Buckeye is the Nation's Fastest-Growing City, But it Doesn't Have the Water to Keep it Up*, Arizona Republic, Feb. 11, 2020, https://www.azcentral.com/in-depth/news/local/arizona-environment/2020/02/10/buckeye-nations-fastest-growing-city-must-find-more-water-keep-growing/1308129001/.

[124] ARIZ. DEP'T. OF WATER RESOURCES, *supra,* note 19, at 2-6.

[125] *Id.* at 2-21

[126] ARIZ. DEP'T. OF WATER RESOURCES, *supra,* note 29, at 2-1.

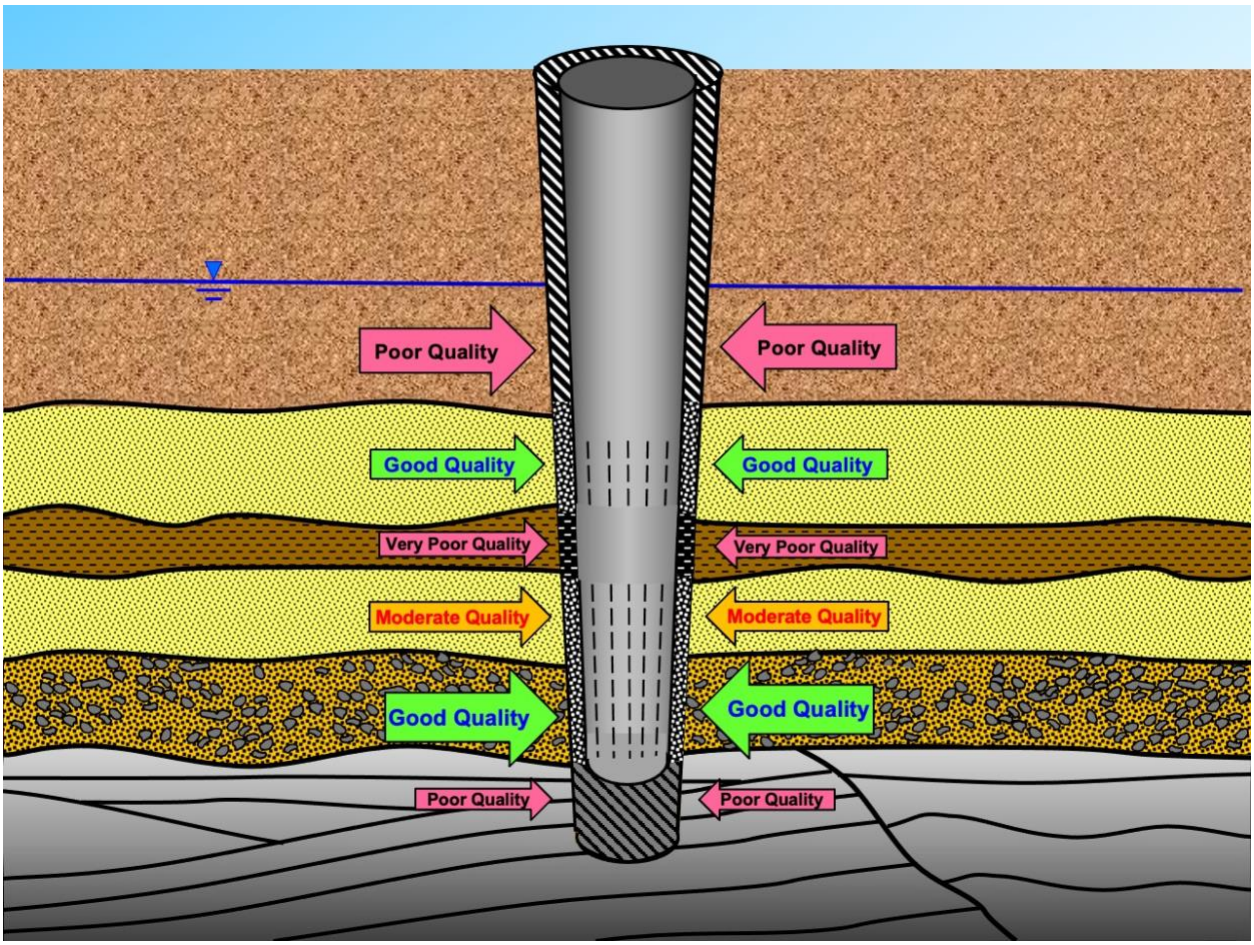

Figure 8. Wells must be designed to account for aquifer layers to prevent the infiltration of poor quality water (Source: Clear Creek Associates).

The Hassayampa Subbasin

ADWR has estimated the amount of groundwater in storage in the Hassayampa Subbasin to be 18,714,000 acre-feet.[127] But a review of ADWR's records shows that the agency has already allocated almost two-thirds (over 11 million acre-feet) of this amount of groundwater, under Analyses of Assured Water Supply for master-planned communities (MPCs) in the Hassayampa Subbasin. These are huge proposed developments, one of which has been described as comparable in size and population to the City of Tempe.[128] Making development on desert land at that scale even more

[127] ARIZ. DEP'T OF WATER RESOURCES, *supra,* note 19, at 2-21.
[128] Catherine Reagor, *Bill Gates Invests $80 Million in Real Estate on Phoenix Area's Western Edge*, Arizona Republic (November 8, 2017; updated November 16, 2017), https://www.azcentral.com/story/money/real-estate/catherine-reagor/2017/11/08/bill-gates-cascade-invests-belmont-real-estate-development-near-phoenix/842280001/.

tenuous is the possibility that, as in the Pinal AMA, the amount of groundwater in storage in the Hassayampa subbasin is considerably less than ADWR currently estimates. ADWR's models project groundwater availability for 100 years, but the agency's modeling capabilities are constantly changing, and models are imperfect at predicting the future. It is quite likely that not all of the groundwater in storage can be accessed or used due to impermeable layers, poor quality, or ongoing pumping by non-assured water supply groundwater users. Summing up the weaknesses of water modeling, Eric Holler, a retired Bureau of Reclamation engineer, observed:

> "You have to have a well-calibrated model to look ahead even 20 years. Forty years, forget about it. I wouldn't bet 100 bucks on a future like that."[129]

Currently, there is no surface water supply available for municipal use in the Hassayampa Subbasin.[130] As competition, anxiety over water transfers, megadrought and climate change limit available supplies, it is extremely doubtful that CAGRD will be able to acquire the water necessary to replenish all of the groundwater for all of the proposed master-planned communities. The City of Buckeye, which would be responsible for serving water to many of these MPCs, finalized a Water Resources Master Plan in 2020 that points out:

> "The CAGRD groundwater replenishment requirement of all of these MPCs significantly exceeds the volume of water that may be available from the CAGRD. Without a change in direction, the physical groundwater supply underneath Buckeye will decrease and will not be sustainable."[131]

At the same time, pumping so much groundwater would have serious consequences. As Buckeye's Water Resources Master Plan reports, groundwater depletion can lead to fissures in developed areas that would significantly reduce property values, soil consolidation that reduces the ability of the ground to hold water, limitations on additional development without a physical groundwater supply, and declines in water production and quality changes as the saturated thickness of the aquifer changes.[132]

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[129] TONY DAVIS, *supra,* note 93.

[130] The City of Buckeye holds a subcontract for 68 acre-feet of CAP water. The U.S. Secretary of the Interior recently approved an allocation to the City of Buckeye of 2,786 acre-feet of Non-Indian Agricultural (NIA) CAP water, but it is unclear how CAP water would ever be delivered to the City. https://www.federalregister.gov/documents/2021/01/15/2021-01089/central-arizona-project-arizona-water-allocations.

[131] CITY OF BUCKEYE, *Buckeye Water Resources Master Plan, Final Draft*, *Executive Summary,* February 2020*,* at ES-1.

[132] *Id.* at ES-2.

The City has adopted a plan to move it from total dependence on groundwater, but according to reporting by Joshua Bowling in the *Arizona Republic*, to do that, Buckeye "would have to pay at least $610.5 million in up-front costs alone," with operating costs reaching from $29.3 million to $34.6 million per year.[133] It is unclear how the City would finance these costs.

The East and West Salt River Valley Subbasins

The problems associated with groundwater as an assured water supply also exist elsewhere in the Phoenix AMA. In the West Salt River Valley Subbasin, for example, many water users lack access to renewable water supplies and rely heavily on groundwater.[134] These water users include municipal providers not designated as having an assured water supply that may continue to serve groundwater to existing subdivisions and to new developments that become members of CAGRD.

Even municipal water providers designated as having an assured water supply are allowed to pump a quantified amount of groundwater under the assured water supply rules. This amount of groundwater, known as the groundwater allowance, is "designed to help municipal providers transition from groundwater to renewable supplies."[135] A review of ADWR's records shows that the agency has allocated a combined total of more than four million acre-feet over 100 years under designations of assured water supply in the Phoenix AMA.

In addition to these Designations, ADWR has issued other assured water supply determinations based on groundwater in the East and West Salt River Valley Subbasins. As detailed in ADWR's updated Salt River Valley Groundwater Flow Model of July 2010, these groundwater demands amount to 26,981,200 acre-feet over 100 years.[136]

In total, ADWR has allocated **at least 42 million acre-feet of groundwater over 100 years** under assured water supply determinations in the Hassayampa and the East and

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[133] JOSHUA BOWLING, *"Breathing room": Buckeye Adopts a Plan to Find More Water as City Rapidly Expands,* Arizona Republic, April 28, 2020, https://www.azcentral.com/story/news/local/southwest-valley/2020/04/28/breathing-room-buckeye-adopts-plan-find-more-water-city-grows/5167470002/.
[134] ARIZ. DEP'T OF WATER RESOURCES, *supra,* note 19, at 2-14.
[135] *Id.* at 11-4.
[136] ARIZ. DEP'T OF WATER RESOURCES, *A Salt River Valley Groundwater Flow Model Application 100-Year Predictive Scenarios used for the Determination of Physical Availability in the Phoenix Management Area, Modeling Report No. 22, July 2010, Appendix A,* https://new.azwater.gov/sites/default/files/Modeling_Report_22_2.pdf.

West Salt River Valley Subbasins of the Phoenix AMA. This alarming quantity does not include the groundwater that will continue to be used by residual groundwater pumpers as long as they have access to it. In 2019 alone, the agricultural and industrial sectors pumped over 411,000 acre-feet of groundwater in the Phoenix AMA,[137] and residual pumping by these sectors could continue indefinitely under current law.

When CAGRD was established in 1993, it might have been thought that developments served with groundwater would transition to a renewable supply. That now seems unlikely given the vast amount of groundwater that has been allocated to existing CAGRD member subdivisions and proposed master-planned communities that will rely on CAGRD, the increasing difficulty of acquiring alternative supplies, and the lack of incentives for municipal water providers to find alternative supplies.

The amount of groundwater currently pumped to serve CAGRD subdivisions and municipal providers is quite small in comparison to the amount of groundwater pumped by other users.[138] But the startling amount of groundwater that has been allocated under assured water supply determinations should give every Arizonan pause.

Arizona's leaders, past and present, recognize that we have a problem. Former Governor and U.S. Secretary of the Interior Bruce Babbitt says, "What we've done is now we've set a train in motion that is going to cause a train wreck. CAGRD is allowing development to go forward, with a whole set of unrealistic assumptions. …"[139] "it's building a tower of expectations which is going to collapse."[140] Arizona House Speaker Rusty Bowers calls CAGRD "the weakest link" in the state's entire water management system.[141] And former Arizona Senator Jon Kyl reminds us that "a lot of the groundwater comes from aquifers that are so deep, they're never going to be replenished. It took them millions of years to fill with water. Whatever we take out of there, that's it. There's not going to be more."[142]

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[137] ARIZ. DEP'T OF WATER RESOURCES, *supra*, note 32.

[138] CENTRAL ARIZ. WATER CONSERVATION DIST., CAGRD and Underground Storage Committee Meeting April 15, 2021, https://www.cap-az.com/documents/meetings/2021-04-15/1858-041521-WEB-Final-Packet-CAGRD.pdf.

[139] TONY DAVIS, *Arizona's Water System for Suburban Growth Heads Toward Train Wreck,* Arizona Daily Star*,* Jan. 26, 2020, https://tucson.com/news/local/arizonas-water-system-for-suburban-growth-heads-toward-train-wreck-babbitt-says/article_ee1b84b9-7977-5ebc-8bd7-17f17833fc48.html.

[140] TONY DAVIS, *Water Management Fixes Won't Come Soon for Arizona Experts Say*, Arizona Daily Star*,* Feb. 10, 2020, https://tucson.com/news/local/water-management-fixes-wont-come-soon-for-arizona-experts-say/article_60fa6f9c-1228-5278-be26-a2a6e85eb321.html.

[141] TONY DAVIS, *supra,* note 139.

[142] JOSHUA BOWLING, *supra,* note 122.

Recommendations to Prevent Over-Reliance on Groundwater as an Assured Water Supply

- Require ADWR to complete an updated hydrologic model of each subbasin in Phoenix, Pinal and Tucson AMAs to determine the amount of groundwater in storage and the acceptable depth to which groundwater may be withdrawn in order to preserve a sustainable supply of groundwater indefinitely. The acceptable depth to groundwater should consider:
    - Current uses of groundwater in the subbasin and the extent to which those uses are expected to continue in the future.
    - The amount of natural and artificial recharge reaching the aquifers in the subbasin.
    - Whether the subbasin has acceptable sites available for underground storage projects and the amount of water that could be stored at those sites.
- Pause the issuance and extensions of Analyses of Assured Water Supply based on groundwater until ADWR completes an updated hydrologic model for the subbasin in which the land is located to determine the amount of groundwater in storage in the subbasin and the sustainable depth to which groundwater may be withdrawn.
- Require ADWR to deny an application for a Certificate of Assured Water Supply based on groundwater for a subdivision in the Phoenix, Pinal or Tucson AMA if the subdivision for which the Certificate is sought is located in a subbasin in which there is no replenishment site available for CAGRD to replenish the excess groundwater that would be used by the subdivision.
- Require ADWR to undertake a more rigorous examination of how much water for replenishment is realistically available for acquisition by CAGRD.
- Require master-planned communities to acquire their own water supplies for direct use or replenishment by CAGRD, thus reducing CAGRD's water acquisition needs and costs.

Conclusion

The Groundwater Management Act spurred a new era of water management in Arizona's most populous areas. Without the Act, groundwater withdrawals in the AMAs over the last 40 years would have been far, far greater. More land would have been cleared for farms, new high-capacity wells would have been drilled for agricultural, municipal and industrial use, unrestrained by any limits, and the aquifers would be in critical condition. Conservation requirements, while perhaps flawed, have helped to increase efficiency and reduce demand, and municipal water providers have invested

billions of dollars in treatment plants required to use CAP water and reclaimed water as alternatives to groundwater. They have also constructed projects to store surface water and reclaimed water underground when those supplies could not be put to immediate use, so they can be called upon when inevitable shortages of surface water occur in the future.

Yet, after 40 years, there is no real prospect of any AMA sustaining a long-term balance between annual withdrawals and recharge, which is what the safe-yield goal is about. What's more, the AMA-wide approach leaves many areas within the AMAs vulnerable to groundwater mining, land subsidence and deteriorating water quality. Despite this troubling situation, ADWR lacks the tools and resources to manage groundwater at a local level, residual groundwater pumping continues, and reliance on groundwater pumped from unsustainable depths for an assured water supply threatens the useful life of groundwater aquifers. Meanwhile, climate change, aridification and a drier future will put more stress on Arizona's surface water supplies, making the protection of our groundwater even more crucial, so that it can be called upon in emergencies when we need it most.

If Arizona is to prosper into the next century, our focus needs to turn to what is essential for our future: The preservation of our groundwater and our increasingly fragile aquifers. Our own survival is at stake.

Summary of Recommendations

Water managers and policy leaders should consider the following strategies to achieve sustainable groundwater management in the AMAs:

Address Long-Term Rights to Pump Groundwater

- Explore methods to reduce pumping by residual groundwater users, such as:
  - A 5% reduction in groundwater use over a five-year period;
  - A "mined groundwater" fee to make the value of groundwater more comparable to renewable water; and
  - A maximum annual allowable groundwater decline rate for wells used by residual pumpers.
- Investigate mechanisms to encourage new urban development on agricultural lands, especially lands in proximity to existing municipal providers that have access to renewable supplies and infrastructure that could be used to serve the urban development.
- Develop incentives to encourage existing industrial users to convert to renewable water supplies, such as treated wastewater, and curtail ADWR's authority to issue new industrial groundwater use permits.

Improve the Safe-Yield Goal

- Refine the AMA-wide safe-yield goal to:
  - Reflect the hydrogeologic differences within each AMA.
  - Consider the rate of recharge in each subbasin of the AMA.
  - Prevent the chronic decline of groundwater levels in each subbasin of the AMA, taking into account existing uses of groundwater, rates of recharge and projected declines of Colorado River water.
- Give ADWR the financial resources to manage groundwater at a more local level using a variety of methods such as:
  - More stringent well spacing requirements;
  - Limits on new wells;
  - Incentives and methods to rebuild groundwater resources.
- Require ADWR to develop a yearly metrics table to communicate what's happening in each AMA, evaluate the effectiveness of management programs, and raise awareness of problems and potential solutions.

Limit Hydrologic Disconnect

- Create incentives to store water in locations of the AMA experiencing groundwater declines and recover the water in areas of the AMA where groundwater levels are rising.
- Create disincentives to recover stored water in areas experiencing groundwater level declines. Such disincentives might include increasing the "cut to the aquifer," which is currently 5%. The cut to the aquifer may not be pumped but must be left behind to benefit the aquifer.
- Require that before ADWR issues a Certificate of Assured Water Supply based on membership in CAGRD, CAGRD must have a replenishment facility in the area of impact where groundwater will be pumped to serve the subject development.

Prevent Over-Reliance on Groundwater as an Assured Water Supply

- Require ADWR to complete an updated hydrologic model of each subbasin in Phoenix, Pinal and Tucson AMAs to determine the amount of groundwater in storage and the acceptable depth to which groundwater may be withdrawn in order to preserve a sustainable supply of groundwater indefinitely. The acceptable depth to groundwater should consider:
    - Current uses of groundwater in the subbasin and the extent to which those uses are expected to continue in the future.
    - The amount of natural and artificial recharge reaching the aquifers in the subbasin.
    - Whether the subbasin has acceptable sites available for underground storage projects and the amount of water that could be stored at those sites.
- Pause the issuance and extensions of Analyses of Assured Water Supply based on groundwater until ADWR completes an updated hydrologic model for the subbasin in which the land is located to determine the amount of groundwater in storage and the sustainable depth to which groundwater may be withdrawn.
- Require ADWR to deny an application for a Certificate of Assured Water Supply based on groundwater for a subdivision in the Phoenix, Pinal or Tucson AMA if the subdivision for which the Certificate is sought is located in a subbasin in which there is no replenishment site available for CAGRD to replenish the groundwater that would be used by the subdivision.

- Require ADWR to undertake a more rigorous examination of how much water for replenishment is realistically available for acquisition by CAGRD.
- Require master-planned communities to acquire their own water supplies for direct use or replenishment by CAGRD, thus reducing CAGRD's acquisition needs and costs.

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Appendix A: A Closer Look at the Management Plans by AMA

The Phoenix AMA (PhxAMA)

In the First Management Plan for the Phoenix AMA, ADWR projected that in 2025, assuming implementation of the conservation requirements of the first plan, "mined" groundwater – meaning groundwater removed from aquifers and not replaced – would still make up 365,000 acre-feet of the supply needed to meet total water demands in the AMA.[143]

ADWR warned that the safe-yield goal "will be difficult to reach, and it is fortunate that the lawmakers allowed forty-five years to attain the goal."[144] It also outlined a long-term management strategy that included regulating "new groundwater withdrawals to reduce, and eventually eliminate damage from water quality changes, cones of depression and land subsidence."[145]

In the Second Management Plan, ADWR projected that, with implementation of the plan's conservation requirements, by 2025 mined groundwater would be reduced to 245,308 acre-feet of the AMA's total annual water demand.[146] Compared to the First Management Plan's projected 2025 overdraft of 365,000 acre-feet, this was a step in the right direction.

But in the Third Management Plan, ADWR projected that even if all water using sectors met the plan's conservation requirements and continued that level of efficiency, the annual overdraft would increase to about 431,000 acre-feet in 2025,[147] more than 80 percent higher than the 2025 overdraft projected in the Second Management Plan.

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[143] ARIZ. DEP'T. OF WATER RESOURCES, *Management Plan First Management Period: 1980-1990, Phoenix Active Management Area* 23 (1984), http://infoshare.azwater.gov/docushare/dsweb/Get/Document-10006/1MP%201980-1990%20Dec.1984.pdf.

[144] *Id.* at 35.

[145] *Id.*

[146] ARIZ. DEP'T OF WATER RESOURCES, *Management Plan Second Management Period: 1990 – 2000, Phoenix Active Management Area* 25 (1991), http://infoshare.azwater.gov/docushare/dsweb/Get/Document-10661/PHXAMA%202MP%20Complete.pdf.

[147] ARIZ. DEP'T. OF WATER RESOURCES, *Management Plan for the Third Management Period, 2000 – 2010, Phoenix Active Management Area* 8-41 (1999) http://infoshare.azwater.gov/docushare/dsweb/Get/Document-10007/PhoenixAMA_3MP.pdf.

The Third Management Plan contained stark assessments, including that safe-yield could not be achieved so long as "residual" pumping permitted under the Act by agricultural, industrial and certain municipal users was allowed to continue without being replenished.[148] It noted a "growing consensus" to address management problems in specific areas of the AMA,[149] and warned, "In certain areas of the AMA, continual high levels of groundwater pumping may lead to detrimental, and possibly irreversible, negative impacts to the aquifer."[150] ADWR advised that it would be necessary to:

> "Reexamine the assured water supply depth-to-water rule which currently allows groundwater levels to decline to 1,000 feet below the land surface over 100 years. This depth-to-water provision may need to be more closely tied to impacts and damage caused by groundwater declines. **It is conceivable that under the current 1,000 foot limit, substantial irreversible damage could occur prior to that limit being reached.**"[151]

ADWR also stated that, "a closer association between land use planning and water policy planning is needed,"[152] including a need "to evaluate the water resource implications of development occurring on desert land rather than on retired farmland."[153] In the Fourth Management Plan, adopted on March 11, 2020,[154] ADWR did not project the volume of the overdraft in 2025. Instead, it stated that, “the range of potential variables and changes to policies have made it so that any projection is likely to be outdated by the time it is published,” and that "ADWR has moved to decouple projections" from the Fourth Management Plan "in the hopes that this shift will allow for more continuous updates to the various planning scenarios and to avoid placing too much reliance and weight on any single set of assumptions."[155]

The Fourth Plan contains detailed graphics and tables of water use and supplies over time. ADWR has also posted online dashboards of historical supplies, demands and overdraft for each AMA. According to the Plan, the overdraft in the Phoenix AMA

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[148] *Id* at 11-25.
[149] *Id.* at 12-3.
[150] *Id*. at 11-25.
[151] *Id.* at 12-9 (emphasis added).
[152] *Id*. at 12-4.
[153] *Id*. at 12-5.
[154] ARIZ. DEP'T OF WATER RESOURCES, *Order of Adoption, The Adoption of the Management Plan for the Phoenix Active Management Area for the Fourth Management Period, Ariz. Dep’t of Water Resources, Before the Dir.,* March 11, 2020, https://new.azwater.gov/sites/default/files/media/Final%20Order%20Phx%204MP_1.pdf.
[155] ARIZ. DEP’T OF WATER RESOURCES, *Fourth Management Plan Phoenix Active Management Area 2010-2020* 11-1, https://new.azwater.gov/sites/default/files/media/FULL%20FINAL%20PHX%204MP_1.pdf.

between 1985 and 2017 has varied widely, with the greatest overdraft in 2004 (234,193 AF) and no overdraft in a number of years during that period.[156]

These overdraft numbers vary significantly from numbers published in previous management plans. For example, in the Third Management Plan published in 1999, ADWR wrote that the 1995 overdraft was 360,019 acre-feet. However, the Fourth Management Plan shows no overdraft in 1995.[157] ADWR explains that it "now has a greater understanding of the susceptibility of the PhxAMA aquifers to drought and natural recharge during wetter periods," and has updated its figures to reflect actual conditions.[158] Even so, the updated numbers in the Fourth Management Plan show that since 2011, the AMA has been in an overdraft condition, **with a cumulative overdraft of 902,837 acre-feet over the period between 2011 and 2017**.[159]

In the Fourth Management Plan, ADWR explicitly concedes what it has long known – that conservation "is insufficient by itself to bring the PhxAMA to safe-yield."[160] As in the Third Management Plan, ADWR cautions that residual pumping by several categories of existing users and potential new pumping by others will contribute to the overdraft unless the groundwater pumped is replaced,[161] and that localized groundwater declines could "result in land subsidence, wells going dry, increased pumping costs, and water quality changes."[162] It opines that a "sub-regional" approach to water management may help to protect against the negative impacts of groundwater pumping.[163]

ADWR also continues to support a closer association between land use planning and water management.[164] Importantly, it restates the Third Management Plan's caution against allowing urban growth to occur on desert land.

> "A key assumption of the Code was that urban growth would largely occur on retired agricultural land, with the water no longer needed by the farms being available to serve new houses and industries. In fact, much of the new growth is occurring on native desert land rather than on retired farmland. Development on desert land does not result in one type of demand replacing another; it results in a new demand being added to

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[156] *Id.* at 3-19, 20.
[157] *Id.* at 3-18.
[158] *Id.* at 3-17.
[159] *Id.* at 3-19
[160] *Id.* at 1-5.
[161] *Id*. at 11-3.
[162] *Id.* at 11-5.
[163] *Id.* at 11-8.
[164] *Id.* at 11-6.

> existing demands, resulting in significantly greater demands than originally assumed."[165]

The Tucson AMA (TAMA)

In the First Management Plan for the Tucson AMA, ADWR projected that in 2025, assuming implementation of the conservation requirements of the first plan, full use of CAP water, and reduction in agricultural water demands, mined groundwater would make up 58,000 acre-feet of the total water supply of the AMA, down from an average annual overdraft of 249,000 acre-feet for the period 1975 to 1980.[166] ADWR advised that:

> "The attainment of safe-yield requires gradual reduction, and elimination by 2025, of the groundwater overdraft. **Change in water level is the single most important indicator that overdraft is occurring.** To prevent acceleration of the overdraft rate in the Tucson AMA, the Department must restrict new withdrawals in areas with excessive decline rates."[167]

In the Second Management Plan, ADWR projected that with the implementation of the plan's conservation requirements, importation of CAP water and retirement of non-Indian farmland, the overdraft would be 90,000 acre-feet in 2025. This projected overdraft resulted primarily because of an increase in water demand.[168]

In the Third Management Plan, ADWR presented several water budgets and concluded that "**actual groundwater overdraft will continue and the AMA may not reach safe-yield by 2025."[169]** (Emphasis in original.) The Plan noted that most of the ongoing pumping of mined groundwater was associated with the agricultural sector and water providers not designated as having an assured water supply, and that the "industrial

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[165] *Id.* at 11-6, 11-7.

[166] ARIZ. DEP'T OF WATER RESOURCES, *Management Plan First Management Period, 1980-1990, Tucson Active Management Area* 22 (1984), http://infoshare.azwater.gov/docushare/dsweb/Get/Document-10008/1MP%201980-1990.Dec.1984.pdf.

[167] *Id.* at 110 (emphasis added).

[168] ARIZ. DEP'T OF WATER RESOURCES, *Management Plan Second Management Period, 1990-2000, Tucson Active Management Area* 17 (1991), https://new.azwater.gov/sites/default/files/media/TAMA_2MP_Complete.pdf.

[169] ARIZ. DEP'T OF WATER RESOURCES, *Management Plan for the Third Management Period, Tucson Active Management Area, 2000-2010* 11-36 (emphasis in original), http://infoshare.azwater.gov/docushare/dsweb/Get/Document-10035/TucsonAMA_3MP.pdf.

sector is likely to be responsible for a significant component of the groundwater overdraft."[170]

ADWR advised that although groundwater in storage in the AMA was estimated in 1995 to be about 63 million acre-feet to a depth of 1,200 below land surface, "it is not feasible to pump groundwater from this depth due to land subsidence, water quality deterioration, loss of well productivity, and increased pumping costs."[171]

The Plan concluded that while "safe-yield is an attainable goal, it is apparent that sufficient progress has not been made toward this goal nor have the statutory and institutional structures necessary to succeed been fully established."[172]

In the Fourth Management Plan, adopted in 2016, ADWR revealed that although the TAMA had been at or near safe-yield in recent years, it faced many challenges in meeting and maintaining this goal.[173] These challenges encompass many of those facing the Phoenix AMA, including that:

- Conservation will not by itself achieve safe-yield.[174]
- Several categories of water users may legally withdraw groundwater without replenishing it, contributing to the overdraft.[175]
- Localized areas within the TAMA could become dewatered, resulting in land subsidence and wells going dry.[176]

The Prescott AMA (PRAMA)

In the First Management Plan for the Prescott AMA, ADWR projected that, assuming conservation as required by the plan, mined groundwater would account for 5,400 acre-feet of total water supplies of 39,800 acre-feet in 2025.[177] This overdraft would occur even with the importation of CAP water.

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[170] *Id.* at 12-6.
[171] *Id.* at 11-26.
[172] *Id.* at 12-1.
[173] ARIZ. DEP'T OF WATER RESOURCES, *Fourth Management Plan, Tucson Active Management Area* 12-7 (2016), http://infoshare.azwater.gov/docushare/dsweb/Get/Document-10038/TAMA_4MP_Complete.pdf.
[174] *Id.* at 1-5, 12-7.
[175] *Id* at 1-5, 12-1.
[176] *Id.* at 1-6
[177] ARIZ. DEP'T OF WATER RESOURCES, *Management Plan First Management Period, 1980-1990, Prescott Active Management Area* 19 (1984), http://infoshare.azwater.gov/docushare/dsweb/Get/Document-10091/PRAMA_1MP.pdf.

In the Second Management Plan, ADWR predicted that the overdraft could be eliminated by 2025 “through the implementation of Second Management Plan conservation programs, urbanization of agricultural land, and water supply augmentation measures.”[178] At the time, the City of Prescott was proposing to exchange its CAP allocation of 7,127 acre-feet for water from the Verde River, an exchange ADWR called “vitally important” to achieving safe-yield.[179]

By the Third Management Plan, however, it had become clear that utilization of CAP water through the proposed exchange of Verde River water was not economically feasible for the Prescott AMA.[180] The plan included a current water budget for the years 1990 through 1997 showing that the PRAMA was not in safe-yield and that there was “a persistent level of overdraft” through that time period.[181] ADWR concluded “that the AMA must expand its efforts to use renewable water supplies while also looking for ways to import groundwater from the Big Chino Subbasin if it is to ensure safe-yield conditions by 2025.”[182]

ADWR adopted the Fourth Management Plan for the Prescott AMA in 2014.[183] The Plan stated that the PRAMA is in overdraft and that, "there is insufficient management authority, infrastructure, or financing in place to ensure that safe-yield will be achieved by the year 2025."[184] The Plan posited that, as in the Phoenix and Tucson AMAs, conservation alone will not achieve safe-yield,[185] and noted that several categories of existing and potential water users may withdraw groundwater in perpetuity.[186]

Unlike the Phoenix and Tucson AMAs, however, the Prescott AMA lacks access to significant renewable water supplies. ADWR continued to observe that "[i]mportation of

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[178] ARIZ. DEP’T OF WATER RESOURCES, *Management Plan Second Management Period, 1990 - 2000, Prescott Active Management Area* 186 (1991), https://new.azwater.gov/sites/default/files/media/PRAMA%202MP%20FULL.pdf.
[179] *Id*.at 21.
[180] ARIZ. DEP’T OF WATER RESOURCES, *Management Plan Third Management Period, 2000 - 2010, Prescott Active Management* 2-20 (1999), http://infoshare.azwater.gov/docushare/dsweb/Get/Document-10009/PrescottAMA_3MP.pdf. According to experts, the exchange was not environmentally feasible due to potential negative impacts to the Verde River.
[181] *Id.* at 3-26 and 3-28.
[182] *Id.* at 11-13.
[183] ARIZ. DEP'T OF WATER RESOURCES, *Annual Report Fiscal Year 2015* 29, http://www.azwater.gov/AzDWR/documents/ADWRDirector/2015 ADWR Annual Report.pdf.
[184] ARIZ. DEP’T OF WATER RESOURCES, *Management Plan Fourth Management Period, 2010 - 2020, Prescott Active Management Area* 1-5, http://infoshare.azwater.gov/docushare/dsweb/Get/Document-10037/PrescottFourthManagementPlan.pdf.
[185] *Id.* at 12-4.
[186] *Id.* at 12-1.

water supplies from outside the PRAMA or other management techniques to augment the water supply are critical to the PRAMA achieving its safe-yield goal."[187]

Water use from exempt wells also poses a much larger problem in the Prescott AMA than in other AMAs. An exempt well has a pump with a maximum capacity of 35 gallons per minute and may be drilled without a permit from ADWR.[188] Exempt well pumping is estimated to make up about 11% of the total water demand in the PRAMA,[189] and ADWR records show that between 1985 and 2012, the number of exempt wells increased more than 150 percent.[190] Additionally, most exempt well homes have septic systems, reducing the amount of wastewater that can be reclaimed and reused.

[187] *Id.* at 1-5.

[188] ARIZ. REV. STAT. ANN. § 45-454 (2020). Before drilling an exempt well, a Notice of Intention to drill must be filed with ADWR, but as long as the Notice is complete, ADWR must issue a drilling card to the well driller. ARIZ. REV. STAT. ANN. § 45-596 (2020).

[189] ARIZ. DEP'T OF WATER RESOURCES, GOVERNOR'S WATER AUGMENTATION, INNOVATION AND CONSERVATION COUNCIL POST-2020 AMAS COMMITTEE, Issue Brief #2, Exempt Wells AT 7.

[190] ARIZ. DEP'T OF WATER RESOURCES, *supra,* note 42 at 3-5.