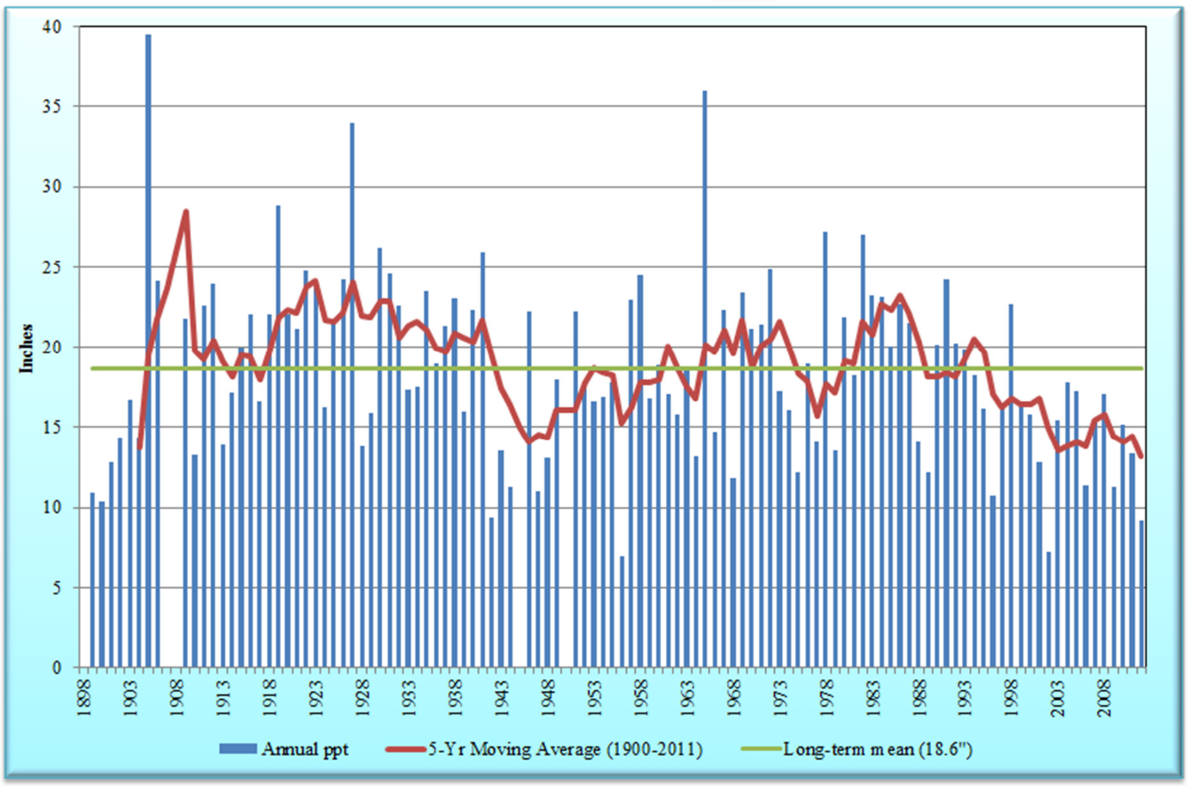
11.1 INTRODUCTION

The management goal of the PRAMA is to achieve a long-term balance between the annual amount of groundwater pumping and the annual amount of net natural and incidental recharge in the AMA (safe-yield). This goal is to be achieved by the year 2025 and maintained thereafter. In all five AMAs, maintaining a safe-yield condition will be complicated by the vacillating weather conditions common in the southwest *(See Figure 11-1)* which result in fluctuating net natural recharge to aquifers, primarily in the form of stream channel recharge.

FIGURE 11-1
ANNUAL PRECIPITATION
PRESCOTT, ARZIONA
PRAMA



Like most of Arizona's groundwater basins, the PRAMA experiences years of lower than average precipitation and occasional high rates of precipitation, resulting in flood flow. This vacillating pattern means that even after achieving safe-yield, there may be several consecutive years where the PRAMA may experience small, modest or large rates of overdraft. However, over time, several years of low volumes of overdraft can be offset by significant net natural recharge in a high flood year, resulting in a temporary surplus in the water balance calculation in flood years due to natural conditions. (Changes in climate resulting in a shift towards drier conditions much of the time will result in a decline in long-term average annual net natural recharge. Reduction in precipitation not only results in reduction in stream channel flow, but also in groundwater outflow, both are components of net natural recharge.)

Without effective water management, these "feast or famine" conditions could endanger the long-term reliability of the water supply of the PRAMA. Therefore steps must be taken to manage against these conditions in order to achieve and thereafter maintain the water management goal of safe-yield. Continued monitoring of pumping, the location of underground water storage and recovery of stored water, the effects of precipitation, and depth to water level measurements in AMA wells, coupled with comprehensive water management planning to anticipate and allow sufficient time to respond to changing conditions, are all imperative in achieving and ultimately managing the AMA's water management goal.

The *Water Demand and Supply Assessment 1985-2025, Prescott Active Management Area* (Assessment) (ADWR, 2011) included seven different water demand and supply projection scenarios and water budgets, each with slightly different assumptions. The Assessment utilized long-term averages of stream channel and mountain front recharge for the natural system components of the water budgets. This method masks the annual variability of net natural recharge, which is an important characteristic to understand in making water management decisions and implementing water management programs in the PRAMA.

As discussed and described in Chapter 3 of this plan, since the publication of the Assessment ADWR Hydrology staff have continued to refine and adjust the PRAMA hydrologic model. Subsequently, natural recharge components have been updated for the 4MP based on the current version the PRAMA model (Nelson, 2013).

During the model update process ADWR Hydrologists identified the impacts of the seasonally and annually fluctuating net natural recharge characteristics in PRAMA. ADWR then developed statistically generated projections for net natural recharge to be used in the 4MP. These projections mimic the observed historical variability for purposes of planning and visually show what overdraft conditions the AMA might experience given variable supply conditions with increased demand. As in the Assessment, a "normal" and "dry" net natural recharge scenario was developed. However for comparative purposes this chapter includes only the "normal" net natural recharge projections. The "dry" conditions exacerbate difficulties in achieving and maintaining safe-yield.

The results of three scenarios are included in this chapter. During the fourth management period ADWR intends to utilize scenario planning techniques to model and understand the implications of potential water management decisions. There are multiple other scenarios that may and should be considered during the fourth management period. Examination and analysis of the results of additional scenarios will allow water resource managers and planners to understand which water management decisions have the greatest potential impact in securing long-term sustainable supplies and maintaining the economic viability of the AMA for as long as possible.

Unlike the Assessment, the historical period in this chapter is from 1985 through 2012. The projected years are from 2013 through 2025, and beyond. Future water demand and supply are affected by the requirements and implications of the Assured Water Supply Program (AWS Program), as well as the Augmentation and Recharge Program (ARP) and need to be understood in the context of the 100-year planning time frame addressed by the AWS Program. For purposes of these projections ADWR did not incorporate any limitations on the physical availability of groundwater under the AWS Rules in any of the scenarios included in this chapter. However, under current law, physical availability of groundwater could limit the approval of new subdivision demand.

Many of the decisions water users will make between now and 2025 will be made in the context of water management needs during the 100-year time frame of the AWS Rules. Statutory and rule changes, infrastructure improvements and expansions, and shifting approaches to water management are intractable conditions for this agency on its own, but are necessary for achievement of safe-yield in the PRAMA, and in other AMAs as well. For these reasons, the projection period in this chapter has been extended to the year 2110 to give insight into how demand and supply decisions may affect safe-yield beyond 2025.

Due to the timing of the development of new population projections by the Arizona Department of Administration and local Associations of Government, ADWR has not incorporated revised population projections from these jurisdictions into the scenarios in this chapter. However, ADWR has re-projected population in PRAMA using statistical analyses and other planning assumptions based on recent population trends and the 2010 Census data. During the fourth management period the Assessment templates on the ADWR website will continue to be updated annually. A summary of the projection assumptions for the scenarios included in this chapter and a description of ADWR's general approach are included in the section below, and in Appendix 11-A.

11.2 WATER BUDGET SCENARIOS

There are three scenarios included in this chapter. However, ADWR intends to construct and analyze multiple scenarios throughout the fourth management period, which will then be analyzed to identify those factors which most strongly influence the ability of the PRAMA to achieve and maintain safe-yield. That knowledge will be one piece of information to help identify appropriate water management strategies for the AMA moving towards and beyond 2025. Demand and supply assumptions included in each scenario are described below.

11.2.1 Municipal Demand and Supply

For the 4MP, ADWR re-projected population due to the release of the 2010 Census data and recent trends in growth rates. Different water demand use rates were also utilized from those used in the Assessment. Most importantly, water supply assumptions were modified. All the scenarios included in this chapter assume: 1) importation of groundwater from the Big Chino subbasin initiates in the year 2020 and ramps up over time, 2) the proportion of the AMA population on central sewer systems increases over time, 3) infrastructure improvements providing for the regional collection of wastewater and storage of reclaimed water are funded and constructed, and 4) recovery of as much reclaimed water as is physically feasible from within the area of impact of storage occurs.

City of Prescott

All three scenarios have these assumptions in common for the City of Prescott:

- The water service area population was re-projected using the 1985 – 2012 water service area population and a linear trendline for 2013 – 2110. This results in a service area population of 134,522 people in 2110.
- Prescott's direct use of reclaimed water is 2,240 acre-feet per year for 2013 – 2110.
- Prescott annually stores and recovers 1,335 acre-feet of surface water per year.
- Big Chino importation begins in 2020, and ramps up to 4,365 acre-feet per year by the year 2044 and maintains that volume each year through 2110.
- For 2013 – 2024 Prescott uses up to 8,000 acre-feet of groundwater per year.
- For 2025 – 2110 Prescott uses zero groundwater; all pumpage is recovered water, either surface water or reclaimed water, equivalent to the remainder of Prescott's projected demand minus the assumed volume of direct use reclaimed water, recovered surface water, and Big Chino groundwater.

Variations in scenarios A, B, and C for the City of Prescott are as follows:

Prescott Scenario A:

- Demand is projected at 150 GPCD through 2110.

Prescott Scenario B:

- Prescott adopts a "WaterSense" ordinance in 2015, which changes the new residential interior model to 39 GPCD.

These assumptions result in an overall GPCD in the Prescott service area of 141 GPCD by 2110.

Prescott Scenario C:

- Prescott adopts a "WaterSense" ordinance in 2015, which changes the new residential interior model to 39 GPCD.
- Prescott adopts a landscape ordinance for new development resulting in a reduction of the exterior gallons per housing unit per day (GPHUD) from 75 down to 50 GPHUD for single family homes and from 58 down to 20 GPHUD for multi-family homes.

These assumptions result in an overall GPCD in the Prescott service area of 130 GPCD by 2110.

- Beginning in the year 2050, Prescott accesses and stores another 3,200 acre-feet of surface water from its other surface water claims.

The volume of Prescott's annual surface water recovery is related to the volume of water that annually flows into Watson and Willow Lakes, certain legal agreements between SRP and CVID which Prescott inherited, and Prescott's water management strategy. In dry years with low net natural recharge there may be insufficient surface water to store and recover. In addition to legal constraints which restrict the periods of time that Prescott can store surface water, Prescott also has a priority of maintaining water in the lakes for recreational purposes, which can limit the volume of water that could be stored and recovered. Prescott also has the ability to use surface water from Goldwater Lake, the Hassayampa River, and Del Rio Springs. To use these surface water supplies would require additional infrastructure.

Prescott's current water management policy assumes 8,000 acre-feet per year of groundwater pumping, and Prescott's Designation of Assured Water Supply (DAWS) includes 9,466 acre-feet per year of groundwater pumping. However, pumping this volume of groundwater will not allow the AMA to achieve its goal. For all three scenarios, for the years 2013 through 2024, Prescott is assumed to use groundwater to meet the remainder of its demand up to 8,000 acre-feet. However with the population and demand assumptions in these scenarios, Prescott never reaches the 8,000 acre-feet of groundwater through the year 2024. For the years 2025 through 2110, it is assumed that Prescott uses no groundwater and the remainder of Prescott's demand minus direct use reclaimed water, recovered surface water, and Big Chino groundwater is met with recovered reclaimed water, primarily in the location of impact of storage. ADWR's hydrologic model indicates that an optimal location for regional underground storage is along a linear stretch of Granite Creek from approximately the location of Watson and Willow lakes and extending for several miles northward to the Chino Valley area (Nelson, 2013).

Town of Prescott Valley

All three scenarios for Prescott Valley have these assumptions in common:

- The service area population was re-projected assuming 4.1 percent growth from 2013 – 2025, 2.2 percent growth from 2026 – 2035, and 1.25 percent growth from 2036 – 2110. This results in a service area population of 238,760 people in the year 2110.
- Demand is projected at 118 GPCD.

- Prescott Valley begins using Big Chino groundwater in the year 2020 and ramps up to 3,703 acre-feet in the year 2045. From 2045 through 2110, Prescott Valley will continue to use 3,703 acre-feet of Big Chino groundwater each year.
- For 2013 – 2024 Prescott Valley uses up to 6,000 acre-feet per year of groundwater.
- For 2025 – 2110 the remainder of Prescott Valley's demand each year after subtracting Big Chino groundwater is recovered reclaimed water, primarily from within the area of impact of storage either at Prescott Valley's existing recharge projects or at an assumed new regional recharge facility located along Granite Creek.

Prescott Valley has prepared a projection assuming approximately 6,000 acre-feet per year of groundwater pumping; however, pumping this volume of groundwater will not allow the AMA to achieve its goal. In addition to its existing reclaimed water underground storage projects, the storage and recovery of reclaimed water along Granite Creek will require the construction of additional infrastructure to transport reclaimed water to Granite Creek for underground storage, the construction of recovery wells in the area of impact of storage along Granite Creek, and infrastructure to transport the recovered water back to the Prescott Valley service area for distribution.

Small Municipal Providers
All scenarios for small providers have the following assumptions:

- Small municipal provider population as a whole, including the Town of Chino Valley, was re-projected using the 1985 – 2012 population and a linear trendline for 2013 – 2110. Currently the Town of Chino Valley is a small municipal provider. At some point in the future, Chino Valley and potentially other small providers will begin using more than 250 acre-feet per year of water, and will transition to large municipal providers; however for these scenarios Chino Valley and others remain in the category of small municipal providers.

  Using these assumptions the sum of small municipal provider population is 42,390 people by the year 2110.

- Because Chino Valley owns and operates a wastewater treatment plant, Chino Valley was included in the calculations of projected reclaimed water available to store, described below, in all three scenarios.
- Small provider demand was projected assuming 90 GPCD.
- For the years 2013 through 2024 small providers are assumed to use 100 percent groundwater. However, in 2025 through 2110, it is assumed that regional reclaimed water storage and recovery will be implemented to offset or replenish small provider demand such that between small providers and exempt well population, only 3,000 acre-feet of municipal groundwater is withdrawn per year. The remainder of the small provider demand is either met with recovered reclaimed water or is replenished by non-recoverable storage of reclaimed water.

Variations included in scenarios B and C for small providers are as follows:

- Town of Chino Valley begins using Big Chino groundwater in 2020 and ramps up to 3,483 acre-feet in the year 2045 and maintains that volume of Big Chino groundwater thereafter.

A regional wastewater collection system is in place beginning in the year 2020, to collect wastewater from all new small provider and exempt well population added in 2020 and thereafter, thus increasing the supply of reclaimed water that can be stored and recovered.

Exempt Well Population

All scenarios for exempt well population have these assumptions:

- Exempt well population can only be calculated for the 2000 and 2010 Census years. In the 4MP, for 2011 and 2012 the 4.3 percent growth rate that was used in the Assessment was used to estimate exempt well population. Using these figures, a trendline was developed using the estimated exempt well population for 1985-2012 to project the population from 2013-2110.

These assumptions result in an exempt well population of 33,010 people in 2110 using a trendline. This population projection is conservative, but it is assumed local entities undertake efforts to limit the number of new exempt wells in PRAMA as a water management strategy for the fourth management period and continuing thereafter.

- Demand for exempt well population was projected using 90 GPCD.
- Exempt population is assumed to use 100 percent groundwater for the years 2013 through 2024. For 2025 through 2110, it is assumed that a regional reclaimed water storage and recovery projected will have been constructed and will operationally have the result of limiting the sum of small provider and exempt well groundwater pumping to 3,000 acre-feet per year. The remainder of exempt well demand is either met with recovered reclaimed water or is replenished by non-recoverable storage of reclaimed water.

Scenarios B and C for exempt well population include the following additional assumptions:

- A regional wastewater collection system is in place beginning in the year 2020, to collect wastewater from all new small provider and exempt well population added in 2020 and thereafter, thus increasing the supply of reclaimed water that can be stored and recovered.

Projected Reclaimed Water Supply, Underground Storage and Recovery

All three scenarios project the volume of reclaimed water available to store based on an assumption that the entire service area populations of both the City of Prescott and the Town of Prescott Valley are connected to the sewer system. For the Town of Chino Valley all population growth within the Census Designated Place (CDP) for Chino Valley in the future is assumed to be connected to the sewer system. (This is an area much larger than the current Town of Chino Valley water service area.)

The projected volume of reclaimed water generated was based on specific assumptions for each entity:

- For Prescott, it was assumed that 54 percent of the total water deliveries became reclaimed water.

- For Prescott Valley, it was assumed that 58 percent of deliveries, ramping up to 64 percent of deliveries by 2024, and continuing at a rate of 64 percent of deliveries each year through 2110, would become reclaimed water.

- For Chino Valley, it was assumed that 60 percent of deliveries became reclaimed water. To estimate the new population in Chino Valley, a trendline was developed using the 1985 – 2012 CDP population. The trendline was applied to project population growth within the Chino Valley CDP. The increase in population within the CDP each year was then added to the Chino Valley service area population, which assumed that any new population within the Chino Valley CDP is connected to Chino Valley’s sewer system rather than septic systems.

Scenarios B and C assume that a regional wastewater collection system is in place beginning in the year 2020, to collect wastewater from all other new small provider and exempt well population added in 2020 and thereafter, thus increasing the supply of reclaimed water that can be stored and recovered.

The total volume of reclaimed water stored each year is equal to the total volume estimated to be generated by all entities, minus Prescott's direct delivery of 2,240 acre-feet per year, minus evaporative losses. It was assumed that all reclaimed water would be stored via a constructed USF facility, and that there would be no cut to the aquifer imposed. Under these assumptions, depending on the demand and other supply assumptions, by the year 2024 there would be between 77,000 and 85,000 acre-feet of reclaimed water long-term storage credits in the PRAMA.

Beginning in the year 2025, only 3,000 acre-feet of groundwater is assumed to be pumped, associated with the 2012 exempt well and small municipal provider demand. Then, the next sources used are direct use reclaimed water, Big Chino groundwater, and recovered surface water. The remainder of the AMA's municipal demand after these supply sources are subtracted out is presumed to be annual or long-term storage credit recovery of reclaimed water.

As noted above, it is assumed in these scenarios that the PRAMA municipalities will cooperatively develop and construct an underground storage facility along Granite Creek, including infrastructure to direct reclaimed water to a stretch of the Creek to store, recovery wells located at intervals along Granite Creek to recover, and infrastructure to transport the reclaimed water that was recovered within the area of impact of storage back to each municipality according to its share.

11.2.2 Industrial Demand and Supply

The Assessment Baseline Scenario One demand from the Assessment was incorporated into all three scenarios included in this chapter for the industrial sector (consisting of Type 1 and Type 2 Non-Irrigation Grandfathered Groundwater Rights and Permits). This assumption holds industrial groundwater demand, which is essentially all of the demand, at about 1,500 acre-feet per year through 2110. There is currently about 8,000 acre-feet of industrial pumping authority in the AMA, but actual industrial use within the AMA over the historical period 1985 – 2012 was approximately 1,000 acre-feet. This assumes that industrial demand will continue in the PRAMA, but the majority of future industrial demand will be served by a municipal water provider pursuant to their service area rights rather than through a Type 1 or Type 2 GFR, or a permit.

11.2.3 Agricultural Demand and Supply

The Baseline Scenario One demand from the Assessment was also incorporated into all the scenarios in this chapter for the agricultural sector. This demand was based on the agricultural sector in PRAMA continuing to decline to only about 30 acre-feet of groundwater use by 2025, with the CVID recovering about 750 acre-feet per year of reclaimed water to meet agricultural demand. CVID's recovery of reclaimed water is pursuant to the district's agreement with the City of Prescott and limited to a total of 33,000 acre-feet of recovered reclaimed long-term storage credits. Under these assumptions, Prescott fulfills its 33,000 acre-foot obligation to the CVID in the year 2037. After that, it is assumed the remaining agricultural users return to groundwater, and the agricultural groundwater pumping is volume is held constant at about 800 acre-feet per year from 2038 through the year 2110.

11.3 PROJECTED NATURAL SUPPLY

Water supply in the PRAMA has been projected using a statistical approach based on development of the PRAMA hydrologic model and its recent updates. During model update, ADWR Hydrology staff gained new understanding into the variability of the natural water supply in the PRAMA not evaluated in the Assessment. The projected natural supplies included in this chapter are not intended to be supply forecasts for each projection year, but rather are intended to mimic the historical annual variability in net natural recharge in order to bring to light any water management issues that may arise from increased demand coupled with supply variability over time *(See Figure 11-2)*.

Historical data reveals the pattern referred to earlier in this chapter of periods of little precipitation and streamflow with occasional flood events that replenish the aquifer. This variability, which can be impacted further by climate change, is the reason using a long-term annual average for net natural recharge is not useful in PRAMA. Such an assumption would give the false impression that the natural supply is consistently available.

Observational data of water levels in wells provides additional information on the frequency, magnitude, and variability of natural recharge. Streamflow data show that significant streamflow events occurred at higher frequencies between the mid-1970s and the mid-1990s, compared to the period from the 1940s through the mid-1960s, or as compared to recent decades. Water level data shows rises in response to streamflow patterns, and declines in the absence of recharge, especially in wells with direct hydraulic contact with major streams and tributaries. In Chapter 2 of this plan, refer to Figures 2-7E, 2-7I and 2-7Q, in addition to the hydrographs shown here in Appendix 11-B, Figures 11-B1 and 11-B2.

Net natural recharge is the sum of stream channel recharge, mountain front recharge and groundwater inflows minus groundwater outflow. Based on the outputs from the updated PRAMA hydrologic model, annual and five-year moving average volumes for annualized streamflow are shown in Figure 11-3 and the five year moving average net natural recharge shown in Figure 11-4. The period from 1985 through 2012 reflects historical data. For 2013 through 2110 the statistically generated simulation of fluctuating net natural recharge for 2013 – 2025 was repeated each year. Again, this is not intended to forecast net natural recharge, but to provide some variability to compare against the AMA projected water demand to determine the potential impacts on supply availability and provide insight into the direction of water management planning for the future.

FIGURE 11-2
AVERAGE ANNUALIZED STREAMFLOW
AGUA FRIA RIVER NEAR MAYER, ARZIONA
PRAMA

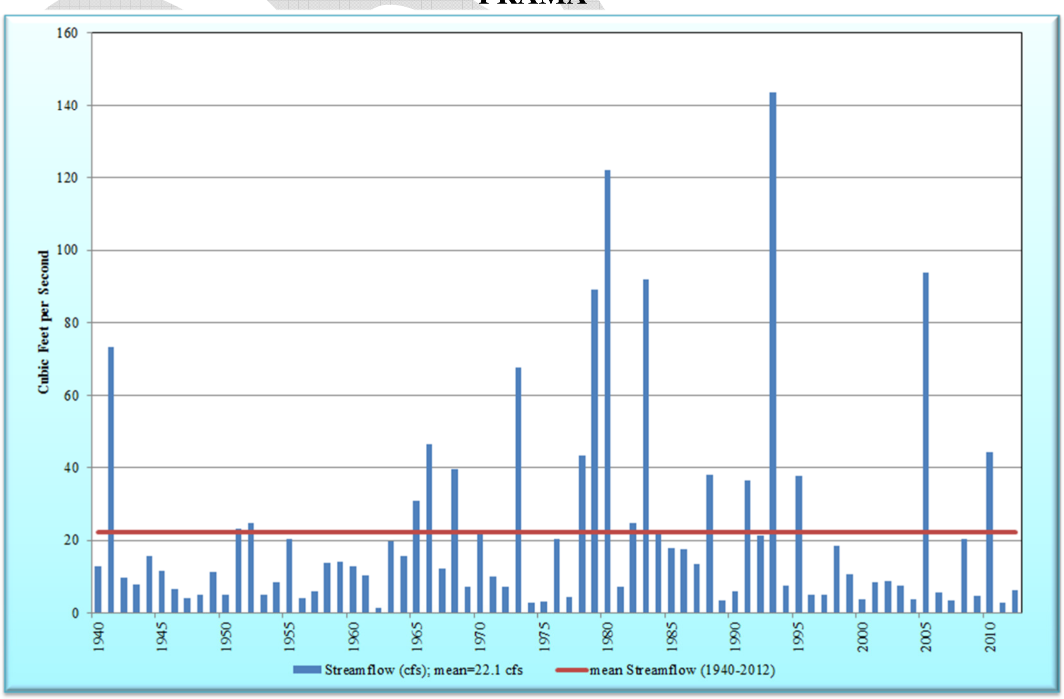


FIGURE 11-3
FIVE-YEAR MOVING AVERAGE ANNUALIZED STREAMFLOW
AGUA FRIA RIVER NEAR MAYER, ARZIONA
PRAMA

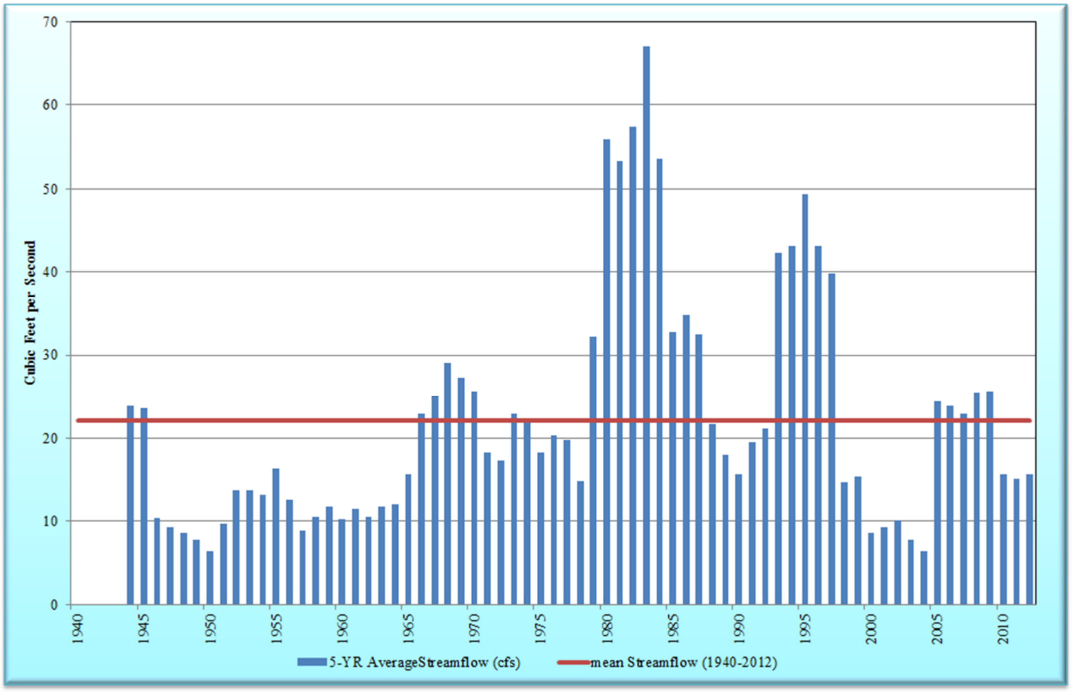
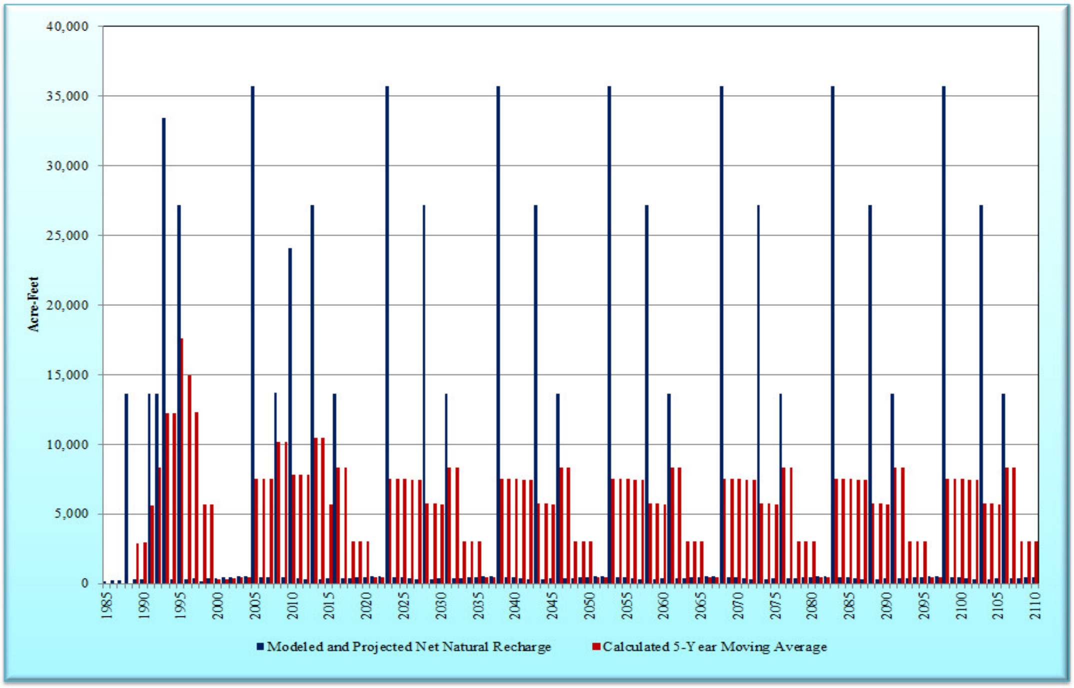


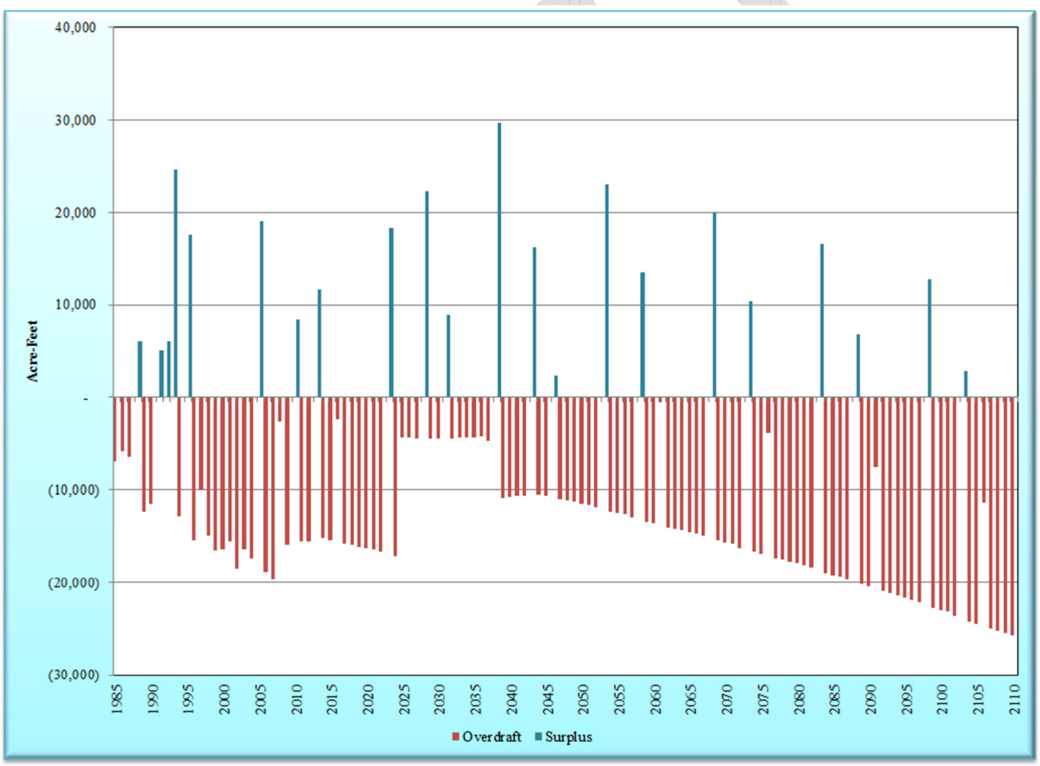
FIGURE 11-4
MODELED AND PROJECTED
ANNUAL AND FIVE-YEAR MOVING AVERAGE NET NATURAL RECHARGE
PRAMA



For water management purposes, using a 5-year moving average of net natural recharge is more reflective of the changing aquifer conditions than a flat, long-term average. When a 5-year moving average is applied to streamflow, the extended positive impact of occasional flood events becomes evident. After a significant flood event, the benefits to the aquifer may endure for more than one year.

It is important to note that storing significant volumes of reclaimed water along Granite Creek will need to be done mindful of the availability of storage capacity in the aquifer. During periods of low precipitation more storage can occur than immediately after a flood event. When the aquifer is full, pumping can occur in the replenished areas until water levels begin to decline, at which point artificial recharge would increase.

FIGURE 11-5A
PROJECTED WATER BUDGET: BASE SCENARIO
PRESCOTT AMA



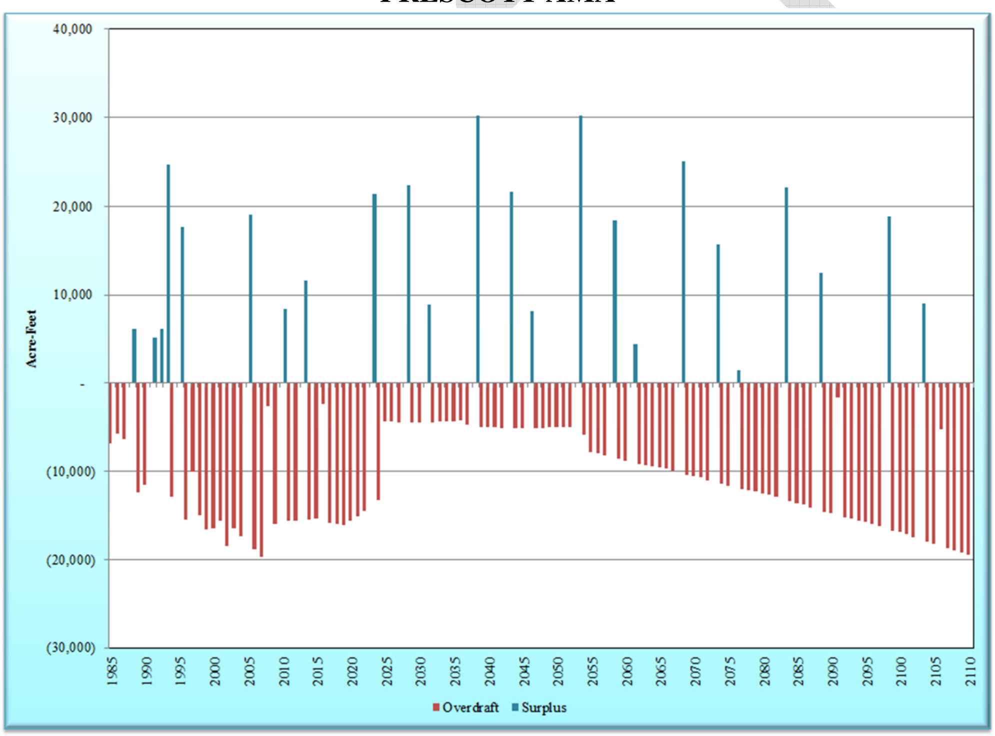
There has historically been a seasonal pattern to water level increases and declines in localized areas of the PRAMA. Under this management scheme, localized aquifers would need to be managed carefully to avoid artificial recharge "daylighting." Pumping would need to be managed to be able to shift from areas where aquifers are replenished and away from areas experiencing seasonal declines. In this way the stored water could be visualized as a reservoir. When the reservoir runs low, pumpage is shifted to areas away from the recharge location. Historically, much of the groundwater withdrawn in the PRAMA has been in the Chino Valley area. Under these scenarios, some of that groundwater withdrawal would be seasonally shifted closer to Granite Creek.

11.4 RESULTS OF WATER BUDGET ANALYSIS

The overdraft values shown in the water balances in this chapter represent AMA-wide annual balances. For the historical period, these are estimates based on ADWR's hydrologic model and reported and estimated water demand information for the AMA. These figures do not reflect seasonal fluctuations in precipitation and stream channel recharge, which may require shifting pumping between well fields, more or less artificial recharge, and more or less recovery within the area of impact where water is stored.

Figures 11-5A through 11-5C illustrate the historical and projected overdraft or surplus in the PRAMA, under the assumptions for the 1985 – 2012 (historical period) and the 2013 – 2110 (projected period). Of note is the persistent overdraft in both the historical period and the early part of the projected period until 2025. With the water management approaches included in the assumptions above, minimal overdraft occurs between flood events, which replenish the aquifer as long as reclaimed long-term storage credits persist. When reclaimed long-term storage credits are exhausted, the AMA once again begins overdrafting the aquifer.

FIGURE 11-5B
PROJECTED WATER BUDGET: WATERSENSE, CHINO VALLEY BIG CHINO PRESCOTT AMA

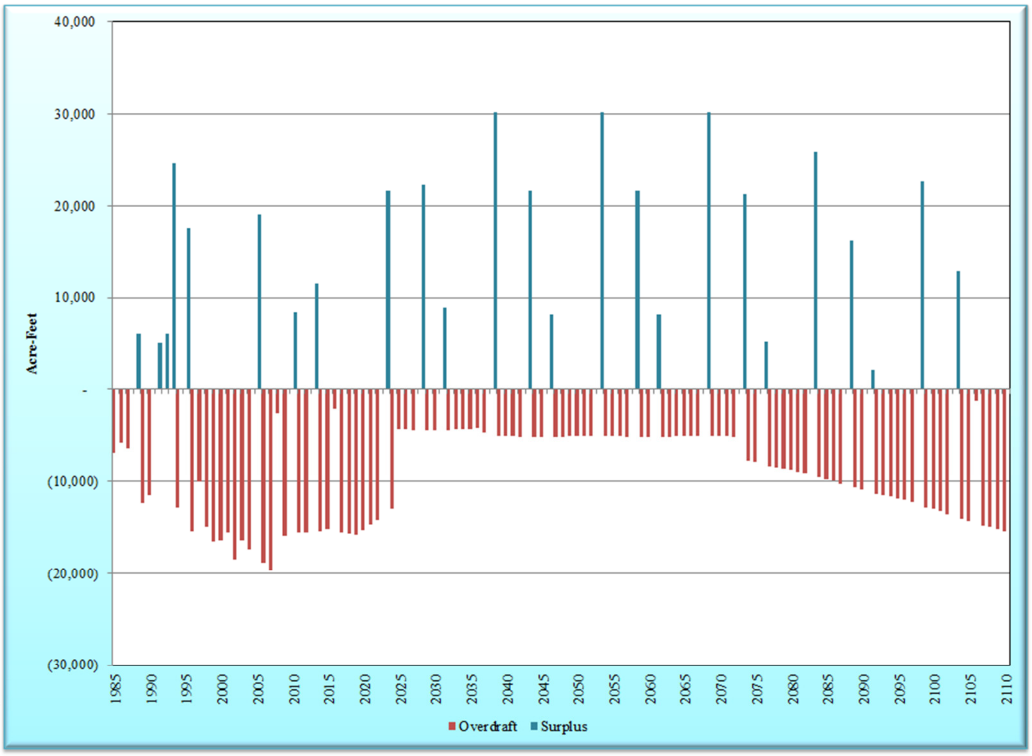


In Figures 11-5A through 11-5C overdraft is shown with red bars. For the historical period of 1985 through 2012, there were a few years where the water supply, based on net natural recharge into the AMA, exceeded the volume of pumping (surplus years). Surplus years are shown in teal colored bars in Figures 11-5A through 11-5C.

With the use of the additional supplies and reduced demand assumptions included in scenarios B and C, the period for which safe-yield can be maintained is lengthened. In Scenario A, the AMA is out of safe yield again in the year 2037. In Scenario B this period is extended to the year 2054, and in Scenario C, safe-yield can be maintained until the year 2072. Thus, the water budget scenarios illustrate the range of possible overdraft in the PRAMA from 2013 through 2110, given the statistically generated, annually variable net natural recharge components and the demand and supply assumptions described above.

Projected supplies to meet demand through 2110 are shown in Figures 11-6A through 11-6C. These scenarios indicate the range of volume of water conservation savings and/or supply augmentation needed to offset future groundwater overdraft. The water budget scenarios and are not intended to suggest limitations on individual water users or sectors, but are included here to illustrate the need for additional water management planning, infrastructure construction, and augmentation.

FIGURE 11-5C
PROJECTED WATER BUDGET: WATERSENSE, CHINO VALLEY BIG CHINO, ADDITIONAL SURFACE WATER CITY OF PRESCOTT
PRESCOTT AMA



Although the projected scenarios include years of surplus which mimic the historical pattern of overdraft with occasional years of surplus, once the reclaimed water long-term storage credits are exhausted, the surplus years are not able to offset the overdraft that occurs in between surpluses and the AMA once again begins a trend of persistent overdraft as observed in the historical period. Because the water table is greatly affected by localized recharge and withdrawal, achieving safe-yield AMA-wide does not ensure that all local areas of the AMA will attain a balance of supply and demand. There may be areas within the AMA where localized groundwater declines result in subsidence, dry wells, increased pumping costs, and water quality changes. Conversely, the benefits of recharge may be confined to areas where recharge basins and stream channels are located. Addressing the impacts of local water level declines and recovery in localized areas of the AMA must be addressed during the fourth management period. A more comprehensive approach to water management is needed to ensure that all areas of the AMA receive the benefits of stable water levels.

11.4.1 Determining Factors

Only a portion of the water management factors affecting the PRAMA's ability to achieve safe-yield are under ADWR's authority. These include conservation requirements, DAWS, permitting recharge facilities, well permitting, and incentives for use of renewable supply.

FIGURE 11-6A
PROJECTED SUPPLIES: BASE SCENARIO
PRESCOTT AMA

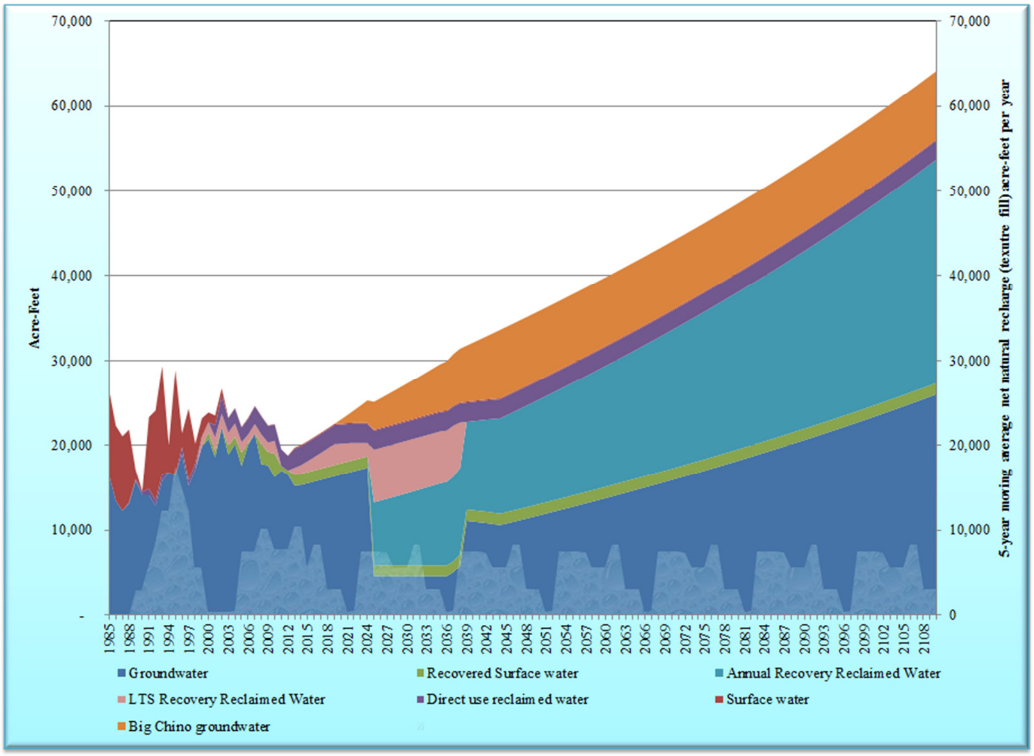


FIGURE 11-6B
PROJECTED SUPPLIES: WATERSENSE, CHINO VALLEY BIG CHINO
PRESCOTT AMA

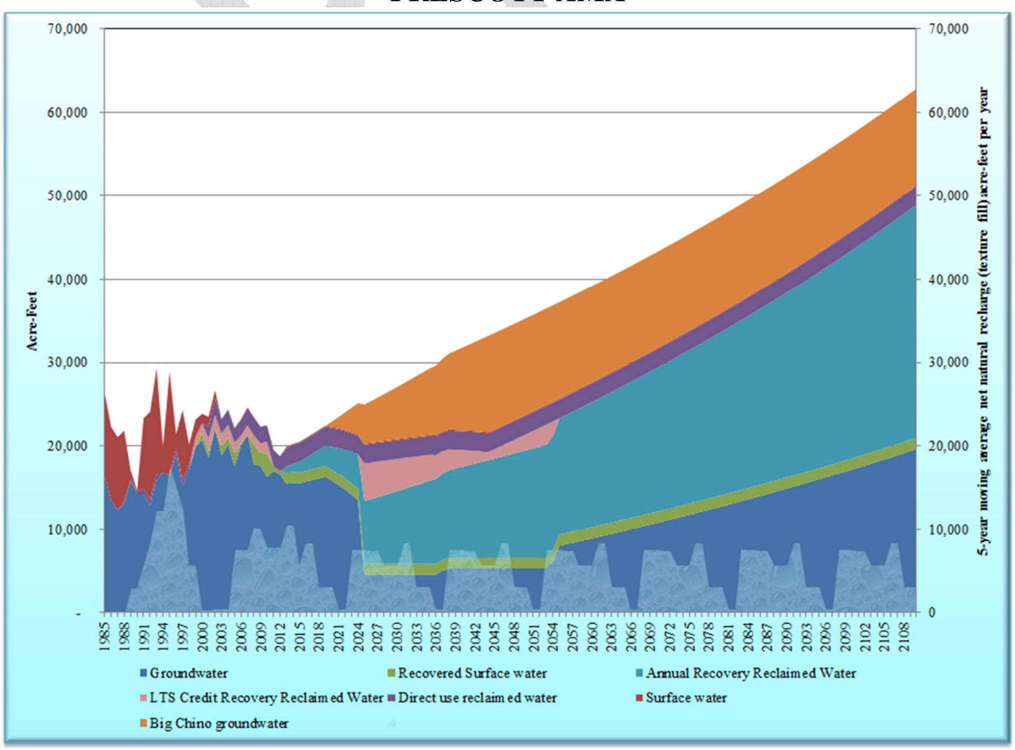
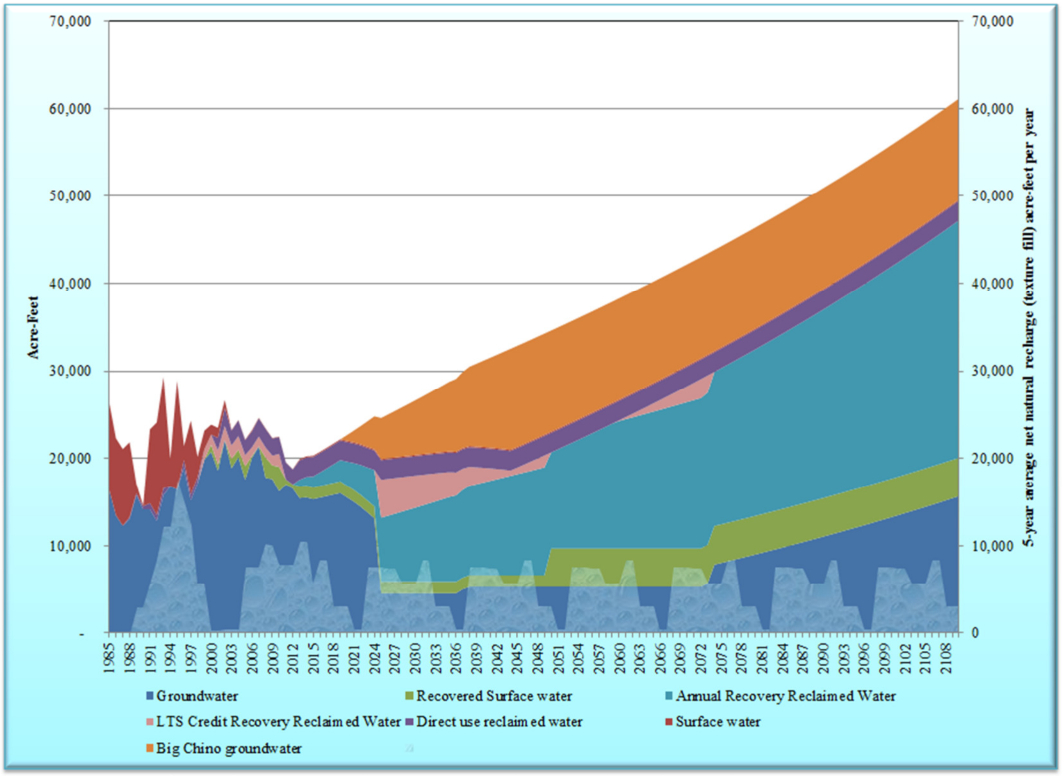


FIGURE 11-C
PROJECTED SUPPLIES: WATERSENSE, CHINO VALLEY BIG CHINO, NEW EXTERIOR MODELS, ADDITIONAL SURFACE WATER CITY OF PRESCOTT
PRESCOTT AMA



Many more water management factors are not under ADWR's authority and are difficult to predict, including economic factors, local initiatives and ordinances, and individual attitudes and habits. The outcome of these variables could either impede or enhance the PRAMA's ability to reach safe-yield. Economic and growth factors are impacted by water pricing. Water rates are controlled by water providers and the Arizona Corporation Commission. Pricing can have a direct effect on water use. Energy costs affect water pricing to some extent as well. Water rates paid by customers in the PRAMA fall in line with those paid in other AMAs. The City of Tucson (Tucson Water) customers pay about $15 per 5,000 gallons. In contrast some private water companies who have invested in constructing and operating their own water treatment plants to treat and deliver CAP water have rates of more than $50 per 5,000 gallons.

Customers of the City of Prescott and Town of Prescott Valley pay between $15 and $25 for the first 5,000 gallons of water that they use. Both large municipal providers have increasing block water rates, where customers with the highest water use pay increasingly higher rates for blocks of water above the first 5,000 gallons they use. Increasing block water rates encourage conservation where high utility bills become less affordable for customers.

Economic conditions can have positive or negative effects on water demand. Population growth can lead to retirement of agricultural land to make room for housing, but increased growth can also result in higher water demand for support industries and increased municipal demand.

In a November 2009 city election, Prescott voters passed Proposition 401 which requires a public vote on all city projects that cost more than $40 million. The Big Chino importation project has been estimated to cost between $170 and $200 million. Other augmentation strategies are likely to be in excess of the cost of Big Chino, and under current law, would require a vote to proceed.

In addition to the concept of importing groundwater from the Big Chino basin, some have supported the idea of macro water harvesting as a method of augmenting the water supply in the PRAMA. The idea is based on harvesting stormwater at large-scale facilities to be used for AWS purposes. In addition to impervious surfaces, water could be captured from saturated soil via subsurface drainage systems. There may be possible legal obstacles to water harvesting. ADWR currently recognizes three types of water that qualify for either long term or short term recharge credits. They are reclaimed water, Central Arizona Project (CAP) water from the Colorado River, and appropriated surface water. Based on discussions with ADWR staff, there is no current mechanism in statute that describes methods for obtaining recharge credits for unappropriated surface waters. More information is needed to evaluate the water management and hydrologic impacts of macro water harvesting.

11.5 CONCLUSIONS

ADWR's understanding of the hydrology of the PRAMA has improved since the adoption of the 3MP. This information, coupled with rapid growth during the third management period, and growth projections under several different scenarios, indicates that the PRAMA must increase use of renewable water supplies and continue the commitment to import water. Both of these approaches involve the construction of new infrastructure. Based on the projections included in this chapter, the PRAMA can achieve safe-yield by 2025, but the period of time for which the AMA can maintain safe-yield will depend on choices related to conservation, importation, infrastructure construction and water management strategies. Many of the assumptions included in the scenarios illustrated in this chapter will require unprecedented regional and cross-jurisdictional cooperation from today and continuing thereafter.

APPENDIX 11-A
4MP SCENARIO ASSUMPTION SUMMARY
PRAMA

	Population	Demand	Supply
City of Prescott	Re-projected service area population from 1985-2012 using a linear trendline from 2013-2110. Results in 2110 service area population of 134,522 people.	For Scenario A = 150 GPCD; For Scenario B and C assumed Prescott adopts a "WaterSense" ordinance in 2015, this changes the new interior use model from 57 GPCD down to 39 GPCD. For Scenario C also assume Prescott adopts a landscape ordinance for new development resulting in a reduction in the exterior GPHUD from 75 to 50 for single family homes and from 58 down to 20 GPHUD for multi-family homes, similar to actual rates observed in the Town of Prescott Valley. This results in an overall GPCD in the Prescott service area of 141 GPCD by 2110 for Scenario B, and an overall GPCD in the Prescott service area of 130 GPCD by 2110 for Scenario C.	All three scenarios assume Prescott direct use of reclaimed water is 2,240 acre-feet for 2013-2110. Scenarios A and B assume Prescott annually stores and recovers 1,335 acre-feet of surface water per year. Scenario C assumes that Prescott accesses and stores, beginning in the year 2050, another 3,200 acre-feet of surface water from its other surface water claims. All scenarios assume that Prescott begins using Big Chino groundwater in 2020 and ramps up to 4,365 acre-feet by the year 2044 and maintains that volume of Big Chino groundwater importation through 2110. For all three scenarios, for 2013 through 2024, Prescott is assumed to use groundwater to meet the remainder of the demand, up to 8,000 acre-feet. With these demand assumptions and population projection assumptions, Prescott never reaches 8,000 acre-feet of groundwater through 2024. For 2025 through 2110, it is assumed that Prescott uses no groundwater, and the remainder of Prescott's demand minus direct use reclaimed water and recovered surface water and Big Chino groundwater is met with recovered reclaimed water.
Town of Prescott Valley	Re-projected service area population assuming 4.1% growth rate from 2013-2025; a 2.2% growth rate from 2026-2035; and a 1.25% growth rate from 2036-2110. Results in 2110 service area population of 238,760 people.	For Scenarios A, B and C: 118 GPCD	For all three scenarios, for 2013 through 2024, it is assumed the Prescott Valley uses groundwater up to 6,161 acre-feet per year. It is also assumed that Prescott Valley begins importing Big Chino groundwater in 2020 and ramps up to 3,703 acre-feet by 2045 and maintains that volume of Big Chino groundwater importation thereafter. Any additional demand in each year above 6,161 acre-feet is met with recovered reclaimed water. For the year 2025 through 2110, it is assumed the Prescott Valley uses no groundwater, but supplies all its demand with recovered reclaimed water and Big Chino groundwater.
Small Providers	Including the Town of Chino Valley, small provider population was re-projected using the 1985-2012 historical data and a linear trendline for 2013-2110. This results in a small provider population of 42,390 people in 2110.	For Scenarios A, B and C: 90 GPCD	In all three scenarios, for 2013 through 2024 small providers are assumed to use 100% groundwater. However, in 2025 through 2110, it is assumed that regional reclaimed water storage and recovery will be implemented to offset or replenish small provider demand such that between small providers and exempt well population, only 3,000 acre-feet of municipal groundwater is withdrawn per year. The remainder of the demand is met with recovered reclaimed water. In scenarios B and C it is assumed that the Town of Chino Valley begins importing Big Chino groundwater in 2020 and ramps up to 3,483 acre-feet in the year 2045 and maintains that volume of imported Big Chino groundwater thereafter. Also in scenarios B and C, it is assumed that a regional wastewater collection system is in place beginning in the year 2020, to collect wastewater from all new small provider and exempt well population added in 2020 and thereafter, thus increasing the supply of reclaimed water that can be stored and recovered.

	Population	Demand	Supply
Exempt wells	Exempt well population is known only for the 2000 and 2010 Census years. In the Assessment, exempt well population was estimated for 1985-1999 using a 5% growth rate (back-calculating from the 2000 Census figure). For 2011 and 2012 the 4.3% growth rate that was used in the Assessment was used to estimate exempt well population. Using these figures, a trendline was developed using the estimated exempt well population for 1985-2012 to project the population from 2013-2110. This results in an exempt well population of 33,010 people in 2110 using the "power" trendline. This projection is low. It is assumed that steps are taken to restrict the number of new exempt wells in PRAMA as a water management strategy for the fourth management period and continuing thereafter	For Scenarios A, B and C: 90 GPCD	In all three scenarios, exempt wells are assumed to use 100% groundwater for the years 2013 through 2024. For 2025 through 2110, it is assumed that a regional reclaimed water storage and recovery projected will have been constructed and will operationally have the capability to limit the sum of small provider and exempt well groundwater pumping to 3,000 acre-feet per year. The remainder of exempt well demand will be offset with recovered reclaimed water. In scenarios B and C is assumed that a regional wastewater collection system is in place beginning in the year 2020, to collect wastewater from all new small provider and exempt well population added in 2020 and thereafter, thus increasing the supply of reclaimed water that can be stored and recovered.
Industrial		From Baseline Scenario One in the Assessment: 1,640 acre-feet per year for 2013-2110. This assumed that industrial demand will somehow be limited in the PRAMA, to allow the achievement and maintenance of safe-yield for as long as possible. This does not mean that there won't be any commercial uses or industry in PRAMA. These types of uses can occur and be served by a municipal water provider pursuant to their service area rights. What it does mean is that GFR and permit pumping would need to be limited under the assumptions in these scenarios in order to allow for safe-yield.	Industrial demand is assumed to be met primarily with groundwater, with a very small volume each year as direct diversion of surface water. This assumption was held constant in all three scenarios.

	Population	Demand	Supply
Agricultural		From Baseline Scenario One in the Assessment: reduces to 783 acre-feet in 2014 and maintains thereafter.	It is assumed that the Prescott continues to transfer reclaimed water long-term storage credits to the CVID until a total of 33,000 acre-feet of credits have been transferred and recovered by CVID to meet agricultural demand. At an assumed rate of 750 acre-feet of recovered reclaimed water LTS credits per year, the 33,000 acre-feet is exhausted in the year 2037. At that point, the agricultural sector returns to using groundwater and maintains that use through 2110. This assumption was used in all three scenarios

APPENDIX 11-B
SELECTED HYDROGRAPHS
PRAMA

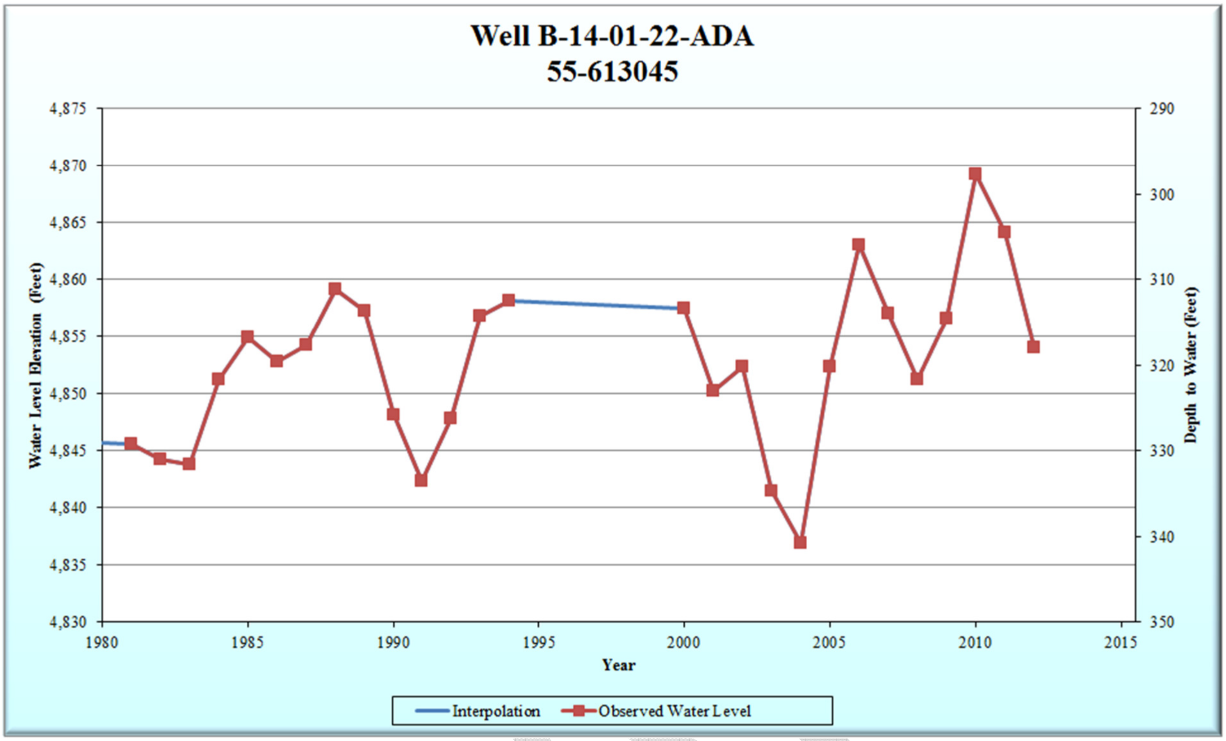


Figure 11-B1. Groundwater Level Data UAF Sub-basin adjacent to Lynx Creek, (B-14-01)22ada (1971-2013).

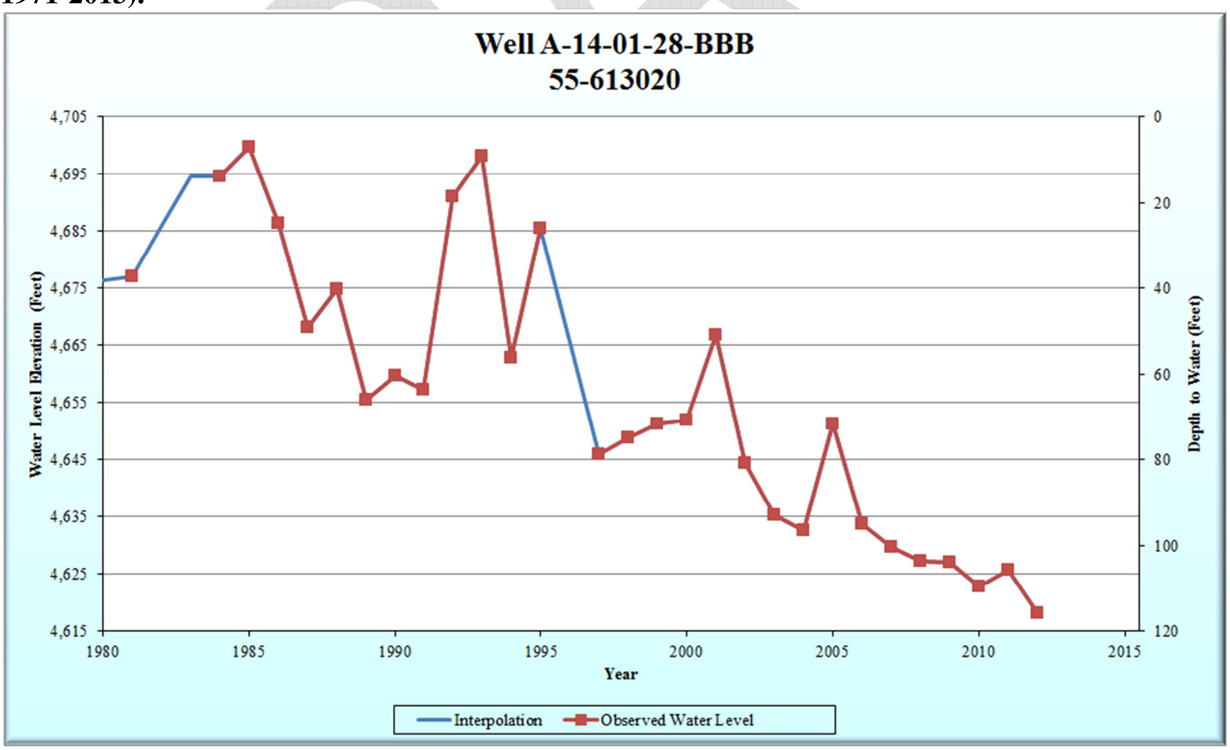


Figure 11-B2. Groundwater Level Data in the UAF Sub-basin adjacent to Lynx Creek, (A-14-01)28bbb (1956-2013). Groundwater level data shows the impacts of significant and frequent recharge in the 1980's and 1990's.

Bibliography

ADWR. (2011). Water Demand and Supply Assessment 1985-2025, Prescott Active Management Area.

Nelson, K. (2013). *Hydrogeology and Simulation of Groundwater Flow, Prescott Active Management Area, Yavapai County, Arizona (Report No. 25).* ADWR.