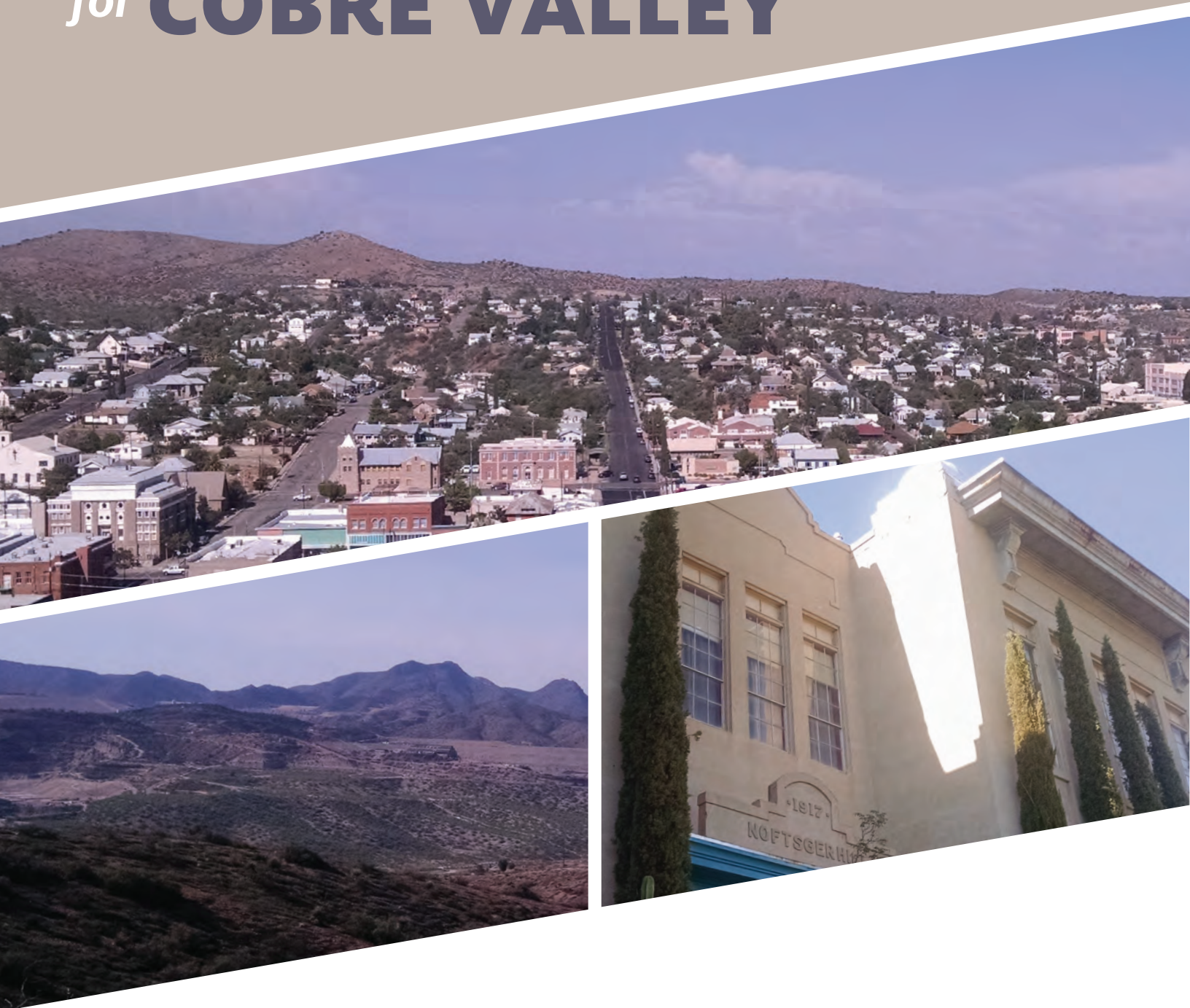


# WATER HANDBOOK

for **COBRE VALLEY**



*Thank You To Our Community Partners*



COLLEGE OF AGRICULTURE & LIFE SCIENCES  
COOPERATIVE EXTENSION  
**WATER RESOURCES  
RESEARCH CENTER**



THE UNIVERSITY OF ARIZONA  
COLLEGE OF AGRICULTURE & LIFE SCIENCES  
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**Capstone**  
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COOPERATIVE EXTENSION

## **WATER RESOURCES RESEARCH CENTER**

The University of Arizona Water Resources Research Center (WRRC) promotes understanding of critical state and regional water management and policy issues through research, community outreach, and public education.

### **ACKNOWLEDGMENTS**

We thank our Steering Committee for their guidance and assistance in planning the Cobre Valley Small Town Forum on Water, including Jessica Asbill-Case, Stan Gibson, Joe Heatherly, Chris Jones, Brad Mecham, Cathy Melvin, Mary Anne Moreno, Brent Musselwhite, Linda Oddonetto, Sandy Palmer, Deborah Patton, Daphne Place-Hoskie, and Timothy Ralston. We appreciate the time and many contributions by the people concerned about water management who provided expertise, advice, and suggestions. Special thanks go to Joel Rose, Bethany Sullivan, and Mia Hammersly at the University of Arizona Law School Natural Resources Clinic for introducing complicated but important water law issues.

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## PART 1: INTRODUCTION

### ABOUT THE HANDBOOK

This handbook provides an introduction and snapshot in time of current water-related topics based on available data, especially as they relate to water supply and demand in Cobre Valley. Its purpose is to provide a foundation for discussion during the Cobre Valley Small Town Forum on Water (September 6, 2018). It is our hope that, on this foundation, forum participants can create a well-informed and progressive water resource management plan for the Cobre Valley region.

[Discussion Topics and Questions](#) are placed at the end of each section to summarize primary challenges and prompt discourse.

The work leading up to this forum was undertaken by the WRRRC and Gila County Cooperative Extension, through a cooperative agreement with the U.S. Bureau of Reclamation.

### WATERSHED PARTNERS

The gap between water supply and demand is predicted to grow ever larger in the western United States in the coming decades (U.S. Bureau of Reclamation, 2012). When demands for water approach or exceed available supplies, competition intensifies among various interests and scarcity becomes a potential source of conflict. It is necessary to have a mechanism to not only understand and allocate available resources, but also foster cooperation among stakeholders. This cooperation is particularly critical in rural areas with limited resources. One mechanism for cooperation is through watershed partnerships, which, if provided the right tools, can be powerful mechanisms for improved management of water resources.

#### [Cobre Valley Watershed Partnership](#)

Over the next two years, a watershed partnership will be created for Cobre Valley through funding from the US Bureau of Reclamation WaterSMART program. This is an important and exciting initiative, that can provide needed watershed coordination and projects, as has been demonstrated in other parts of the Southwest. A watershed partnership can assist with any number of water-related efforts. All results and priorities from the Small Town Forum will be reported to the watershed partnership for consideration.

Membership in a watershed partnership is open to any interested individual or organization. Inclusiveness is a major goal. Everyone with a stake in the water resources of the region is encouraged to participate. Members will select a steering committee and/or advisory board, which will contract for staff support. [A detailed plan for the development of the Cobre Valley Watershed Partnership will be produced cooperatively during the next year.](#)

## SMALL TOWN FORUM

Based on what we currently know, what choices can we make to safeguard and enhance our most precious resource - water - into the future? Water supply, water quality, water uses, drought, economic factors, and water-dependent environmental values are just a few of the topics that are intricately intertwined in the watershed.

On September 6, 2018, Cobre Valley Small Town Forum on Water brings together decision-makers and water managers in the Globe-Miami area, with other interests and experts on water resources, to decide on top priorities and areas for possible collaboration to enhance the water resilience of the region. With the formulation of actionable next steps, local leaders and water experts can begin aligning organizational goals and partnering on watershed initiatives.

Forum outcomes will contribute to the completion of a [water resources objectives report](#) and assist the creation of a watershed partnership for Cobre Valley.

### Forum Goals

- Build a common understanding of water resources management and water supply/demand in Cobre Valley
- Agree on a vision for the watershed with consideration of social, environmental, and economic resilience and adaptivity
- Set and rank priorities in the following categories:
  - 1) system efficiency and conservation,
  - 2) economy and development, and
  - 3) recreation and environment
- Form working groups to focus on specific areas, including funding opportunities, water supply and demand data, and recreation
- Prepare for our next Forum, which will outline an action plan and detail how different partners may contribute to a watershed-wide collaboration

This work requires iteration, collaboration, and perseverance, and we thank you for being part of an effort to manage water for current and future generations.

**A second Small Town Forum will be held in Spring 2019.** In the interim, working groups will be coordinated by the WRRRC and partners to make progress on top priorities as determined at the first Small Town Forum.

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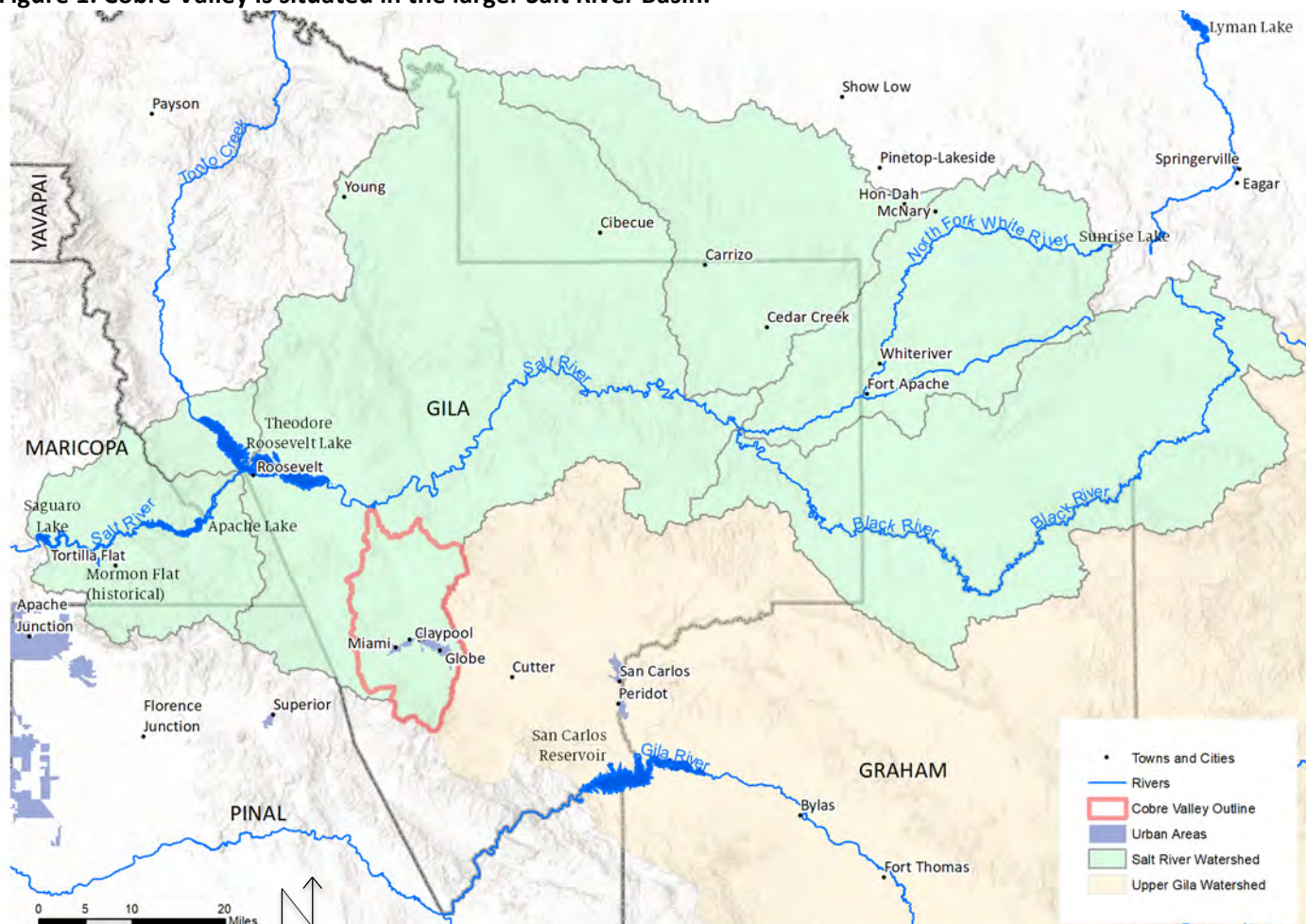
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## PART 2: WATER PRIMER

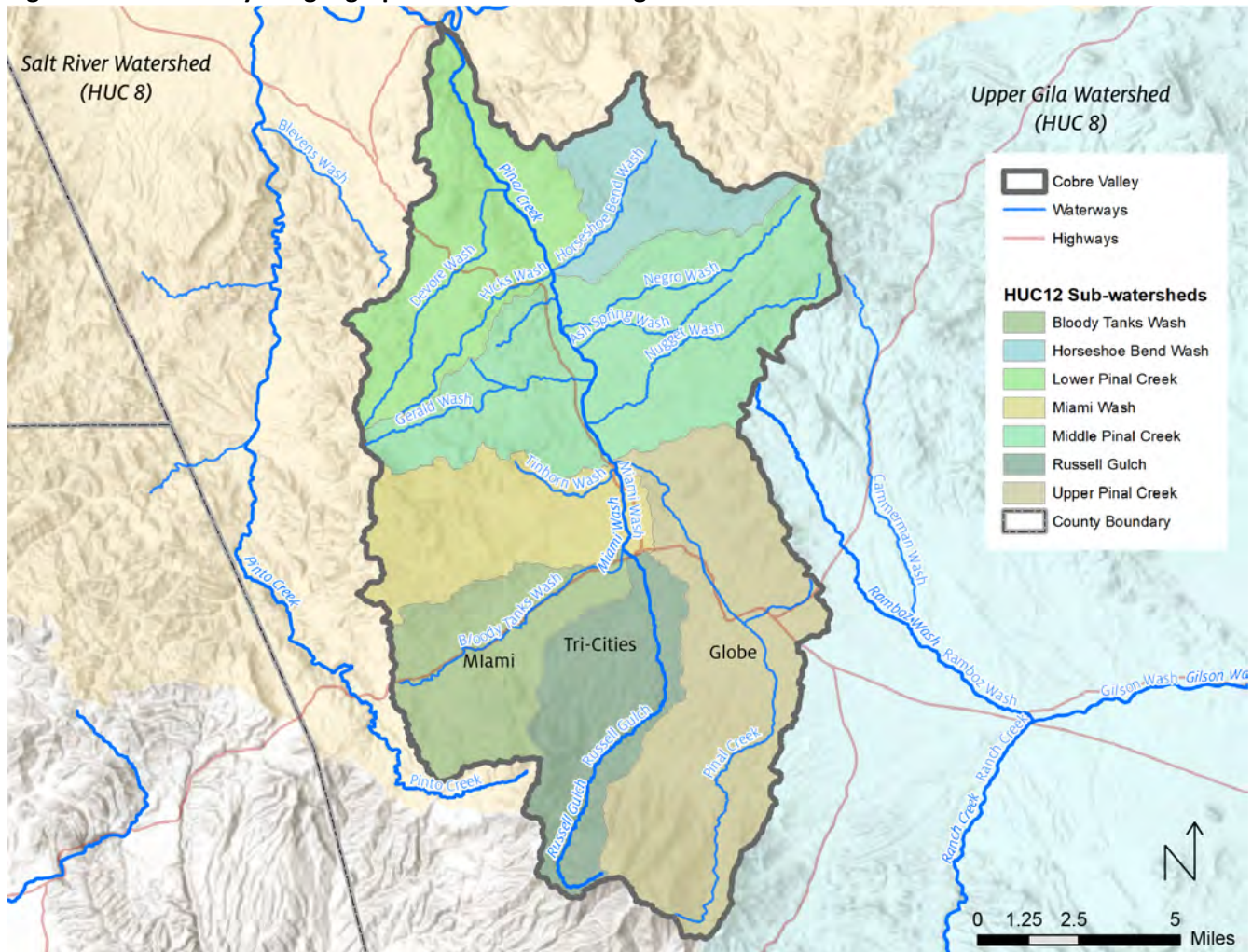
### WATERSHED CONTEXT

Cobre Valley is located in the mountains of southern Gila County, east of Phoenix in central Arizona, and is part of what is known as the “Copper Corridor.” This corridor includes Globe, Miami, Claypool, Central Heights, and other unincorporated areas located on the edge of the Salt River Basin in the Salt Lakes sub-basin (**Figure 1**). Cobre Valley spans approximately 100 square miles and consists of seven sub-watersheds within the Upper Salt River Watershed (HUC 15060103): Lower Pinal Creek, Middle Pinal Creek, Upper Pinal Creek, Russell Gulch, Bloody Tanks Wash, Miami Wash, and Horseshoe Bend Wash (**Figure 2**). (“HUC” refers to “hydrologic unit code,” created by the US Geological Survey as a hierarchical system that divides and subdivides regions based on drainage area. The bigger the number or “code,” the smaller the region.)

**Figure 1. Cobre Valley is situated in the larger Salt River Basin.**



**Figure 2. Cobre Valley is a geographic location consisting of seven sub-watersheds in the Salt River Basin.**



Cobre Valley is a typical alluvial basin within the Basin and Range geography of the Southwest. Narrow valleys and alluvial basins are separated by steep, north to northwest trending mountain ranges. The Pinal Mountains are on the southern end of the basin and reach a maximum height of 7,848 ft. at Pinal Peak. The communities of Globe-Miami are located at approximately 3,500 ft. The lowest point in the basin at Roosevelt Lake (2,000 ft.). The basin is bounded on the north by a 2,000-foot high escarpment (the Mogollon Rim), on the south by the Natanes Plateau, on the east by the White Mountains, and on the west and southwest by the Sierra Ancha and Superstition Mountains (ADWR, 2014). Extensive bedrock exposure results in relatively high runoff and small water storage capabilities compared to southern parts of the state (ADWR, 2014).

## People

Cobre Valley contains about 1/5 of the population of Gila County (roughly 11,000 people out of 55,000 people) (Arizona Office of Economic Opportunity, 2015) (**Table 1**).

**Table 1. Historical and projected population in Cobre Valley between 2010 and 2030 (Arizona Office of Economic Opportunity 2015).**

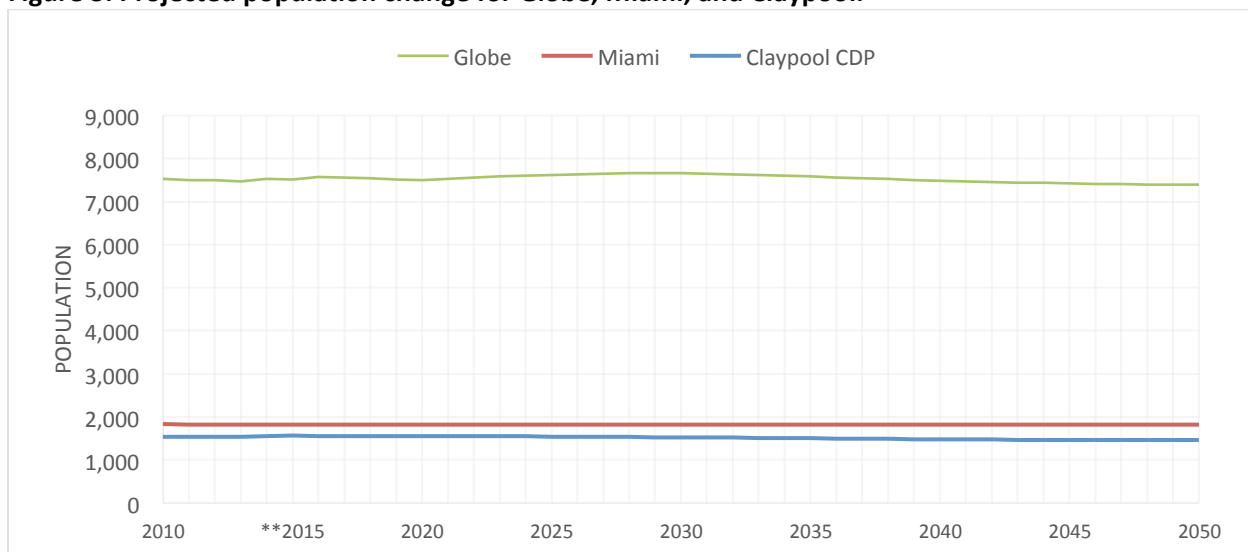
	2010 (Census)	2010*	2011*	2012*	2013*	2014*	2015*	2016**	2017**	2018**	2019**	2030**
<b>Gila County</b>	53,597	53,565	53,577	53,626	53,670	54,219	54,406	54,611	54,781	54,924	55,045	55,327
<b>Globe</b>	7,532	7,533	7,503	7,500	7,471	7,525	7,520	7,576	7,560	7,540	7,521	7,667
<b>Miami</b>	1,837	1,834	1,827	1,823	1,819	1,826	1,828	1,828	1,828	1,828	1,828	1,828
<b>Claypool CDP</b>	1,538	1,539	1,541	1,542	1,543	1,561	1,564	1,556	1,556	1,556	1,556	1,527
<b>Central Heights-Midland CDP</b>	2,534	2,535	2,539	2,541	2,542	2,572	2,578	2,563	2,564	2,564	2,563	2,516

\* For incorporated places, these are previously published estimates for July 1 of each year; for CDPs and reservations, these are estimates produced in the projection process.

\*\* Projections for 2016 and beyond refer to July 1 of each year.

The Arizona Department of Administration (ADOA) projected that population in Globe and Miami (AZ) would decrease between 2010 and 2019, but long-term projections remain stable and provide little insight for local planning (**Figure 3**). While projections suggest that population will be the same or decrease slightly, there are other factors that can impact this trend, such as new mining projects or other new activities could attract more inhabitants. Gila County is expected to have only modest growth (0.3% annually) in population over the next five years and then remain somewhat stable over the next few decades.

**Figure 3. Projected population change for Globe, Miami, and Claypool.**



\*\* For incorporated places, these are previously published estimates for July 1 of each year; for CDPs and reservations, these are estimates produced in the projection process.

Meanwhile, Arizona's population is expected to grow. On the low end, overall Arizona population may increase by 2.5 million people by 2050, and on the high end, the increase will be 5 million people by 2050. [It is an open question what impact this growth will have on Cobre Valley.](#)



## Land Ownership

Cobre Valley is characterized by a patchwork of land ownership (**Figure 4**). The U.S. Forest Service is one of the largest water and land managers in the Cobre Valley and the greater area. The San Carlos Apache Tribe has major land and water holdings upstream of the Cobre Valley. Only a small percentage of the land is privately owned. Land under different ownership is managed in different ways. The San Carlos Apache are a sovereign nation with an independent system of land and water management. The US Forest Service (USFS), Bureau of Land Management (BLM), and Arizona State Land Department lease lands to private citizens for uses such as grazing, mining, recreation, and rights-of-way for transportation and utilities. The harvest and collection of forest products is also permitted on USFS land. State-owned land is often interspersed with federally managed land and privately owned land, and some of this land may be sold into private ownership in the future. Even though there is a relatively small amount of privately owned land, planning for healthy water resources within this patchwork of ownership can be challenging.

**Figure 4. Land ownership in the Cobre Valley.**



## CLIMATE AND NATURAL RESOURCES

With hot summers and moderate to warm winters, Cobre Valley has a mild and semi-arid climate. Due to the higher elevation in Globe-Miami, at about 3500 ft., this area has the advantage of more precipitation and lower temperatures than the nearby, non-mountainous regions such as Phoenix and Tucson. In Globe, average temperature ranges between 43°F (December) and 81°F (July). In Miami, average temperature ranges between 46°F (January) and 83°F (July) (ADWR, 2009). Annual precipitation in Globe and Miami fluctuates between 13.78 in/year and 19.49 in/year; compared to an Arizona average of 12.4 in/year and a Phoenix average of 8.0 in/year (at elevation 1000 ft.). Typical of Arizona, precipitation has a bimodal pattern, with precipitation peaks in both the winter and summer. The area receives 64% of its annual precipitation during the winter months, with a smaller fraction received during the summer monsoon months from July-September (ADWR, 2009).

Regional temperatures have slowly been increasing over the past 100 years (WRCC, 2018) (Figure 5). The long-term increasing temperature trend is likely to affect water resources and environmental conditions in the watershed. Shifts in climate can influence temperature, evaporation, precipitation, and spring runoff – all of which have ramifications to water supply. Furthermore, increased temperatures are linked to patterns of fire, drought, and flood over time (ADWR, 2009).

The region has experienced recent episodes of fire, flooding, and drought with consequences for its water resources. Fire in the region has historically increased peak stream flows, flooding risk, and water quality issues, with increasing incidents of erosion and sedimentation. The Rodeo-Chediski Fire is an example of fire's effects on water resource. In June 2002, it burned continuously for more than 3 weeks and devastated over 700 square miles in central Arizona. Peak storm flows after the fire were found to reach as much as 2,230 times greater than runoff/surface flow rates than pre-disturbance flows due to the lack of vegetation and ground cover following the event (Ffolliott et al., 2011).

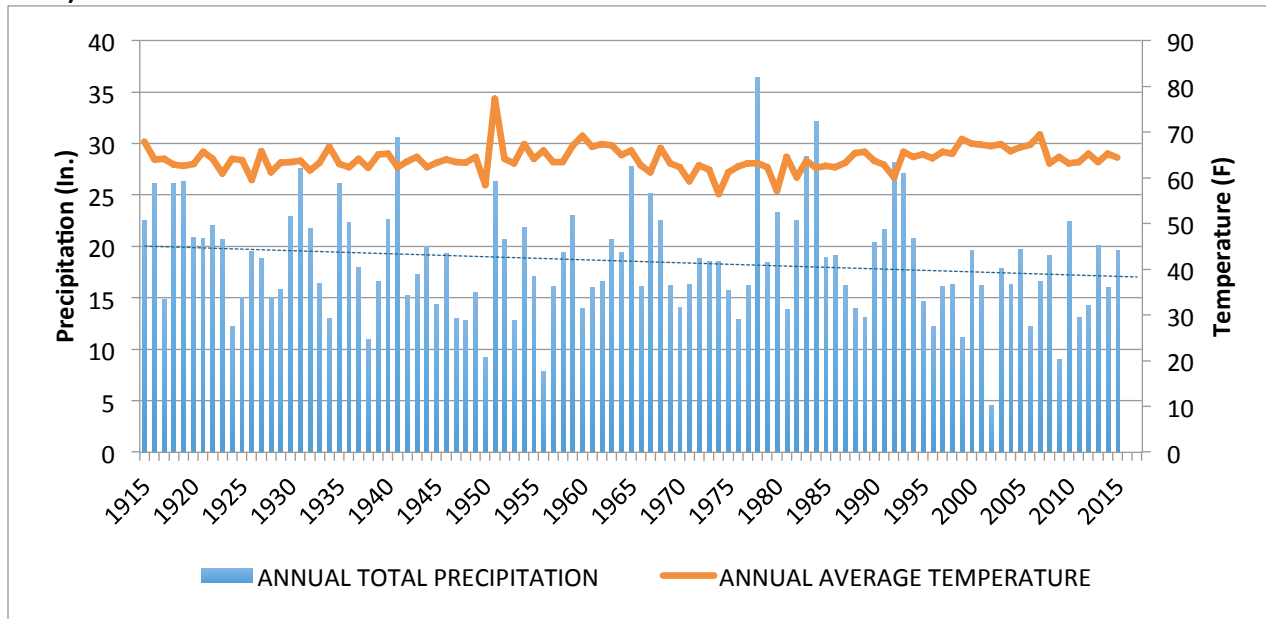
Substantial fires can be the result of accumulation of combustible materials, such as leaf litter and dead vegetation following a major disturbance such as disease or insect infestation. Combined with low water levels, hot, and dry conditions, these fires can have devastating effects.

Severe and extended droughts are an inevitable and natural part of climate cycles. While the impacts of drought can vary from place to place, one aspect is the same – a lack of precipitation. A region can experience long-term weather patterns that produce drought, but have short-term changes in the overall pattern that result in short-term wet spells. Using tree ring science, it is known that the Southwest region has experienced “mega” droughts that have lasted for over 50 years. Extended drought will result in critical water stress on plants, leading to large areas of dead or dying vegetation. The current drought in the Southwest makes native species of vegetation vulnerable to increased disease, reduced plant production, dying off of immature plants and eventually mature plants, and invasion of non-native species. With the increased temperatures that frequently associated with drought, there is also a higher demand for water that increases with the severity of drought.

Flooding has also been a recurring issue in the valley. As the Pinal Creek basin flows directly through the municipalities of Globe and Miami, during high precipitation events properties, especially near surface water channels, have been heavily damaged. As part of a previous WRRC project developing a historical water timeline for the region ([wrcc.arizona.edu/Globe-Miami](http://wrcc.arizona.edu/Globe-Miami)), community members told

personal anecdotes of flood events that occurred over the history of the towns (WRRC, 2016). Alternative storm water control techniques could help address some of these flooding issues. Storm water managers may also need to work in conjunction with fire and forest managers as the health of the forests directly influences the impacts of storm events on the community.

**Figure 5. Average Temperature and Total Annual Precipitation (1915-2015) (Western Regional Climate Center 2018).**



### DISCUSSION TOPICS AND QUESTIONS

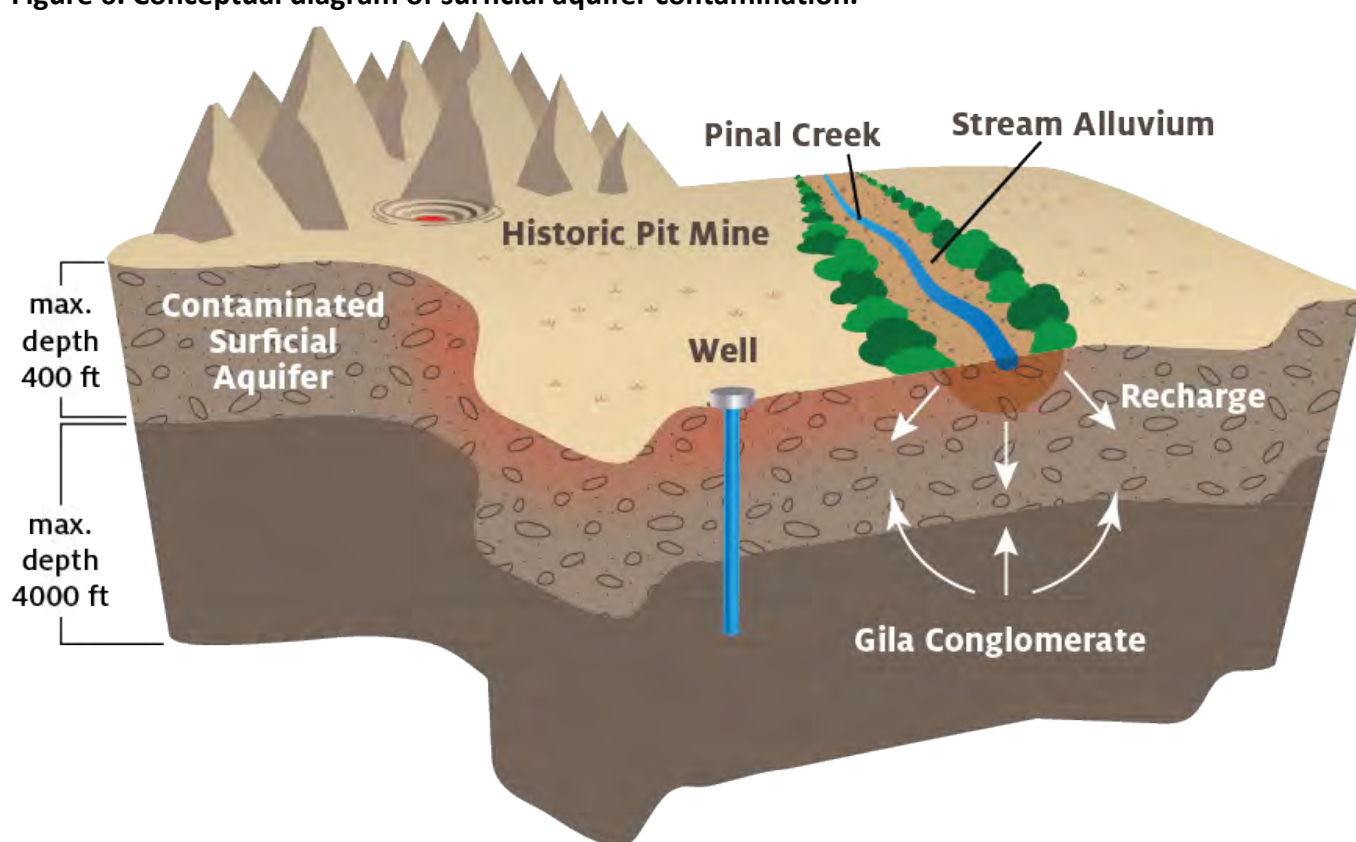
- The elevation of Globe-Miami leads to milder temperatures and more rainfall than other areas of Arizona.
- The frequency of fires may increase as air temperature increases, which dries out fuel sources. Land affected by fire is more likely to have increased runoff and erosion. Associated waterways may experience atypical flooding and impaired water quality.
- Changing weather patterns and hotter temperatures may affect precipitation patterns, water recharge, and runoff. These changes would affect water availability for human activities.
- Land management practices, such as forest thinning, are particularly resource- and time-intensive. These efforts are critical for watershed health, but complicated by a patchwork of public and private land ownership as well as the difficult terrain in the watershed.
- How might we utilize climate models to help plan for future supplies?
- Wildfire risks impact a large portion of Cobre Valley, both upstream and downstream. How might we prioritize work to understand the percent of acres susceptible to fire and increased risk based on climate projections?

## WATER QUALITY

Cobre Valley groundwater is pumped from two aquifers (**Figure 6**). Local water providers (Arizona Water Company and City of Globe) source water from the uncontaminated aquifer, to deliver water that meets both state and federal drinking water quality standards (ADWR, 2017). About 89% of the population in the area is served by one of these municipal water providers. In 2009, there were 5,680 private, domestic wells registered in Gila County, many located in the Cobre Valley (ADWR, 2009). Private domestic wells should also be drilled into the uncontaminated Gila Conglomerate aquifer. Due to historical contamination, the surficial aquifer may yield water that does not meet drinking water standards. There are concerns among private well owners about possible health-risk because testing found numerous supply wells had been contaminated over the years with metals, sulfate, acidity, and high levels of dissolved solids in the area from Miami to Wheatfields along Pinal Creek. (AWR, 2017).

Testing private well water to identify the possible presence of heavy metals is important to ensuring public health. Public education events encouraging appropriate well testing have occurred recently in the region, but they require greater outreach efforts for rural areas where populations are more dispersed (Personal communication: Artiola, 2017).

**Figure 6. Conceptual diagram of surficial aquifer contamination.**

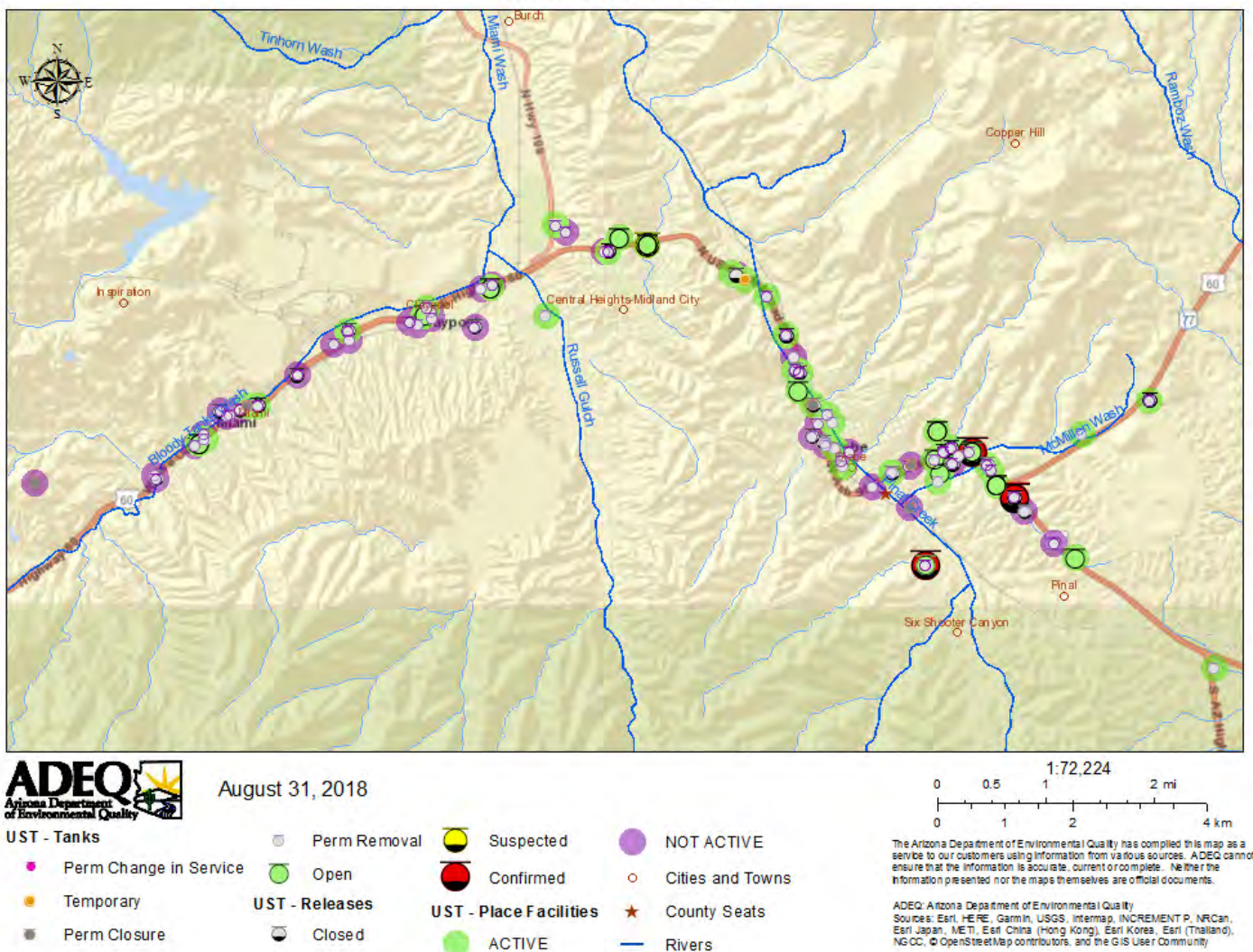


Soil and aquifer contamination by metals, pathogens, and hazardous substances has occurred in the valley through processes of natural mineralization as well as human actions associated with development, waste disposal, mining, and other industrial activities. The main contaminant sources are erosion and storm water runoff from mining waste and tailings piles, leakage and spills from process solution impoundments and leach dumps, and deposition of wind-blown tailings and copper smelter

emissions. The most significant contamination has occurred in the alluvial aquifer along Pinal Creek and Miami Wash, where elevated concentrations of sulfate and heavy metals, such as cadmium and nickel, have been found (ADWR, 2017). As a result of remediation activities, approximately 107 million pounds of heavy metals had been removed from the aquifers by 2008 (ADWR, 2009). Additional contamination has occurred through unlined or poorly designed underground storage tanks for commercial, industrial, and residential waste products.

Exposure to human and household waste can also occur due to the presence of malfunctioning waste disposal systems that include cesspools and dysfunctional septic tanks (map of Leaking Underground Storage Tanks (LUSTs) shown in **Figure 7**). Although the use of cesspools was prohibited by ADEQ in 1976, it has been estimated that more than 50 percent of homes in Miami, Globe and Claypool use cesspools for sewage disposal (TRSD Board of Supervisors). Since January 2002, state septic regulations have required newly installed systems to meet more stringent minimum standards. These new standards may protect against sewage contamination but may also make it difficult for Cobre Valley homeowners to upgrade their waste disposal systems because of lot size, terrain, and other property characteristics.

**Figure 7. Map of LUSTs in Globe-Miami (ADEQ, 2018).**



### DISCUSSION TOPICS AND QUESTIONS

- There is one primary drinking water aquifer in the basin - the Gila Conglomerate aquifer. (The City of Globe withdraws most of its water from a basin outside the watershed.)
- The shallow alluvial aquifer has been contaminated by a variety of constituents, many derived from mining, industrial, and human activities. These constituents include sulfate, heavy metals, and pathogens from human waste.
- The Tri-city Regional Sanitary District and community leaders continue to work toward solutions to address failing septic systems and cesspools, with their negative consequences for property values in the area.
- Increased population or the establishment of new housing could put pressure on the development of services. What initiatives may be required to reclaim cesspools when these properties transition to centralized treatment?

## WATER SUPPLY AND DEMAND

The primary water source in the Cobre Valley is groundwater, and the main users are the communities of Globe and Miami (service areas shown in **Figure 8**) and local mining companies.

### Water Supplies

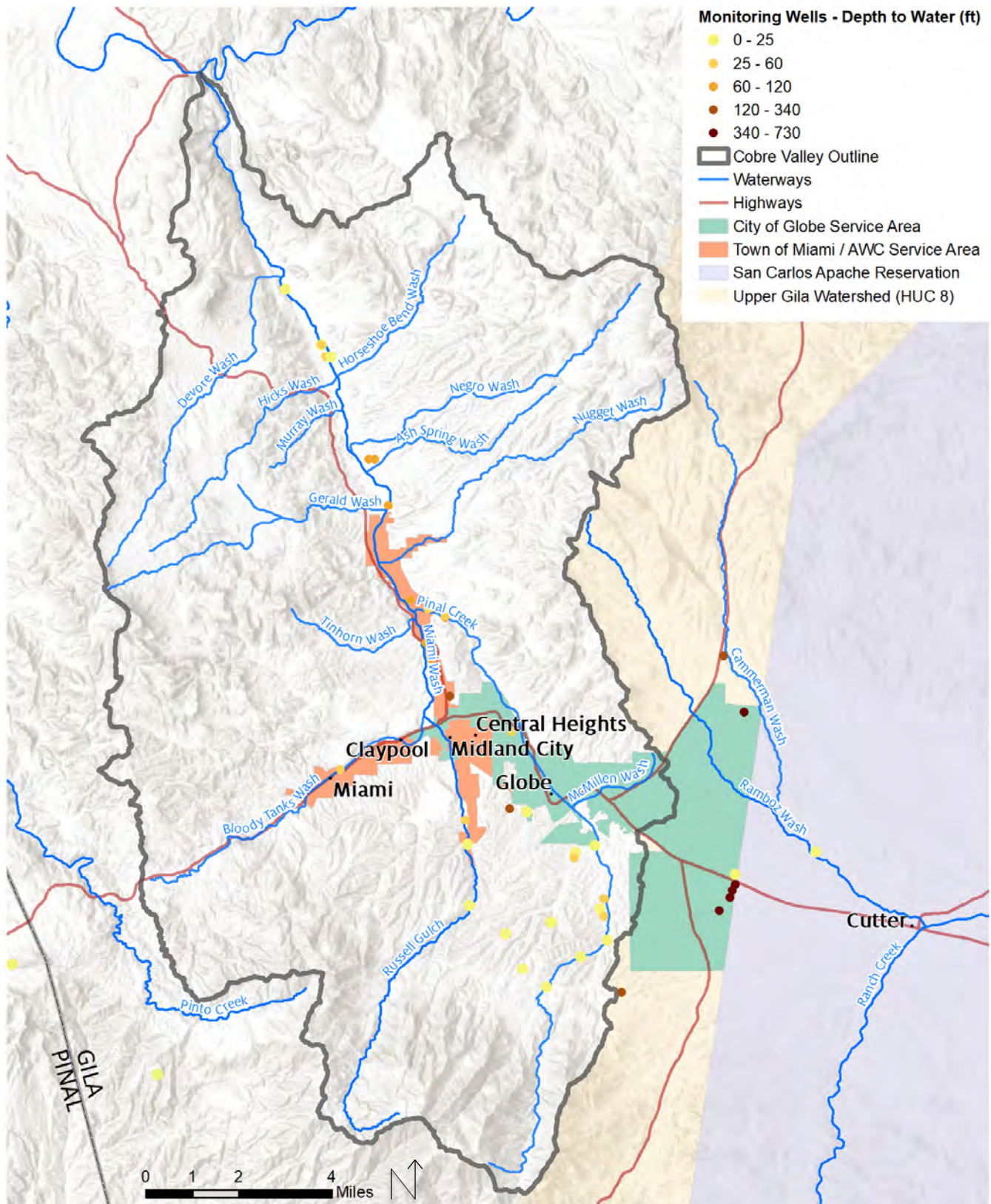
Water demand in Arizona is supplied from: surface water, groundwater, and reclaimed water. Groundwater supplies most municipal, industrial, and agricultural demand in Cobre Valley. Very little surface water is available for local use and only a tiny fraction of local demand is supplied by reclaimed water. Reused wastewater accounts for only 1-2% of total volume of water used in the Salt River Watershed (ADWR, 2009), of which roughly 1/3 takes place in the Globe-Miami area. In the future, water reuse could increase as traditional supplies (groundwater and surface water) fail to keep up with demand and infrastructure funding and public acceptance of water recycling increase.

### Groundwater

There are two principal aquifers in the valley: the shallow alluvial aquifer and the regional Gila Conglomerate aquifer composed of semi-consolidated to consolidated basin-fill sediments. Most of the groundwater pumped from within the valley for domestic and industrial water supply comes from the Gila Conglomerate aquifer. A localized limestone aquifer also supplies water to the Globe-Miami area, and west of Globe several small basin-fill deposits form isolated groundwater aquifers (ADWR, 2009).

Wells of varying depths are scattered throughout the valley but are concentrated in urban areas (**Figure 8**). The Arizona Department of Water Resources (ADWR) monitors groundwater levels (WL) using observation wells located throughout Arizona. [An ADWR 2016 report indicates the second greatest mean decline in WL \(from 2015 to 2016\) was in the Salt River Lakes Sub-basin, the sub-basin where Cobre Valley is located \(ADWR, 2017b\).](#)

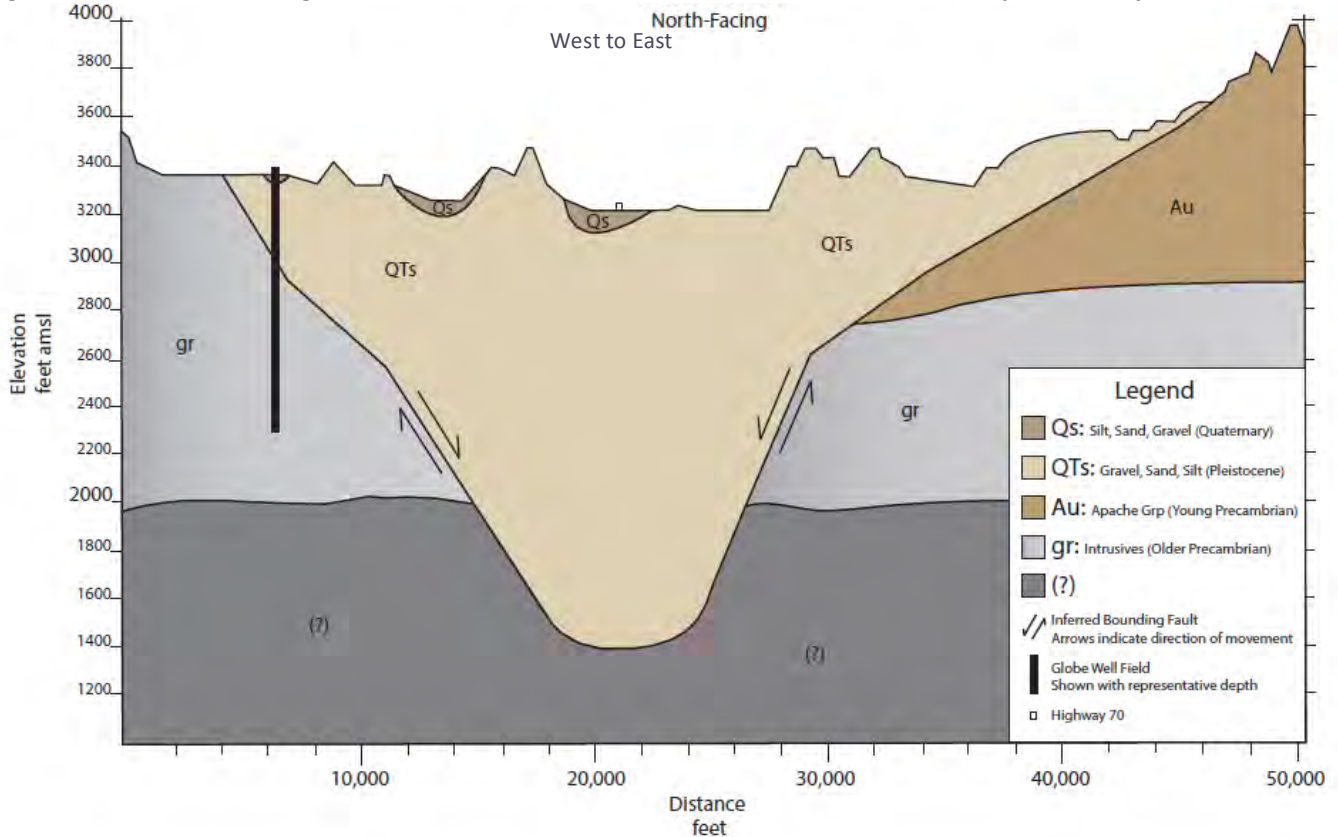
Figure 8. Cobre Valley wells, depth to water (ADWR, 2018).





The City of Globe pumps its water from the Cutter Basin, which is located in the Safford Basin, southeast of Cobre Valley (see **Figure 9** for a cross section and the placement of Globe water supply wells). Some evidence indicates that the Cutter Basin is hydrologically disconnected from the Safford Basin.

**Figure 9. Schematic Geologic Cross Section of the Cutter Alluvial Basin (information provided by Stan Gibson).**



### Surface Water

Surface water streams in the basin are mostly ephemeral, occurring only in response to precipitation events. The primary surface water body found in Cobre Valley is Pinal Creek, which flows northward through mining properties and the incorporated and unincorporated communities of the valley to the Salt River upstream of Roosevelt Lake.

The Pinal Creek catchment area is 172 square miles (mi<sup>2</sup>) and is constrained by the Pinal Mountains to the south, Apache Peaks to the northeast, and Globe Hills to the east. Small tributary canyons (Six-shooter Canyon, Icehouse Canyon, Kellner Canyon) make up the headwaters of the system in the south, with additional source waters entering the system further north from Nugget Wash, Negro Wash, and Wood Springs Wash. Major tributaries of Pinal Creek include Bloody Tanks Wash and Russell Gulch, which join to form Miami Wash.

Ephemeral flows are present in the southern portion of the basin as a result of precipitation events, and a perennial stream emerges in the north end of the channel where bedrock impinges on the alluvial aquifer and forces groundwater to the surface. The perennial flow is present in the northern 3.41 miles of the basin (ADEQ, 2017).

Forest management practices in the upper watershed, such as vegetation removal and forest thinning, can produce increased surface flows; however, they can also increase chances of flooding. Additionally, evaporation rates can increase from the loss of shade-cover as temperatures increase.

### **Reclaimed Water**

The City of Globe operates a 1.2 million gallon per day (MGD) oxidation ditch wastewater treatment facility located along Pinal Creek Road. Incoming wastewater is received from downtown Globe, Crestline, Skyline, the Pioneer Hills, and Fry's Grocery. The facility has been at the same location since the 1970s but has been upgraded over the years. Currently, nearly all city residents' sewage is collected by the City of Globe, with only a few properties (~20) still on individual septic systems. As of August 2016, the city operated a used belt press (from the City of Buckeye) to generate dewatered, Class B biosolids that are then landfilled (Personal communication: Globe Public Works, 2016).

In 1983, the city signed a contract with Inspiration Copper (now FMI) to discharge 600,000 GPD (672 AF/yr) of effluent into Pinal Creek, creating one of the only effluent dependent systems in the basin (Walker, 2015; Personal communication: Globe Public Works, 2016). A new 30-year agreement allows FMI to take 500 AF (163 MG) of the total 700 AF (228 MG) of effluent generated each year for groundwater injection and reclamation purposes.

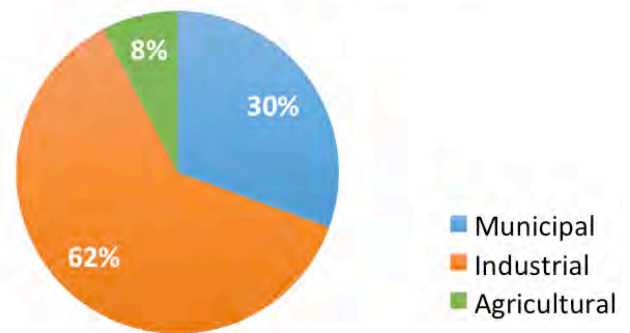
With funding and technical help from Freeport McMoRan, the Town of Miami built a new wastewater treatment plant between 2011 to 2012. The plant produces A-plus quality water, the highest quality category for reclaimed water defined by ADEQ. The plant serves 800 to 950 homes and businesses along Highway 60. Freeport McMoRan receives the produced water that is not discharged into Miami Wash as an exchange for plant funding.

## Water Demands

In Arizona, water use, otherwise called “water demand,” is generally categorized into three sectors: agricultural, municipal, and industrial. Unlike many other parts of Arizona, agricultural water use is minimal in Cobre Valley beyond some ranching. Industrial demand includes water used by golf courses and mining along with manufacturing and other industrial processes. Arizona Department of Water Resources estimated that annual municipal demand within the entire Salt River Basin, where Cobre Valley is located, is approximately 4,000 acre-feet (ADWR, 2009).

## Salt River Basin Demand by Sector - Ground Water

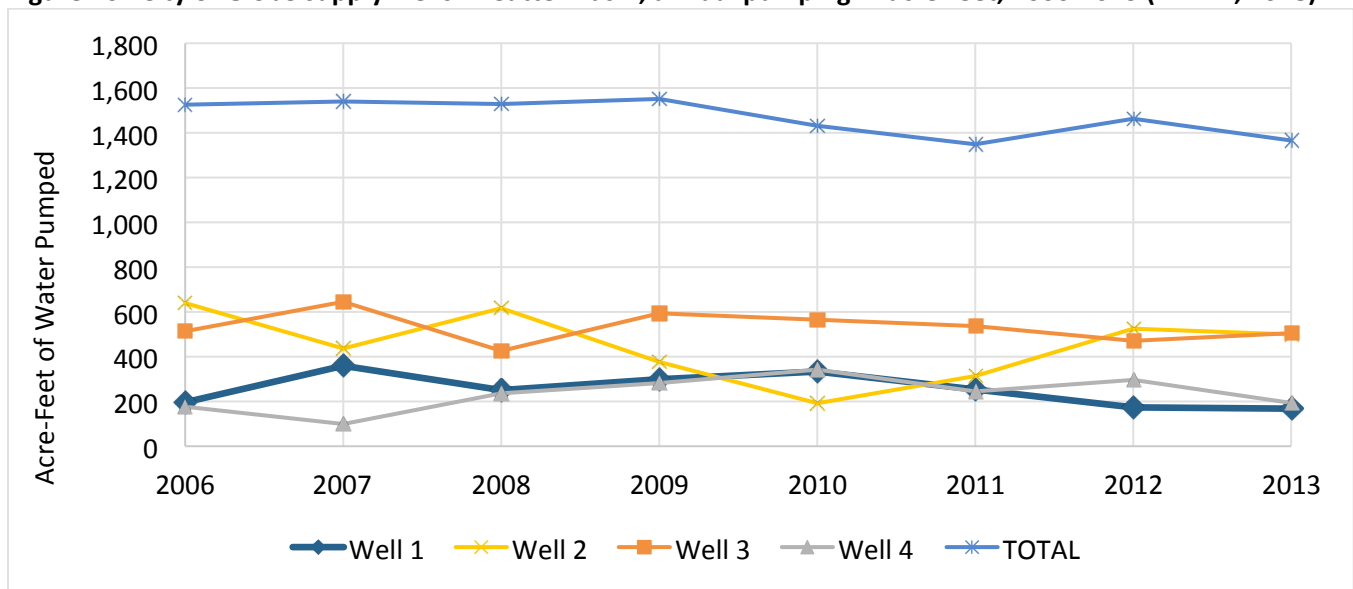
Data Sources: ADWR (2005), USGS (2007)



## City of Globe

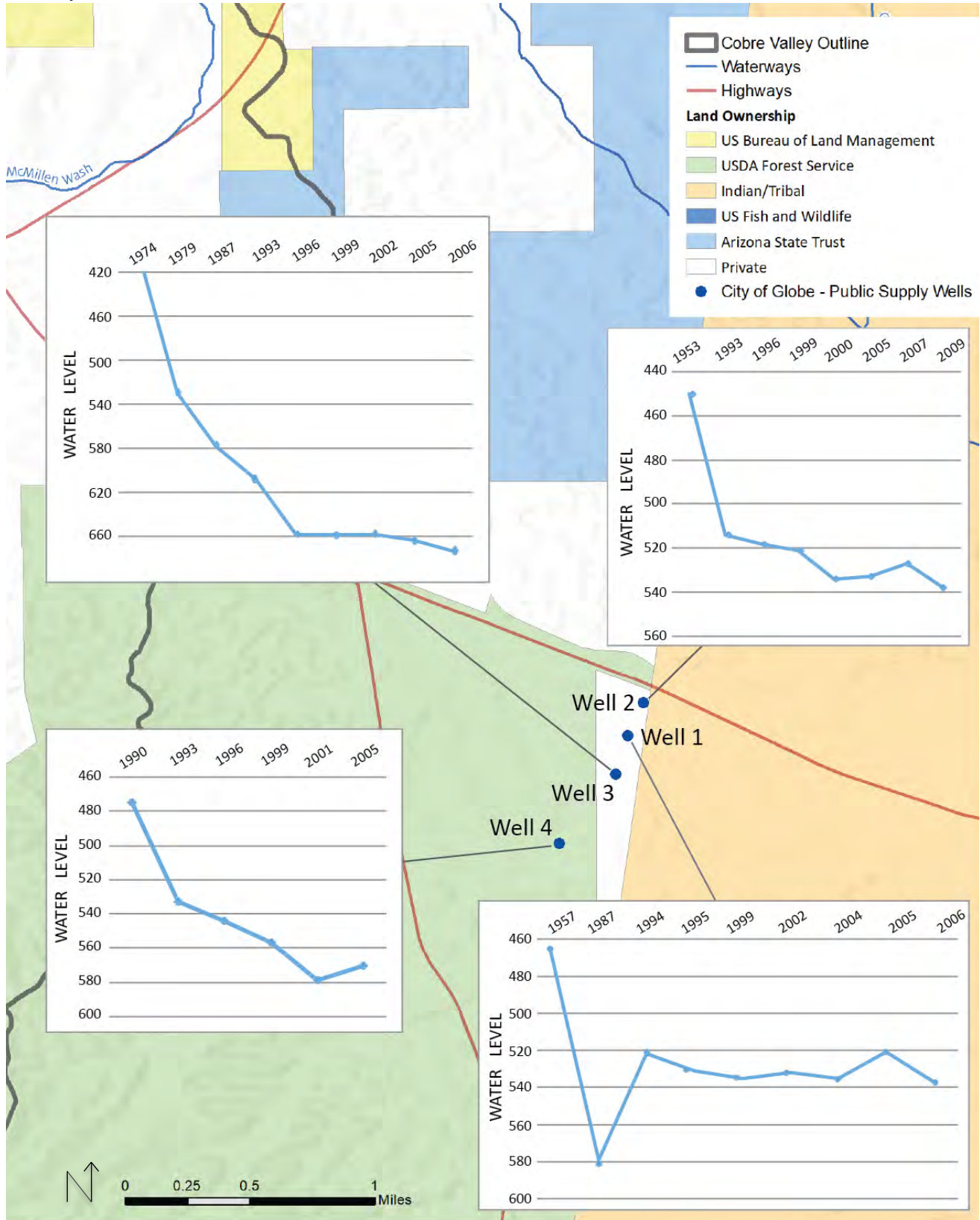
In 1957, wells were placed close to the San Carlos Apache Reservation to pull water from the upper edge of Cutter Basin (located within, or adjacent to, the Safford Basin, southeast of Cobre Valley) (see **Figure 10, Table 3** for pumping information). This aquifer has been the primary water source from the 1950s to the present (Walker, 2015). The city currently provides water to downtown Globe, Alhambra, Crestline, Skyline, Icehouse, Sixshooter, Kellner Canyons, the prison, and Globe mobile home park on Highway 60. City of Globe serves approximately 3,565 customers with 362 million gallons of water per year (Walker, 2015). Two-thirds of deliveries are to residential properties, with the remaining third for non-residential users. Groundwater levels in the Cutter Basin wellfield have declined over the last few decades, and the City of Globe is identifying alternative options (**Figure 11**).

**Figure 10. City of Globe supply wells in Cutter Basin, annual pumping in acre-feet, 2006-2013 (ADWR, 2018). \***



\*One acre-foot of water is equivalent to 325,851 gallons.

**Figure 11. City of Globe supply wells in Cutter Basin, depth to water over time (information provided by Stan Gibson).**



## Town of Miami

Town of Miami residents have had their water provided by the Arizona Water Company (AWC) since 1955. AWC pumps local groundwater from 17 wells throughout the Miami area (ADWR, 2009). Some of these wells are over 40 years old. Most of the system is gravity-fed, flowing downhill to various areas within Miami, Claypool, Central Heights, Russell Road, parts of Globe, and near Kellner Canyon and Highway 188. In 2006, well levels range between 109 and 860 below land surface (bls) (Arizona Water Company, 2007). AWC has approximately 2,921 customers using 303 million gallons per year (Walker, 2015). Approximately 87% of customer connections are for residential purposes (ADWR, 2009).

**Table 3. Municipal Water Demand, Annual Well Pumping in Acre-Feet, 2006-2015 (ADWR).**

Owner	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Average
AWC	65	67	51	66	37	75	46	73	72	41	59
AWC	13	14						43	55	26	30
AWC	20	21	14	27	40	31	11	14	7	19	20
AWC	86	90	82	89	84	74	67	80	84	69	81
AWC	44	43	64	1	34	106	91	89	95	68	63
AWC	25	4	14	12	8	27	29	35	55	44	25
AWC		1	1			3	3	3		16	5
AWC		1	1		10	20	0	9	27	14	10
AWC	44	65	70	63	12		38	81	34	17	47
AWC	79	68	61	79	63	80	70	44	86	49	68
AWC	111	130	116	133	131	112	104	115	114	90	116
<b>Town of Miami Average Annual Water Demand</b>											<b>627</b>
City of Globe	77	101	38	93	169	100	19	30	287	109	102
City of Globe*	196	360	250	298	333	255	173	168	-	-	254
City of Globe*	176	99	236	283	342	244	296	193	-	-	234
City of Globe*	513	645	426	595	564	536	470	505	-	-	532
City of Globe*	641	437	616	376	192	314	525	501	-	-	450
<b>City of Globe Average Annual Water Demand</b>											<b>1,470</b>

\*Public supply withdrawn from Cutter Basin, which is located outside of Cobre Valley and the Salt River Watershed.

## Domestic Wells

There are 576 registered domestic wells in Cobre Valley (ADWR, 2018) (**Figure 11**). All domestic wells within the study area are exempt from the monitoring, reporting, and regulatory practices that Arizona Water Company and City of Globe must adhere to. For this reason, it is difficult to make an accurate estimate of water use for these private wells. Each of these wells is assumed to use 0.50 acre-feet of water per year, yielding a total estimated annual water use of **288 acre-feet per year**. This estimate is based on the assumption that an average household uses 75 gallons per person per day and an average household of 2.67 people (200 gpd/household).

## **Industry and Mining**

Cobre Valley has 297 registered wells in the categories of “Industry” and “Mining” (ADWR, 2018). Throughout Arizona, the primary industrial water uses are related to mining. Gravel operations and golf courses are also considered industrial water uses. Industrial water demand is estimated to be 5% of total water demand in Arizona (ADWR 2016), but it is more likely to be at least half of total water demand in the Cobre Valley, based on estimates for the Salt River Basin and the prevalence of mining in the area.

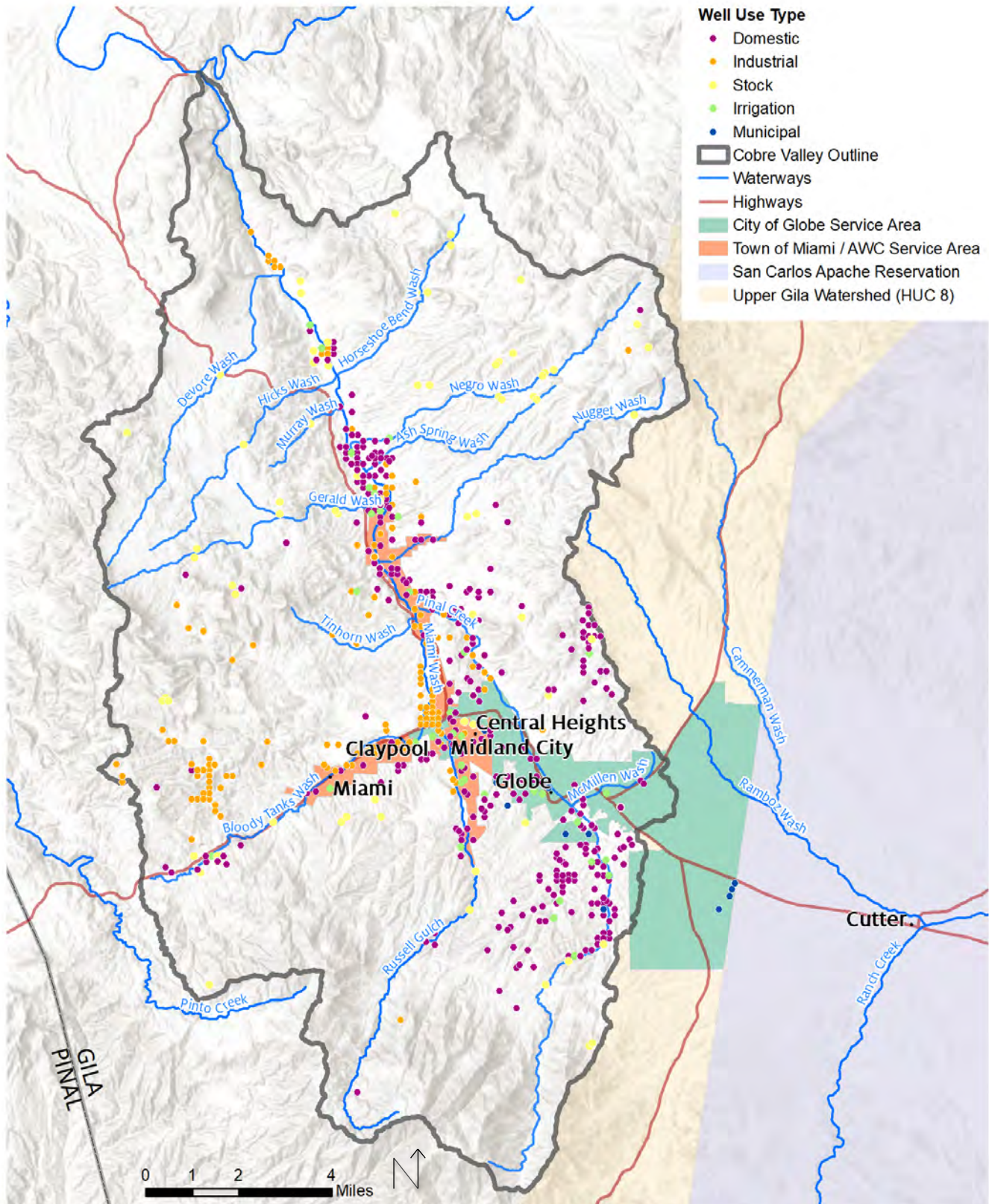
## **Agriculture**

The water demands of ranching and farming are sometimes lumped into one category. As any rancher will tell you, however, the water consumption in cattle production is very different from water use for crop production. Considering the limited amount of farming in Cobre Valley and the surrounding area, using typical ranching water demand to estimate local agricultural demand may yield more accurate results. There are 52 “Irrigation” wells registered in Cobre Valley, and 96 registered “Stock” wells (ADWR, 2018).

### **DISCUSSION TOPICS AND QUESTIONS**

- Calculating the quantity of groundwater in an aquifer is complicated and imprecise where data are scarce. What is the value of an accurate inventory of active water wells and water consumption to watershed planning?
- What can local water users do to assist with accurate and updated water demand information?
- Groundwater resources are limited. Where well are experiencing locally significant water level declines, what can communities do to better understand these declines and keep their municipal wells productive?
- How might watershed partners collaborate to keep water in the catchment zone, consider diversion of surface waters to keep water clean, and enhance the natural replenishment processes of our alluvial waterways?
- Is there opportunity to engage local industrial water users in sharing any data that may support better understanding groundwater in the region?

Figure 12. Cobre Valley wells by type (ADWR, 2018).



## Water Budget Example: Supply vs Demand Exercise

**A watershed budget is a lot like a household budget; if you spend more than you make, you're going to run out.** See below for a simplified in a two-step approach to calculating a water budget. This simplified example gives a snapshot of water budget calculations that will be useful for water resources planning and collaboration into the future.

Note: For ease of conversion, metric measurements are used below.

**STEP 1: Calculate Demand or Spending:** How much annual recharge would be needed to sustain the residents of Cobre Valley, and the flow and trees along creeks and washes?

Water demands:

- Population (US census): *10,924 people*
- Average human water use (NAU): *197 m<sup>3</sup> per person per year*
- Avg. riparian evapotranspiration rate (Isar&Resnick 1996): *1.83 m/yr per unit area*
- Riparian surface area (~0.7% watershed area): *3,182,143 m<sup>2</sup>*
- Avg. non-riparian evapotranspiration rate (I&R 1996): *0.419 m/yr per unit area*
- Pinal Creek Watershed Area (ADWR): *445,500,000 m<sup>2</sup>*

Annual water demand =

Human demand + riparian demand + non-riparian demand + creek demand

ADD THESE 3 NUMBERS FOR ANNUAL WATER DEMAND

Human demand = population x average per-person use

$$\underline{10,924} \times \underline{197} = \underline{2,152,028 \text{ m}^3/\text{yr}}$$

Riparian Demand = Riparian surface area x average riparian ET rate

$$\underline{3,182,143 \text{ m}^2} \times \underline{1.83 \text{ m/yr}} = \underline{5,823,322 \text{ m}^3/\text{yr}}$$

Non-Riparian demand = Non-riparian surface area x average non-riparian ET rate

Note: non-riparian surface area = watershed area - riparian surface area

$$\underline{442,317,857 \text{ m}^2} \times \underline{0.419} = \underline{185,331,359 \text{ m}^3/\text{yr}}$$

Creek demand = 959,050 m<sup>3</sup>/yr

**Calculated the annual water demand in m<sup>3</sup>/year: 193,306,709 m<sup>3</sup>/yr**



**STEP 2: Calculate Input or Income:** How much water is recharged per year in Pinal Creek’s watershed, assuming that 100% of precipitation and effluent is recharged? What if only 50% of precipitation and effluent is recharged?

Water inputs:

- Annual precipitation (~18 inches/year): *0.4572 m/year per unit area*
- Pinal Creek Watershed Area (ADWR): *445,500,000 m<sup>2</sup>*
- Available Effluent (200 AF/yr): *246,696 m<sup>3</sup> per year*

Annual water inflow = Wastewater input + Precipitation input

**ADD THESE 2 NUMBERS FOR WATER INFLOW AT 100% RECHARGE**

Wastewater input = Available effluent x 100%

$$\underline{246,696 \text{ m/yr}} \times \underline{100\%} = \underline{246,696 \text{ m}^3/\text{yr}}$$

Precipitation input = Watershed area in m<sup>2</sup> x Annual precipitation in m per m<sup>2</sup>

$$\underline{445,500,000 \text{ m}^2} \times \underline{0.04572 \text{ m}} = \underline{203,683,057 \text{ m}^3/\text{yr}}$$

<b>Is this enough to meet the demand?</b>	<b>YES</b>	<b>NO</b>
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**DISCUSSION TOPICS AND QUESTIONS**

- Did we leave anything out in our budget?
- This calculation did not include groundwater from outside the Pinal Creek Watershed, such as the Cutter Basin.
- How might that change the picture of what’s going on?
- This calculation assumes that available effluent is recharged. What if it is used directly?
- Is that going to affect our planning?
- If evapotranspiration in the watershed is 0.419 per m<sup>2</sup> and precipitation is 0.4572 per m<sup>2</sup>, then the watershed is using 92% of the precipitation on the watershed. This leaves only 8% for recharge (not 100% or 50%). However, human demand is only slightly more than 1% of total demand. What does this mean for meeting water demands with groundwater?
- Groundwater recharge is not considered above, but is an important consideration in the water budget.

## PART 3: CONCLUSION

### WATER RESOURCES OBJECTIVES

It is imperative that decision-makers and water managers have access to objective, usable information in a forum that promotes communication and collaboration in order to identify and implement efficient solutions. While data gaps do exist, the collaboration of water using sectors and jurisdictions can support robust water resources planning efforts through data sharing.

Increased public awareness and commitment to achieving resilient water resources are necessary to sustain healthy communities and respond to established needs. Possible collective actions and collaboration could revolve around:

- Education campaigns to raise public awareness about local water resources
- Support for soliciting water infrastructure funding
- Assistance and marketing of new proposed trail projects
- Linkage of plans into cross-cutting projects to address multiple issues
  - Constructing storm water management/aquifer recharge facilities
  - Preparation for severe floods and extended droughts

As the number of water-conscious communities has continued to grow in Arizona in the last few decades, a variety of innovative programs have been developed and improved with practice. These practices have also been studied and modified to fit the specific needs of other communities. A similar strategy of study and adaptation may yield benefits for Cobre Valley. Ideas to consider might include:

- Community Water Budget
- Erosion control
- Surface water diversions
- Ordinance to limit water wasting practices
- Greywater re-use program
- Rainwater harvesting
- Long-term education programs
- Augmentation
- Voluntary septic system conversion
- Aquifer recharge with reclaimed water
- Non-potable reuse
- Potable reuse (direct or indirect)
- Hierarchy of water uses

Achieving sustainable development requires careful planning to protect the watershed and its associated ecosystem services. Exploring the present and projected rates of groundwater pumping will help consider future groundwater conditions. Increases in groundwater pumping, whether from municipal wells or from additional private wells, are a primary factor to consider. Population growth would place further pressure on groundwater sources, assuming per capita consumption levels remain steady. Broad community-supported measures can help address these concerns and allow for growth at levels that can be sustained without negatively impacting the watershed. Policies can also be used to offset demand and manage water use patterns so that the region's economy can grow.

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