Kyl Center for Water Policy at Morrison Institute

Arizona State University

IMPACTS OF COLORADO RIVER SHORTAGE TO TAP WATER DELIVERIES IN CENTRAL ARIZONA

A PRIMER

About this Primer

This primer provides information regarding Colorado River shortage impacts to the provision of *tap water*. The intent of this primer is to:

- Ensure that Arizona stakeholders have access to the best information possible as they make critically important decisions about negotiating strategies and management of the Colorado River now and into the future. A goal of this primer is to ensure that stakeholders in Arizona have access to facts about the impact of shortages on tap water deliveries.
- Help Arizona stakeholders weigh alternative futures. Arizona must measure the value of any bargain it enters into now and for Colorado River operations post 2026. Understanding the size and location of the impact of deep Colorado River shortages on reliable tap water deliveries is one of the most important considerations in determining this value.
- Help the media better understand the impact of Colorado River shortage on tap water deliveries in Central Arizona.
- Help concerned citizens understand the impacts of Colorado River shortage on tap water deliveries in their communities.

Although discussed at a high level, this primer is not meant to detail the impacts of Colorado River shortage to artificial aquifer recharge in Central Arizona.

The Big Picture

Some municipal water providers in Central Arizona use Colorado River water treated at surface water treatment plants for tap water deliveries. Of these, some may experience vulnerabilities to tap water deliveries during deep Colorado River shortages. In addition to employing other strategies, these water providers will likely pump more water from wells as a backup water supply when Colorado River water availability is inadequate to meet tap water demands.

Most municipal water providers in Central Arizona do not use Colorado River water for tap water because they lack the necessary surface water treatment plants and associated infrastructure. Rather, they use Colorado River water to recharge groundwater aquifers and pump groundwater from wells to deliver to customers' taps. Tap water deliveries in the service territories of these municipal water providers are largely invulnerable to Colorado River shortages over the short term. These water providers will continue pumping groundwater to meet tap water needs but during shortages will have less Colorado River water with which they can recharge aquifers.

For both of these reasons, increased aquifer depletion in Central Arizona is likely to occur during Colorado River shortages.

Key Terms

Surface Water: Water flowing in streams, canyons, ravines and other natural channels.

Groundwater: Water found under the surface of the earth between the pores and fractures of sand, gravel and rock known as aquifers.

Stored Water: Water that has been stored or saved underground in groundwater aquifers pursuant to a storage permit issued by the Arizona Department of Water Resources. While stored water physically becomes groundwater, for legal purposes it is considered a different water source.

Underground Storage Facility: A facility designed and constructed to store water underground.

Groundwater Savings Facility: An irrigation district at which groundwater withdrawals are reduced by farmers who use in-lieu water (CAP water or treated wastewater) as a substitute for groundwater.

Long-term Storage Credit: A credit to use in the future water that has been stored or saved underground.

Municipal Water Provider: A city, town or private water company that provides water service.

Tap Water: For purposes of this primer, tap water is the water that is delivered to customers that are connected to the main supply of the local water system. Tap water is treated before delivery to meet the requirements of the Safe Drinking Water Act and is delivered within proper pressure parameters. Tap water is delivered to households, businesses, and industries and is used for many different purposes, including domestic uses indoors, domestic uses outdoors (such as landscape irrigation), and business and industrial purposes of all kinds, both indoor and outdoor. In a general sense, tap water is drinking water, though it can be used for non-drinking water purposes such as landscape irrigation or industrial processing. Tap water does not include untreated water deliveries to golf courses, turf facilities, farmers, or underground aquifer storage facilities.

Highlights

- In Central Arizona (Maricopa, Pinal, and Pima Counties), groundwater is the primary tap water source in most communities. As used in this Primer, groundwater includes stored water.
- Most municipal water providers in Central Arizona use their Colorado River water to artificially recharge local aquifers—not as tap water.
- Annually, less than 350,000 acre-feet of Colorado River water is delivered to surface water treatment plants and then subsequently as tap water in Central Arizona. In comparison, under a Tier 3 shortage Central Arizona can expect to retain access to over 800,000 acre-feet of Colorado River water.
- Still, cuts even deeper than Tier 3 can be expected. If Colorado River shortages in Central Arizona become very deep, tap water vulnerabilities may emerge because Colorado River water is delivered in priority to those who have an entitlement to it or have an agreement to use someone else's entitlement. There is no preferred delivery of Colorado River water to municipal water providers in Central Arizona that use it for tap water deliveries.
- To protect public health, municipal water providers that deliver Colorado River water as tap water should develop the strategies necessary to ensure that alternative water supplies can be delivered as tap water during extreme Colorado River shortages.
- Aquifer depletion will occur because there will be less Colorado River water available to artificially recharge local aquifers and because municipal water providers that deliver Colorado River water as tap water will likely turn to groundwater as a backup supply during shortages.

Colorado River Water Use Among Municipal Water Providers in Central Arizona

Municipal water providers in Central Arizona include both private water companies, water utilities owned by cities and towns, and water improvement districts. Private water companies tend to serve smaller service areas on the fringes of the metropolitan areas, although there are some notable exceptions. Nearly all the medium- and large-sized municipalities in Central Arizona operate their own water utilities.

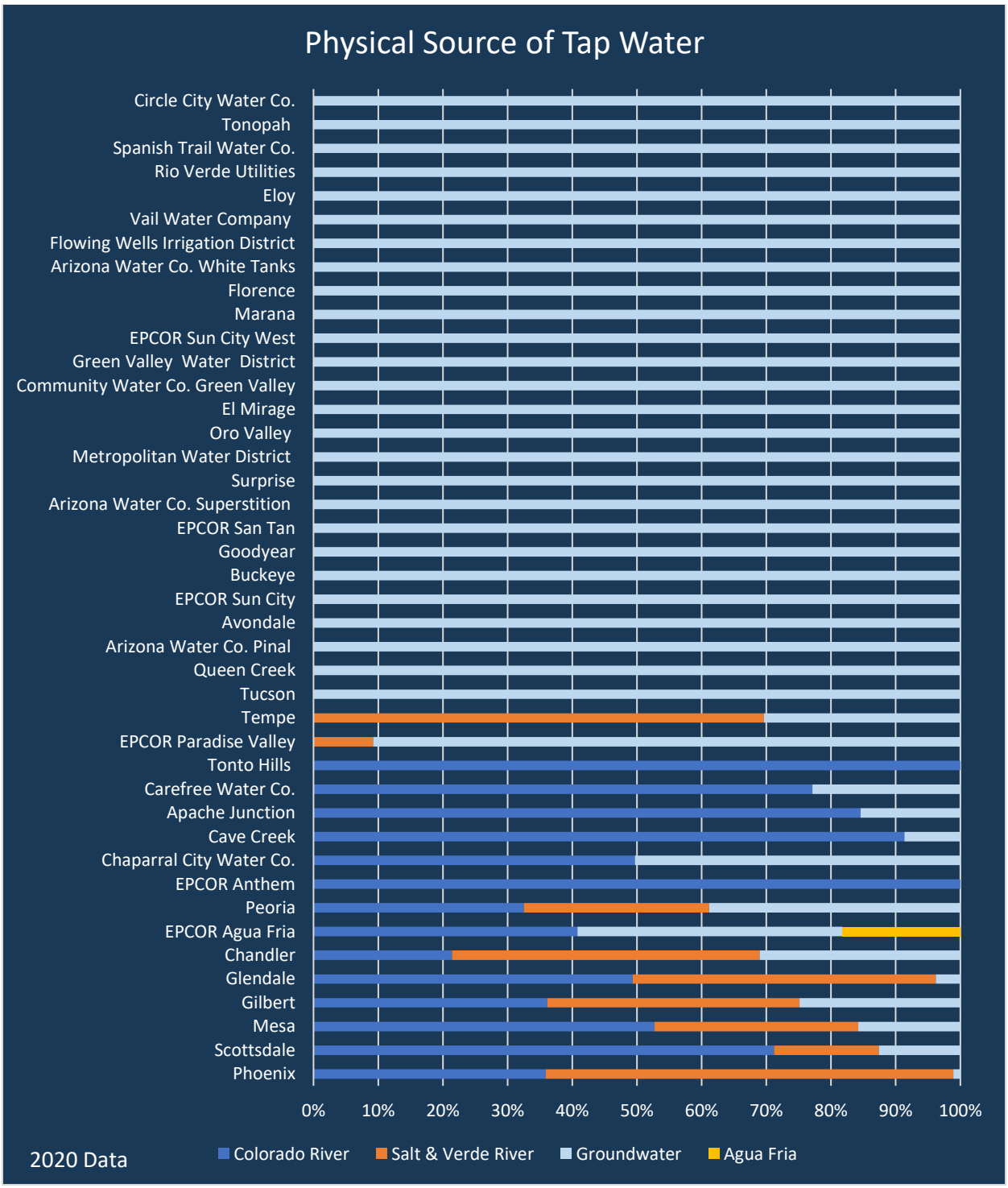
Colorado River water imported into Central Arizona via the Central Arizona Project (CAP) canal is used by municipal water providers in five main ways:

- It can be delivered to a surface water treatment plant, where it is treated to meet Safe Drinking Water Act requirements and then pumped through the municipal water provider's transmission and distribution system to customers' taps,
- It can be delivered directly to a non-potable use such as a park or golf course,
- It can be delivered to another entity in exchange for other water sources,
- It can be delivered to an underground storage facility (USF) for percolation into local aquifers, or
- It can be delivered to a groundwater savings facility (GSF) where it is used to grow crops.

In the case of delivery to a GSF, the farmer uses the Colorado River water instead of groundwater to irrigate crops, and the groundwater thus "saved" becomes a water "credit," called a long-term storage credit—a right to pump groundwater that can be used in the future, traded, or sold. Long-term storage credits can also be created at USFs based on the amount of Colorado River water stored (recharged) in a year that exceeds the amount of groundwater the storing entity pumps from its wells in that year.

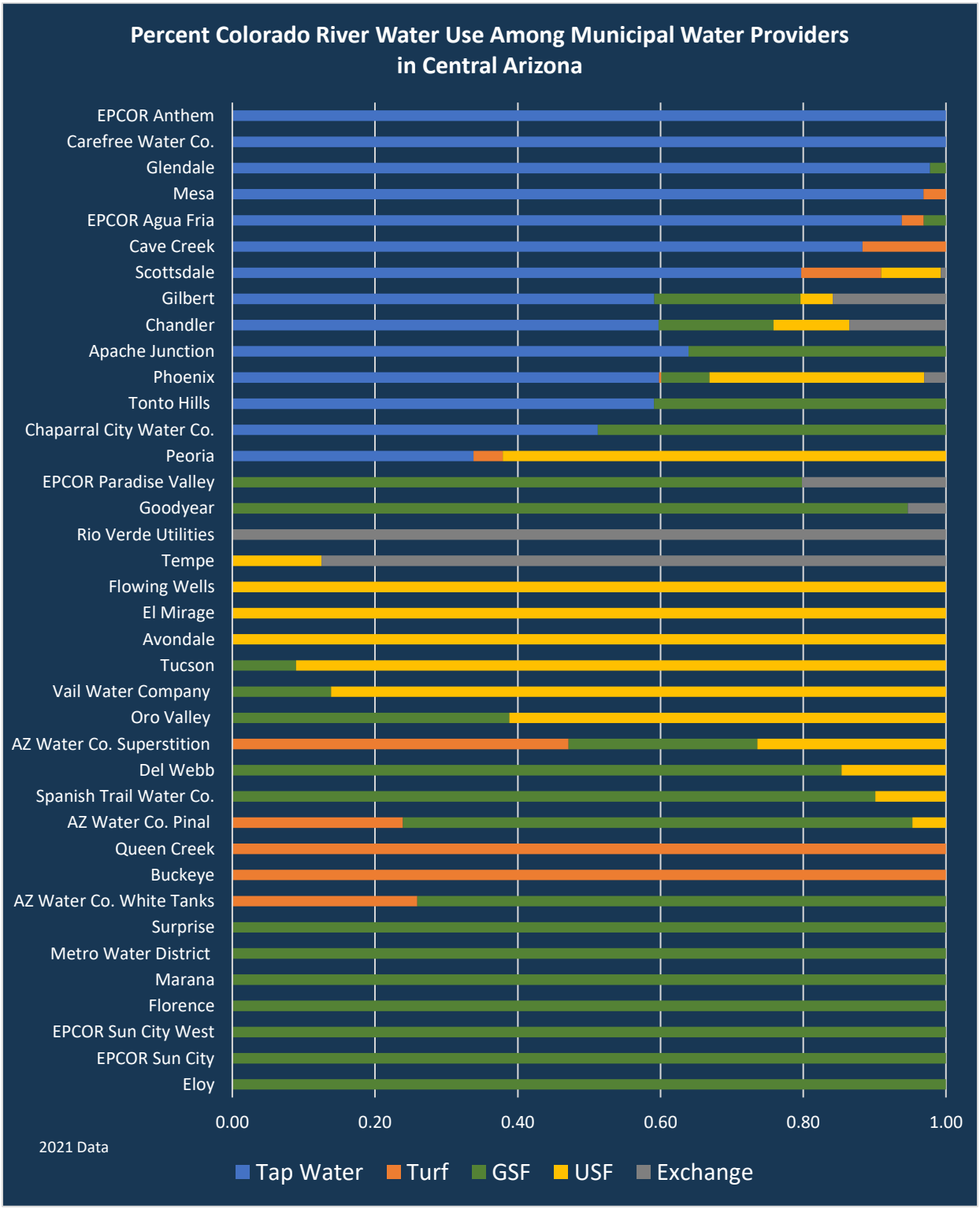
Most municipal water providers in Central Arizona use groundwater as the source for customers' tap water at least in part because the development and operation of groundwater wells is generally less expensive than the development and operation of surface water treatment plants. Under this strategy, the municipal water provider's Colorado River water is delivered to USFs to replenish aquifers from the impacts of the groundwater pumping, and to GSFs to create an underground bank of water that they can use in the future. This "indirect" use of Colorado River water is the main strategy pursued by municipal water providers in Pima and Pinal Counties.

A surface water treatment plant. Source: City of Phoenix Water Services Department.

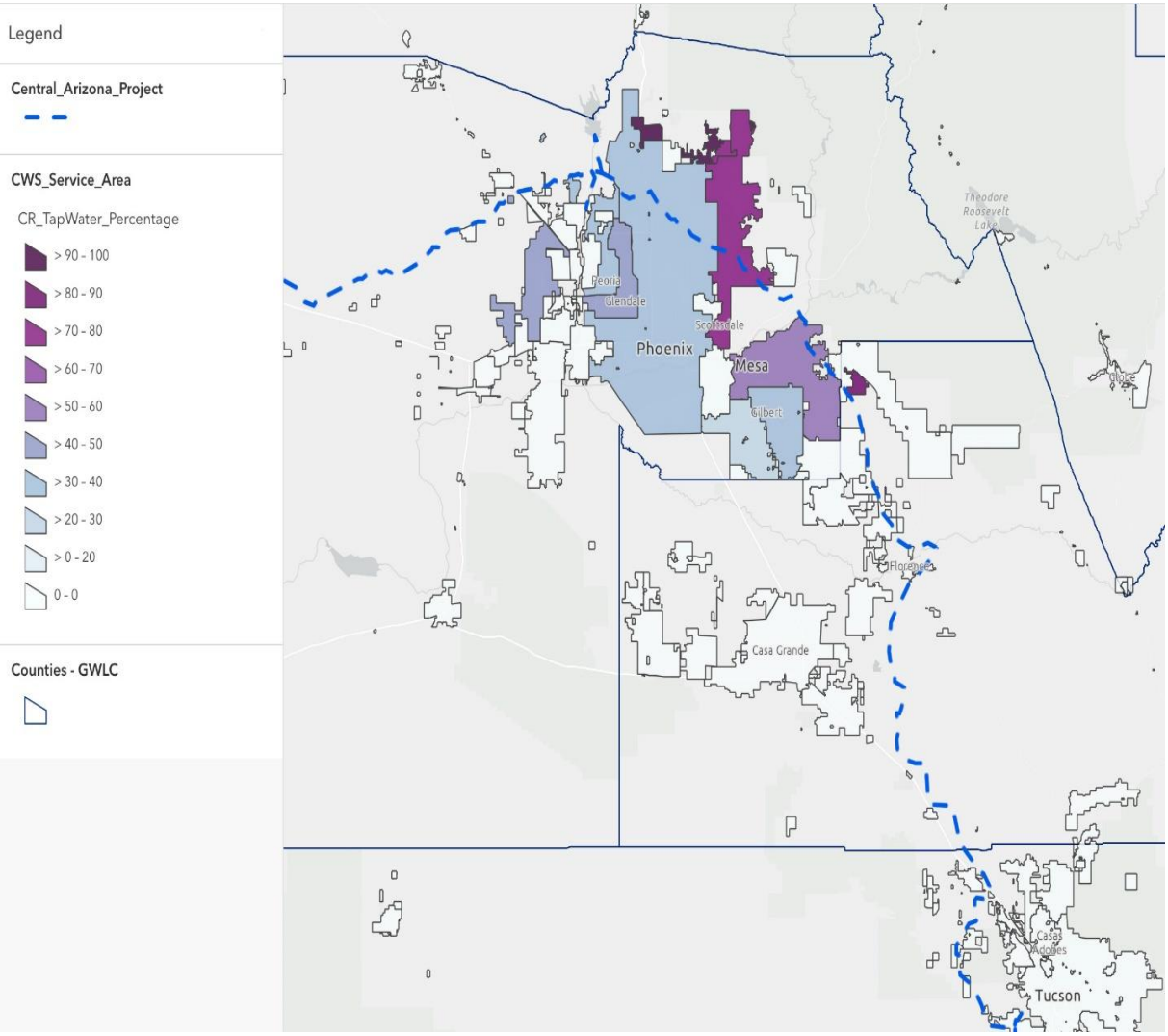


In Maricopa County, many municipal water providers also pursue this strategy of indirect use, but others operate surface water treatment plants that treat Colorado River water and subsequently deliver it as tap water. This "direct" use of Colorado River water is pursued by the largest cities in the Valley of the Sun as well as some private water companies. Some municipal water providers pursue a mixed strategy—they deliver Colorado River water directly as tap

water and they use some indirectly for aquifer recharge and replenishment. All are reasonable strategies that entail differences in vulnerability to Colorado River shortage.



The following map shows the percentage of tap water that is Colorado River water delivered through a surface water treatment plant in different municipal water utilities in Central Arizona:



Colorado River Shortage Impacts to Tap Water Among Municipal Water Providers in Central Arizona

Colorado River shortages may impact tap water deliveries for "direct use" municipal water providers. For "indirect use" municipal water providers, shortages will impact the aquifers by reducing the amount of recharge. In Central Arizona less than 350,000 acre-feet per year of Colorado River water is used directly at surface water treatment plants. This compares with total Colorado River water deliveries in Central Arizona during non-shortage years of more than 1,600,000 acre-feet annually.

Fundamentally, this means that Central Arizona can withstand some Colorado River shortages without impact to tap water deliveries. The impact of shortages will also fall on aquifers because there will be less Colorado River water available for recharge and replenishment and more finite groundwater will be pumped.

Colorado River water shortages in Central Arizona could impact tap water deliveries in the service territories of the Apache Junction Water Utilities Community Facilities District, the Carefree Water Company, the Town of Cave Creek, the EPCOR service territories of Fountain Hills, Agua Fria, and Anthem, the Tonto Hills Domestic Water Improvement District, and the cities of Chandler, Gilbert, Glendale, Mesa, Peoria, Phoenix, and Scottsdale. These are the municipal water providers that operate surface water treatment plants that rely on water delivered through the CAP canal. Collectively, these municipal water providers serve approximately 3.5 million people in the Valley of the Sun.

The Ak Chin Indian Community operates a surface water treatment plant that relies in part on Colorado River water, but the community has access to the highest priority Colorado River water available in Central Arizona, and due to federal contractual obligations, its supplies are not expected to be impacted by shortage.

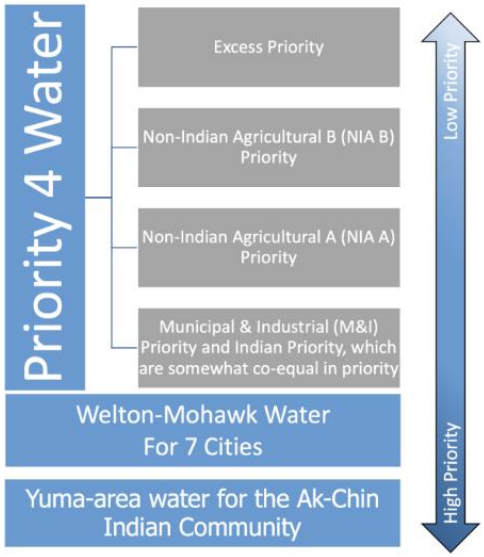
The city of Avondale and EPCOR Water Company—Paradise Valley send Colorado River water to the interconnect between the CAP canal and the SRP canal system. SRP then delivers water through its canals to the surface water treatment plants operated by the city of Phoenix. Phoenix in turn delivers water to the city of Avondale and EPCOR Water Company—Paradise Valley via specially designed interconnects. This type of activity is known as "wheeling" water. The city of Goodyear wheels its Colorado River water via SRP canals to a surface water treatment plant it operates. For these communities, Colorado River shortages can impact their ability to deliver adequate water to SRP to effectuate the wheeling arrangement. However, as there will still be Salt and Verde River water in the SRP canal system, the exposure becomes a "paper water" problem of backfilling the water deliveries to the SRP canal system, and is not necessarily a physical vulnerability. This is a tap water vulnerability caused by Colorado River shortage but a fundamentally different one than that experienced by municipal water providers that operate surface water treatment plants with Colorado River water delivered via the CAP canal.

The city of Tempe operates a surface water treatment plant that relies on Salt & Verde River water delivered via Salt River Project (SRP) canals.

Of the "direct use" municipal water providers, only in EPCOR Anthem and Tonto Hills does Colorado River water comprise all tap water deliveries. All other providers deliver a blend of groundwater and Colorado River water. Some deliver a blend of groundwater, Colorado River water, and Salt & Verde River water. Some have access to Agua Fria River water.

Colorado River water delivered through the CAP canal follows a priority system specifying the order in which water users experience cuts during shortage. Different municipal water providers have access to Colorado River water of different priorities.

Colorado River water delivered through the CAP canal is delivered in priority to those entities with an entitlement to the water and to those entities that lease from or exchange water with an entitlement holder. Within Arizona there is no legal mechanism to subvert this priority system and instead deliver Colorado River water directly to municipal water providers that use it at surface water treatment plants.

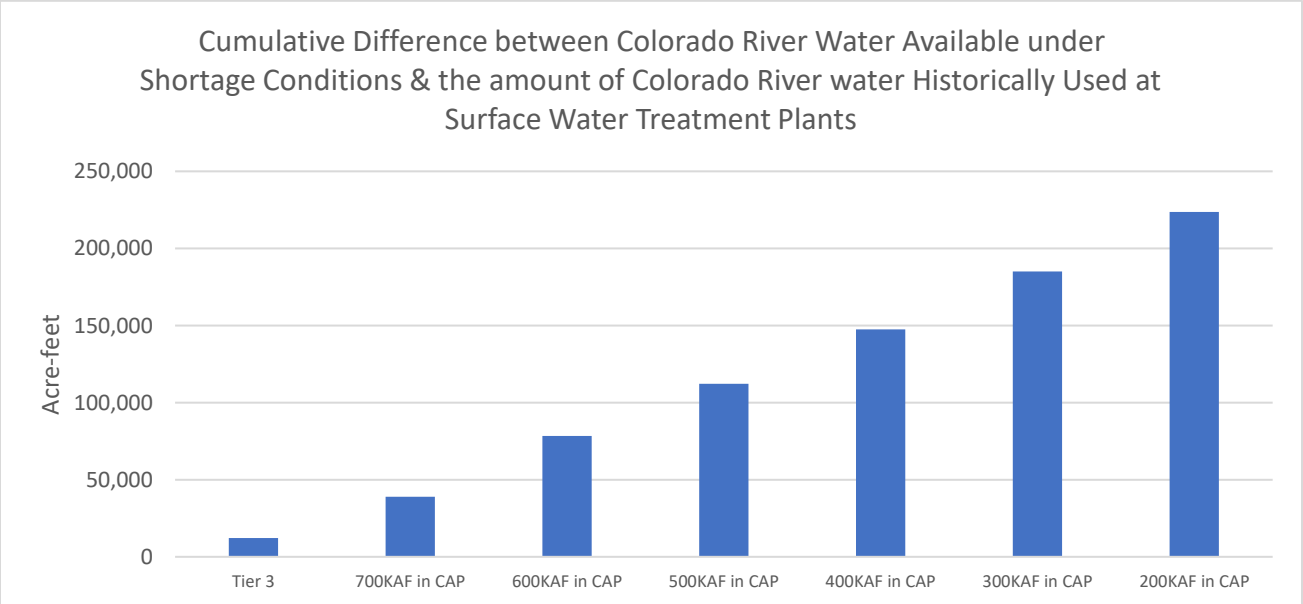


Priorities in the CAP canal (from lowest to highest)

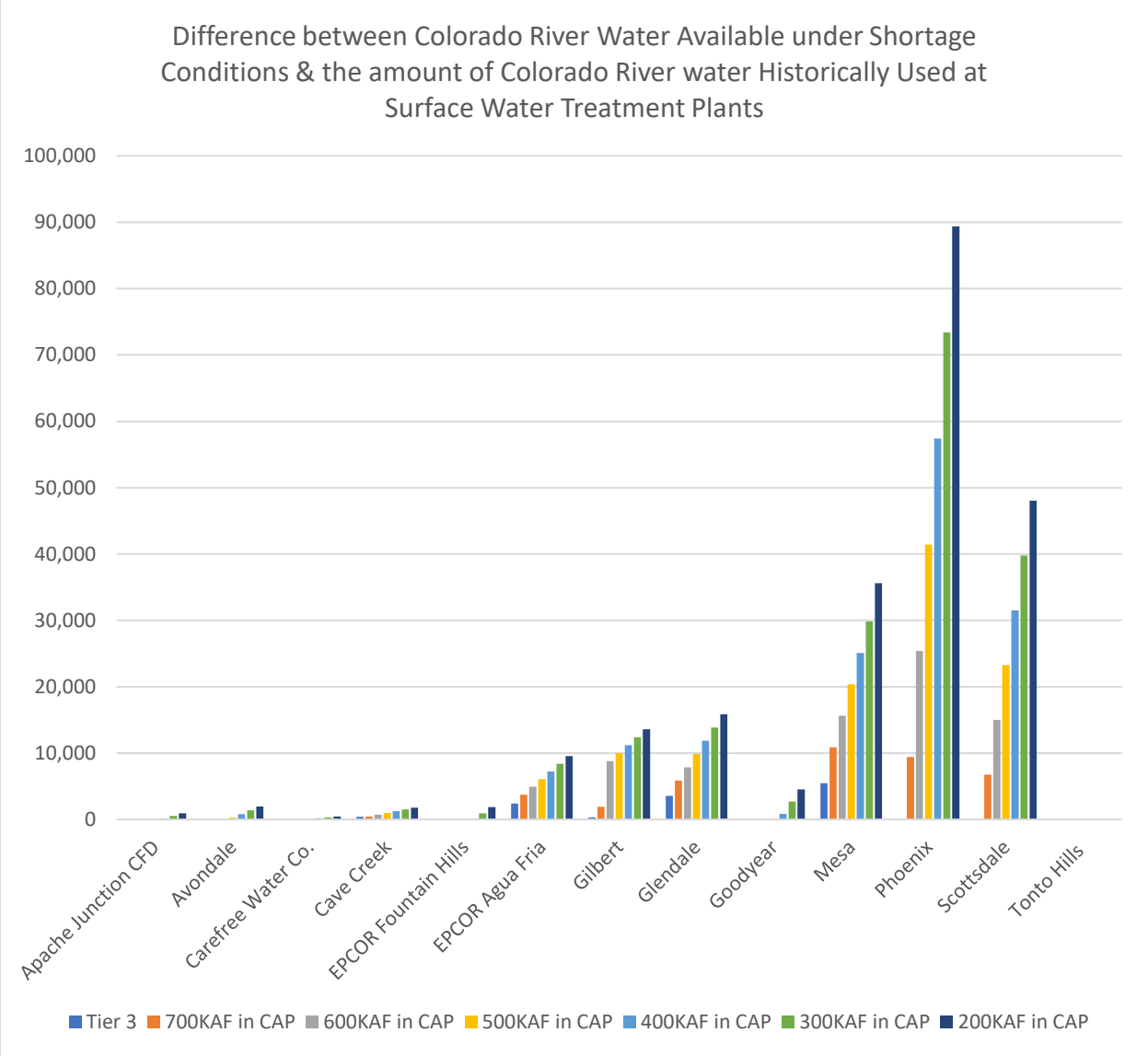
Because the water is delivered in priority, even when more Colorado River water is available in total in the CAP canal than is used directly at surface water treatment plants (350,000 acre-feet), the water is not necessarily available to the municipal water providers that use it directly at surface water treatment plants *in amounts historically used at those water treatment plants*.

For example, Phoenix uses approximately 120,000 acre-feet of Colorado River water each year at its surface water treatment plants and under non-shortage conditions has access to around 190,000 acre-feet per year. In shortage conditions that result in only 700,000 acre-feet of Colorado River water available in the CAP canal, Phoenix still has need for 120,000 acre-feet of Colorado River water at its surface water treatment plants, but will have access to only around 105,000 acre-feet.

Under Tier Zero, Tier 1, Tier 2a, and Tier 2b shortage cuts to Colorado River water in Central Arizona, water delivered in priority will make its way to surface water treatment plants in amounts adequate to meet historic tap water demands served by that plant. At or around Tier 3 shortage cuts of 720,000 acre-feet, this may no longer be the case.

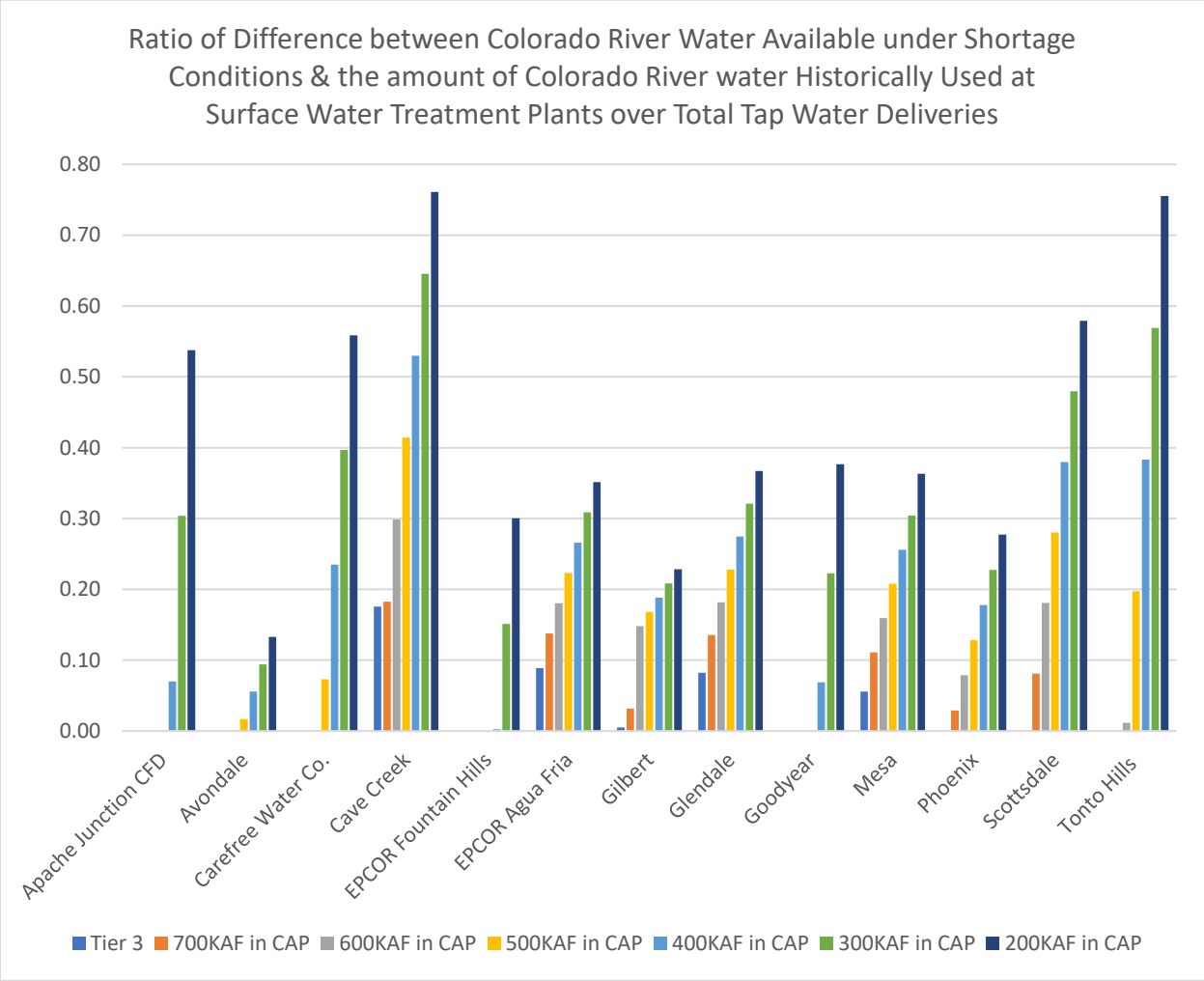


Not every municipal water provider that delivers Colorado River water as tap water will experience such a deficit because some have access to additional, or higher priority Colorado River water via lease or exchange that mitigates the impact of shortage. For example, EPCOR Water Company—Anthem relies on high priority Colorado River water leased from the Ak-Chin Indian Community and tap water deliveries in the city of Chandler are relatively protected from shortage because it exchanges reclaimed water for Colorado River water with the Gila River Indian Community. The following chart shows the difference between the amount of Colorado River water available under shortage conditions and the amount of Colorado River water historically treated at surface water treatment plants for delivery as tap water.



Phoenix is one of the nation's largest water utilities, so volumetrically the deficit it may experience looks large in comparison to nearby, smaller utilities, but the amount isn't as large relative to the total amount of tap water Phoenix delivers because Colorado River water makes

up only a portion of the tap water it delivers. Looking at these results in comparison to total potable deliveries shows a different picture of relative vulnerability to Colorado River shortages.



It should be noted that gaps between the amount of Colorado River water available under shortage conditions and the amount of Colorado River water needed at surface water treatment plants for delivery as tap water will likely increase over time as "direct use" cities continue to grow in population and new business enterprises are developed.

The ability to deliver safe and reliable tap water via surface water treatment plants depends not just on the total amount of Colorado River water available in a given year, but also on its seasonal availability. Water treatment, transmission, and distribution systems are generally designed to meet demands that peak during hot weather and thus may require multiple times more water during days and months with peak demands than during low-demand days and months. When confronted with less Colorado River water than has historically been available, utility operators at surface water treatment plants will need to schedule the water that is available across different months to best meet seasonal demands. As this entails operating conditions different from the norm, some risk is involved.

Measures to Mitigate the Impact of Colorado River Shortages for Municipal Water Providers that Use Colorado River water Directly at Surface Water Treatment Plants

Conservation and Demand Management

Conservation and demand management can lower the difference between the amount of Colorado River water available and the amount needed at a surface water treatment plant. Conservation across an entire service territory is always helpful and wise, but when mitigating Colorado River shortage impacts to tap water, what matters is the amount water demands can be reduced in areas of the service territory that are physically dependent on Colorado River water delivered via surface water treatment plants. As an example, water conservation in west Mesa is wise, but west Mesa is served with Salt and Verde River water, and conservation in this area does not lessen the difference Mesa may experience between the Colorado River water it will receive in deep shortages and the amount of Colorado River water it needs to continue to meet tap water demands in east Mesa.

It is also worth noting that municipal water providers cannot conserve their way out of physical limitations in their water transmission and distribution systems. Homes must continue to receive a minimal amount of water necessary for cooking, cleaning, and basic sanitation. Water distribution systems must have pressures adequate for fire protection and adequate water must flow through them at rates that prevent the formation of trihalomethanes regulated under the Safe Drinking Water Act. In portions of the service territory that are entirely dependent on Colorado River water delivered as tap water, conservation can lessen but not close the gap between Colorado River water available during deep shortages and the amount needed to protect public health.

Exchanges

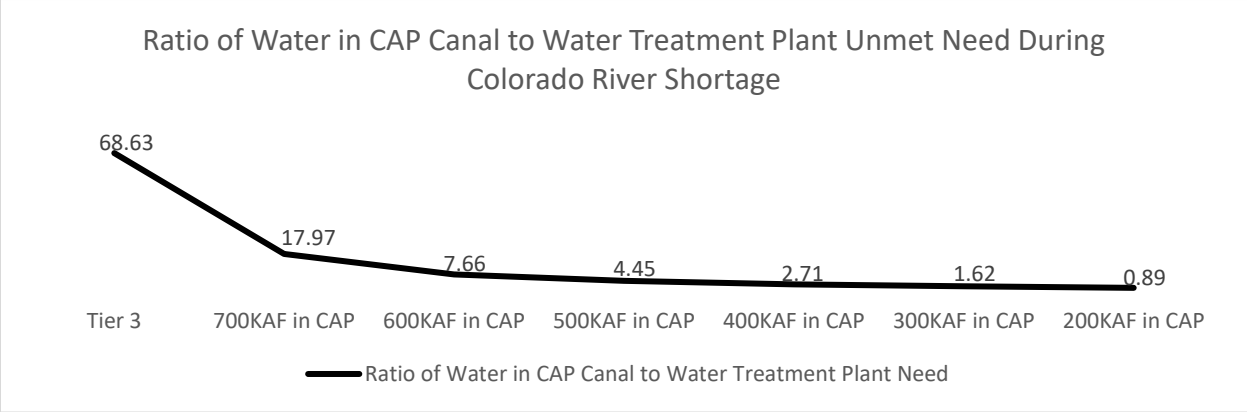
Municipal water providers can shore up each other's vulnerabilities during Colorado River shortages by exchanging water. The cities of Phoenix and Tucson have already developed such an exchange. Phoenix is dependent on Colorado River water delivered to its surface water treatment plants, whereas Tucson delivers groundwater to its customers and relies on Colorado River water to recharge and replenish its aquifers. Over the last several years, Phoenix has recharged some of its Colorado River water in Tucson's aquifers. During shortage, Tucson will pump this water from its wells and deliver it to customers in its service territory. In exchange, Tucson will allow Phoenix to divert some of Tucson's Colorado River water to Phoenix's water treatment plants.

Similar exchanges can take place across Central Arizona. Millions of acre-feet of Colorado River water have been recharged in local aquifers, including by municipal water providers, tribes, and the Arizona Water Banking Authority, resulting in the creation of long-term storage credits. Municipal water providers that rely on Colorado River water deliveries to their surface water treatment plants ("direct users") can exchange their recovered long-term storage credits for Colorado River water with municipal water providers that have adequate well capacity and are willing to pump the long-term storage credits to deliver water to their customers ("indirect users").

To the extent the direct user is providing recovered long-term storage credits in the same USF or GSF in which the indirect user would have recharged its Colorado River water, the direct user is made better off through the exchange and the indirect user is made no worse off.

		City A in West Valley	City B in East Valley
Current State		Recharges 10,000 AF of Colorado River water at West Valley USF. Pumps 10,000 AF from wells to meet tap water demands.	Needs 10,000 AF of Colorado River water at its surface water treatment plant. Owns 10,000 AF of LTSCs at West Valley USF
	End Result	Gains 10,000 AF of Colorado River water at West Valley USF. Pumps 10,000 AF from West Valley aquifer.	Short 10,000 AF of Colorado River water at its surface water treatment plant
		City A in West Valley	City B in East Valley
Future State		Delivers 10,000 AF of Colorado River water to City B's surface water treatment plant	Transfers 10,000 AF of its LTSC from West Valley USF to City A
	End Result	Gains 10,000 AF of LTSCs at West Valley USF. Pumps 10,000 AF from West Valley aquifer.	Not short 10,000 AF of Colorado River water at its surface water treatment plant. Has 10,000 AF fewer LTSCs.

At Tier 3 shortage levels, the amount of water that would need to be exchanged to make the surface water treatment plants whole is extremely small in relative terms—only around 12,000 acre-feet of more than 800,000 acre-feet of Colorado River water available in Central Arizona. However, as shortages deepen, such exchanges become more difficult to effectuate. Under deeper shortages, the ratio of the Colorado River water available in Central Arizona to the amount needed at surface water treatment plants changes drastically, as can be seen in the chart below.



There may be cases where the long-term storage credits on offer for the exchange were ***not*** originally created in the same USF or GSF in which the indirect user would have recharged its Colorado River water. Exchanges of this kind can still take place, but the indirect user may be withdrawing more water from the local aquifer than would be the case without the exchange.

The indirect user may be willing to be compensated for additional aquifer drawdown to help out another city, but the drawdown may have implications for future generations.

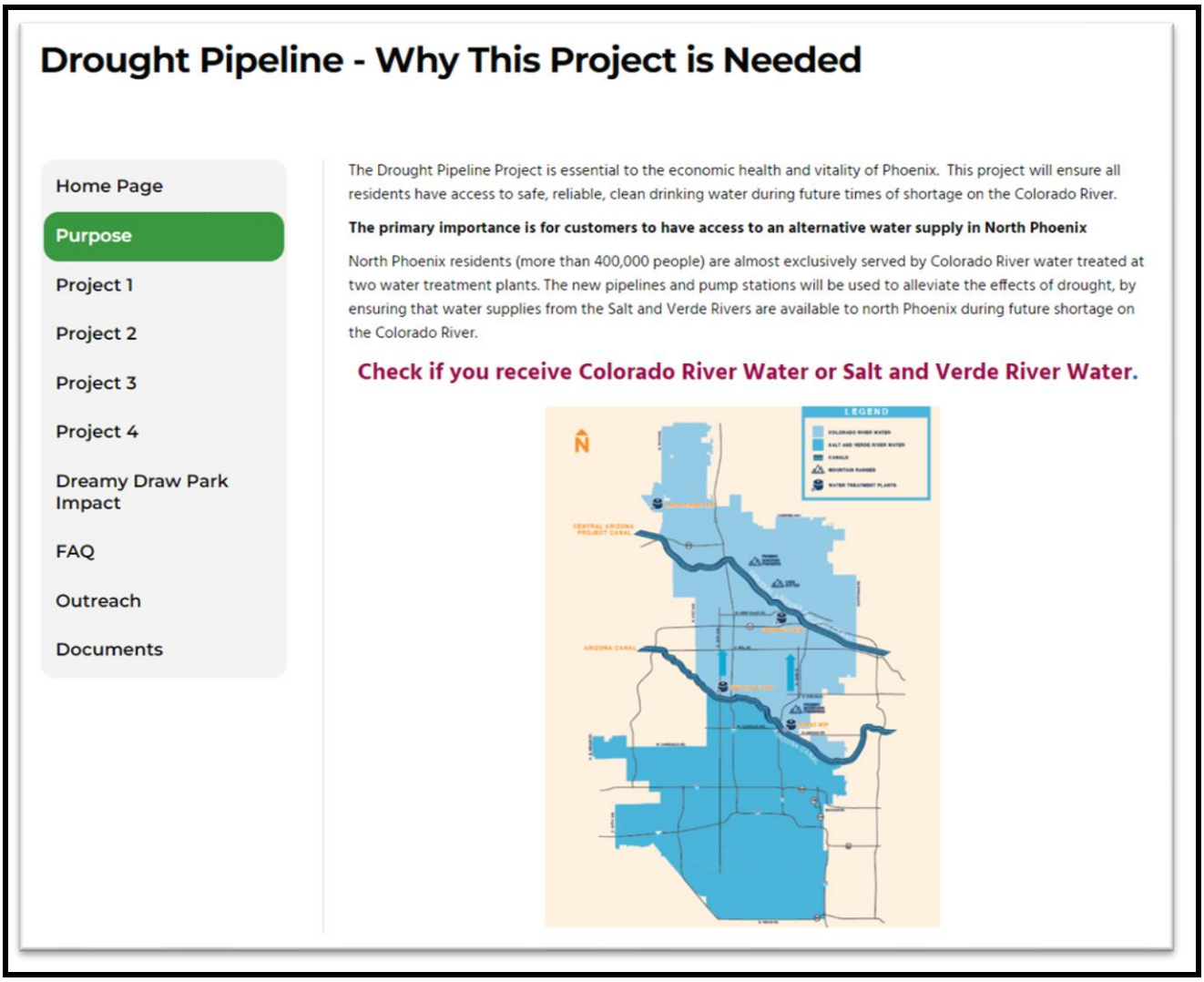
Current State		City A in West Valley	City B in East Valley
		Recharges 10,000 AF of Colorado River water at West Valley USF. Pumps 10,000 AF from wells to meet tap water demands.	Needs 10,000 AF of Colorado River water at its surface water treatment plant. Owns 10,000 AF of LTSCs at East Valley USF
	End Result	Gains 10,000 AF of Colorado River water at West Valley USF. Pumps 10,000 AF from West Valley aquifer.	Short 10,000 AF of Colorado River water at its surface water treatment plant
Future State		City A in West Valley	City B in East Valley
		Delivers 10,000 AF of Colorado River water to City B's surface water treatment plant. Pumps 10,000 AF from West Valley Aquifer.	Transfers 10,000 AF of its LTSC from East Valley USF to City A
	End Result	Gains 10,000 AF of LTSCs at East Valley USF. Pumps 10,000 AF from West Valley Aquifer.	Not short 10,000 AF of Colorado River water at its surface water treatment plant. Has 10,000 AF fewer LTSCs.

Exchanges can help ensure that Colorado River water makes it to surface water treatment plants, but at some point they will become only marginally effective.

Infrastructure

The ability of municipal water providers that deliver Colorado River water as tap water to ensure reliable deliveries during extreme Colorado River shortages ultimately depends on the design and functioning of their water transmission and distribution systems—basically, their plumbing. Some have adequate well capacity and the necessary plumbing to deliver groundwater to portions of their service territory that are normally served with Colorado River water. Some have the plumbing to allow deliveries of Salt & Verde River water in lieu of Colorado River water. Others are in the process of building up the infrastructure that allows for alternative water sources for tap water deliveries.

As an example, the city of Phoenix invested hundreds of millions of dollars to build a transmission main that allows for the delivery of Salt and Verde River water supplies to areas of the Phoenix water service territory that are dependent on Colorado River water supplies delivered through surface water treatment plants.



Picture from City of Phoenix Water Services Department Web site explaining its drought pipeline.

Municipal water providers can also develop interconnects between their delivery systems to help each other out during deep Colorado River shortages. Interconnects allow water to flow from one water utility to another to help maintain pressures in the distribution system of the utility receiving the water. Water transferred and costs incurred in such deliveries can be paid back over time. Municipal water providers in the Valley of the Sun have developed additional interconnections in preparation for Colorado River shortages and for use in emergency situations. However, these interconnections exist at the physical boundary of each utility where water pipeline sizes tend to be smaller. This creates a significant physical limitation on the amount of water that can be transferred between utilities. An interconnect boosting supplies by two million gallons per day is helpful, but won't solve what is more likely to be a problem in the tens of millions of gallons per day.

Well pumping infrastructure can mitigate the impacts to tap water deliveries due to Colorado River shortages in Central Arizona. Central Arizona is blessed with large and productive groundwater aquifers and under the state's 1980 Groundwater Management Act, municipal water

providers can access groundwater via wells and develop the infrastructure necessary to ensure its availability as an alternative tap water supply during Colorado River shortages. In addition, the Arizona Water Banking Authority has stored millions of acre-feet of Colorado River water in aquifers that can be pumped back out, or "recovered" during times of shortage. However, developing adequate well capacity in the precise locations of the water service territory necessary to continue reliable tap water deliveries may be extraordinarily expensive where the amount of groundwater needed is great and the distance over which the groundwater must be pumped in the water distribution system to meet tap water demands is large, or where groundwater requires extensive treatment, such as desalination, before it can be delivered. It may also entail significant re-plumbing of the transmission and distribution system at considerable expense.

Meeting tap water demands from an alternative water supply (i.e. groundwater or Salt & Verde River water instead of Colorado River water) and/or different infrastructure (i.e. wells instead of surface water treatment plants) can entail different physical conditions and limitations related to treatment techniques, pump, reservoir, and pipeline sizes, as well as different hydraulic gradients in the water distribution system. Changing water sources and hydraulic gradients can involve water quality issues (Flint, Michigan as an example) and generally requires additional actions to comply with the Safe Drinking Water Act.

The upshot is that alternative water supplies delivered through alternative infrastructure may be used to meet tap water needs, but doing so is not easy. The venture must be carefully studied, planned, and implemented. It is likely very expensive, and it may come with significant operational risk.

Additionally, the federal government conditioned approval of the Central Arizona Project on Arizona's willingness to manage its groundwater supplies. Prior to 1980, in Maricopa, Pinal and Pima Counties the estimated overdraft of groundwater was 1.8 million acre-feet annually. While the overdraft has been reduced due to implementation of the 1980 law, more groundwater is still being withdrawn than is replenished. When less Colorado River water is available to deliver to taps or artificially recharge and replenish aquifers, the sustainability of groundwater is threatened. Consequently, it should not be assumed that substituting groundwater for Colorado River water indefinitely is the solution to Colorado River shortages.

Acquisition of Additional Colorado River Water via Transfer or Lease

It is possible to acquire or lease rights to water from the mainstem of the Colorado River in Arizona and import the water through the CAP canal. The Secretary of the Interior is the water master for the lower Colorado River basin and must approve the acquisition or lease. The approval process requires a favorable recommendation from the Arizona Department of Water Resources and that includes environmental considerations and public comment. Permission to transport the water through the CAP canal must be obtained from the U.S. Bureau of Reclamation and the Central Arizona Water Conservation District (CAWCD), which operates the CAP canal. Transporters also must pay various fees to CAWCD for energy, operations and maintenance, and infrastructure costs associated with the canal. The Arizona Department of

Water Resources recommended approval of a proposed transfer of Colorado River water from irrigated lands in the Cibola Valley area of La Paz County to the Town of Queen Creek and the United States Bureau of Reclamation (BOR) has issued a finding of no significant impact from the transfer. However, the transfer is opposed by many irrigation districts and governmental entities along the River.

In Arizona, transfers off of the mainstem of the Colorado River must occur through voluntary transactions—for example between a farmer with a water right who is willing to sell and a municipal water provider that wants to buy. *Strict adherence to the priority system of Colorado River water rights in Arizona during deep shortages will put pressure on municipal water providers to acquire water rights from the mainstem that are higher in priority*. To the extent there are not enough willing sellers, there may be pressure to enable condemnation with compensation, such as under Colorado's domestic preference doctrine.

Tribal water rights cannot be acquired. Tribes are sovereign nations and those with rights to Colorado River water lease such water at their own discretion. However, many tribes in Central Arizona have entered into leases of their water, and it is possible that one or more may be willing to lease additional water to municipal water providers.

The Colorado River Indian Tribes, which have access to the largest and most senior right to Colorado River water in Arizona, received congressional approval to lease some of their water for use in Central Arizona. The water will be available only for short-term leases of as yet undetermined length. It will likely be necessary to acquire environmental approvals and permission to transport the water from the BOR as well as the CAWCD. Because this water would presumably be transported in federal space in the CAP canal, the terms of moving the water, including energy and infrastructure costs are undetermined.

<u>Groundwater Importation via the CAP Canal</u>

Under Arizona law, groundwater from the Harquahala, Butler, and McMullen Valley basins to the west of the Phoenix-Mesa metropolitan area may be imported to an Active Management Area. Each basin has a separate list of requirements for transporting groundwater. To date, the most interest has been shown in the Harquahala Irrigation Non-Expansion Area (INA). The Harquahala INA shares boundaries with the Harquahala groundwater basin west of the Phoenix Active Management Area (AMA). The INA was established in 1981 to prohibit the farming of additional land in the INA. In 1991, Arizona law was changed to allow the state or a political subdivision of the state that owns land eligible to be irrigated in the INA to pump groundwater from that land and transport it for use in the Phoenix, Pinal, and Tucson AMAs.

According to the Arizona Department of Environmental Quality (ADEQ), groundwater in the INA is generally not suitable for drinking water purposes without adequate treatment.

Contaminants include nitrates and arsenic and facilities to treat the groundwater to an acceptable quality for conveyance through the CAP canal will be needed. To use the CAP canal to transport the groundwater, a system use agreement with the CAWCD and the Secretary of the Interior will also be required, and the Secretary of the Interior must complete a favorable environmental assessment.

To date no entity has successfully imported groundwater via the CAP canal. The U.S. Bureau of Reclamation is not moving forward with necessary approvals at this time because of litigation with the Ak Chin Indian Community over water quality in the Santa Rosa canal in Pinal County.

Interconnections between the CAP Canal and the Salt River Project Canal System

Currently Colorado River water can be introduced into the Salt River Project (SRP) canal system, but Salt and Verde River water from the SRP system cannot be introduced into the CAP canal. SRP and CAWCD are studying the possibility of creating an additional connection that would allow the introduction of Salt and Verde River water into the CAP canal. There is no timeline for such a connection, and its feasibility may hang on resolution of litigation over water quality concerns between the Ak Chin Indian Community and the U.S. Bureau of reclamation. However, if completed it would allow cities with access to Salt and Verde River water to deliver that water downstream of the SRP/CAP interconnect in exchange for Colorado River water at surface water treatment plants.

Regional Direct Potable Reuse

The cities of Glendale, Mesa, Phoenix, Scottsdale, Tempe, and others are studying the possibility of developing a regional water treatment plant that would enable direct potable reuse of reclaimed water from the 91st Avenue Wastewater Treatment Plant. If ultimately constructed, such a plant would feed reclaimed water treated to Safe Drinking Water Act standards into the Phoenix water distribution system for delivery as tap water. The cities that provided the source reclaimed water to the facility for treatment would then receive some amount of surface water in exchange for this new source of potable water. Depending on the source of the exchange water, it could theoretically be delivered to surface water treatment plants currently dependent on Colorado River water and help to mitigate the impacts of shortage.

Expansion of Bartlett Dam

The Salt River Valley Water Users Association, along with the U.S. Bureau of Reclamation and several cities, is working to raise the height of Bartlett Dam on the Verde River. The enlarged reservoir could increase water storage capacity on the Verde River and potentially yield up to 115,000 acre-feet. This project will entail many years of planning and development, numerous environmental compliance hurdles, and a large price tag.

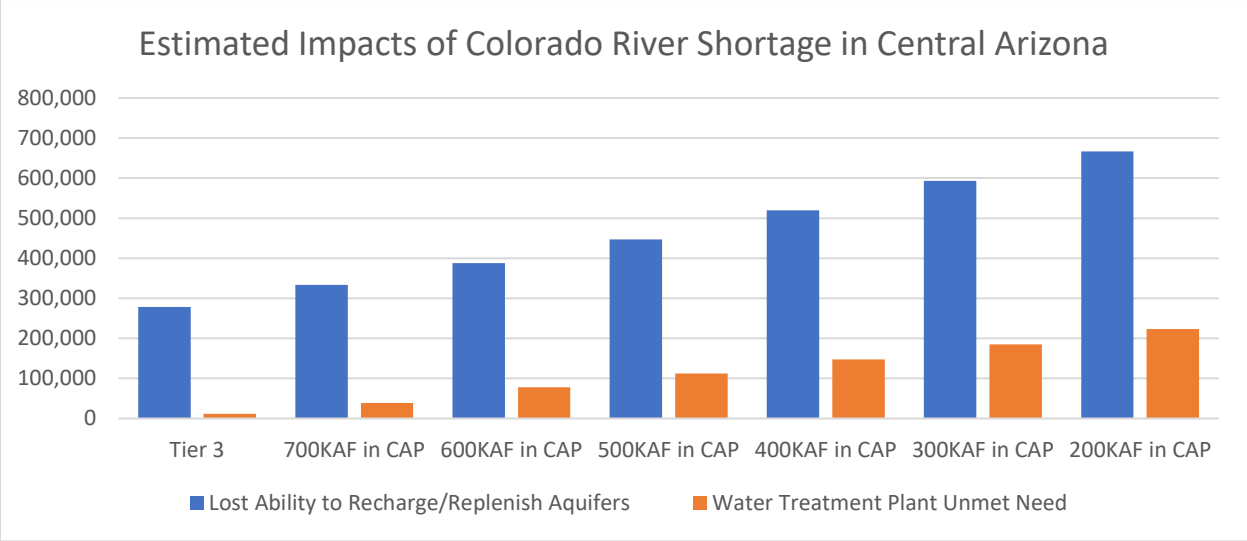
Desalination of ocean water or brackish groundwater

It may be possible to desalinate ocean water and move it into Central Arizona either through exchange with California or Mexico, or by pumping it directly from the Gulf of California. It

may also be possible to desalinate brackish groundwater in the far southwest reaches of the Valley of the Sun and re-purpose it for tap water.

Summary

In deep Colorado River shortages there are tap water vulnerabilities in Central Arizona that must be addressed to protect public health and safety. The impact of Colorado River shortages in Central Arizona will also fall on local aquifers because there will be less water available for recharge and because municipal water providers will likely pump more groundwater to make up for less water availability at surface water treatment plants. The following chart shows estimated impacts of Colorado River shortages in Central Arizona to aquifer recharge and water treatment plant needs.



Municipal water providers in Central Arizona have various means to ensure continued reliable tap water deliveries even under very deep Colorado River shortage conditions, but some have not yet fully developed or implemented alternative strategies. To the extent they have not already, municipal water providers that deliver Colorado River water as tap water should develop the strategies necessary to ensure that alternative water supplies can be delivered as tap water during extreme Colorado River shortages.