RIPARIAN HABITATS AND RECLAIMED WATER IN TUCSON:

A BATTLE FOR RIGHTS

By

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Abstract

Water scarcity is a major problem in Arizona. The state as well as the western United States in general is reliant on the Colorado River for its supply of water. A long history of water development and law has shaped the current situation. There are many different water users that compete for a share of the limited water supply. With Arizona's rapidly growing population municipal water use has increased. Because of this the hunt has begun to find additional water to meet the needs. Unfortunately, one sector where water may be taken from in the environment. The Santa Cruz River in Tucson has riparian areas that are kept going because of reclaimed wastewater that is discharge into the river. Without this water the riparian areas will disappear. Finding water for all of the different use sectors is proving to be a difficult dilemma.

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Introduction

Though the methods to efficiently manage and allocate water resources in an arid environment such as Arizona are disputed, the environmental situation of the state itself is not. Since 1895, Arizona has only received on average twelve inches of precipitation annually. The majority of this precipitation is from summer rains beginning in July and ending typically in the middle of September. These summer rains occur as thunderstorms, deriving their moisture from two gulfs, the Gulf of Mexico and the Gulf of California. The precipitation levels are highly variable between different locations in the state. On average, the northern city of Flagstaff has seventy days during the year with measureable precipitation, while the southwestern city of Yuma only averages fifteen. Desert areas in the state have recorded temperatures as high as 125 degrees Fahrenheit, with an average high of 104.3 degrees F during the summer months of June, July, and August. Nearly non-existent precipitation combined with high average temperatures creates an unforgiving climate. Almost counter-intuitively, it is in these areas, the Sonoran Desert, where most of the population of Arizona resides (Desert Research Institute).

Since the 1970's, central Arizona has been one of the most rapidly growing regions in the nation. With similar growth predicted into the future, population for the area is predicted to hit 11 million by the year 2050. Both of the major metropolitan areas in the state, Phoenix and Tucson, located in Maricopa and Pima County respectively, are within the Sonoran Desert. Population in the metropolitan counties of Maricopa and Pima swelled to about 4.7 million in 2006 from roughly two million in 1980, demonstrating a 131 percent increase. Overall, between 1980 and 2006 the population of the entire state increased 126 percent, from 2.7 million to 6.2 million (Albrecht, pg. 2). This concentration of population in an extremely hot and arid

environment has created a conflict between a high demand from various sectors and a low supply of water in the area.

The increasing population has put an important water user at a disadvantage, the environment. Often forgotten as a water user, the environment is commonly cut out from a supply of water. Riparian areas across Arizona rely heavily on reclaimed water to support their animal and plant life. Water debates now are discussing taking water allocated for these areas and diverting to it to serve municipal needs. The showdown between environmental and municipal interests is not the first debate about water allocation in Arizona and it is surely not the last. But it may signify a shift in the way that water users are prioritized in the future. This paper illustrates a snapshot in Arizona's ongoing battle with water scarcity.

It is easy to find news articles about the water crisis in Arizona. But in order to fully understand the current and future issues of Arizona water supply it is first essential to put the situation in context with historical examples. This makes it easier to comprehend what is happening, formulate educated opinions, and make educated decisions. It is beneficial to review the major historical events in Arizona water development that led us into the 20th Century. Past court cases and decisions affect decisions in the future. Such is the case in Arizona. Also, the current water infrastructure such as dams and canals dictate the current storage and distribution of water in the west. This is especially the case considering that no major dams have been built in the western United States since the 1970's. This is partially due to costs, but a lot of it has to do with the negative environmental costs that come with dams that were not as well known during the dam building era in the U.S. Any water related decisions that are made today must be within the framework of the current infrastructure and any existing laws and previous court

decisions. This is why understanding the history of water development is important before analyzing current issues.

Jack August and Grady Gammage, Jr. wrote, “The history of Arizona is largely written in the ability to hold, store, and move water” (August and Gammage, pg. 10), and they couldn’t have been more accurate. In locales where water is abundant, the management of water is not essential to the workings of that society; but in areas where it is scarce, institutions, laws, and policies are essential to govern the its management. As written by August and Gammage the story of Arizona is dictated by its management of water, and therefore its ability to transform a barren desert into a land able to sustain large scale agriculture and population.

Chapter 1: Arizona Water Development and Law

Western United States Context

Before focusing in on Arizona it is valuable to know where the state falls in the broader context of the Western United States. The entire region is water scarce, and relies almost entirely on its one reliable source of renewable water, the Colorado River. Seven states in the upper and lower basins receive some water from the river: Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming. Donald Worster wrote in his book *Rivers of Empire*, "For some time to come, the region will likely be ruled over by concentrated power and hierarchy based on the command of scarce water." The history of the river has been dominated by laws and law suits concerning allocation and use of water from the river. The Colorado River Pact designates which states get how much water. Colorado and California get the most water out of all the states. Mexico is also supposed to receive some water from the river before it reaches the Gulf of California. But, because so much water is being diverted out of the river before that point by projects such as the Central Arizona Project, the river is essentially dried up before it reaches the border. That is not the other issues concerning distribution of the water. Many states want more than they currently have to supply their growing populations, especially in Arizona and Nevada, but there is only so much to go around. Also, during the year that the pact was made, 1922, the river was running unusually high. The river does not reach those levels anymore; therefore more water was allocated than in actually present in the river at any given time. This has caused issues for the allocation between states. While each individual state has plans in place for water distribution and conservation, there needs to be more inter-state discussions about the whole region's water situation. All of the states are tied together because of their use of Colorado River water. Higher levels of cooperation would result in a more strategic long term plan for water

security in the future. Water in the region, and specifically Arizona, has been an issue going far back in history. This chapter provides an overview of the major events in Arizona water development.

Early Development of Water Works

The story of water management in Arizona begins with the Hohokam tribe. The Hohokam inhabited the area that is now southern Arizona between 300 B.C. and 1450 A.D. (Reisner, pg. 255). They reached their peak population around 1200 A.D. (Gillilan and Brown, pg. 11). The Hohokam were the first of many to attempt to tame the desert landscape around them. The Hohokam constructed water projects that could be categorized into two development techniques: irrigation methods, and more indirect methods such as conserving the moisture that can be contained in soil. The Hohokam built over 350 miles of canals in the Salt River area and other canals in the southern part of the state. They used additional techniques such as terracing, check dams, rock piles, and linear and grid borders. All of these techniques resulted in over 100,000 acres of irrigation land maintained by the Hohokam (August and Gammage, pg. 11).

The Spanish West and Water

As Spanish colonizers moved into Arizona they utilized the Hohokam techniques to re-develop the area, but they also changed agriculture in the area by utilizing their own ideas. The Spaniards brought in a variety of new crops, along with livestock, and domestic animals (August and Gammage, pg. 12). Water was used by the Spanish for mining, agriculture, and domestic purposes. Water laws from Spain carried over to the new territories in the Spanish West, including that all running water was owned by the Crown and was accessible to everyone for activities such as drinking, fishing, and navigation. Water law in the New World continued rights to water for such activities. People could only get individual allocations after the general public

**Much of this chapter relies on August and Gammage, "Shaped by Water: An Arizona Historical Perspective."*

received all the water that they needed. A land grant promised use of the water for domestic purposes. But under law only the right to use the water was given, actual ownership of the water still belonged to the state. Water was divided with the intent to determine what was best for the common good. In disputes between the community and an individual, the interests of the community were valued more. Also, a factor considered in disputes was the age old idea of "first in time, first in right," which added information when deciding which side of the argument had a more legitimate need for water (Gillilan and Brown, pg.12).

The Arizona Territory: Irrigation, Law, the Reclamation Act, and Federal Involvement

When the Arizona Territory was founded in 1863 a new all-inclusive legal code was created. Judge William T. Howell authored the code, and it was subsequently called the Howell Code. There were many sections of the code that dealt with water in the new territory. The code was a combination of the area's historical policies created by Spanish and Mexican traditions and Howell's mining background from his experiences in Michigan. Prior appropriation was kept in the new document, but Howell added the declaration that water rights are attached to the land and therefore pass down in conjunction with the land rights. The Howell Code also applied prior appropriation to mining, stating that the water rights were given to the first person to unearth minerals (August and Gammage, pg. 12). The Howell Code in part determined the development of the territory during its infant years.

Pressures for Federal involvement in water came when the Arizona Territory experienced widely varying climate conditions during the 1890's. In 1891 there was a massive flood of the Salt River that destroyed infrastructure and disrupted social and economic processes in the region. The flood led many people to call for river storage, regulation, and federal aid. However, a decade-long drought hit the area almost instantly after the flood waters receded.

These severe and inconsistent weather conditions caused a bevy of legal disputes concerning water. Judge Joseph H. Kibbey stepped in as the chief justice of the territorial Supreme Court to resolve select water rights and canal company disagreements, and to set legal precedent in water law. In the case of Wormser v. Salt River Valley Land Company in 1892, Kibbey maintained the prior appropriation doctrine. In this decision, Kibbey stated that no particular company owned the water; instead, that it belonged to the land, and therefore it could not be sold as a separate commodity. His decision was upheld in 1910 in the case of Hurley v. Abbott (August and Gammage, pg. 13).

As more and more people moved into the area after the Civil War, it became apparent that many places in the region, if given water, were suitable for agriculture. But for this to be possible, a large system of irrigation networks would be necessary. Initially, many tried to use the previously-existing Hohokam canal system, but the groups soon began to lobby for irrigation and water projects. The NIA, or National Irrigation Association, was created and they petitioned the federal government for funds to build irrigation projects. In 1902, the group's efforts were rewarded when the Newlands Reclamation Act was passed (August and Gammage, pg. 13). The Reclamation Act was the Federal government's first foray into water development for irrigation. The act stated that all money generated from the sale and disposal of public lands in sixteen states west of the Mississippi River would go toward the, ""reclamation fund," to be used in the examination and survey for and the construction and maintenance of irrigation works for the storage, diversion, and development of waters for the reclamation of arid and semiarid lands in the said States and Territories, and for the payment of all other expenditures provided for in this Act . . . ." (U.S. Congress). The Reclamation Act of 1902 paved the way for decades of federally-funded construction of water works in all western states, including Arizona.

The first Federal project was the Roosevelt Dam, named after President Teddy Roosevelt. The dam was built at the meeting of Tonto Creek and the Salt River. At the time of its construction the Roosevelt Dam was the largest in the world. The dam created Roosevelt Lake which when filled was the largest man-made lake in the world for a number of years (National Park Service). During Roosevelt's dedication speech he proclaimed that he could see a time in the future when the valley in Phoenix could be home to over 150,000, with help from such projects as the Roosevelt Dam (August and Gammage, pg. 14). While 150,000 was a bold number when the speech was given in 1911, Roosevelt at the time could not have foreseen the boom in water works construction by the federal government, and the subsequent population growth in Arizona, and the Western United States as a whole.

Battle for the Colorado

The next part of Arizona water history is dominated by Arizona's attempt to lay claim to Colorado River water. Because of the arid climate of Arizona and the limited supply of groundwater, the Colorado River is vital to sustaining the population in the state. Understanding the source of our water is essential information in deciding how to best allocate it. In the battle for Arizona's rights to Colorado River water, the state of California was viewed as the enemy throughout the saga. Beginning with the passing of the Federal Reclamation Act in 1902, California had been extremely active in water development and the pursuit of water resources for its population. In response to California's aggressive diverting of Colorado River water, the Colorado River Compact of 1922 was drafted by the other members of the Colorado River Basin. Designed by Delph Carpenter, a Colorado water law attorney, the compact divided the basin into two parts at Lee's Ferry in northern Arizona. The upper basin consisted of Colorado, New Mexico, Utah, and Wyoming, while the lower basin contained Arizona, California, and Nevada.

Each basin received 7.5 million acre-feet of water per year. The compact was designed to keep water issues out of the courts (August and Gammage, pg. 15).

Even though the compact was devised in 1922, it took Arizona 22 years to ratify it. However, while Arizona was simply trying to ratify the compact within the state, California had already introduced the bill to the U.S. House of Representatives in the first swing-Johnson bill. The bill defined specifications for storage, power production, and the All-American Canal, all designed to bring California substantial amounts of Colorado River water. Carl Hayden, the only congressman from Arizona, opposed the bill and successfully held it up as long as he could. While all this was all happening, Delph Carpenter recommended to Herbert Hoover that the compact be ratified because six of the seven states had agreed to its contents. Hoover agreed and by 1926 the compact was passed into law. For the next two years, Arizona desperately tried to prevent California from getting their canal and dam. But despite their efforts, the Boulder Canyon Project was passed in 1928. The ripple effects from the ratification were enormous. In addition to authorizing the Hoover Dam and the All-American Canal, it also repealed the law of prior appropriation related to the upper and lower basins with reference to Colorado River water. It allotted California 4.4 million acre feet of water and Arizona 2.8 million acre feet. Many in Arizona felt that they got the short end of the stick in the deal. This belief led to standoffs between the two states and even disagreements between Arizona's congressman and state leadership (August and Gammage, pg. 16).

However, when Sidney Osborn, a former state's right supporter, was elected governor of Arizona in 1940 drastic changes affected Arizona's water policy. Osborn declared that after the passing of the Boulder Canyon Act the "era of philosophizing and theorizing about the river had ended" (August and Gammage, pg. 17). He said, "Whatever our previous opinion about the best

place or plan, we can only recognize that decisions have been made and the dam constructed" (August and Gammage, pg. 17). Consequently, in 1944 a bill was passed by the Arizona legislature that gave authorization for a water-delivery agreement with the Secretary of the Interior. The agreement was for 2.8 million acre feet of water per year. This bill was a milestone in quieting the internal debate about water policy that was taking place within the state of Arizona. (August and Gammage, pg. 17).

With Arizona's renewed interest in being active in Colorado River dealings, Carl Hayden went to work obtaining appropriations for the Bureau of Reclamation to investigate the possibility of irrigation and multi-use water projects in the lower Colorado Basin. Later in 1944, hearings were held discussing the feasibility of the new "Central Arizona Project." The CAP was a plan to divert the full-share of Arizona's water to where the demand was, in the heart of the state. In 1948, J.A. Krug, the Secretary of the Interior at the time, accepted the feasibility plans for the CAP because it prevented drastic changes in Arizona's agriculture system by supplying the area with a new source of water (August and Gammage, pg. 17).

The Central Arizona Project: The Beginning

The CAP would come to have far reaching effects in Arizona and across the region. The Central Arizona Project:

> …would transform the Colorado River into a truly multipurpose natural resource that would replace depleted groundwater, create hydro-electric power for a developing region, provide supplemental water to lands currently in production but not adequately irrigated, and increase Tucson's domestic water supply (August and Gammage, pg 17).

Some believed that the CAP would save agriculture in Arizona from the problems surrounding groundwater pumping (Hanemann, pg. 1). However, there were three issues that needed to be settled before any construction on the canal began:

1) Water allocation questions still remained between California and Arizona. California argued that the 1 million acre-feet of water from the Gila River should be subtracted from Arizona's allotment of Colorado River water. Obviously, Arizona disputed that the water should be subtracted, and said that Gila River was aside from the Colorado River allotments.

2) Arizona needed to pass a law controlling the amount of groundwater that could be pumped from areas that were being supplied with CAP water.

3) Arizona needed to create an improvement district to contribute to repaying construction costs and help to watch over local management of the project.

Without these issues being resolved, the delegation from Arizona had no luck in pushing the CAP legislature through Congress. Eventually, the issue made its way to the Supreme Court. After a hotly contested eleven-year court case in *Arizona v. California* that ended in 1963, the court altered the legal framework dealing with the allocation of Colorado River water that had been previously claimed by California; these steps allowed for action on the CAP to move forward. The Colorado River Basin Project Act of 1968 was the fruits of the labor in the negotiations. The Act allowed construction on the CAP to begin, and symbolized Arizona moving on from struggling to get more water to, instead, taking advantage of the resources that they were given (August and Gammage, pg. 18).

Originally, the CAP had been planned to mostly supply the agricultural users in the state. But municipal leaders soon began to see that the canal was the best way to supply water to their growing cities, allowing for larger populations and increased economic growth. But issues still

existed that needed to be resolved. One such issue was the repayment for the construction of the canal from the state of Arizona. In 1970, Congress approved $1.2 million to be used for the construction of the CAP, but the U.S. Office of Management and Budget (OMB) declined to issue the money because a repayment agreement had not been made between the Secretary of the Interior and water users in Arizona. In response to this the Central Arizona Water Conservation District (CAWCD) was created on June 16, 1971. The group was tasked with overseeing the repayment of the debt incurred from the construction of the CAP to the federal government (August and Gammage, pg. 19).

The Groundwater Management Act of 1980

In addition to repayment, the issue of groundwater pumping was still present. Between 1953 and 1968 the main agricultural areas averaged 4.5-5 million acre-feet of pumping per year. However, the natural recharge in this area was only 1.5 million acre-feet a year. Because of this imbalance, groundwater levels in some areas sunk by 125 feet (Hanemann, pg 2). Then President Jimmy Carter stated that since the CAP was touted as a method to reduce groundwater pumping, Arizona had to indeed demonstrate reductions in its groundwater use. With help from then Governor Bruce Babbitt, the Arizona legislature passed the Groundwater Management Act of 1980. The groundwater act, "…established a timeline for reduction and elimination of groundwater pumping in certain areas of the state by creating active management areas (AMAs) and irrigation non-expansion areas" (August and Gammage, pg. 19). Inside the newly created AMAs development was restricted to locations with an "assured water supply." "Assured water supply" was defined as a place with water supply enough for a 100-year span. However, this designation could be easily met by signing an agreement with the CAP. A city with such a CAP agreement was given the 100-year title. The act also created a new governmental agency, the

Arizona Department of Water Resources (ADWR). This organization replaced the Arizona Water Commission which had positions appointed by the governor. The act created three types of groundwater rights:

- Type I non-irrigation, water that used to be used for irrigation but has not been since 1965.
- Type II non-irrigation, water that was not being used for irrigation when the AMAs were created.
- Irrigation rights, rights that come from lands that were irrigated between 1975 and 1980.

These rights designations were important because they dictated the flow of water and water rights between AMAs (Colby et al, pg. 80). Knowing the situation surrounding the potential sources of water is necessary to understand Arizona's water predicament. Up until this point Arizona was content with using groundwater as their main source of water, ignoring the long terms effects that over drafting was having on the aquifers. This piece of legislation may have helped politicians see that new sources of water would be needed for the state's growing population. Today the "100 year" water supply provision is important in deciding where and how much development there will be in the state. It is possible that the mandate to provide proof of a 100 year water supply has limited the amount of development in Arizona and Tucson, therefore effectively also lowering the increase in water demand from the municipal sector, and slowing the rate of water table lowering. Groundwater levels are extremely important when it comes to riparian areas because such areas are fragile and extremely susceptible to short term and long term changes in the water table. Without restrictions on groundwater pumping through the act the water table in Arizona and Tucson could be even lower than it currently is, putting the riparian areas in further jeopardy.

The Central Arizona Project: Nearing Completion

But as construction on the CAP was wrapping up there were still three problems:

1) The Central Arizona Project cost substantially more than was originally planned. The repayment agreement signed by the CAP and the feds was overly complicated and was not read the same way by both parties. Thus, when each side calculated the amount for repayment they were apart by almost $1 billion.

2) The plan was charging customers using the CAP water that was not used by cities. The water would be paid for and utilized by Arizona farmers. The farmers were required to pay for percentages of the water supply in contracts known as “take or pay.” Repaying these amounts proved to be difficult for the farmers. To make matters worse the value of cotton plummeted making it even harder for farmers to make their payments. Consequently, CAP deliveries to farmers decreased from 500,000 acre-feet to 50,000 acre-feet between 1993 and 1994.

3) When Tucson was finally hooked up to the CAP, water users across the city experienced brown liquid coming from their faucets instead of clear water. The problem was that the city had done an instantaneous switch from using only groundwater to using only CAP water. The chemical properties of the CAP water were so different than those of the groundwater that buildup inside the pipes had been loosened and dragged out of the system. There is no longer direct delivery of CAP water to Tucson water users (August and Gammage, pg. 20).

The organization that had to deal with the problems identified surrounding the CAP was the CAWCD. Upon investigation they found out that the federal government was more concerned with how much water the CAP was going to give to the Native American tribes in Arizona rather than the repayment of the CAP costs. Native Americans were and are typically left out of conversations on the distribution of resources because of their lack of a strong voice in

the debates. In this case, the CAWCD wanted to make sure that the native populations received their proper share of water. They were particularly concerned because of the Supreme Court ruling in *Winters v. United States* in 1908 stating that the federal government had declared that reservations had enough water to irrigate all useable acres when they were created. The federal government needed the CAP water in order to assure water supply for the Native Americans in Arizona. Negotiations between the feds and Arizona were unsuccessful and the issue was not settled until 1995 when the CAWCD sued the United States over the repayment costs. The decision on the case was made four years later when it revealed that the CAP would be forced to pay $1.65 billion and that 653,000 acre-feet of water would be directed to Native American reservations. This would give the Native Americans control of 48 percent of the total CAP Colorado River water supply (August and Gammage, pg. 21).

To fix the problem regarding CAP water delivery to agricultural users a Governor's task force decided that an "economic restructuring" was necessary. This meant that that CAP water could be sold to agriculture for less than the marginal cost of delivery, with the difference in cost being carried by the cities in Arizona. The program was a success for the CAP because they were able to make a higher number of water deliveries and since agriculture was receiving cheap water, the CAP water use by agriculture increased back to over 500,000 acre-feet a year in 2001 (August and Gammage, pg. 22). However, this may not have been a success for everyone because even though the CAP's business increased, it also meant that there was an increase in water use which is not a good thing given Arizona's water situation.

In Tucson, in response to the brown water problem, the City decided to begin pumping the CAP water into underground reservoirs to mix it with local groundwater. This changed the chemical makeup enough that it allowed the water to be run through the existing pipes and there

were no longer any complaints concerning the color or taste of the water by Tucsonans. The CAP/groundwater mix was available to citizens on May 3, 2001 during the “Start Your Pumps” initiative in the city started by then Major Bob Walkup (August and Gammage, pg. 22).

Now that the Central Arizona Project is completed it is 335 miles long, transporting 1.5 million-acre feet of water from the Colorado River from Lake Havasu to locations in central and southern Arizona. The water requires being lifted 2,400 feet over those 335 miles by fourteen pumping stations. Final costs for the project were calculated at just under $5 billion (Hanemann, pg. 1).

Water Use in Arizona

As of the year 2000 eighty percent of all water in Arizona was used for irrigation. The second largest use was water for the public at 16 percent. Groundwater is being used less now than in the past. The percent of total water use that groundwater makes up is at 50 percent, down from over 60 percent in the 1950’s. Much of the decline can be attributed to the aforementioned Groundwater Management Act of 1980. However, total water extractions in the state have increased from 5.37 million acre-feet in 1950 to now 7.53 million acre-feet feet in the year 2000 (Anderson et al, pg. 55). Arizona’s rapid population growth over the past decades has resulted in the domestic sector undergoing the largest rate of water use increase. Domestic water use was at 1,240,000 acre-feet in 2000 which was a significant rise from the year 1950 when it was at 100,000 acre-feet, which marks an increase in overall water use despite a decrease in per-capita use of water. Agricultural use increased from 5.22 million acre-feet to 6.05 million acre-feet during the same time period (Anderson et al, pg. 55). General irrigation accounts for 87 percent of Arizona’s water use, with agriculture consuming for 80 percent of all irrigation. (Reisner, pg. 9). Even with this increase in total agricultural use, the amount of groundwater used has

decreased because of the availability of surface water brought by the CAP, and the decreased amount of agricultural lands because of urbanization in the state (Anderson et al, pg. 56).

Effluent Law in Arizona

Even though the majority of, if not all, of the water in the state is allocated, it is not all used completely in those processes. Gravity-fed irrigation that is along the Colorado River usually returns about fifty percent or more of the water back to the stream after the crops consume the water they need (Pearce, pg. 34). This remaining water is commonly called return flows. Like in agriculture, municipal water use results in water being left over from various uses, such as showering, washing, and landscape irrigation. This water is considered effluent. In the past, municipal effluent was viewed as un-wanted waste. Only about twenty percent of municipal effluent was being collected. Even though some cities in Arizona are still collecting at this percentage, the overall trend of effluent collection is on the upswing. Effluent is now seen as an economic commodity, and cities are beginning to value it. For example, Surprise, Arizona is collecting and reusing about 50 percent of their effluent (Pearce, pg. 34).

However, this much value was not always placed on effluent in Arizona. Six cities in the 1980s organized a deal with two public utilities to sell the effluent for the cooling of the Palo Verde nuclear power plant. However, the ability to enter into such a deal was challenged by two ranches that were downstream of the waste water treatment plants. They stated that the negotiation would take the effluent out of the natural steams where they collected it and used it for agricultural purposes. The disagreement made it to the Arizona Supreme Court in the case of *Arizona Public Service Company v. Long* (1989). The case was overly complicated because the water that makes up effluent is both groundwater and surface water. Therefore, effluent fell under two different water laws. Some argued that the surface water in the effluent could not be

taken away from whom it was originally apportioned to. While some argued that since groundwater made up some of the effluent the water was under the restrictions of the Groundwater Management Act, and therefore was not able to be transported. Both ideas were rejected by the court and instead it was decided that effluent did not fall under prior appropriation of the GMA, making it entirely unregulated. With this decision the cities were able to sell the water as they wished. However, the court also said that while effluent was not surface water or groundwater, it was still water as viewed by Arizona law, and was able to be regulated by the state legislature (Pearce, pg. 35).

Even with the given ability the state legislature has not regulated effluent at all to date. Effluent has become popular across the state for irrigating golf courses, parks, and landscaping in housing subdivisions. Pima County even makes effluent use mandatory for watering golf courses and turf areas. With Arizona's increasing population effluent will continue to become a bigger issue across the state, with the amount of it produced and its possible uses likely to increase.

Chapter 2: Pima County and Tucson

Water Situation

Pima County in Southern Arizona is an example of the predicament of the state of Arizona as a whole, and the Southwest in general. Pima County's water is currently being supplied by the Colorado River, tentatively. The flow of the Colorado River is vulnerable to climate change, creating unknown variables and, at times, unreliable water supply for Tucson. Water scarcity in an unforgiving desert environment has put pressure on the county government to find solutions for the water shortage. Fortunately, residents of Tucson, the largest city in Pima County and second largest in the state, are more progressive when it comes to reducing water use. In 2002 the average per capita daily water use for a Tucson resident was 160 gallons. In Phoenix, it was 226 gallons or 38 percent higher than in Tucson. Per capita water use has decreased in Tucson by 20 percent since mid-1970. In Phoenix, however, there has been an insignificant change (Copenhaver). Decreasing per capita water use is beneficial, but has only delayed the inevitable; alternative sources of water are needed. It is unlikely that the water saved by conservation alone will be able to supply the current population and population growth in the future. One way to mitigate water problems in Tucson may be the extended use of reclaimed water.

Water Facilities and Reclaimed Water in Tucson

Tucson is the last stop of the Central Arizona Project on its trip from the Colorado River through the state. Because of the history with Tucson and CAP water and the water quality problems associated with the city's hook-up to that system, Tucson passes the CAP water through a process upon its arrival at the outskirts of the city. The chemical makeup of CAP water and Tucson groundwater are different, not only creating problems in the piping but also causing

a difference in taste. To curb these problems the city mixes the CAP water with the groundwater. The Clearwater Recharge Facility is the primary location where CAP water is artificially recharged into underground aquifers to make the chemical makeup of the water suitable for potable use in Tucson. The water is delivered via canals to the basins. The water is then kept at certain depths to promote the infiltration, and due to specific ground conditions at this location, the water can be kept at a high standing depth. The basins here are kept on a wet/dry cycle to optimize the recharge. The water in the aquifer is then pumped out through pumping stations and sent through a pipeline over Gates Pass and then down to the city. Gravity from the elevation change is able to carry the water to the outer reaches of Tucson without having to use any additional energy.

Once the mix of CAP and groundwater is pumped back out of the aquifers, the water is then distributed around the city. The Hayden Udall Treatment Plant, located west of the I-10 interstate in a fairly remote area, controls this. At this facility there is a central control room which manages potable water flow throughout all of Tucson. Everything can be controlled from that one room, which is equipped with many computers and large monitors, with several operators monitoring the equipment.

Reclaimed water is another class of water aside from potable CAP/groundwater. Reclaimed water is domestic water that has been treated to a high degree, and is then used for non-consumption based purposes. There are five different classes of standards for the cleanliness of reclaimed water. The classes are based on the level of risk of human exposure to potential pathogens in the reclaimed water. Reclaimed water has been used in Tucson for over 20 years, and Tucson Water delivers reclaimed water to about 900 locations including: 14 golf courses, 35 parks, 47 schools, and over 700 single family homes. This is largely due to a city law that

mandates golf courses and turf facilities over ten acres use reclaimed water. The Tucson reclaimed water infrastructure system boasts more than 100 miles of underground pipeline and five reservoirs with a total storage capacity of over 15 million gallons. In 2008 15,568 acre-feet of reclaimed water were delivered to customers in Tucson (Tucson Water). The majority of the reclaimed water in Tucson is filtered at the Roger Road Wastewater Treatment Facility. The facility, originally constructed in 1951, has undergone numerous expansions and renovations to increase efficiency and output. Its starting capacity was 12 million gallons a day (mgd). Today, the capacity has been increased to 41 mgd to meet increasing amounts of wastewater due to Tucson's growing population. Sludge was originally stored at local landfills, and beginning in 1985, some of it was shipped to Marana for agricultural purposes. Now sludge from Roger Road is shipped to a facility on Ina Road where it is treated.

Water and Wastewater: Infrastructure, Supply and Planning Study

In April 2008, to help to "assure a sustainable community water source given continuing pressure on water supply caused by population growth" the City of Tucson Mayor and Council and the Pima County Board of Supervisors started a "multi-year study of water and wastewater infrastructure, supply and planning issues" (City of Tucson). This is a joint effort because water systems in Tucson are run by two organizations: Tucson Water and the Pima County Regional Wastewater Reclamation Department. The Phase 1 Report was published in May 2009. After analysis of the current state of the different water systems, the committee detailed seven observations in their Phase 1 Report:

- Tucson Water and the Pima County Regional Wastewater Reclamation Department are reliable and well maintained. The systems are in better shape than that of many other older cities.

- Both utilities require investment in maintenance, rehabilitation, and replacement. As water quality standards increase so will the need to update equipment. Water rates must be raised in order to provide funding for such projects.
- Tucson Water has invested heavily on CAP related projects but now focus must be shifted to aging main, pipes, and other parts of the water infrastructure. Lost water accounts for ten percent of the total water delivered by Tucson Water. This proves the need to upgrade the system.
- Pima County Wastewater needs to make large improvements to its facilities to meet wastewater quality standards. Work needs to be done to both the Roger Road and Ina Road facilities.
- It is apparent that expansion of the reclaimed water system would be ideal, planning and exploration of possible funding must be conducted to make it possible. Major questions would include, “what are the most appropriate uses, who pays, how much resource is available and how should it allocated, cost trends, and barriers to increased use” (Phase 1 Report). For example decisions must be made regarding how much wastewater will be used for municipal versus environmental uses.
- The system is designed so that growth in water and wastewater use should pay for itself. The system of fees and costs for the water should change to pay for expanding pipes, or other parts of the water delivery infrastructure. This will prevent the government from having to pay the costs themselves, and possible raise taxes to cover the costs.
- Energy costs are a large part of operating costs of the water systems. Ways to lower costs and increase sustainability through alternative energy sources should be researched.

The observations made by the study concerning the water systems in Tucson point to a need to update parts of the system to increase efficiency and allow for an increase in water deliveries across the city. This includes not only the pipes that transport the water, but also the different processing and filtration facilities that the water passes through. The acknowledgement that an expansion of the reclaimed water system would be beneficial shows that the city is looking toward the future, and realizes that it needs other sources of water. At this point they can accept that reclaimed water may need to play a larger role in the overall water supply for Tucson in the future. But, obviously costs are an issue, as they are in most government projects. Building in mechanisms to deal with rising costs associated with expanding the processing and delivery system would help to make sure that the extended use of reclaimed water is not derailed due to lack of funding. The citizens of the state and of the city should be willing to pay more for the water due to the scarcity. Higher prices of water can also lead to more conservation. This would be a positive side-effect of the proposed cost structure. However, one issue that may become larger in the future is that of energy. As the system is expanded it will take more and more energy to filter and transport the water. The production of energy has all of its own debates related to emissions and its own effects on the environment, and increased energy use to give the population water would only add on to that. Utilizing gravity as much as possible for the transportation of water would cut down on energy use and costs. Also, the city could look into using alternative sources of energy, such as solar, to power their filtration facilities. Another possibility could be harnessing the power of the water itself to generate energy. This would probably have high start up costs but could end up saving money and energy in the long run.

The two utilities also did an assessment of the water resources for Tucson and outlined the following observations:

- Tucson Water has enough water supply for its current users and also for some future growth.
- There are a variety of unknowns that could affect our water resources, such as global warming and El Nino events. It is very possible in the future that the area could receive higher temperatures and less rain, exacerbating the scarcity problems that we have currently.
- The Tucson Water service area will need to be expanded but this should be done only after careful planning. Economic, social, and environmental implications of expanding service need to be researched before any moves are made.
- The cooperation between the City of Tucson, Pima County, and the Southwest region as a whole needs to improve to make sure that water delivery and conservation is being done smartly and as efficient as possible.
- Even though we have enough water for now and the short term more water will be needed in the future and steps need to be taken now to plan for acquisitions of these sources to assure Tucson's residents will have the water they require (City of Tucson).

When it comes to the assessment of the water resources the committee found that Tucson Water has enough water supplies for its current users and future growth. However the question is how much future growth. Over the past decades the population in Arizona and specifically Tucson has been very high. The likelihood that there would be enough water to supply the same type of growth in the next few decades is slim. Even if water could be found for this period of time it would probably be at the expense of underground aquifers that would be destroyed by over-pumping. Once the aquifer collapses due to lack of water its future ability to store water is very limited. This means that after that point Arizona would permanently lose a segment of its

supply of water. Therefore, steps need to be taken now to lower the water use to try to avoid this situation as much as possible. The report does a good job acknowledging that there are many unknowns that could change the projected water supply. These should be worked into different estimates to make sure that the city is ready for multiple scenarios. Expansion of the Tucson Water service area is obviously necessary because Tucson has not only grown in population but it has also grown in land area. The population is very spread out and areas that are farther and farther away from the city center have populations that demand high levels of water. This will undoubtedly raise costs as described previously, but it is a necessity as groundwater reserves decrease, leaving these areas no choice but to receive their water from Tucson Water. Tucson Water states that more water will be needed in the future but they do not state where the water will come from. This puts Tucson is a very uncomfortable, and uncertain position in the future. Because as more and more water is used, more wastewater is generated. Reclaimed water may be able to make up a big part of the necessary water, assuming the filtration technology makes it fit for human use. Reclaimed water is the only source of water that is projected to increase in the future, making it ideal to fill some of void left by depleted groundwater reserves and created by continuing population growth. However, the stigma attached to “reclaimed water” could be a problem with its acceptance as a true source of water. Opponents of reclaimed water coined the phrase, “toilet to tap.” However, our future water situation may deem extended use of this water necessary.

Phase 1 Report Continued: Environmental Analysis

In the Phase 1 Report there was also an analysis of the sustainable water future of Tucson. There were a few observations made concerning the environment and water. The committee stated that there needs to be a better balance of human, environmental, and economic

needs for water. They acknowledged the fundamental human need for water but also said that the environment requires water. They concede that we have not been very considerate of the environment's need for water, and say that in the future three things are needed: "recognize the environment as a water user, allocate water to environmental needs, and decrease groundwater pumping in environmentally-sensitive areas" (City of Tucson). The report estimates that in 2007 $22 billion gross domestic product was generated from the 136,000 acre-feet of water that Tucson Water delivered to municipal uses. But the environment can also provide economic benefit. In 2001 the Arizona Game and Fish Department estimated that "watchable wildlife recreation opportunities" created $173 million in sales profit (City of Tucson). This potential for profit should be just one of the motivating factors to ensure that the environment is not forgotten in planning. Unfortunately, it is not usually enough to save the environment just for biodiversity. There typically needs to be another factor that would convince voters and politicians to do so. Economic value could prove to be enough to sway support for protecting riparian areas. If this is the case then numbers such as these should be made more public by the supporters of riparian habitats.

The report admits that it does not fully address the environmental needs of water. It states that water management and planning practices have failed to take into account environmental considerations when making plans. Another shortcoming that the report details is the legal protection of river and riparian areas. There are major riparian areas along the Santa Cruz River located by the wastewater treatment facilities in Tucson, where effluent water is discharged to maintain the areas. The in-stream flow requirements are outdated and need to be re-thought in relation to current and anticipated population growth. The management codes that are in place relate to human water supplied, not those of the environment. Also, studies regarding impacts to

rivers, streams, riparian systems, and other water systems are not required (City of Tucson). These conditions are putting the environment at a disadvantage and possibly causing long-term damage.

Chapter 3: Riparian Areas and Reclaimed Water in Tucson

Not Enough Water to Go Around: Riparian vs. Municipal

While much of the water used by Arizona is delivered either via the Central Arizona Project from the Colorado River or pumped from underground aquifers, there are still sources of surface water in the state, many of which are riparian areas. While such riparian areas are rare in Arizona, only 0.4% of the state's land or 113,000 hectares, they are extremely important for the support of plant and wildlife biodiversity (Zaimes, pg. 1). However, with prolonged drought in the state these areas are drying up and must therefore rely on anthropogenic sources of water to sustain them. In the case of the Santa Cruz River in Tucson, the source is reclaimed wastewater. But as the population in Tucson grows, there is interest in diverting the water from riparian areas to sustain other uses within the city. The conflict between water supply and the value of ecosystem services provided by riparian areas has put the Santa Cruz River at the forefront of policy debates.

What Makes a Riparian Area?

Riparian areas are ecosystems characterized by three main factors: soils, hydrology and vegetation (Zaimes, pg. 4). There are commonly two ecosystems bordering a riparian area, an aquatic system and an upland terrestrial system, as seen in figure 1.1. The soils in a riparian area reflect the added moisture that is present because of the nearby water, this results in the soil being wetter than the upland terrestrial ecosystem, but dryer than that of the aquatic system. Therefore, riparian areas are viewed as a "transition zone" between aquatic and terrestrial systems and reflect the different characteristics of each. This is largely responsible for the high levels of biodiversity that riparian areas have. This position of being between the two other ecosystems also allows for the unique interactions between them that create processes that are

not present in the others. Successful riparian areas are characterized by their capacity to move and store water and sediment. This ability, combined with their proximity to the water sources, promotes the growth of different plant species. Much of the vegetation patterns in riparian areas are related to the amount of precipitation that the area receives. In Southern Arizona precipitation is not abundant, making the ground extremely hard. This means that when it does rain the water tends to run off the surface rather than infiltrate down into the soil as it passes through the uplands until it reaches the low-lying riparian areas, as shown in figure 1.1 (Zaimes, pg. 5). This results in riparian areas being significantly greener than the upland areas.

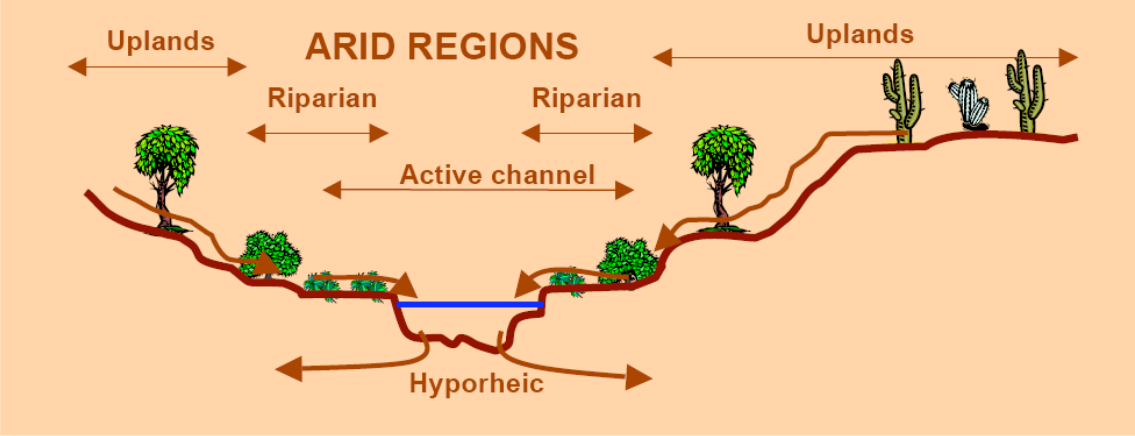

Figure 1.1 (Illustration by G. Zaimes)

Ecological Functions

Due to the unique conditions that are found in riparian areas, or “ribbons of life”, they are not only home to diverse vegetation and wildlife, but also facilitate more ecological functions than the upland terrestrial ecosystem. Zaimes writes that there are six main ecological functions of riparian areas:

1) support animal habitat and enhance fish habitat

2) filtrate and retain sediments and nutrients from terrestrial upland runoff or out-of bank floods

3) reduce chemical inputs from terrestrial uplands by immobilization, storage and transformation

4) stabilize stream banks and build-up new stream banks

5) store water and recharge subsurface aquifers

6) reduce floodwater runoff.

Due to the arid climate of Arizona, riparian areas are considered critical areas for wildlife. In the state over eighty percent of all vertebrates spend at least some part of their life in a riparian area foraging, nesting, or using the area for cover. Also, riparian vegetation provides many necessary conditions for fish such as food, cover, and a regulated stream temperature. Today, seventy percent of threatened and endangered vertebrates in Arizona are reliant on riparian areas. Because of the dense vegetation found in most riparian areas the amounts of sediment, nutrients, and chemicals that would have reached the stream are reduced, resulting in a higher water quality (Zaimes, pg. 2). This is part of the reason why riparian areas are such good habitats for wildlife.

Despite the valuable functions that riparian areas fulfill, they are under attack by human forces. It is estimated that 70-90% of riparian ecosystems have been greatly altered by anthropogenic agents (Zaimes, pg. 3). Across the country a large percentage of riparian areas are classified as degraded or non-functioning and require some degree of restoration effort. Attention has been drawn to the benefits that riparian areas provide and also to the degree of damage these areas are suffering, bringing the management of riparian areas to the forefront of national political ecological debate (Zaimes, pg. 3).

Definition

Because riparian areas are studied by so many different academic disciplines, including plant ecology, hydrology, fisheries, wildlife, geology, geomorphology, forestry, soil science, range science, biology, entomology, and engineering, there are many varied definitions of this space. Agencies and organizations such as the U.S. Department of Natural Resource Conservation Service (USDA-NRCS), the U.S. Forest Service, the Bureau of Land Management, the U.S. Fish and Wildlife Service, and the U.S. Environmental Protection Agency, to name a few, each have their own definition of riparian areas and this can make it difficult to communicate and gain agreement between agencies to align the goals for use of riparian areas and projects to protect and restore them. The U.S. Forest Service defines riparian areas as:

> Riparian areas are geographically delineated areas, with distinctive resource values and characteristics that are comprised of the aquatic and riparian ecosystems, floodplains, and wetlands. They include all areas within a horizontal distance of 100 feet from the edge of perennial streams or other water bodies…. A riparian ecosystem is a transition between the aquatic ecosystem and the adjacent terrestrial ecosystem and is identified by soil characteristics and distinctive vegetation communities that require free and unbound water (Zaimes, pg. 7).

However, Zaimes describes that there are four main points that all of the definitions of riparian areas have in common:

1) adjacent to a body of water and dependent on perennial and intermittent water
2) without clearly defined boundaries
3) transitional zones between aquatic and terrestrial ecosystems
4) linear in nature

The many different definitions for riparian areas between different organizations may be partially the blame for a lack of protection or support. Some areas may be considered riparian by some groups, but not by others. A central definition could help to solidify arguments for the maintaining riparian areas, and therefore protect their supply of reclaimed water to do so.

The Santa Cruz

The Santa Cruz River is an international river that begins in the San Rafael Valley and flows south into Mexico before heading west and then eventually north back into the U.S. where it continues north past Tucson until it ends almost halfway between Tucson and Phoenix. The River makes a 35 mile loop in Mexico while the majority of the river is located within the United States. With the exception of a two mile stretch of perennial river just north of the border, most of the river is ephemeral, meaning that flow only exists shortly after some form of precipitation (Logan, pg. 198).

Figure 1.2 (Source: Google Images)

The Santa Cruz River is ecologically very important. The river is home to valuable riparian and grassland ecosystems, important wildlife migration corridors, and diverse plant and animal species including many that are endangered. The river supports an extremely diverse group of mammal species along with migrating waterfowl that use the area in the Fall and Spring seasons. Endangered plants, fish, and reptiles are also part of the ecosystems that surround the Santa Cruz River (Ledbetter and Sejkora).

River Resources

While the Santa Cruz River was not always an ephemeral river it has become so in most locations due to extremely little rainfall over a sustained period of time, and in some places to the removal of water from the river by heavy groundwater pumping around the banks. The latter is true in the section of the river located in Mexico as pumping of groundwater has lowered the water table to such an extent that the surface water is depleted from the river. The area of the river that commonly receives most of the attention in the U.S. is the section that flows on the west side of Tucson. Water is only present in this part of the river during and after rainfall events. However, there are important riparian areas along this stretch of the river, although these areas are largely present due to artificial recharge of the stream with reclaimed wastewater from the city of Tucson (Tucson Water).

Reclaimed Water and the Santa Cruz Riparian Corridor

Some of Tucson's reclaimed water is diverted from municipal uses and is discharged into the Santa Cruz River. As stated earlier, this water source supports riparian ecosystems along the stream that would not be present without the artificial recharge. The issue that is under debate is that as Tucson's population grows and water demand increases the city is searching for new

sources of water from which to supply their citizens. Presently, Tucson's reclaimed water meets the Arizona Department of Environmental Quality (ADEQ) standards for Class A reclaimed water (Tucson Water). It is believed that further technological advances in the purification process could increase the frequency and diversity of uses that reclaimed water is appropriate for, which will further increase the desirability of this water source. This raises the question of whether legislators, administrators, and the public will believe that supporting riparian areas is important enough to divert water that could be used instead for municipal purposes around the city.

Politics

Historically, Tucson developed by relying on groundwater to meet its water supply needs. Over time, with continued groundwater use, the regional aquifer system transitioned from being in a close balance between groundwater withdrawals and natural recharge, to being depleted in an accelerating pattern. The arid climate, drought conditions, and population growth accounted for rapidly declining water levels in the metropolitan and surrounding areas which has resulted in increased groundwater mining, and secondarily the gradual loss of natural habitat along local riparian corridors. In order to address these issues, Tucson Water stated in *Water Plan: 2000-2050* that:

> "renewable water supplies such as Colorado River water and municipal effluent would need to be increasingly utilized in order to satisfy projected water demand. To achieve long-term sustainability, the use of available water sources must be prioritized so that utilization of renewable supplies is maximized and the use of groundwater is limited to sustainable amounts. To help accomplish this goal, Tucson Water has continued to

> develop the Reclaimed Water System to make direct use of municipal effluent as a renewable water resource" (Tucson Water Department).

Effluent ownership is governed by a series of inter-governmental agreements between the City of Tucson and Pima County. The use of reclaimed water offsets part of the area's customer demand that would otherwise be met by mining additional groundwater or by redirecting Colorado River water. There are many competing interests vying to get their share of reclaimed water.

Despite efforts in establishing the Reclaimed Water System, some sectors are still under-served. Arizona's 1980 Groundwater Management Act addressed the state's water needs in regards to municipal, agricultural, and industrial aspects, but did not address the needs of the environment. Riparian areas have suffered on this account. In attempts to improve this situation, a number of agencies, environmental organizations, and individuals throughout the state are undertaking projects to revive threatened riparian areas (Megdal et al.). The Conserve to Enhance Program, for example, offers water customers the option of donating the money they save through water conservation in their home to a fund that purchases water supplies for environmental enhancement projects. "The proposed mechanism allocates money, rather than water, saved through conservation, this money can purchase water for enhancement projects at a different time, location, or quality than water saved. This provides more flexibility and efficiency in the allocation of limited supplies" (Megdal et al.) Public awareness campaigns educating about water conservation are helpful to increase proper use of reclaimed water in the community, as well as avoid abuse of municipal water resources. In the end, this will decrease overall water demand and create less coveting of this alternate water source to augment municipal needs, allowing more flexibility in the use of reclaimed water for environmental preservation. But saving the environment will require more than the efforts of community members alone.

"Reviving riparian areas will require reliable financial and water resources. One way to meet these needs is for our legislature and other leaders to clearly recognize the importance of preserving valuable habitat and act to create reliable funding for the Arizona Water Protection Fund" (Megdal).

Pressing Issues

Having large amounts of reclaimed water processed to a high quality, that it is available for a wide selection of uses would be extremely beneficial for a city such as Tucson in an arid environment, facing a water scarcity situation. Reclaimed water would relieve some of the pressures on the Tucson water supply for at least the short term. Reclaimed water combined with groundwater, and the water received from the Colorado River via the Central Arizona Project (CAP) would help to solidify the city's water supply. The answer to the question of whether supporting riparian areas is important enough to divert water from municipal uses is hard to figure out; because while it is relatively easy to put a dollar value on municipal services, it is extremely hard to do so with ecological services such as the ones provided by the riparian areas along the river. But Tucson Water asserts that, "The needs of the environment are becoming an even more central part of (our) service to the community. The environment can be viewed not only as a stakeholder but also as a customer of the Utility, and effluent is being considered for a variety of environmental uses including riparian habitat restoration" (Tucson Water Department).

Conclusion

In the arid climate that Arizona experiences year-round, conserving current water resources and identifying new sources is essential to the success of the city of Tucson. With a growing population and increasing water demand, the city of Tucson is under rising pressure to secure its water future. Reclaimed water is currently an additional source of water that is being

used to primarily water golf courses and other large sections of turf. But reclaimed water is also used to support riparian areas along the Santa Cruz River. These areas are extremely ecologically important and rely almost exclusively on the water that they receive artificially, introduced from the effluent. Due to the increasing quality of reclaimed water, some people are calling for this water source to play a larger role in meeting the water demands of Tucson. However, the secondary cost of such a practice could be losing valuable riparian habitats. A policy debate has started trying to discern what the best course of action is: maintaining ecologically valuable riparian ecosystems, or utilizing a potential source of water for the city. Tucson Water itself identifies their struggle to hold to this mission when they state, “How to strike an equitable balance between the needs of a growing community and the needs of its natural environment will require continued community-wide discussion and collaboration” (Tucson Water Department). As the primary owners of effluent in the Santa Cruz River Basin, the Bureau of Reclamation and Tucson Water will play critical roles in determining future use of reclaimed water as they consider their responsibility for environmental stewardship yet fulfill their primary mission as provider agencies.

Part of the problem is that there is not actually any effluent water that is specifically allocated to the river. The only reason that there is discharge is because it needs to be disposed of. This would not be the case in municipal uses took the water. The Santa Cruz riparian area and other riparian areas across the state need to have reclaimed water allocated and guaranteed specifically for their uses. This would make sure that in the future these areas would receive the water that they need to sustain their ecosystems. Supplying municipal uses is extremely important but it should not be at the expense of the environment. Public support needs to be garnered for these areas by showing the value that these locations provide. For example along the

Santa Cruz River in Tucson there is a location called Sweetwater Wetlands. The wetlands provide a natural filtration process for reclaimed water as the water passes through the reeds and other various plants. Besides these ecosystem functions the wetlands also provide education and recreation opportunities for Tucson residents. This entire area is only possible due to the availability of reclaimed water. This is only one example of such locations that demonstrate that riparian areas deserve an allocation of reclaimed water for their needs.

Though this paper discussed the issues related to riparian areas, it is only one example of the environment being sacrificed when it comes to allocating scarce resources. We need to realize the value of such ecosystems and do more to protect them. Problems related to water are only accentuated in Arizona because of its scarcity. This is why we must plan ahead by allocating environmental uses their own water now, so they are ensured for the future, even if it forces municipal and other uses to secure other sources. In the desert, no solution is a perfect one.

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