Central Arizona Salinity Study

Phase II Final Report

September 2006

The Study Partners: City of Glendale, City of Mesa, City of Phoenix, City of Scottsdale, City of Tempe, Arizona-American Water Company, City of Chandler, City of Goodyear, City of Peoria, City of Surprise, City of Tucson, Town of Buckeye, Town of Gilbert, Queen Creek Water Company, Brown and Caldwell and the Bureau of Reclamation

Regional Solutions to Salinity in Central Arizona
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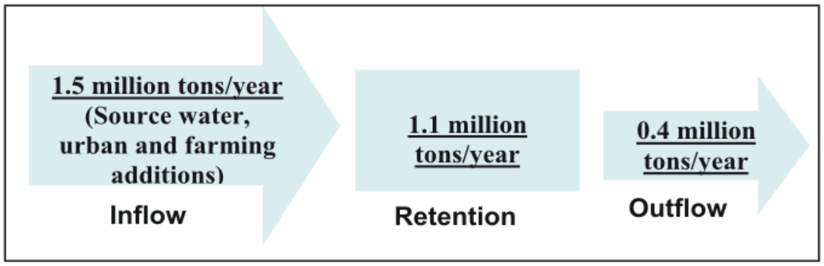
1.0 Introduction

Currently, over 1.75 million tons of dissolved salts are imported into central Arizona's Maricopa, Pinal and Pima counties annually from the Salt, Verde and Colorado Rivers. Before the Salt River Project (SRP) system was constructed in the early 1900's, the Salt and Verde Rivers transported salts through central Arizona to the Colorado River and then into the Sea of Cortez. Upon construction of the SRP dams and completion of an extensive canal system, most of the Salt and Verde River water was diverted for agriculture and domestic uses. Along with the water that was diverted came the salts and they began accumulating in large amounts within the Phoenix metropolitan area. The accumulation of salts in central Arizona was further increased in the mid 1980s when the Central Arizona Project (CAP) aqueduct system was completed, introducing Colorado River water and another source of imported salts to central Arizona.

The Salt and Verde rivers bring valuable water to Central Arizona

Society adds additional salts into the water cycle through the use of fertilizers, water softeners, industrial water treatment, and many other activities. The sewer system carries salts from residential, commercial and industrial sources to wastewater treatment and water reclamation plants. Because of society's contribution, the total dissolved solids (TDS) concentration in effluent is between 300 to 500 milligrams per liter (mg/L) greater than the TDS concentration of the potable water supply. The salts remain in the water as it passes through the wastewater treatment plant (WWTP). The effluent is then discharged into a river or is used for agricultural irrigation, landscape irrigation, groundwater recharge and power plant cooling water. Although, effluent is used in many different ways, a majority of the salts ultimately end up in the groundwater.

Since about 1985, the Phoenix metropolitan area has been accumulating salts at a rate of about 1.1 million tons annually. This is equivalent to a pickup load of salt coming into the Valley every 15 seconds. Currently, in the Tucson metropolitan area the salts are accumulating at about 100,000 tons annually but that will increase to a rate of about 200,000 tons annually



Phoenix Metro Area Salt Balance shows 1.1 million tons/year of salt is retained in the soil and groundwater when their full CAP allocation is used.

The Central Arizona Salinity Study (CASS) was initiated in 2001 to examine the problems created by the importation of salts into central Arizona. CASS began through a cooperative partnership between the Bureau of Reclamation (Reclamation) and Sub-Regional Operating Group (SROG), which is represented by the cities of Glendale, Mesa, Phoenix, Scottsdale, and Tempe, Arizona. After the first year of the study, the cities of Chandler, Goodyear, Peoria, Surprise, and Tucson; the towns of Buckeye, Gilbert and Oro Valley; the Arizona-American Water Company; the Arizona Water Company; and the Queen Creek Water Company joined CASS and financially contribute to the effort. CASS serves as a coordinator of the participating agencies and communities in order to identify salinity problems and develop potential solutions. CASS undertook a study which consisted of two phases conducted over four-years. Phase I of the CASS study has been completed and Phase II will conclude with this report.

1.1 CASS Phase I

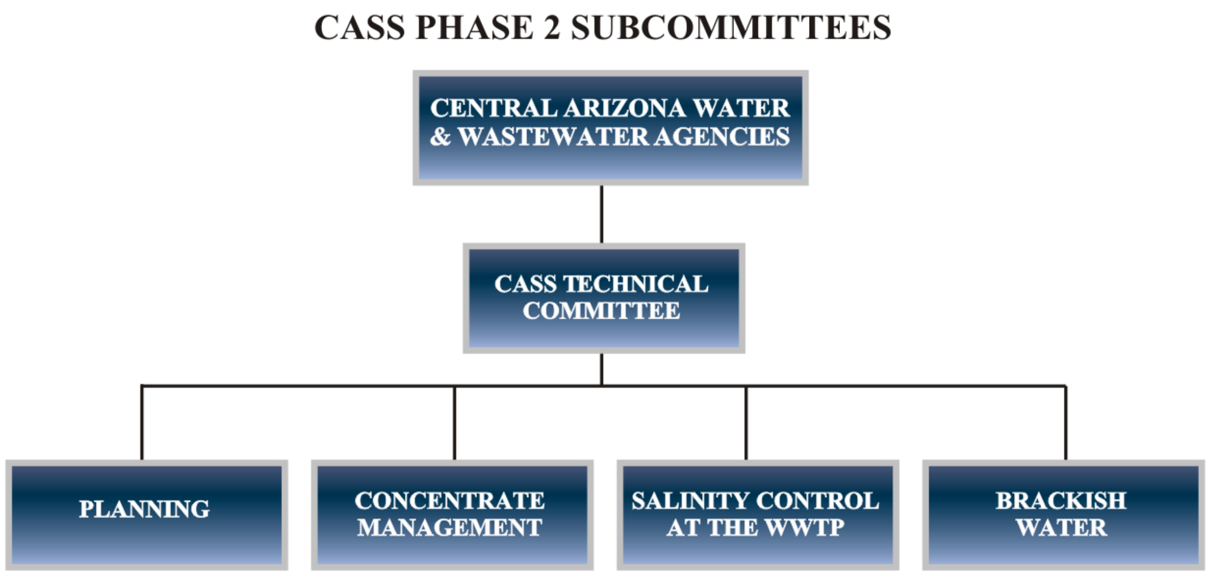
Water with a high TDS concentration has negative impacts for virtually all water users - residential, commercial, industrial, and agricultural. For the homeowner, high salinity reduces the useful life of household appliances, such as water heaters, evaporative coolers, faucets, garbage disposals, clothes washers, and dishwashers. Homeowners also incur salinity "avoidance costs", such as buying bottled drinking water and installing water softening systems. The commercial sector (schools, hospitals, retail stores, etc.) experience salinity-related issues similar to homeowners, with water-intensive commercial operations bearing higher costs. Some industries in central Arizona (such as food and beverage manufacturers and semiconductor manufacturers) need a very high quality water for production. In such cases, their advanced water treatment costs are directly related to the TDS concentration of the water they receive from municipal water providers. Currently, the agricultural sector experiences economic losses as high TDS water reduces crop yields, requires additional fertilizers and soil additives, and additional water is needed to flush salts below the root zone.

Residents see the affects of salts by deterioration of appliances and fixtures

CASS Phase I modeling equated an increase of 100 mg/L of TDS of the three primary surface water sources (the Salt, Verde, and Colorado Rivers) with approximately a $30 million annual increase in salinity related costs. About 93 percent of those costs incur within the metropolitan Phoenix area. Though costs of high-TDS water in central Arizona appear to be large, they have not yet substantively affected economic development, as evidenced by continued growth and development in the region. In the future, costs related to salinity issues are expected to increase because of the continued accumulation of salts associated with imported surface water and the additional salt loading due to continuing population growth.

1.2 *CASS Phase II*

The focus of CASS Phase II was to evaluate a range of potential approaches to managing salinity in central Arizona. Four subcommittees were formed and each subcommittee was tasked with examining a salinity issue in detail. Those subject areas were:



1.2.1 Planning

The Planning subcommittee was charged with two major tasks. The first task was to identify the consequences of taking no action in managing salinity. The "no action" analyses assumed that no further actions, above what is currently being done, would be taken to manage salinity in central Arizona. The second task was to assess where it would be most economical to apply salinity management strategies.

In regard to the "no action" analyses, the Planning subcommittee concluded the following:

- Salinity levels will increase in the soil, reclaimed water and groundwater. Salinity levels in reclaimed water and groundwater may increase to a point where these water resources will not be suitable for their intended uses. A "salt balance" will be necessary for the long term sustainability of central Arizona.

- Salt River TDS concentration fluctuates dramatically from drought cycles to wet cycles because the sources of salinity are salt springs located on the White Mountain Apache Reservation. Therefore, the TDS levels in the Salt River will increase during drought conditions due to less dilution of the spring flows and will decrease during wet periods because of high dilution of spring flows. But the Salt River will not continue to rise in salinity above these fluctuations.

- The Colorado River salinity concentration will continue to be controlled as long as the Colorado River Basin Salinity Control project is properly funded. Therefore the influx of salinity from surface water imports will remain, approximately, at the current levels.

- Continued growth and development will increase society's contribution to the accumulation of salts in central Arizona.

The Planning subcommittee examined 21 potential options for removing salt from the water cycle to assess where it would make the most economic sense to apply salinity management strategies. These sites included the watershed, on rivers/canals, at water treatment plants, at wastewater treatment plants, and through treatment of brackish groundwater.

The criteria used to evaluate the options were: Institutional Considerations, Water Resources Utilization, Technical Feasibility, Operational Feasibility, and Environmental/Public Acceptability.

Using RO Membranes and Evaporation Ponds as a baseline cost indicator, CASS evaluated 14 options for managing salinity.

Seven options were removed from consideration after being evaluated against the criteria because they had "fatal flaws" associated with them. A cost analysis was performed on the remaining 14 options. To ensure that all the options were evaluated equally, a cost model developed by Reclamation, which used reverse osmosis (RO) as the method of desalination and evaporation ponds for concentrate management, was used for the analysis.

The subcommittee's conclusions were as follows:

- Salinity management on the Colorado River via the Colorado River Basin Salinity Control Program (CRBSCP) is the most cost effective method to reduce salinity in central Arizona, the Lower Colorado River Basin States, and Mexico by preventing salt from entering the Colorado River. The CRBSCP should be fully funded.

- Large scale desalination projects along the Colorado or Salt Rivers, or along the CAP canal are not viable due to high capital and operating costs, significant loss of potable water in the desalination process, and difficulties in managing the large amounts of concentrate produced.

- Constructing desalting facilities at existing potable surface water treatment plants is a possible option. One of the advantages of desalination at water treatment plants is that the salts are removed before they cause damages to the urban infrastructure. Some of the disadvantages are; the increased costs associated with advanced water treatment, the loss of approximately 15 percent of the water supply in the wasted concentrate, and the large quantity of concentrate that would have to be managed. Depending on local conditions and public expectations (i.e. the willingness to pay, the water quality expected, etc.), the benefit of removing salt at water treatment plants may or may not be practical.

- Advanced water treatment could be used to treat high TDS effluent. TDS concentrations are increasing at some wastewater treatment and water reclamation plants to the point where the effluent may not be usable for "high end" purposes, such as golf course turf irrigation and artificial groundwater recharge. Desalination of effluent is one method which would keep high TDS effluent in a city's water portfolio.

- Desalination of brackish groundwater is a viable option for augmenting water resources. The cost to desalinate brackish groundwater is costly but potentially less expensive than other new water resource options.

1.2.2 Brackish Water

The Brackish Water subcommittee focused on issues that need to be addressed to develop brackish groundwater as a water resource. Issues associated with utilizing brackish groundwater are: regulations, water sustainability, water quality, and treatment technology. The following is a summary of the key findings:

- The long-term sustainability of pumping brackish groundwater is uncertain and would have to be evaluated on a site specific basis. Pumped groundwater must comply with the Arizona Department of Water Resources (ADWR) Groundwater Management Code that manages long-term water supplies.

Brackish groundwater requires RO treatment for potable uses.

- Depending on local conditions, brackish groundwater may need to be treated for a variety of constituents other then just TDS to meet federal, state, and local water quality regulations.

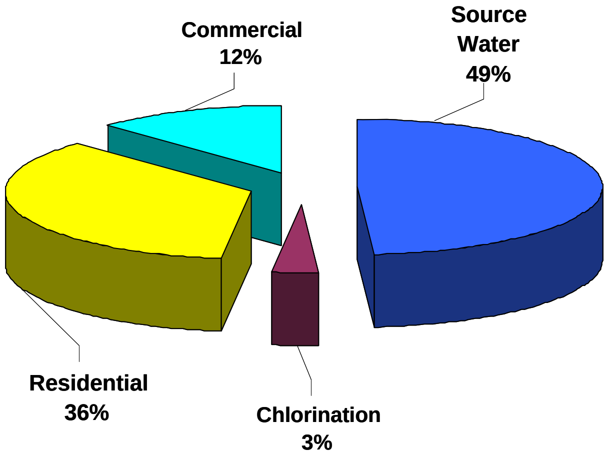
- It may be beneficial to use a blending scenario where a portion of the brackish water is treated by a desalination process and then blended with non-desalinated groundwater prior to introduction to the public water supply system. Blending scenarios may also mitigate the need to post-treat or stabilize water prior to sending it to the distribution system and may decrease treatment costs.

- The most common concentrate disposal methods in central Arizona are evaporation ponds and discharge to sanitary sewers. Both technologies have pitfalls that may limit the amount of brackish groundwater that can be utilized. Evaporation ponds are land intensive which increases the over all costs dramatically where land is expensive such as urban areas. Discharging concentrate to a sanitary sewer increases the salinity of the effluent leaving the WWTP.   This is especially a problem at smaller WWTP's which don't have the size to fully dilute the incoming concentrate.

1.2.3 Salinity Control at the Wastewater Treatment Plants

The Salinity Control at the Wastewater Treatment Plants subcommittee focused on identifying salinity issues at WWTP's. It is anticipated that WWTPs will continue to experience increasing salinity concentration in the future because of high TDS source waters, increased residential and commercial water softener usage, industrial processes, increased quantities of concentrated salts from cooling towers, and increased concentrate from membrane treatment facilities.

A survey (Insights and Solutions, 2004) was conducted on residential water softener usage in the Phoenix metropolitan area. The study indicated that 26 percent of homes in the Phoenix area have water softeners. But newer homes have a greater chance of having a water softener, about 51 percent of the homes built after the year 2000 have water softeners. As Arizona continues to develop, the overall percentage of homes with water softeners will increase.



The salinity in the water doubles between the WTP and the CC WRP because of added salts.

The subcommittee investigated sources of salinity entering the Cave Creek Water Reclamation Plant (CCWRP). Flow and salinity data were collected at the sewer interceptors that deliver wastewater to the CCWRP. The source water for this sewershed is mostly CAP which has an averages TDS of 650 mg/L. Effluent leaving the CCWRP averages 1,200 mg/L. The study identified that 36 percent of salinity comes from residential sources, 12 percent from commercial sources, 3 percent from water treatment and 49 percent is attributable to the source water.   The salinity in the water doubles between the WTP and the CCWRP because of added salts.

While the CCWRP study was in progress, a parallel study was conducted to determine the cause of chronic toxicity of *Ceriodaphnia dubia*, first identified during routine CCWRP whole effluent toxicity (WET) testing, and subsequently confirmed during a toxicity identification evaluation. WET tests employ standardized methods to measure the acute or short-term chronic adverse effects of effluents and receiving waters monitored under National Pollutant Discharge Elimination Systems (NPDES) permits. The test can either be acute or chronic. The acute test is a short term test to determine if the effluent would be lethal to aquatic life and measures whether the *Ceriodaphnia* live or die. Chronic tests are longer term tests that measure whether the effluent effects reproduction of the *Ceriodaphnia*. The chronic test also measures if the effluent would be lethal to aquatic life. The probable cause of this toxicity was identified as chloride, an important issue to consider in future studies (Alan Plummer and Associates, 2006).

High levels of TDS may render reclaimed water unusable for irrigation. It may also significantly degrade the groundwater if recharged into the aquifer either directly or indirectly. Several options can be implemented separately or in combination to manage salinity entering wastewater treatment plants. These options include the following:

- Regulate TDS discharges from large point source contributors such as industrial facilities.

- Assess a surcharge to pay fro the cost of desalinization at the WWTP. The fee would be proportional to the amount of salt a customer contributed to the sewer.

- Promote a Best Management Practices (BMP) program to manage salinity entering the sewer system from non-point sources. An examples of a BMP would be to use demand-based water softeners instead of timer-based water softeners.

- Desalinate effluent prior to reuse where necessary, such as turf irrigation and groundwater recharge.

1.2.4 Concentrate Management

The Concentrate Management subcommittee evaluated alternatives for managing concentrate produced through desalination. Depending on the circumstances, the cost of concentrate management can be 50% of a major desalinization facility. In Arizona, the most common concentrate management strategies are sewer disposal or evaporation ponds. New approaches to concentrate management are being evaluated through several national and regional research projects. Overall, the Concentrate Management Subcommittee developed the following consensus:

New concentrate management alternatives such as DewVaporation, wind aided intensified evaporation (WAIV), and Sal-Proc were evaluated.

- Current approaches to concentrate management are either costly or incur significant water losses.

- There is no single technology that will meet all concentrate management applications.

- Further research is needed to better develop new approaches to concentrate management.

- Once salts are removed from water they should be disposed of in an environmentally sound manner and not put back into the water system, such as sewer disposal of concentrate.

2.0 Salinity Management in Central Arizona

CASS developed approaches to salinity management that can be implemented by water providers individually or collectively. These approaches could assist water utility managers in making decisions regarding salinity management practices for their communities. The salinity management approaches recommended by CASS are:

- Support full funding of the CRBSCP
- Establish a public education program on salinity issues
- Limit the amount of salts entering sewer systems
- Desalinate brackish groundwater to augment water supplies
- Desalinate effluent for specific non-potable uses and possibly for indirect potable reuse
- Dispose of concentrate in an economical and environmentally sound manner to remove salts from the water cycle
- Promote research into concentrate management and desalination technologies that reduce costs and water losses.

2.1 Colorado River Basin Salinity Control Program

2.1.1 Description

The Colorado River Basin Salinity Control Forum (Forum) was established by the Colorado River Basin states (Arizona, California, Colorado, Nevada, New Mexico, Wyoming and Utah) in 1973 to address salinity in the Colorado River. The Forum developed flow–weighted numeric criteria on salinity in the Colorado River. The numeric criteria are set at three locations in the mainstream Colorado River and are: 1) Below Hoover Dam, 723 mg/L; 2) Below Parker Dam, 747 mg/L; and 3) At Imperial Dam, 879 mg/L. Arizona takes its allocation of Colorado River water through the Mark Wilmer Pumping Plant just upstream of Parker Dam in Lake Havasu.

In 1974 the United States Congress, with the full support of the Forum, passed into law the Colorado River Basin Salinity Control Act (Act). Title I of the Act addresses the United States commitment on the quality of Colorado River water delivered to Mexico and established the International Boundary and Water Commission. Title II of the Act created the Colorado River

Basin Salinity Control Program (CRBSCP) and directed the Department of the Interior and the Department of Agriculture to manage the river's salinity, including salinity contributed from public lands which are located in the upper basin states. The law directed that preference be given to those projects which are most cost-effective, i.e. obtain the greatest reduction in salinity per dollar spent.

The CRBSCP was created to reduce salinity by preventing salts from entering into the Colorado River. The CRBSCP is a long-term, interstate and interagency public/private partnership which uses a variety of methods to control salinity. Naturally occurring sources of salinity, such as at Paradox Valley, Colorado, are being controlled at the point source. In Paradox Valley, a natural, extremely salty underground brine is intercepted, treated, then injected into deep wells. Human-influenced increases in salinity due to irrigated agricultural activities in the upper basin are primarily controlled via irrigation improvements, canal lining and vegetation management to reduce excess irrigation water, which would transport salts vertically and laterally into the river.

2.1.2 Effects on Central Arizona

The CRBSC Forum estimates that the combined efforts of the salinity control program have resulted in the control of up to 1,000,000 tons of salt per year or 100 mg/L TDS (Forum, 2005). The reduction of 100 mg/L TDS on the Colorado River results in lowering annual salinity related costs in Central Arizona by approximately $15 million. About 50 percent of the targeted salinity control projects had been completed by the year 2000. The plan of implementation calls for the control of the remaining amounts of targeted salt over the next two decades.

The Forum addresses salinity in the Colorado River Basin.

2.1.3 Challenges of Implementation

Full federal funding of the CRBSCP is difficult because of federal budget constraints.

2.2 Public Outreach

A two-step public outreach effort from the water industry is recommended to educate the public on salinity issues. One component could be a salinity awareness campaign, which can provide basic information on salinity and how it affects water resources. The second component could be a water softener efficiency campaign. The goal of these combined campaigns would be to provide water users with the information they need to understand salinity problems and why there may be increased costs in the future to provid good quality water.

2.2.1 Description of Salinity Awareness Campaign

A significant component of the public outreach program would be illustrating how water resources are used and reused in Arizona to highlight the point that increasing salinity can limit water resource availability. The targeted audience could be the residential and commercial sectors with information disseminated through public meetings, distribution of written materials, press releases, programs for schools, television and utility bill inserts.

The specific message has not been developed in CASS Phase II because the needs of each water provider are different. Developing a message will require water providers to work together and gain input from other water authorities (e.g.: Central Arizona Water Conservation District, Salt River Project and Arizona Department of Water Resources) to educate the public on this subject.

2.2.2 Water Softener Efficiency Campaign

Data extrapolated from the residential water softener survey, which was conducted as part of CASS, indicated that 25 percent of the salinity in effluent above the source water salinity comes from residential water softeners. A water softener efficiency program could help reduce this source of salinity in the effluent. The program could build upon the basic knowledge gained by the public from the salinity awareness campaign but be focused on how to use water softeners more efficiently to decrease the amount of salinity entering the sewer system.

Efficient water softeners can help reduce salinity contributions to sewer system.

Messages targeting the residential sector could be developed to help people identify whether or not they are using their water softeners correctly and to offer suggestions on improving their efficiencies. A significant recommendation could be to switch from a timer-based water softener to a more efficient demand-based water softener. Another option could be to switch from a timer-based water softener to a portable exchange unit.

Other components of this campaign could be offering rebates on more efficient water softeners and having water resources staff provide training on correct settings for water softeners. Examples of rebates and replacement programs are currently in place with water conservation programs and the water softener campaign could do something similar.

2.2.3 Effects on Central Arizona

Creating these programs would benefit the public's understanding of salinity, hard water, and use of water softeners. The desired effect of this public outreach program would be a decrease in the amount of salinity entering the sewers from residential sources.

2.2.4 Challenges of Implementation

An "unintended consequence" of educating the public on salinity issues may result in more people purchasing water softeners to help extend the life of their water-using appliances. In such a case, the increased number of water softeners could increase the amount of salt entering the sewer system and be counter productive to reducing salinity.

A challenge of implementing a water softener efficiency program would include developing measurable goals.   A great deal of effort would be required to develop this program. Emphasis would be on setting goals, getting the message out, and reducing the amount of salinity entering the sewer system.

2.3 Limiting Salinity Entering Sewers

Limiting the amount of salinity entering the sewer system is very important to maintaining the quality of reclaimed water. While residential inputs of salinity may be reduced through education and habit modification, salinity inputs from commercial and industrial processes, concentrated water from cooling towers, and concentrate from membrane treatment facilities may require other techniques to control salinity. Some of these techniques may be in the form of local limits, surcharges, and point source treatment.

2.3.1 Administrative Approaches

Local limits, surcharges and point source treatment are all established practices implemented in Arizona in the wastewater industry to limit difficult-to-treat pollutants or to provide funds for treatment of those pollutants. Similar methods could be used to reduce salinity inputs into the sewer.

2.3.1.1 Local Limits

Local limits are regulations which restrict the amount of pollutants which can be discharged from a source; 1) to prevent introduction of pollutants into the sanitary sewer system that might harm wastewater treatment facilities. 2) to protect the health of treatment plant staff and the public. 3) to allow continued beneficial reuse of treated effluent and biosolids. 4) to maintain compliance with National and/or Arizona Pollutant Discharge Elimination System (NPDES/AZPDES) permits.

Other local limit strategies include use of BMPs and prohibitions. An example of a BMP might be encouraging use of water softening methods that do not add salts to the sewer (portable exchange units), while a prohibition might be not allowing use of self-regenerating water softeners. Another example of a prohibition might be prohibiting discharge of RO concentrate to the sewer.

2.3.1.2 Surcharges

The process of developing surcharges to support sewer services is well established. Municipalities typically develop wastewater charges for flow, strength (measured by biological oxygen demand [BOD] and total suspended solids [TSS]), and other parameters, as needed to pay for the cost of wastewater treatment. Some parameters, such as strength are measured accurately at the WWTPs to determine the actual number of pounds of BOD and TSS being treated. A cost per pound is developed, typically on an annual basis by dividing the number of pounds sewer treated by the actual cost to treat the wastewater. Then the pollution load (pounds) is measured by sampling at Significant Industrial Users (SIU), and the SIU are billed by the pound.   In other cases, analysis is done for a class of users, such as commercial facilities, and those facilities are billed at a uniform rate that ensures cost recovery.

It is currently possible to measure the number of pounds of TDS entering each WWTP and to develop the actual cost of treating TDS. It will also be possible to develop costs for new treatment equipment, personnel, and disposal that may be required to manage TDS. It is essential to first understand the sources of TDS entering the system, both water and wastewater, and by accurate measurements or by developing models, to identify the load generated by various industrial, commercial, and residential user classes. Then it will be possible to fairly apportion the cost of treatment to the contributors, based upon their contributions.

Since the waters imported into central Arizona from the CAP and SRP are the principal TDS sources, all water users would bear some of the burden of treatment, just like they would to treat high turbidity, algae, or other water contaminants. However, it is possible to develop a surcharge system that identifies certain contributors that exceed a threshold, and those users could be charged appropriately. On the residential side, a strategy could be to identify homes with water softeners and to add a small monthly fee to treat the added load associated with the softener regeneration discharge.

2.3.1.3 Requiring Point Source Treatment

Point source treatment for salinity would eliminate the contribution from facilities which contribute large amounts of salts. Alternative disposal methods could be up by the originator of the salt load. Requiring large producers of salts not to discharge those salts into the sanitary sewer could bring the forces of the free market into discovering the best and most economical methods of managing salinity.

2.3.2 Effects on Central Arizona

The goals of limiting salinity inputs into the sewer are to prevent impacts to the treatment process and to maintain effluent as a reusable water source. At some locations, this will require reducing the amount of salinity entering the sewer system. At other locations this will require maintaining the current TDS concentrations.

Local limits and/or the use of point-source treatment for identified large TDS contributors could help achieve these goals by limiting the commercial and industrial sectors to a specified amount of salinity they could add to the sewer system. Surcharges may not reduce salinity inputs into the sewer system but may recapture the cost of desalination of effluent.

2.3.3 Challenges of Implementation

The biggest challenge to limiting salinity inputs into the sewer is the current lack of regulation on TDS. New regulations and standards would be opposed by the very ones they are meant to regulate because of the increased costs which would be borne by them. Surcharges would be politically opposed by the ones who would have to pay. The commercial and industrial sectors may suggest that the water providers are at fault because of the high salinity source waters that they are provided. Homeowners might also blame the water providers for providing hard water, therefore requiring the homeowner to purchase a water softener to protect his or her home investment.

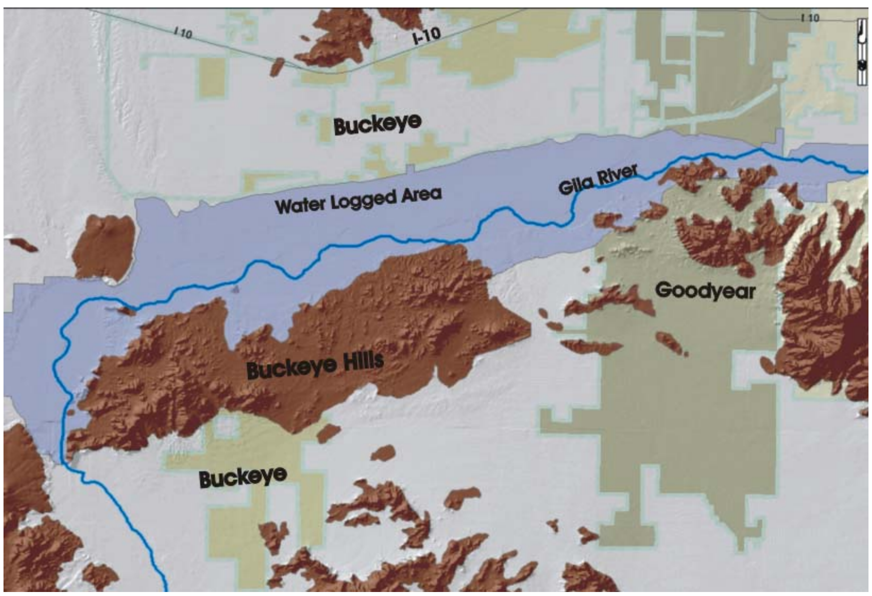
Further study may be required to evaluate whether it is preferable to prevent salinity from entering the sewer system or to allow salinity to enter the sewer system and then desalinate effluent for specific uses.

2.4 Desalination of Brackish Water

2.4.1 Description

Brackish water is defined as having a TDS ranging from 1,000 mg/L to about 25,000 mg/L. Although there is no primary federal MCL drinking water standard for TDS, generally, brackish water is not consumed by the public because the water is non-palatable or non-potable. There are numerous brackish groundwater aquifers located in central Arizona, a significant one is located the southwest Phoenix metropolitan area where TDS concentrations ranges from about 1,500 mg/L to 3,000 mg/L. Typically, this groundwater also has other contaminants, such as nitrates and arsenic, often in concentrations exceeding primary MCLs and Arizona Aquifer Water Quality Standards (AWQSs).

Advanced treatment methods, like RO, will remove the pollutants to a level below their respective MCL and decrease TDS to extremely low levels.



Brackish groundwater in the southwest Phoenix Metro area ranges in TDS concentrations between 1,500 – 3,000 mg/L.

2.4.2 Effects on Central Arizona

Desalination of brackish water creates a “new” potable water resource. Several Arizona communities have implemented advanced treatment of brackish groundwater to augment water supplies.

2.4.3 Challenges of Implementation

The largest challenge of implementing any advanced water treatment option comes with managing concentrate. Currently, the two most common options for disposing of concentrate in central Arizona are evaporation ponds and disposal to the sewer. Neither of these options works well for large concentrate volumes on a sustainable basis. No other good alternatives have been implemented.

A second challenge is the current RO technology. Recovery rate of RO is approximately 80 to 85 percent of water as permeate for a state of the art 3-stage RO system, while the remainder is lost as concentrate. Other systems may only get 60% to 70% recovery. Improvements in the technology leading to higher recovery rates are necessary if advanced treatment is to be used on a large-scale.

Another significant challenge is ADWR regulations concerning groundwater pumping. Water providers are limited by ADWR on the quantity of groundwater that can be pumped annually and in fact, water providers designated as having an Assured Water Supply are allotted a finite volume of groundwater that diminishes over time. Water providers are required to pay a pump fee on each acre-foot of groundwater pumped. Water providers using brackish groundwater are still subject to the ADWR water conservation plan pumping limits and fees although they lose a significant volume of water to concentrate and have much higher treatment costs.

And finally costs, costs are significantly higher for advanced water treatment then for standard water treatment processes. On the other hand, treating brackish groundwater is a “new” water resource that may be less expensive then other sources of “new” water.

2.5 Desalination of Effluent for Reuse and Recharge

2.5.1 Description

Reclaimed water is recognized as a source for both direct non-potable use and potentially, for indirect potable reuse via groundwater recharge. The most typical reclaimed water uses include agricultural irrigation, turf irrigation (parks and golf courses), and artificial groundwater recharge. The agricultural sector has accommodated high salinity water by growing salinity tolerant crops, such as cotton. Golf courses, especially the greens, do not do grow well with high TDS water. Over watering is often necessary to leach salts away from the root zone, wasting up to 20 percent of the available water. Leaching is a less viable option for the turf industry as it is for agricultural water users due to strict water use conservation requirements mandated by ADWR.

Artificial groundwater recharge is a common practice used for excess effluent to store water for future reuse. Effluent recharge requires a recharge permit from ADWR and an Aquifer Protection Permit (APP) from the Arizona Department of Environmental Quality (ADEQ). Soil aquifer treatment, while quite effective in improving water quality for a number of parameters, does not reduce TDS. Over time, effluent recharge can increase the salinity of native groundwater. If salinity concentration in effluent is significantly greater than native groundwater, the storage/recharge project may not meet anti-degradation standards of the ADEQ APP program and may not be permitted.

2.5.2 Effects on Central Arizona

The ability to reuse effluent allows for a more efficient use of potable water resources. As the applications for reclaimed water expand and replace some potable water uses, the corresponding quantity of potable water can be reallocated for other uses. Desalination of effluent at some locations may be necessary for effluent to remain an acceptable water resource for some uses. In addition, desalination of effluent may be a necessary treatment step in the indirect potable reuse of effluent; this could serve to augment potable water supplies in some communities.

Desalination of effluent for reuse and recharge can benefit the aquifer by reducing the amount of salts that end up in the groundwater. One important point to make, is that once the salt has been removed from the water it should be disposed in an environmentally sound manner to prevent the salts from returning to the water cycle.

2.5.3 Challenges of Implementation

Desalinization of water is energy intensive and expensive. So only for the most important uses would desalination of effluent be undertaken.

One of the greatest challenges in the desalination of effluent is the management of the concentrate. One inexpensive idea would be to desalinate a portion of the effluent for high end uses and then blend the concentrate back into the rest of the effluent which is then used for purposes which do not require low TDS water.

Effluent desalination from wastewater treatment plants may need to be implemented for some intended reuse options.

As costs for desalination decrease, desalinating effluent for certain purposes will become more attractive.

2.6 Improving Concentrate Management Technologies

2.6.1 Description

Concentrate management is a significant portion to the cost of desalination especially if none of the less expensive alternatives are available. Small facilities may still be able to dispose of concentrate in the sewer and small facilities in rural locations may still be able to use evaporation ponds, both these options are inexpensive and easy to implement. But large inland desalinization facilities do not have those options. In central Arizona deep well injection has just about been ruled out due to the wrong geological conditions. Many different options were examined by the Concentrate Management Subcommittee and no one options was found that could be recommended.

The two major factors in preventing a good solution for central Arizona are energy costs and land costs. Most technologies need either large amounts of land or lots of energy for them to be effective.

2.6.2 Effects on Central Arizona

The primary effect is that large scale desalinization plants will not be built in central Arizona with out an economical and environmentally sound method of disposing of the concentrate.

2.6.3 Challenges of Implementation

There is not a solution on the horizon. A regional solution put forward by Reclamation in the late 1990's was rejected. It was the Central Arizona Salinity Interceptor (CASI) which was a pipeline to carry the concentrate from Tucson and Phoenix to Yuma and then either to the Sea of Cortez or the Sultan Sea. The costs and the loss of water were unacceptable to the water community in Arizona at that time.

Reclamation is leading a concentrate management follow up study with the CASS group. And many other people and organizations are working on this problem. Solutions may come in incremental steps with improvements in technologies, which could include improving desalting technologies to lessen the amount of concentrate produced.

2.7 Improving Desalination Technologies

2.7.1 Description

Arizona has numerous desalinization plants in operation, including the large Yuma desalter and the Water Campus in Scottsdale. Smaller drinking water facilities are located in Goodyear, Gila Bend and the state prison located south of Buckeye. In addition, many commercial and industrial desalters are used for high tech manufacturing, for bottled water companies and other uses.

Improved technology needs to be implemented

One of the significant problems for large-scale desalination is the loss of water resources in the concentrate. Current desalination methods recover roughly 60 to 85 percent of water as permeate, but should be improved to 90 to 95 percent recovery rates to preserve water resources and limit the volume of concentrate that needs to be managed. Another advantage is that the more efficient the desalinization process the less energy that will be required to produce a given amount of water.

2.7.2 Effects on Central Arizona

Central Arizona has limited water resources, it is imperative that the efficiency of desalinization be improved to conserve those resources and secondly to reduce the amount of concentrate that must be managed.

2.7.3 Challenges of Implementation

Research is slow, expensive and there is no guarantee that anything of use will come out of a particular line of study.

Reclamation's Water Quality Improvement Center located in Yuma is a national laboratory working on desalinization research. Currently they are developing chlorine resistant membranes, better anti-scalents and different pretreatment processes. This center will partner with any community or company willing to cost share the work. The Metropolitan Water Department (MWD) from California is one of the entities which is working with the WQIC on research, primarily more efficient membranes.

In addition private companies and consultants are pushing forward exotic desalinization technologies. And Arizona's universities are also dabbling in desalinization.

Many communities are too involved in "day to day" operations to put much commitment or money into long term research, which may or may not pay off.

3.0 Future Actions for Central Arizona

Managing salinity is required for the long term sustainability of central Arizona. Over a million tons of salts are accumulating in the Phoenix Metropolitan area and salts are also accumulating, although at a less rapid rate, in the Tucson area, Pinal County and other places in central Arizona. Some groundwater has TDS concentrations which make it none potable. Effluent being produced in some of the WWTP's in central Arizona is also high in TDS and in some places not suitable for the intended use. As the population grows, there will be increasing pressure to use these impaired waters. More communities are turning to Reverse Osmosis or other advanced water treatment systems. The concentrate must be disposed of in a economical and environmentally sound manner. The salts must be removed from the water cycle. It is counter productive to desalt water and then put the salts back into the sewer to eventually end up in the groundwater again. Improvements in both desalination and concentrate management technologies are required for large-scale use of desalination and to allow full utilization of the impaired water resources in Arizona.

Although, the mandate of CASS is complete with the finalization of the Phase II report, there are some things that the CASS community will continue to work on. Public education on salinity issues is a key area. To meet that need, CASS has formed a Public Education Sub-committee which is exploring ways to get the salinity message out to the public. Another area in which the CASS team is moving forward is on concentrate management. Reclamation has sought and received additional funding for work in this area and is seeking to partner once again with SROG find some solutions to this difficult problem. Another area that CASS will continue to explore is salinity control in WWTP's. This would include looking at what legislation may be necessary to keep the effluent "good" at our WWTP's. Finally, research, pilot projects and/or demonstration projects such as the DewVaporation project are a tantalizing area of potential solutions.

But CASS is not the only game in town. The salinity issues are so great that individual cities and engineering/environmental companies are pursuing solutions. The Multi-state Salinity Coalition is another organizations which is seeking answers. Their main focus has been seeking Federal funding and bringing the interstate salinity communities together via the annual Salinity Summit.

The Universities are also involved salinity research. The University of Arizona has partnered with communities north of Tucson to investigate slow sand filtration as a pretreatment to RO and using helophytes to manage concentrate. Northern Arizona University is investigating wind power and its use in desalinating water. Arizona State University has been involved with several different avenues of salinity research including DewVaporation and solar ponds.

Arizona is working towards solving its salinity issues.

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