# WATER PLAN: 2000-2050

**CITY OF TUCSON WATER DEPARTMENT**

**FINAL**

**MAYOR AND COUNCIL**

**NOVEMBER 22, 2004**

# *WATER PLAN: 2000-2050*

# ACKNOWLEDGEMENTS

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*Water Plan: 2000-2050* was developed in cooperation with members of the **City of Tucson Citizens' Water Advisory Committee** (CWAC) and its Planning and Policy Subcommittee. CWAC members graciously volunteer their time and energies to help make Tucson Water a better municipal Utility. Past and present Subcommittee members who worked most closely with Tucson Water's resource planners include **Francis Boyle**, **Sarah Evans**, **Keith Gentzler**, **Stephen Popelka**, **David Smutzer**, **David Turner**, and **Ron Wong**.

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There are many unnamed others who also contributed to this effort. Those who have had to grapple with the intricacies of water-resource planning can appreciate how much indebtedness is owed to so many. Thanks go to all of you…you know who you are.

EXECUTIVE SUMMARY
*WATER PLAN: 2000-2050*

## INTRODUCTION

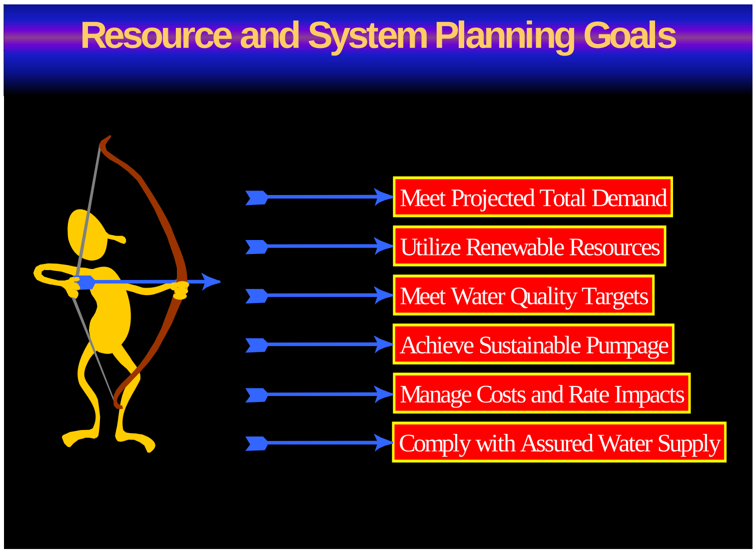
*Water Plan: 2000-2050* was developed to initiate a dialogue between Tucson Water and the community about the water-resource challenges that must be addressed in the coming years. To meet future demand for water, Tucson Water's currently available supplies must be fully utilized and additional more expensive supplies must be acquired and developed. Various opportunities and constraints that will impact the Utility's ability to provide adequate supply are discussed. *Water Plan: 2000-2050* identifies several critical decisions that must be made by the community and decision makers at key points in time. This will ensure the timely implementation of desired projects and programs to guarantee long-term sustainability of water resources for the Tucson Water service area.

This document provides information to Tucson Water customers and other stakeholders concerning the Utility's resource and system plans through 2050. This report is a comprehensive revision of *Tucson Water Resources Plan 1990-2100.* The water resources considered within this assessment are the same as those identified in the original plan and consist of ground water, effluent, and imported renewable water supplies delivered through the Central Arizona Project. However, regulatory changes and agreements with other local water providers have taken place over the last fifteen years that influence Tucson Water's ability to use these water supplies. These changes and agreements have been included within the assessment and are reflected in the available water supplies and service commitments of the Utility. To ensure that *Water Plan: 2000-2050* can accommodate similar changes in the future, a scenario planning approach was utilized to develop a highly-flexible, long range water-resources plan.

The plan will be reassessed and revised as assumptions and circumstances change over time. The recommendations presented will allow the Utility to achieve all of the following planning goals while retaining maximum flexibility. While the plan lays out pathways to maximizing renewable supplies currently owned or controlled by the City, it also emphasizes the need to acquire additional supplies and to develop a more aggressive demand management program in order to sustain growth through 2050 and beyond.

## THE PLANNING GOALS

*Water Plan: 2000-2050* was developed with the following resource management goals:




- **Meet Projected Total Demand**. The Utility's water demand has grown significantly over the years. Current population projections indicate that demand will continue to increase in the foreseeable future.

- **Utilize Renewable Resources**. In order for the community to be sustainable into the future, Tucson Water needs to shift from a historical reliance on "mined" ground water to renewable water supplies. Colorado River water delivered via the Central Arizona Project and treated municipal wastewater effluent are two currently available renewable supplies that must be utilized to the maximum extent possible. It is also a priority to acquire additional renewable supplies as soon as possible.

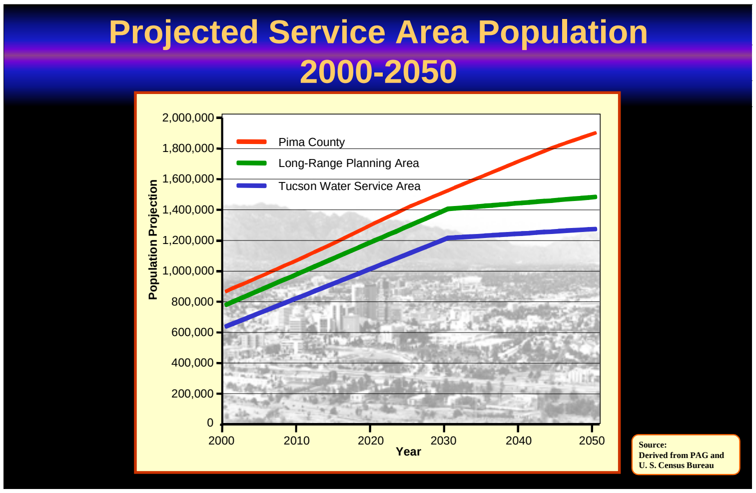
- **Meet Water-Quality Targets**. In addition to complying with federal, state, and local regulations, Tucson Water must also be responsive to the water-quality expectations and preferences of its customers.

- **Achieve Sustainable Pumpage**. There is a quantifiable volume of ground water that is naturally replenished each year. Pumping ground water at or below this annual rate would be hydrologically sustainable and would not cause additional water-level declines and associated subsidence. Sustainable pumping must be consistent with state regulations that govern the legal authority to withdraw ground water.

- **Manage Costs and Rate Impacts**. Projects and programs must be cost effective to ensure that water remains affordable.

- **Comply with Assured Water Supply Program.** The Assured Water Supply (AWS) Program is the regulatory paradigm administered by the Arizona Department of Water Resources (ADWR) for water-resource management in the municipal water-use sector. The AWS Program limits the amount of ground water that the City of Tucson can legally withdraw.

## PROJECTED WATER DEMAND

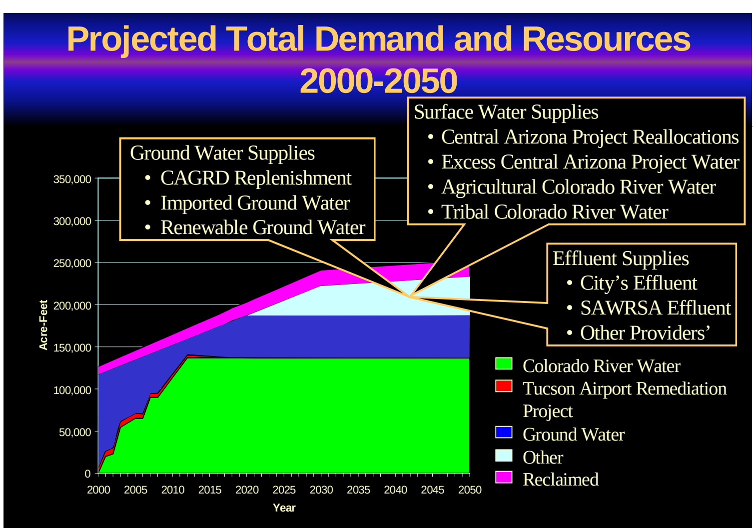



The population in the Tucson area has increased over time creating a growing need for water. Projections of future water demand were developed to ensure that the Utility can plan for sufficient water supplies to meet the needs of the community and the resource challenges that lie ahead.

In order to maintain consistency with other regional planning entities, Tucson Water used the most current population counts and projections available. Population projections were developed from information provided by the U.S. Census Bureau, the Arizona Department of Economic Security, and the Pima Association of Governments (PAG).

To derive a projected total water demand for Tucson Water's service area through 2050, the average amount of per capita water use was determined. Such water usage is commonly measured in gallons per capita per day (GPCD). The total GPCD for Tucson Water's current customer base is 177 GPCD and includes water used to supply both potable and non-potable demands. By applying the total GPCD to projected populations, Tucson Water estimates that annual total demand will grow from 128,521 acre-feet in 2000 to 253,000 acre-feet in 2050. A slower increase in water demand from 2030 to 2050 reflects a shift in population growth to areas outside of Tucson Water's projected service area. Reclaimed water is projected to meet at least eight percent of total water demand; the remaining balance is potable demand.

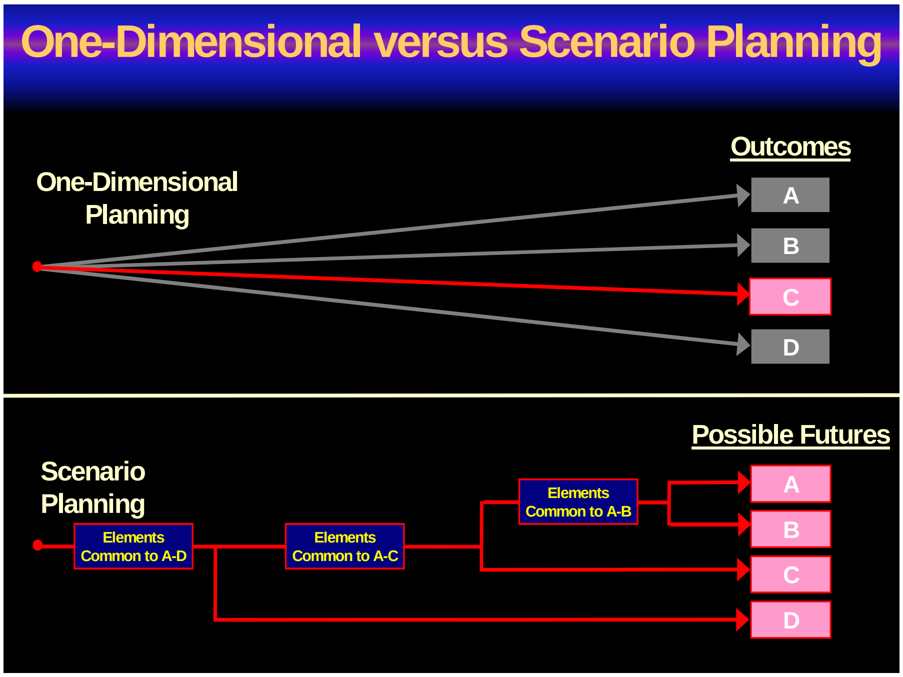
## AVAILABLE WATER RESOURCES




Prior to the early 1990s, the Tucson community relied almost exclusively on ground water to meet water demand. Despite implementation of demand management programs and the strong environmental ethic of Tucson residents, ground-water withdrawals in the metropolitan area continued to increase due to population growth. Rapidly declining water levels have resulted in measurable land subsidence, increased pumping costs, and the gradual loss of natural habitat along local riparian corridors.

The need to develop renewable water supplies to meet projected long-term water demand has long been recognized. *Tucson Water Resources Plan 1990-2100* concluded that Colorado River water and municipal effluent would need to be increasingly utilized to satisfy future demand. To achieve long-term sustainability and comply with regulations, the use of available water sources must be prioritized so that use of renewable supplies is maximized and the availability of ground water is extended.

## THE PLANNING PROCESS




In determining how best to use available water resources to meet projected demands, a scenario planning process was used to develop *Water Plan: 2000-2050*. In order to avoid the potential pitfalls of a one-dimensional planning approach, scenario planning provides a multi-dimensional perspective that considers many possible futures as equally likely, thus allowing greater planning flexibility.

The process involves building pathways to each possible future; however, the objective is to identify the common elements that lie on these different pathways. These elements are the programs and projects that are common to each of the identified futures. By following the path of common elements, capital investments are directed toward projects that apply to multiple futures providing confidence that the decisions made today will remain viable.

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## PATHS TO THE FUTURE

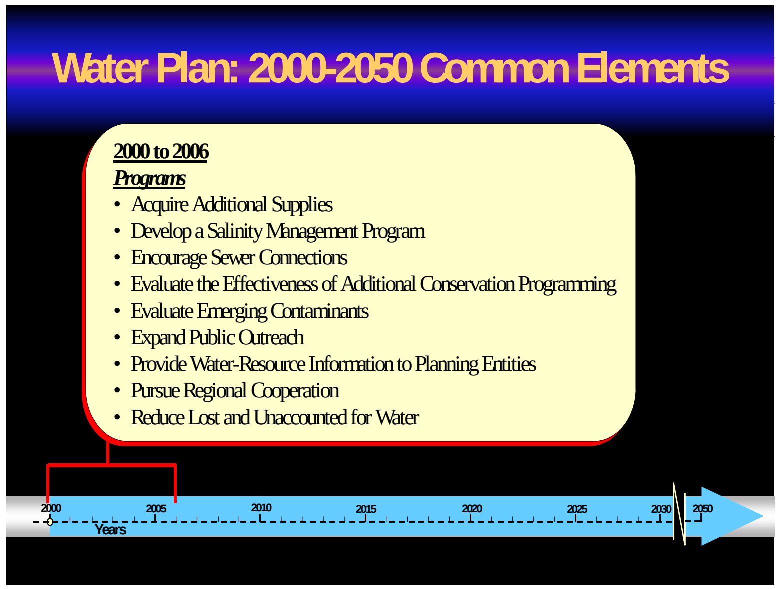
The Plan consists of a series of key decision points and sets of common elements that would be implemented in response to each decision. There are a number of elements common to all of the pathways that lead to each of the futures. Implementing these common elements will maintain flexibility as subsequent decision points are approached and as conditions change in the future. The Recommended Plan will be implemented by following the route of common elements.

## Common Elements

Programs: 2000-2006

The following programs either have already been or will be implemented during the period 2000 to 2006 and will be continued as required throughout the 50-year planning period.

- **Acquire Additional Supplies**. Additional potential sources of supply will be pursued under all scenarios. This can include obtaining additional Colorado River water, effluent, ground water, and any other water resources that may become available over time. Acquiring additional supplies will be a priority throughout the 50-year planning period.




- **Develop a Salinity Management Program**. An increase in the mineral content of the Utility's blended potable water supply will gradually occur over time as Colorado River water and effluent are utilized. Tucson Water will pursue a program to manage potential increases in salinity in watersheds located within its projected service area. The Utility will continue to participate in research on potential salinity impacts, and methods of treatment, reclamation, and/or disposal of the brine waste stream generated during treatment.

- **Encourage Sewer Connections**. To provide a greater volume of municipal wastewater effluent for potential reuse, changes in ordinance and/or code should be considered to encourage sewer connections to reduce the number of septic tank systems installed within Tucson Water's projected service area.

- **Evaluate the Effectiveness of Additional Conservation Programming**. A more aggressive conservation program designed to reduce overall per capita usage will be evaluated. This program will address all sectors of potable water use including residential, commercial, and industrial customers.

- **Evaluate Emerging Contaminants**. Addressing the presence of emerging contaminants in current and future water supplies must be further researched. This research will be increasingly important as the availability of water-resources becomes more constrained over time.

- **Expand Public Outreach**. Tucson Water's outreach program will be expanded to provide information and to obtain input from the public on a range of water-resource issues.

- **Provide Water-Resource Information to Planning Entities**. Tucson Water will provide information regarding water-resource availability to governmental entities that plan for the future of the community. These efforts will allow those entities to take into account the Utility's ability to provide water service within the context of their planning decisions.

- **Pursue Regional Cooperation**. Tucson Water will seek additional opportunities to work cooperatively with other water providers. These efforts may include acquiring additional sources of supply, implementing an integrated regional salinity control program, and making arrangements to distribute renewable resources within the region.

- **Reduce Lost and Unaccounted for Water**. Tucson Water will strengthen its efforts to reduce its percentage of lost and unaccounted for water.

Projects: 2000-2006

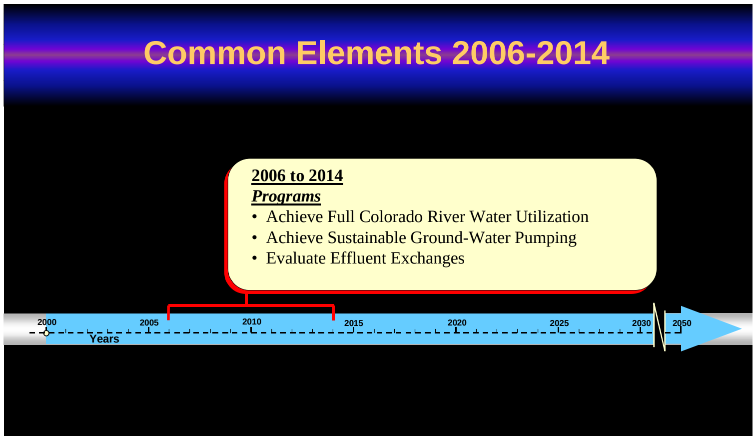
Most of the projects already initiated during this period have been implemented under the Clearwater Program. The program was developed in the late 1990s to utilize Colorado River water by blending with ground water through recharge and recovery facilities. The first major facility developed under this program was the Central Avra Valley Storage and Recovery Project (CAVSARP). A second storage and recovery facility, the Southern Avra Valley Storage and Recovery Project (SAVSARP), is currently under design. Between them, Tucson Water will be able to fully utilize the City of Tucson's current annual Central Arizona Project entitlement and provide capacity for recharging additional water supplies.

Programs: 2006-2014

In addition to the programs initiated by 2006, a second set of programs should be initiated between 2006 and 2014. These programs include the following:

- **Achieve Full Colorado River Water Utilization**. Regardless of what final projects are selected, Tucson Water will achieve full utilization of its current Central Arizona Project allocation by 2012.

- **Achieve Sustainable Ground-Water Pumping**. As the City of Tucson brings its Central Arizona Project allocation into full utilization, its reliance on ground water will decrease. The Utility will seek to reduce its ground-water pumping to a hydrologically sustainable rate within the near-term.




- **Evaluate Effluent Exchanges**. Tucson Water will pursue opportunities to market unused effluent supplies for lease or exchange with other water users within the Tucson AMA.

Projects: 2006-2014

The Avra Valley Transmission Main Augmentation project in conjunction with the Spencer Interconnect Pipeline project will be implemented during this period to provide additional system capacity to convey renewable water supplies from Avra Valley to the Tucson basin. The added capacity will also provide increased redundancy to ensure potable system reliability. In addition, the capabilities of the reclaimed water system will also be expanded in order to meet future reclaimed demand.

## Critical Decisions

Decision Point: 2006

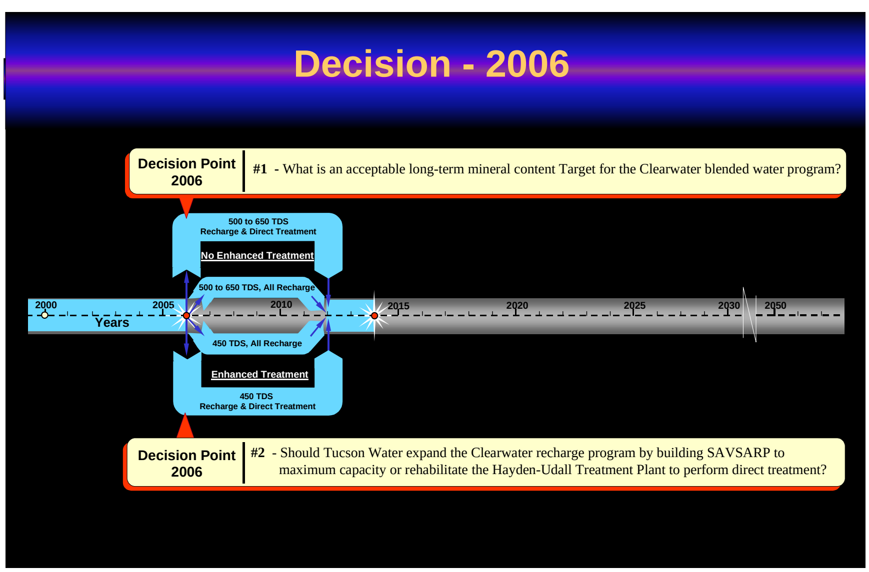
In 2006, two critical resource management decisions must be made regarding the use of Colorado River water:

Decision #1 - What is an acceptable long-term mineral content target for the Clearwater blended water program?

Decision #2 - Should Tucson Water expand the Clearwater recharge program by building SAVSARP to maximum capacity or rehabilitate the Hayden-Udall Treatment Plant to perform direct treatment?

Decisions #1 and #2 must be made by 2006. The choices will determine which decision-dependent elements will be subsequently implemented. In addition, these decisions will significantly impact the overall cost of providing water service. The new elements associated with each critical decision are described below.

Decision #1 will determine the level of Total Dissolved Solids (TDS) in the Clearwater blend. The water recovered from the CAVSARP Well Field will maintain a mineral content at or below the currently targeted TDS concentration of 450 mg/L through approximately 2009. Tucson Water has access to sufficient ground water in Avra Valley to blend with the water recovered from CAVSARP to maintain this TDS target for many years. However, as additional Colorado River water is utilized over time either through direct treatment or expansion of the recharge program (Decision #2), the ability to maintain this TDS target through ground-water blending cannot be sustained and enhanced treatment will eventually be required. TDS

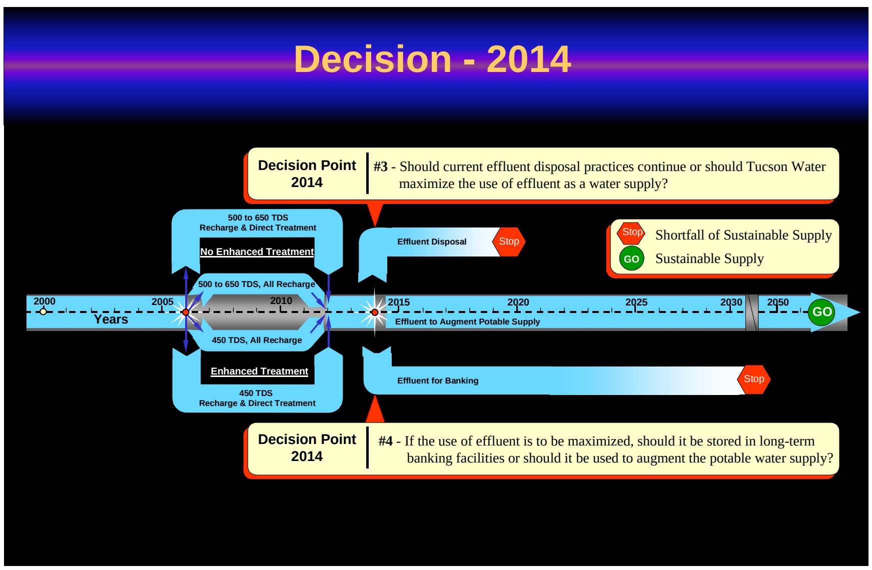


levels are not regulated as a public health issue; rather, TDS concentration can affect the aesthetic quality of the water such as hardness, taste, and mineral deposits. The higher mineral content of Colorado River water was not the cause of the pipeline problems experienced with direct delivery in the early 1990s.

The choice under Decision #2 is to either expand SAVSARP to maximum capacity or to rehabilitate the Hayden-Udall Treatment Plant for direct treatment of Colorado River water. Either option would allow for TDS management to be conducted pursuant to the choice made under Decision #1. By 2012, Tucson Water plans to achieve full utilization of its current Central Arizona Project allocation. This is the first critical step toward attaining water-resource sustainability for the community.

Decision Point:  2014

Additional critical decisions must be made by 2014 concerning the long-term utilization of effluent. If other water supplies are acquired and/or if per capita water demand is significantly reduced, the timeframe in which to maximize effluent use may be delayed. Nonetheless, effluent will continue to be used to meet reclaimed water (non-potable) demands which are estimated to be at least eight percent of projected total demand. This leaves a large volume of effluent potentially available to augment the potable supply. Two critical decisions must be made regarding the future use of effluent:




Decision #3 – Should current effluent disposal practices continue or should Tucson Water maximize the use of effluent as a water supply?

Decision #4 - If the use of effluent is to be maximized, should it be stored in long-term banking facilities or should it be used to augment the potable water supply?

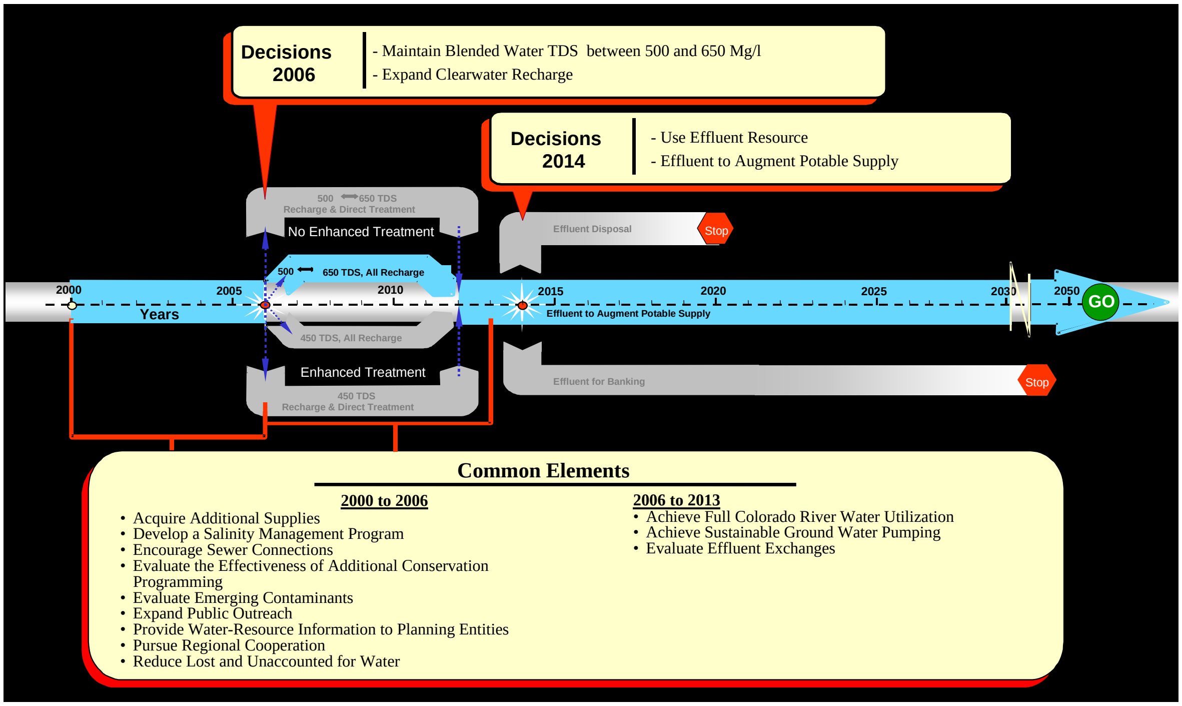
Decision #3 presents the opportunity to provide water supply for the growing community. Tucson Water currently has only a limited amount of available ground water and Colorado River water to meet future potable demand. Without the expanded use of effluent, the successful acquisition of additional water resources, and/or the initiation of a more aggressive demand management program to reduce per capita water use, the Utility will not be able to meet future water demand and could have a shortfall sustainable in supply before 2020. Decision #3 should be made by 2014 to allow sufficient time to maximize the use of effluent by 2020.

If the decision is to maximize effluent usage, then Decision #4 addresses whether to bank effluent in long-term recharge facilities or augment potable supply through the subsequent recovery of recharged effluent. The decision to bank effluent provides the opportunity to preserve the wet water (recharged effluent) for use beyond 2050. This decision would also allow for the accrued paper-water effluent credits to be pumped from the aquifer in areas other than where the water was physically recharged. Even though paper-water credits can be legally recovered this way, it would eventually result in a resumption of ground-water mining. By 2040, this would more than double the hydrologically sustainable rate of pumping from some areas of the aquifer and would cause additional water-level declines and subsidence. The choice to reuse effluent for indirect potable supply provides Tucson Water with the highest potential to meet projected demand through 2050 and offers the greatest opportunity for long-term sustainability. Decision #4 should also be made by 2014.

As Decisions #3 and #4 are made, the Utility will further develop additional options to increase effluent reuse while seeking to acquire additional water supplies. The construction of effluent transmission pipelines would depend on the eventual end use of this water resource. Effluent may be taken to new or existing facilities in Avra Valley and/or to the Tucson basin for recharge. Such facilities could be used for long-term storage and/or to augment potable supply. Regardless of the effluent reuse options selected, some level of additional treatment will be required.

## TUCSON WATER'S RECOMMENDED PLAN

The Recommended Plan consists of sets of common elements that are determined by decisions made at specified points in time. The choices made at each critical decision point will determine the range of possible futures from that point in time. Implementing the Recommended Plan means following the route of common elements with the key decision points providing choices and direction along the way. As the planning environment changes over time, the scenario planning



process is revisited to establish a new baseline of data and assumptions that will again be used to reassess and develop a new range of possible futures.

In order to initiate a dialogue with customers and to facilitate discussion, Tucson Water offers ten recommendations, many of which address the critical decision points identified. Tucson Water believes that implementing these recommendations will allow the Utility to achieve all of the specified planning goals while retaining maximum flexibility. The conclusions and recommendations summarized below are based on Tucson Water's best professional judgment regarding the most effective ways to meet the projected potable and non-potable needs of the community. These recommendations form the basis for a public discussion on *Water Plan: 2000-2050*. The City of Tucson's Mayor and Council, in concert with Tucson Water's customers, will make the critical decisions that provide direction to Tucson Water for plan implementation.

## 1. Emphasize Physical Water Management Strategies

**Conclusion:** The best approach to maintain a sustainable future for the community is to ensure the physical availability of renewable water supplies. The community's sustainable future ultimately depends on maintaining a physical link between renewable water sources and the infrastructure needed to convey those waters to customers within the projected service area. A paper-water management approach that is not hydrologically constrained can not be sustained in the long term.

**Recommendation:** The programs and projects called out in the Recommended Plan emphasize the physical availability of water supplies. These elements should be implemented in as timely a manner as possible to ensure that renewable water supplies will be available to Tucson Water's customers in the long term.

## 2. Utilize Renewable Ground Water

**Conclusion:** From a hydrologic perspective, a limited but quantifiable amount of ground water is naturally recharged each year from precipitation and surface-water runoff. Ground-water withdrawals that do not exceed these replenishment processes should be considered hydrologically sustainable ground-water pumping. Tucson Water plans to limit its ground water withdrawals to this sustainable level in order to ensure the long-term viability of the aquifer and protect remaining riparian zones within the Utility's service area. This concept was identified as a long-term source of water supply in *Tucson Water Resource Plan 1990-2100*. Under the State's AWS Program, all ground-water pumping is counted against the City's ground-water storage accounts. Currently, no legal mechanism is in place to obtain paper-water credits for natural aquifer recharge.

**Recommendation:** The amount of natural recharge that annually occurs represents a hydrologically renewable ground-water supply that is not legally available. Tucson Water recommends that regulatory recognition of renewable ground water be incorporated into the AWS Program. This supply could then be available as an annual renewable water resource that would not be debited against any long-term storage account. This would require changes in the AWS rules and/or a change in legislation.

## 3. Reassess the Water-Quality Target for Colorado River Water

**Conclusion:** Colorado River water currently has an average TDS concentration of 650 mg/L. In contrast, the TDS concentration of ground water provided by Tucson Water averages 280 mg/L. Based on the results of studies and public input associated with the *At the Tap Program*, Tucson Water's customers have accepted a blend of ground water and Colorado River water with a TDS concentration of about 450 mg/L. The choice of 450 mg/L was based on a taste test that was used to establish an aesthetic preference for the blended water. There was no comparative cost analysis done as a consideration for maintaining this preference in the future. All of the planning pathways have the ability to include projects to achieve a TDS concentration of 450 mg/L in the Clearwater blend. However, maintaining this TDS concentration would eventually require some form of enhanced treatment which would be expensive to build and operate. Customers must be offered the opportunity to make an informed choice by considering both aesthetic water-quality preferences and the added incremental cost they would have to pay to maintain that level of mineral content.

**Recommendation:** With regard to Decision #1, Tucson Water recommends that the TDS water-quality target under the Clearwater Program be allowed to increase gradually until it reaches a balance. The ultimate TDS level would be less than 650 mg/L. It is anticipated that this would occur sometime between 2015 and 2030. This recommendation would be the most cost-effective way to provide this renewable resource to the community. It eliminates the need to build an enhanced treatment plant to control TDS concentration as part of the Clearwater Program. In addition, it would preserve more of the available Colorado River water supply by avoiding the estimated 15 percent loss in water volume associated with enhanced treatment and costs associated with brine management and disposal. Should the community decide to maintain the 450 mg/L water quality target, *Water Plan: 2000-2050* can also accommodate that choice. No matter what decision is made in the near term, the overall salinity balance of Tucson Water's potable supplies under any scenario will nonetheless require management at some point in the future.

## 4. Fully Utilize Colorado River Water

**Conclusion:** In 1999, the community initiated the move toward full utilization of Colorado River water by accepting a blended water supply under the Clearwater Program. The Clearwater Program could provide the City of Tucson the physical ability to recharge its entire annual Central Arizona Project allocation by 2010 and deliver that amount by approximately 2012. Currently, the CAVSARP project is operational and provides the capacity to use 60,000 acre-feet per year of Colorado River water. This project is being re-permitted to recharge up to 80,000 acre-feet per year. The SAVSARP Phase I project will be constructed to take delivery of approximately 45,000 acre-feet of Colorado River water per year by about 2007. In order to achieve full utilization of the City of Tucson's Central Arizona Project allocation, Tucson Water can either rehabilitate the Hayden-Udall Water Treatment Plant for direct delivery or build SAVSARP Phase II for recharge and recovery.

**Recommendation:** Tucson Water recommends that an annual recharge capacity of at least 45,000 acre-feet be operational at SAVSARP Phase I by 2007. Implementing SAVSARP Phase

I is identified as a common element because it provides needed drought resistance and expanded long-term storage capacity. With regard to Decision #2, Tucson Water recommends that by 2006, a design be initiated for SAVSARP Phase II to bring the project to an annual recharge and recovery capability of 80,000 to 100,000 acre-feet by 2012. With CAVSARP and SAVSARP, Tucson Water would have excess recharge capacity. This would allow the Arizona Water Banking Authority to store large volumes of surplus Colorado River water at these facilities for use when the Colorado River water supply is interrupted. Banking Colorado River water at these facilities ensures that the Utility will have wet-water supply reliability where Tucson Water has recovery capabilities.

5. **Fully Utilize Effluent for Future Supply**

**Conclusion:** Tucson Water currently uses reclaimed effluent to meet non-potable water demand. Reclaimed water use accounts for approximately eight percent of total water demand. The remaining two thirds of the effluent that is currently owned and controlled by the City of Tucson is discharged into the Santa Cruz River and passively accrues water credits at a rate of 50 percent of the total volume recharged in managed underground storage facilities. If this method of effluent use continues, this renewable water resource cannot be efficiently used to maximize long-term banking or to augment the ground-water system for eventual potable reuse. Tucson Water is projected to have a shortfall in potable water supply by 2020 unless one or more of the following initiatives are successfully implemented: acquisition of additional water supplies, a more aggressive demand management program, full utilization of effluent, and/or the resumption of ground-water mining. However, the latter would cause additional declines in water levels, increase the potential for additional subsidence, and accelerate the rate at which the Utility's allowable ground-water credits would be debited.

**Recommendation:** With regard to Decision #3, Tucson Water recommends that by 2014 a commitment should be made to no longer discharge the City's effluent that is not used in the reclaimed system to the Santa Cruz River. Instead, the resource-management goal would be to maximize the future use of effluent through recharge.

6. **Utilize Effluent as a Wet-Water Resource**

**Conclusion:** Recharging effluent in an area that is not hydrologically connected to where pumping occurs would provide the legal right for additional ground-water withdrawals in Tucson Water's existing well fields. However, continued pumping of ground water at rates that exceed hydrologic sustainability will eventually result in a resumption of ground-water level declines and an increase in the potential for additional land subsidence in the Tucson area. The only viable long-term approach is to physically recover the effluent where it is recharged.

**Recommendation:** With regard to Decision #4, Tucson Water recommends that effluent be used to support the reclaimed water system, for banking, and/or for eventual indirect potable use. Unless additional water supplies are acquired in the near term, an enhanced treatment plant and an effluent pipeline to convey the highly-treated effluent to Tucson Water recharge facilities should be constructed and operational by 2017. The effluent would be treated to remove a wide range of constituents and would allow for managing the mineral content of the water before it is recharged and blended with other source waters for eventual potable use. Decision #4 must be preceded by an intensive outreach effort to inform the public of the water-resource challenge that will soon be facing the community and hence the need to indirectly reuse effluent for potable supply to ensure long-term sustainability. Review of demand projections indicates that without the acquisition of additional supply, the indirect reuse of effluent for potable use may need to be initiated by 2025 to avoid a supply shortfall within Tucson Water's service area before 2040.

### 7. Acquire Additional Water Supplies

**Conclusion:** Other metropolitan areas in Arizona have recently been active in acquiring additional long-term water supplies. As a result, the City of Tucson needs to implement an aggressive program to pursue potentially available supplies even though it has a substantial Central Arizona Project allocation and ground-water portfolio. Water resources will become increasingly limited both locally and statewide. Municipal water providers as well as other water users will be competing to acquire additional water resources. The limited availability of potential sources of supply could make the acquisition of additional resources both expensive and uncertain. Potential supply sources might include additional Central Arizona Project allocations, leased or purchased Colorado River water, local and imported sources of ground water, and locally available effluent.

**Recommendation:** Tucson Water recommends that an aggressive program of identifying and pursuing the acquisition of additional water sources be undertaken in the near term. This program needs to be continued throughout the 50-year planning period.

### 8. Manage Water Demand

**Conclusion:** Tucson Water is currently pursuing a number of avenues to manage demand including conservation programming, reducing lost and unaccounted for water, encouraging the practice of water harvesting, and providing public information programs. Additional demand management efforts should be evaluated to further reduce per capita water use. An extended period of monitoring and evaluation of these programs will be needed to demonstrate actual water savings.

**Recommendation:** Tucson Water should strengthen its efforts to reduce the annual volume of lost and unaccounted for water in its potable systems. The Utility will also continue an ongoing historical review of the conservation program to assess its effectiveness in reducing potable and total per capita water usage rates. In addition, an assessment will be conducted to evaluate the potential to further reduce potable and total per capita water usage rates by implementing more aggressive conservation programs.

9. **Implement a Water-Resource Impact Fee**

   **Conclusion:** The cost of growth is to be paid through a combination of impact fees and rate increases. The cost to expand the system and develop additional water supplies to meet future growth should continue to be shifted from existing to future customers as they become part of the system.

   **Recommendation:** Tucson Water will develop a financial plan that continues to shift the cost burden of growth to new customers as they are added to the system. The Utility has implemented a system equity fee as an important step in this continuing process. This fee requires new customers to pay for the existing excess system capacity that exists today; this is the financial vehicle used to recover the costs already expended to provide the capacity needed to meet the water demands they bring as new customers. As a result, the system equity fee is referred to as a backward-looking fee. As Tucson Water looks to the future, a forward-looking impact fee should be developed to cover the development of additional water resources and system expansions required to meet future growth.

10. **Expand Regional Cooperation**

    **Conclusion:** Other metropolitan areas in Arizona have recently been active in acquiring additional long-term water supplies. Many of Tucson Water's current uncertainties and challenges are similar to those of other water providers in the region. A mix of short-term actions and long-term planning will be needed to address current issues as well as new ones that will arise over time. Such issues can be most effectively addressed if cooperation can be achieved among local water providers in eastern Pima County. If a cooperative structure can be established in the near term, Tucson Water would coordinate its efforts with the other members to work collectively in acquiring additional sources of supply, implementing an integrated regional salinity control program, and making arrangements to distribute renewable resources within the region.

    **Recommendation:** Steps should be taken toward establishing a regional cooperative with other water providers in eastern Pima County. The cooperative should focus on setting guidelines for members to act in a unified and cooperative manner. If a cooperative structure can be established in the near term, Tucson Water would coordinate its efforts with the other members to address regional water issues.

## CONCLUSIONS

Tucson Water developed *Water Plan: 2000-2050* to initiate a dialogue with the community to address the water-resource challenges which lie ahead. The Plan will be reassessed as assumptions and circumstances change over time. In order to sustain growth through 2050 and beyond, Tucson Water must take full advantage of all renewable resources currently available, seek to acquire additional sources of supply, and develop a more aggressive demand management program to reduce per capita water usage.

The evaluation of available water resources, current water usage patterns, and projected growth indicate that Tucson Water is well positioned to support its water needs through the planning period if current water supplies of Colorado River Water, effluent, and ground water are used to their fullest potential. However, in order to support any growth beyond 2050 and to remain compliant with state regulations, additional renewable water resources will have to be acquired. Even if the Utility's customers can reduce their water usage below current levels and the community supports the indirect use of a highly treated effluent through ground-water recharge, additional water supplies will still be needed.

The recommendations presented in this evaluation clearly support the following conclusions to:

- Maximize the use of available renewable water supplies.
- Aggressively pursue acquisition of additional water supplies.
- Reduce water usage through demand management programs.

Each of the three initiatives has its own opportunities for success. Tucson Water must aggressively pursue all three in order to ensure a sustainable water future for the Utility's customers.

*WATER PLAN: 2000-2050*

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## *WATER PLAN: 2000-2050*

# LIST OF ACRONYMS

| | |
|---|---|
| ADEQ | Arizona Department of Environmental Quality |
| ADWR | Arizona Department of Water Resources |
| AMA | Active Management Area |
| AMSL | Above mean sea level |
| AWS | Assured Water Supply |
| CAGRD | Central Arizona Groundwater Replenishment District |
| CASS | Central Arizona Salinity Study |
| CAVSARP | Central Avra Valley Storage and Recovery Project |
| CAWCD | Central Arizona Water Conservation District |
| CWAC | Citizens' Water Advisory Committee |
| EMPACT | Environmental Monitoring for Public Access and Community Tracking |
| EPA | U. S. Environmental Protection Agency |
| GMA | Groundwater Management Act |
| GPCD | Gallons per Capita per Day |
| GSF | Ground-Water Savings Facility |
| IGA | Intergovernmental Agreement |
| MDWID | Metropolitan Domestic Water Improvement District |
| MG | Million Gallons |
| MGD | Million Gallons per Day |
| M&I | Municipal and Industrial |

| | |
|---|---|
| Mg/L | Milligrams per Liter |
| O&M | Operations and Maintenance |
| PAG | Pima Association of Governments |
| SAVSARP | Southern Avra Valley Storage and Recovery Project |
| SAWRSA | Southern Arizona Water Rights Settlement Act |
| TDS | Total Dissolved Solids |
| Tucson AMA | Tucson Active Management Area |
| USACE | U.S. Army Corps of Engineers |
| USBR | U.S. Bureau of Reclamation |
| UV | Ultra-Violet |
| Water Bank | Arizona Water Banking Authority |

*Water Plan: 2000-2050 was developed to update Tucson Water's long-range water resource plan and to initiate a dialogue between the Utility and the community it serves.*

# CHAPTER ONE

# INTRODUCTION

*Water Plan: 2000-2050* was developed to initiate a dialogue between Tucson Water and the community about the water-resource challenges which must be addressed in the coming years. If the community's demand for water continues to grow, Tucson Water's currently available supplies must be fully utilized and additional more expensive supplies must be acquired and developed. Various opportunities and constraints that will impact the Utility's ability to provide adequate supply are discussed. *Water Plan: 2000-2050* identifies several critical decisions that must be made by the community and decision makers at key points in time. This will ensure the timely implementation of desired projects and programs to guarantee long-term sustainability of water resources.

This document provides information to Tucson Water customers and other stakeholders concerning the Utility's resource and system plans through 2050. This report is a comprehensive revision of *Tucson Water Resources Plan 1990-2100* which was prepared by CH2M Hill (1989) in cooperation with Tucson Water. *Water Plan: 2000-2050* also includes analyses and assessments not featured in the original plan. The revised plan assesses how projected population and water demand are spatially distributed within Tucson Water's projected service area. In addition, system planning is incorporated into the resource planning process to assess upgrades to existing systems and extensions into areas currently not served. Finally, a scenario planning approach was utilized to develop a flexible long-range water-resource plan that is structured to address planning uncertainties and possibilities for change.

## GEOGRAPHIC SETTING

The City of Tucson is located in the northern semi-arid reaches of the Sonoran Desert in eastern Pima County, Arizona. As shown on Figure 1-1, the City is situated in the center of the Tucson basin which is a broad desert valley surrounded by the Santa Catalina, Rincon, Santa Rita, Sierrita, Tortolita, and Tucson Mountains. Basin elevations in the City of Tucson range from about 2,300 feet above mean sea level (amsl) in the northwest to about 3,200 feet amsl in the southeast; the surrounding mountains range in elevation from approximately 4,700 to over 9,000 feet amsl.

Various washes and rivers are located throughout the Tucson area as shown in Figure 1-1. When storm flows occur, the Santa Cruz River runs north-northwest, and Rillito Creek runs from southeast to west. The Rillito is formed by the confluence of Tanque Verde Creek and Pantano Wash. In Avra Valley, Brawley Wash is the primary channel and merges with the Santa Cruz River near the Pima County/Pinal County line.

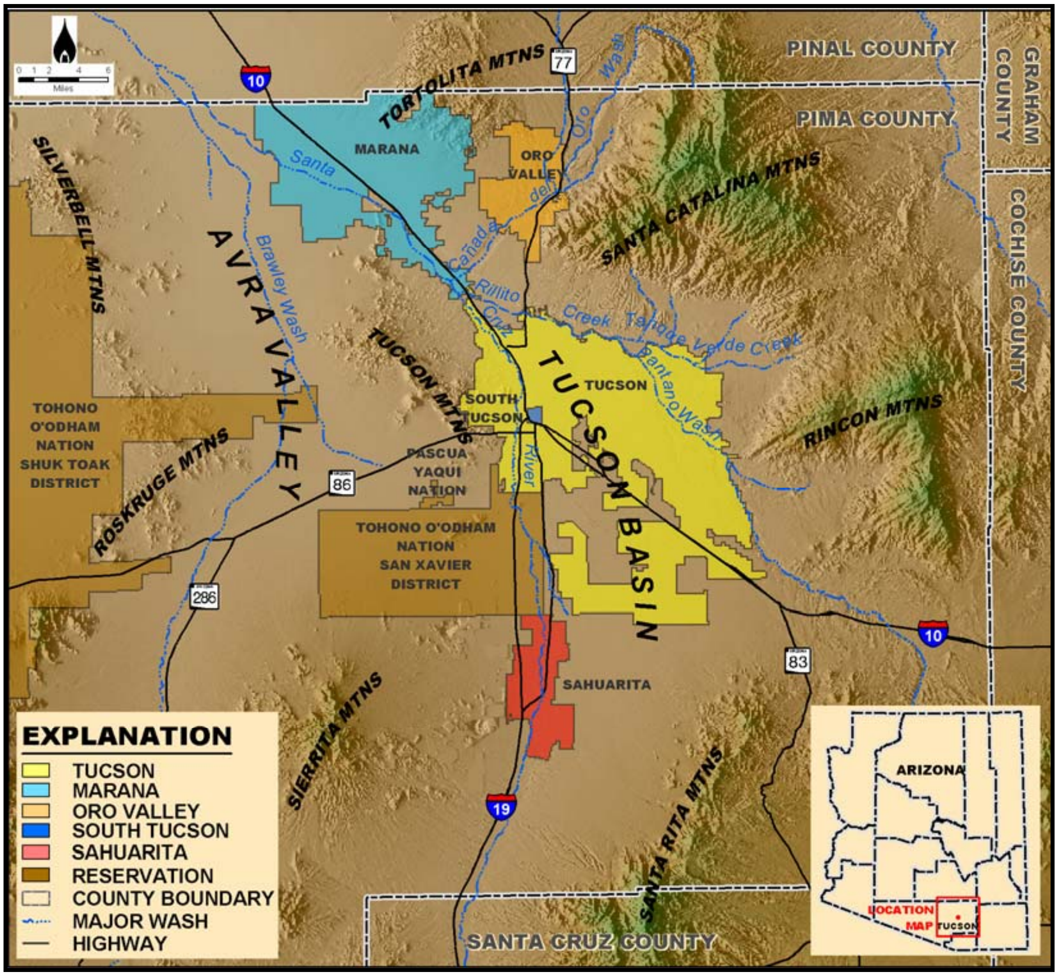



**Figure 1-1:** Map of the Greater Tucson Area.

The average daily minimum temperature in the City ranges from about 39ºF in January to 73ºF in July while the average daily maximum temperature ranges from 65ºF in January to 100ºF in July (National Weather Service, 2004). The local area annually averages about 12 inches of precipitation in the valleys and about 25 inches in the higher elevations. In 2000, the City of Tucson's population was 486,699, making it the second largest city in Arizona (U. S. Census Bureau, 2002).

Tucson Water is a municipal water provider owned and operated by the City of Tucson. The Utility is subject to the authority of the City of Tucson Mayor and Council, and the Director of Tucson Water is subject to the authority of the City Manager. Tucson Water is self-supporting and relies totally on revenues generated from water connection fees and water sales. Actual cost of service is used to determine water rates; customers are charged in direct proportion to the cost of developing supplies and delivering water to customers.

Tucson Water is the largest water provider in southeastern Arizona. In 2000, the Utility served a population of 638,936 within a 300-square-mile service area. Its customers are located both inside and outside the jurisdictional boundary of the City. The Utility operates a dual water system that serves potable (drinking) water and reclaimed water for non-potable use. More information about the other local water providers/users can be found in Appendix A: *Other Water Users in the Region.*

## THE PLANNING GOALS

*Water Plan: 2000-2050* was developed with the following resource management goals:

- **Meet Projected Total Demand**. The Utility's water demand has grown significantly over the years. Current population projections indicate that demand will continue to increase in the foreseeable future.

- **Utilize Renewable Resources**. In order for the community to be sustainable into the future, Tucson Water needs to shift from a historical reliance on "mined" ground water to renewable water supplies. Colorado River water delivered via the Central Arizona Project and treated municipal wastewater effluent are two currently available renewable supplies that must be utilized to the maximum extent possible. It is also a priority to acquire additional renewable supplies as soon as possible.

- **Meet Water-Quality Targets**. In addition to complying with federal, state, and local regulations, Tucson Water must also be responsive to the water-quality expectations and preferences of its customers.

- **Achieve Sustainable Pumpage**. There is a quantifiable volume of ground water that is naturally replenished each year. Pumping ground water at or below this annual rate would be hydrologically sustainable and would not cause additional water-level declines and associated subsidence. Sustainable pumping must be consistent with state regulations that govern the legal authority to withdraw ground water.

- **Manage Costs and Rate Impacts**. Projects and programs must be cost effective to ensure that water remains affordable.

- **Comply with Assured Water Supply Program.** The Assured Water Supply (AWS) Program is the regulatory paradigm administered by the Arizona Department of Water Resources (ADWR) for water-resource management in the municipal water-use sector. The AWS Program limits the amount of ground water that the City of Tucson can legally withdraw.

## THE PLANNING PROCESS

*Water Plan: 2000-2050* was developed using a scenario planning process. Tucson Water utilized the best available information and planning assumptions to address many possible views of the future. The recommended plan was developed to maintain the maximum flexibility as the future unfolds. Figure 1-2 shows the plan development sequence. Planning assumptions will be revisited periodically to assure reliable, high-quality water supplies continue to be available. The plan may be revised over time in order to respond to changing conditions. Tucson Water in conjunction with the Citizens' Water Advisory Committee (CWAC) will determine when a comprehensive revision should be initiated. Mayor and Council created CWAC in 1977 as the official advisory body to the Council on water issues. Revisions to the plan are submitted to Mayor and Council for adoption.

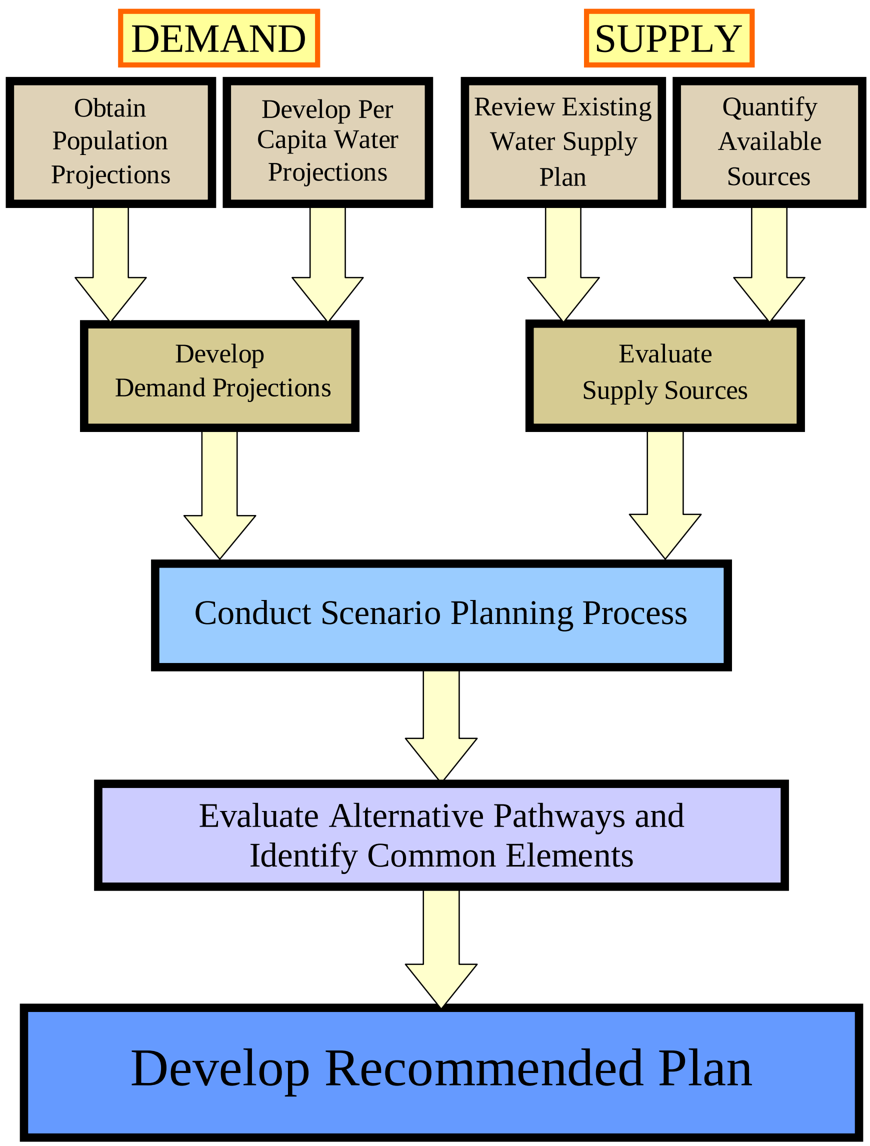



**Figure 1-2:** Plan Development Sequence.

## CONTENTS OF THE REPORT

This report consists of eight chapters and six supporting appendices. Chapters Two through Five summarize the basic information and assumptions used to develop the recommended plan. Chapter Two, *A Community Creates a Demand*, provides a brief overview of the local area's water-resource history and the development of Tucson Water as the largest municipal water provider in the region. Chapter Three, *Projections of Population and Water Demand*, presents the information used to develop a 50-year projection of water demand within Tucson Water's anticipated service area. Chapter Four, *Available Water Resources*, describes and quantifies the various water supplies available to meet demand. Chapter Five, *Water Delivery Systems*, describes the existing potable and non-potable water distribution systems operated by Tucson Water and how the system infrastructure may be upsized and extended to meet future demand.

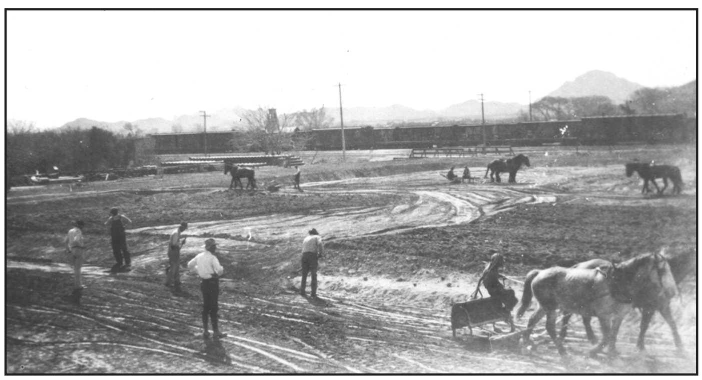
Chapters Six and Seven describe the application of the scenario planning approach and the development of the long-range water-resource plan. Chapter Six, *The Planning Process*, provides a detailed look at how *Water Plan: 2000-2050* was developed. Chapter Seven, *The Recommended Plan*, is a step-by-step road map that will guide the Utility as the future unfolds. In addition, Chapter Seven summarizes Tucson Water's conclusions regarding the community's water-resource future and presents recommendations for the critical decisions identified in the Recommended Plan. Chapter Eight, *Future Issues and Challenges*, describes opportunities and potential constraints that will become increasingly important over time. The Appendices *(A-F)* present the detailed information used to develop *Water Plan: 2000-2050*.

*Water-resource planning has always been a complex puzzle. How best to fit the pieces together will need to be continually reassessed in order to achieve long-term sustainability.*

# CHAPTER TWO

# A COMMUNITY CREATES A DEMAND

In 2000, Tucson Water celebrated its 100th anniversary as a municipally owned and operated water utility. As Tucson Water works toward securing the community's water-resource future, much can be learned from the past since the current issues regarding resource limitation are not new. From those times when the local economy was rural and dominated by agriculture to today's technologically driven urban culture, the local inhabitants have had to contend periodically with the limited availability of water resources. Each time the community has approached its resource limits, it has managed to move beyond these constraints to periods of renewed growth.



***New Reservoir for Plant 1 -*** *Leveling and grading for a new reservoir at 17th Street and Osborne Avenue, circa 1914.*

While growth has resulted in benefits, it has also created many water-resource management challenges. With increasing development, significant ground-water level declines have occurred. These declines contributed to the disappearance of natural perennial surface-water flows along certain reaches of the Santa Cruz River and some of its tributaries. The community's increasing demand for additional ground-water supply has changed the natural environment within the urban area, along riparian corridors, and in the surrounding desert. Though technology has increased the availability of accessible water resources, it has not yielded inexhaustible sources of supply. With current development pressures, the community is again approaching the limits of its available water resources and will require additional supplies to satisfy projected demand.

Local history reveals that the community's current water supply concerns resemble those of a century ago. Water management in the Southwest can be characterized as a recurring pattern of shortfalls followed by technological advances that helped to provide, at least for a time, an adequate water supply for a growing community. Like many times before, the community again has to assess a range of water supply alternatives in order to ensure that it has a sustainable future.

## PRIOR TO 1880: LIFE ALONG THE SANTA CRUZ RIVER

Prehistoric Native American hunters visited the Santa Cruz River near Sentinel Peak ("A" Mountain) as early as 9500 B.C. Archaeological investigations have unearthed evidence of canal irrigation built by predecessors of the Hohokam culture as early as 1000 B.C. The Hohokam settled along the river and grew crops from 650 to 1450 A.D. The Hohokam's network of canals was used to divert river flows to irrigate crops and their sophisticated design demonstrated a keen engineering knowledge. Their activities were so significant that they altered the river's natural course (Logan, 2002). The Hohokam's water diversions undoubtedly reduced the availability of surface-water flows for other inhabitants who lived further downstream. Intensive farming along the Santa Cruz River by the Hohokam peaked between 900 and 1300 A.D., but it was still practiced by the Tohono O'odham when Father Eusebio Kino visited the area in 1694 (Betancourt, 2004; Logan, 2002).

***Human Figurine** –A Cienega Phase (800 B.C. to 150 A.D.) artifact found at the Sweetwater Recharge Facilities.*

Many different cultures have lived near the Santa Cruz River-Native Americans, Spanish colonizers, Mexicans, and finally settlers from the United States and its territories. Spanish missionaries established the San Agustín Mission and Convento village in the mid-1700s just west of present-day downtown Tucson. A Spanish military settlement developed at the Presidio (1775) and the arrival of Spanish settlers stimulated agriculture, ranching, and mining. Over time, these activities resulted in the over-utilization of surface water. An American encampment was later established at Camp (Fort) Lowell (1866) concurrent with a large influx of new settlers into the area. As growth occurred, the surface-water resource upon which the community largely depended continued to be over-utilized and became a constraining factor in the area's development (Logan, 2002).

## POST-1880 TO WORLD WAR II: A LESSENING STREAM

By the early 1880s, Tucsonans could no longer rely on surface-water flows from the Santa Cruz River to satisfy their increasing need for water. Water-resource depletion was in full swing. Surface water was diverted for crops, milling operations, livestock, recreational lakes, and mining. The cumulative effects of overgrazing, increasing stream flow diversions, climatic changes, and the occurrence of high-magnitude floods contributed to further channel erosion, alteration, and gully formation (Logan, 2002).

The arrival of the railroad in the 1880s signaled the beginning of the modern age. Steam-powered water pumps enabled technological advances in water delivery systems that could satisfy increasing water demand. In 1882, the Tucson Water Company, then a privately owned entity, diverted surface water at Valencia Road through a distribution system made of redwood flumes. By the 1890s, the modest system took on the more modern aspects of a water provider as the company constructed its first wells. These wells were dug to about a 20-foot depth and a pumping plant, consisting of a steam-powered pump set at land surface, used suction to withdraw shallow ground water (Logan, 2002).

A frontier and profit-minded ethic resulted in the monopolization of water which in turn led to intense friction within the community (Schaedler and Othmer, 1999). Conflicts over water eventually led to the creation of surface-water and ground-water laws. Apart from "royal decrees and priestly interventions," the earliest law was the doctrine of prior appropriation that was instituted in territorial Arizona in 1864 (Lewis, 2004). Under prior appropriation, landowners who were among the first to file surface-water claims were given a higher priority right. In essence, "first in time" came to mean "first in right." This prioritization of rights made it increasingly difficult for subsequent surface-water claimants to obtain rights to water regardless of the potential benefits that later, lower priority right-holders might offer the community.

The City of Tucson purchased the Tucson Water Company in 1900. In the early 1900s, Tucson Water had a service area population of about 8,000 and provided service through 40 miles of networked water pipelines (Logan, 2002; Baker, 2000). By 1910, all of the water flowing in the Santa Cruz River near downtown Tucson was being diverted for agricultural or municipal uses (Water Resources Research Center, 1999). Policymakers within the City recognized that with continued development, additional water resources would be needed to support the growing community.

Other communities in the Southwest also saw the need for additional future supply. The United States Congress authorized the Colorado River Compact in 1922 which enabled river basin states like Arizona to seek allocations from the Colorado River. Congress subsequently passed the 1928 Boulder Canyon Project Act assuring Arizona and other western states a future water supply from the Colorado River.

High-powered "deep-well" turbine pumps were introduced in the early 1920s and replaced the suction-lift pumps which could only withdraw ground water from shallow depths. This major technological advance provided water users with the ability to utilize ground water as a major source of supply (Driscoll, 1986; Baker, 2000). This innovation enabled Tucson Water and other ground-water users in the area to pump deeper, previously inaccessible ground water. In time, ground water became the only reliable municipal supply source.

***Wrapping Pipe** - Much of the work needed to prepare pipe for installation was done by hand, circa 1940.*

Records from wells located along the Santa Cruz River indicate that prior to the early 1920s, there had been negligible change in ground-water levels and that even by 1930, only a relatively small area showed any significant drop in the water table (Schwalen and Shaw, 1957). By 1940, however, water level declines indicated that ground water was being withdrawn in certain areas at a rate greater than natural replenishment. Perennial surface-water flow that persisted in reaches of the Santa Cruz River around Martinez Hill and "A" Mountain vanished by the onset of World War II (Betancourt, 2003).

## WORLD WAR II TO 2000: THE COMMUNITY EXPANDS

Tucson's post-depression years were ones of growth and prosperity. The community was gaining a reputation as a welcome place of respite for people who came from areas with colder winter climates. In addition, World War II brought soldiers and their families to Davis-Monthan Air Force Base. The population in the Tucson area began to grow and with that growth came an increasing thirst for water which was satisfied through increased ground-water pumping.

This increasing dependence on ground water created widespread ground-water level declines which were documented in the Tucson region by the late 1940s (Davidson, 1973). The largest historical water-level declines have mainly occurred since the late 1940s and the rate of decline accelerated in the metropolitan area during the subsequent 50 years (City of Tucson, USGS, and ADWR, 1998; Schwalen and Shaw, 1957).

Arizona's pursuit of additional water resources intensified in the 1940s. In 1944, the Arizona legislature finally ratified the 1922 Colorado River Compact to address anticipated population growth and to provide a renewable water supply to offset ground-water pumping. The Boulder Canyon Project Act of 1928 established the State's annual allocation of 2.8 million acre-feet of Colorado River water. However, many decades of political maneuvering were required at the federal level before the physical means to convey Colorado River water to central Arizona would become a reality.

Agricultural water use was greater than municipal use in the Tucson region during the 1950s, but some members of the community were able to see that this could change. Schwalen and Shaw (1957) noted that if metropolitan Tucson continued to grow at its then current rate, water would have to be diverted from agricultural use to meet future municipal water demand; otherwise, new sources would have to be tapped. In fact, both eventually occurred.

As the City of Tucson began to expand in the early 1950s, private water companies were purchased by Tucson Water. Since that time, system acquisitions have continued to occur. The City also purchased and retired over 22,500 acres of farmland in Avra Valley in the 1970s and 1980s. These farm purchases secured legal rights to withdraw ground water that had been previously used to irrigate crops. These purchases provided the City of Tucson with the means to preserve local ground water for future municipal use. Throughout this period, Tucson Water was totally dependent on ground water as its sole source for municipal supply. The regional aquifers were increasingly overdrafted due to the cumulative pumping of agriculture, mining, and the growing urban area. Tucson Water's efforts to keep pace with continued growth were particularly challenging in the 1970s when well construction had to be accelerated to keep up with increasing water demand.

Having long recognized the local need for additional water supplies, the City of Tucson submitted a letter of intent to the Central Arizona Water Conservation District (CAWCD) in 1975 to take 100,000 acre-feet of Colorado River water annually through the Central Arizona Project (City of Tucson, 1975). The City of Tucson's annual Central Arizona Project allocation has changed through the years and is currently 135,966 acre-feet.

An environmental consciousness grew nationwide in the 1970s and with it a conservation ethic took root in the Tucson area. Tucson Water's *Beat the Peak* Program was established in 1977 and helped Tucson Water control peak demand and delay costly water system expansions. Although it began as a program to manage daily "peaks" in the water system during the summer, Tucson's residents embraced it as a demand management measure with a conservation emphasis. It became the foundation upon which subsequent conservation programs developed. During this time, Tucson Water implemented an "increasing block" rate structure that provided customers with an economic incentive to use water more efficiently. As Tucson's environmental ethic further evolved, there was a gradual change in landscape preferences and a concerted community desire to conserve water.

This environmental ethic also prompted water-quality as well as water-quantity concerns at national and state levels. These concerns resulted in the establishment of federal and state agencies such as the U.S. Environmental Protection Agency (EPA) in 1970, the Arizona Department of Water Resources (ADWR) in 1980, and the Arizona Department of Environmental Quality (ADEQ) in 1986. ADWR was formed to administer the 1980 Groundwater Management Act. This Act is a compendium of complex regulations particularly aimed at managing ground-water resources in designated Active Management Areas within the State. This Act also established a goal of achieving safe yield in the Tucson Active Management Area (Tucson AMA) by the year 2025. The Tucson AMA is shown in Figure 2-1.

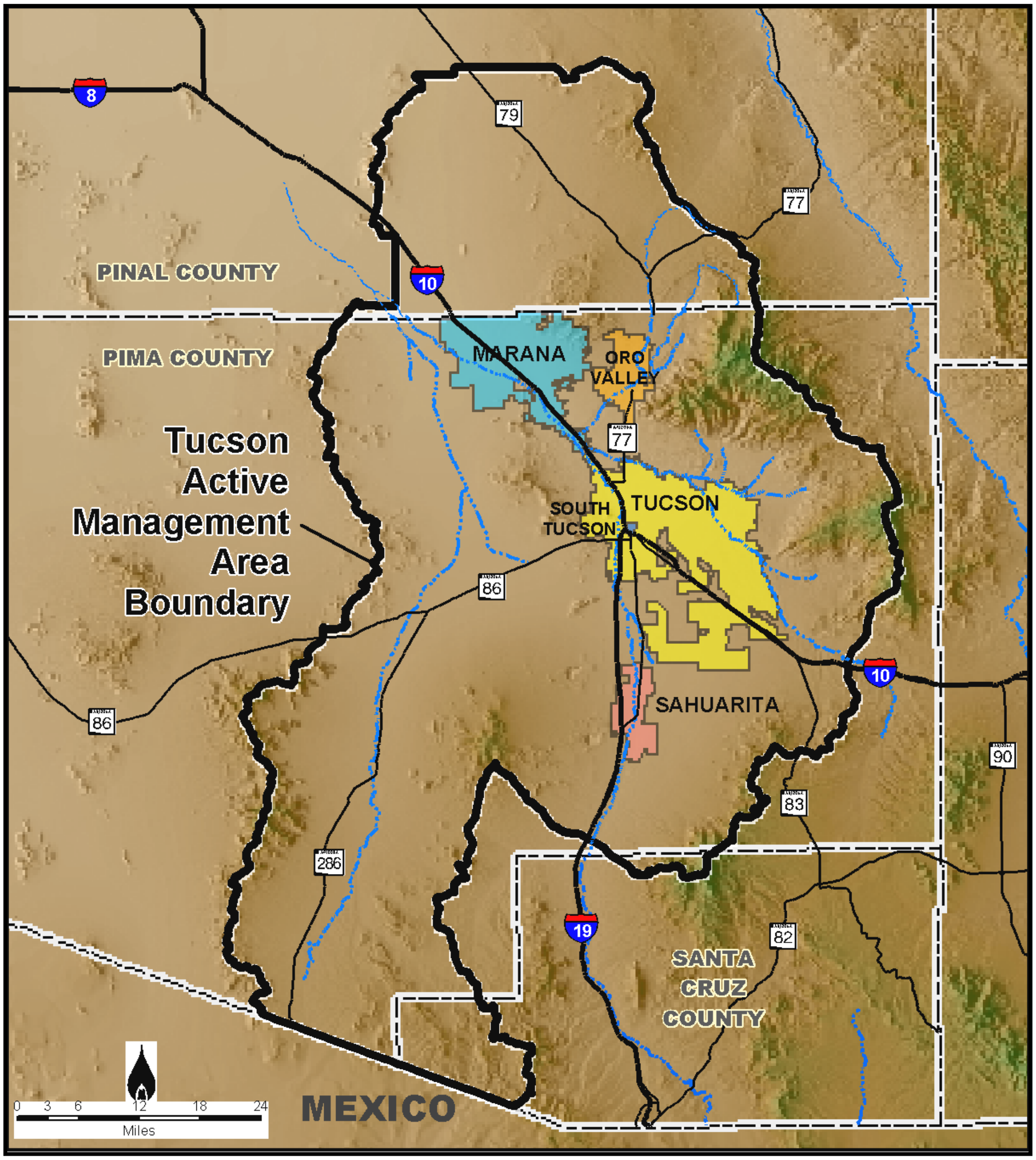



**Figure 2-1:** Boundary of the Tucson Active Management Area.

As shown in Figure 2-2, water use in the Tucson AMA has changed over time. Industrial and agricultural operations in the greater Tucson region reached peak production in the 1970s. After 1975, agricultural water use in the Tucson AMA dropped significantly while industrial use has remained relatively constant. Since 1940, municipal water use has increased and in the mid-1980s replaced agriculture as the largest water-use sector in the Tucson AMA. In 2000, overall water use in the Tucson AMA was approximately 320,000 acre-feet with municipal water providers accounting for about half of the total. For more information about the region's other water providers and users, see Appendix A: *Other Water Users in the Region.*

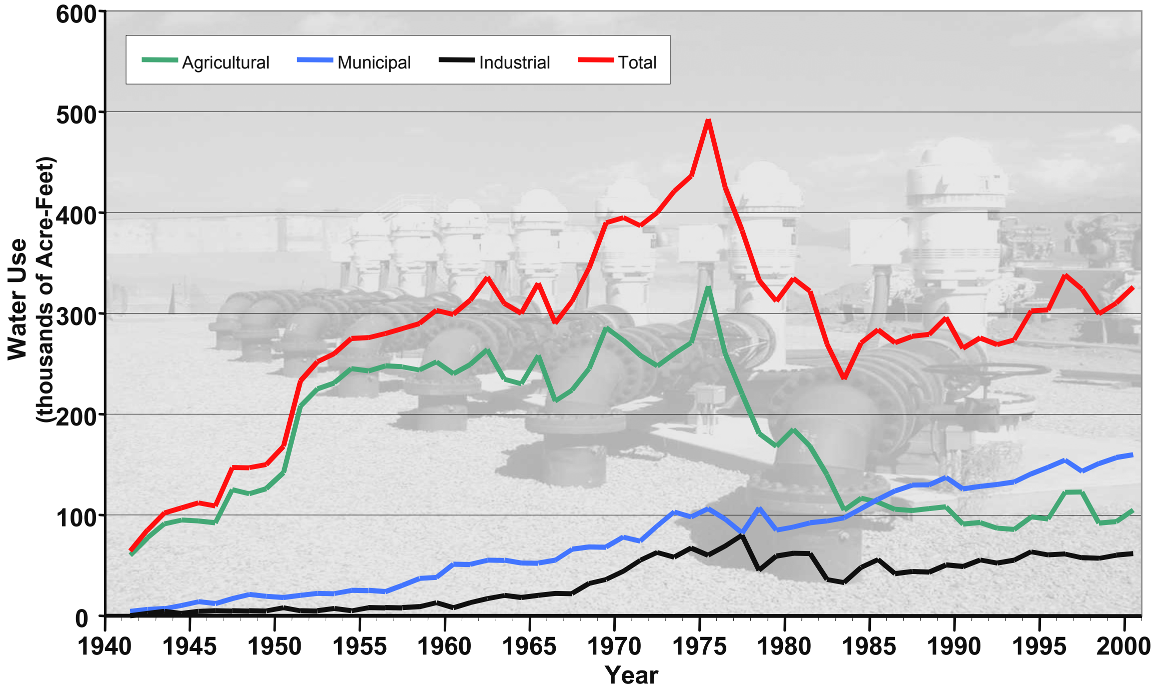



**Figure 2-2:** Historical Water Use in the Tucson AMA by Sector: 1941-2000.

By the 1980s, water-resource management in the Tucson area had become more challenging. It was increasingly recognized that ground water could no longer be relied on as the sole source for municipal supply. Ground-water levels were declining at an accelerated rate and measurable land subsidence was being documented. In 1984, Tucson Water was one of the first water utilities in the western United States to develop a tertiary wastewater treatment and delivery system. This system produces reclaimed water for urban irrigation and industrial use to conserve ground water for higher quality uses and to reduce ground-water pumping. Plans also were in place to utilize imported Colorado River water via the Central Arizona Project by 1992 to ensure the community would have a renewable source of supply to sustain its future.

An assumption of *Tucson Water Resources Plan 1990-2100* was that Tucson Water would treat and convey (wheel) the Central Arizona Project allocations of smaller water providers to their respective service areas. These providers would in turn deliver the water to their customers. By 1989, the Utility's service area population had grown to about 570,000 (CH2M Hill, 1989). Colorado River water and effluent, the region's only available renewable water resources, were to become primary sources of water supply. Ground water was to be utilized as a backup source and its use would be reduced to a more sustainable level that would allow the aquifer to stabilize over time. It was envisioned that effluent would become an increasingly important source of supply and would augment the ground-water system.

Tucson Water began direct deliveries of treated Colorado River water to portions of its service area in 1992. Direct delivery of treated Colorado River water did not include recharge as part of the treatment process. From 1992 to 1994, water-quality issues arose that were traced to the pH level of the new source water which reacted with old water mains in the potable distribution system and in customer plumbing. Contrary to commonly held belief, the problems were not related to the higher mineral content of Colorado River water. Tucson's Mayor and Council directed Tucson Water in 1994 to return to ground water as the sole source of supply until water-quality issues could be resolved. Subsequent passage of a citizen's initiative in 1995 effectively prevented Tucson Water from directly delivering Colorado River water to customers in its service area.

In response to these developments, Tucson Water evaluated other options for utilizing Colorado River water that would comply with the citizen's initiative. The Utility developed the Central Avra Valley Storage and Recovery Project (CAVSARP), a large recharge and recovery facility in Avra Valley, to provide a blend of native ground water and Colorado River water. Customer taste tests were conducted as part of the *At the Tap Program* initiated in 1997. The program showed that the public would accept the taste of a 50/50 blend of ground water and Colorado River water.

***At the Tap** – Extensive research and taste tests were conducted to prepare for the use of Colorado River water, 1997.*

Tucson Water began deliveries of the blended water in 2001. Colorado River water is diverted from the Central Arizona Project and is conveyed to 330 acres of water-spreading infiltration basins at CAVSARP. Colorado River water infiltrates through the basin bottoms and percolates downward through hundreds of feet of sediments to the water table. The percolating water benefits from natural filtration and treatment until it recharges the aquifer and mixes with ground water. Supply wells located nearby recover (pump) a blend of Colorado River water and ground water for municipal supply. CAVSARP is designed to deliver about 60,000 acre-feet of blended water to customers per year. The facility allows Tucson Water to cut back on ground-water pumping in the metropolitan area and to reduce the community's dependence on ground water for municipal supply.

Total water production by municipal water providers in the Tucson AMA was about 160,000 acre-feet in 2000. Of this total, Tucson Water supplied 128,521 acre-feet of water (76 percent) to a service area population of 638,936. As shown on Figure 2-3, Tucson Water is by far the largest water provider in the region. The next largest water providers were the Metropolitan Domestic Water Improvement District (6 percent) and the Town of Oro Valley (5 percent).

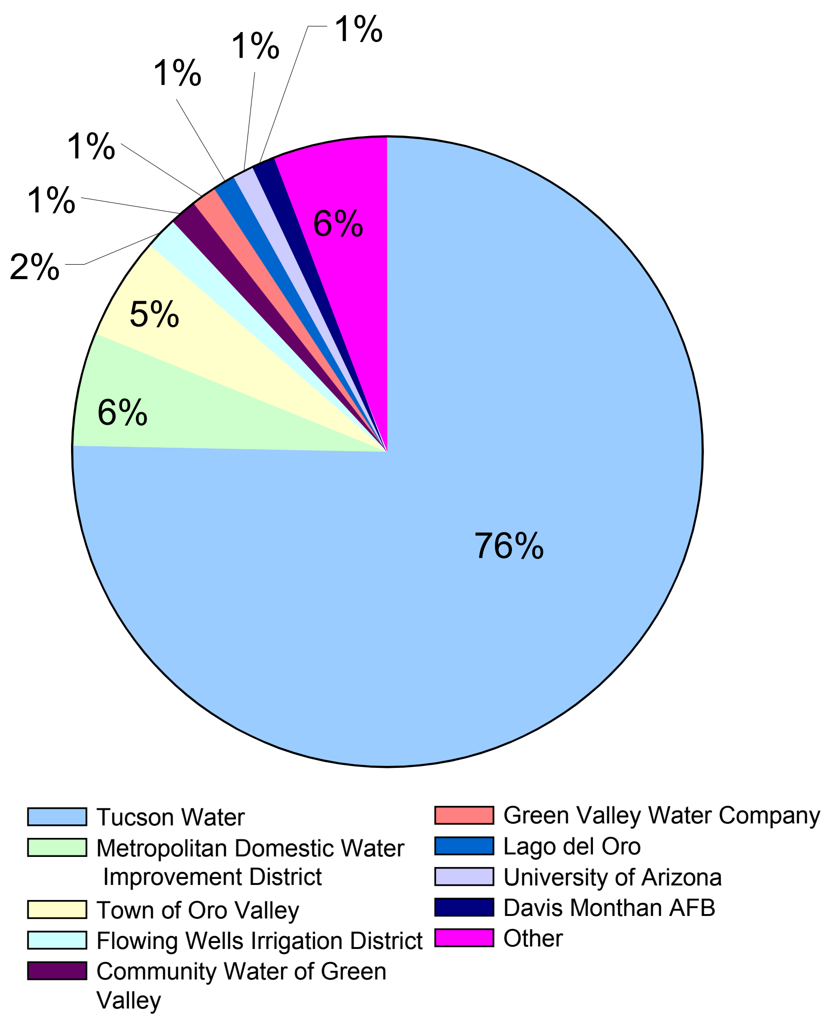



**Figure 2-3:** Total Water Production by Municipal Water Providers in the Tucson AMA in 2000.

## PLANNING FOR A SUSTAINABLE FUTURE

Tucson Water currently has 4,300 miles of pipelines that convey potable and reclaimed water to customers over a 300 square-mile service area. Tucson Water has diversified its use of water resources to include not only ground water but also Colorado River water and reclaimed water. Tucson Water will ensure a sustainable water future within its service area by continuing to reduce the community's reliance on ground water while working toward maximizing the use of its renewable water resources.

Local history shows that competing for additional sources of supply, taking advantage of new technological innovations, contending with droughts, and engaging in water rights and policy disputes are not new. These issues will continue to occur in some form and will require different approaches to address them.

There is already a shift from the traditional approach to water development where the need for new water supplies was satisfied by simply constructing new wells and pipelines to meet localized demands. Problems associated with regional ground-water overdraft and the resulting need to transition to renewable water supplies have made it necessary for water-resource planning to become more sophisticated. The marginal cost of growth will be increasingly placed on new development instead of on the shoulders of existing ratepayers. The new planning approach requires that the service area be managed and expanded as an integrated system.

Addressing concerns over the quality of available supplies, public perception of that quality, and associated customer preferences has become a primary focus in recent years. The current water-resource challenge is to secure adequate water supplies while providing water that meets customer expectations in terms of quality and cost. This is one of the greatest challenges currently facing the Utility and the community.

There is also an increasing awareness of the community's environmental values and efforts to protect and in some cases enhance the riparian corridors and wildlife habitats in surrounding areas. In the past, water-resource development and environmental initiatives have often pursued goals that were in conflict. Tucson Water, in concert with other City of Tucson departments and outside agencies, is exploring win-win opportunities where managing the community's water resources and enhancing local environmental values are compatible. The City has set aside a portion of its effluent supply (Conservation Effluent Pool) to support the development of riparian habitat projects. The Utility's Sweetwater Wetlands, a wastewater treatment facility, is an example of how riparian enhancement and water management can complement each other.

Finally, there is a growing recognition that greater cooperation is needed among Tucson AMA water providers in order to meet the challenges that lie ahead. Significant steps have been taken in this direction in recent years. As available water resources become more limited due to continuing growth, new opportunities to cooperate in acquiring and managing these resources may arise. It is highly probable that statewide competition for new supplies will increase as they become available, and it may prove mutually beneficial if the local water providers work together to augment existing supplies with a common strategy and a unified voice.

Proactive planning will help the community prosper. Growth, annexations of unincorporated areas, purchases of small water providers, acquisitions of additional water resources, changes to City policies, meeting increasingly stringent water-quality standards, and cooperation amongst local water providers are all pieces of the water-resource puzzle. How the pieces fit together will have to be continually reassessed in order to ensure that the community's goal of long-term sustainability can be achieved.

*The projection of water demand through 2050 provides annual supply targets that must be met in future years. Tucson Water will ensure that sufficient water resources will be available to meet the supply needs of the community.*

# CHAPTER THREE

# PROJECTIONS OF POPULATION AND WATER DEMAND

The population in the Tucson area has increased over time, creating a growing need for water. Tucson Water used the most current population counts and projections available to plan for future water demand. These projections were developed from information provided by the U.S. Census Bureau, the Arizona Department of Economic Security, and the Pima Association of Governments (PAG) in order to maintain consistency with other regional-planning entities. The population projections were used with planning assumptions to estimate total water demand for Tucson Water's service area through 2050. These water demand projections are developed to ensure that adequate water supplies will be available to meet the needs of the community during the 50-year planning period and to identify the water-resource opportunities and challenges that lie ahead.

## LONG-RANGE PLANNING AREA

The Long-Range Planning Area, shown on Figure 3-1, defines the maximum area within which Tucson Water could provide direct or indirect water service. Direct service will be provided to customers located within Tucson Water's projected service area (defined below). Indirect service means providing some level of support to other local water providers. The Long-Range Planning Area is largely consistent with the planning area described in *Tucson Water Resources Plan 1990-2100*.

In order to determine how much water must be provided in future years, it is necessary to define the geographic extent of Tucson Water's potential service area. About 60 percent of Tucson Water's residential, commercial, and industrial customers are currently within the City of Tucson's jurisdictional boundary with the balance located outside of the City.

Many other water providers have service areas contained within the Long-Range Planning Area. Tucson Water is not planning on providing direct service to these areas. These other service areas are generally located within the boundaries of the Town of Marana, the Town of Oro Valley, the Metropolitan Domestic Water Improvement District, the Flowing Wells

Irrigation District, and Davis-Monthan Air Force Base. The areas shown in brown on Figure 3-1 contain these other service areas along with all the other areas within which Tucson Water is not planning to provide direct service (see Appendix A: *Other Water Users in the Region).* All water providers located within the Long-Range Planning Area are dependent upon ground water to meet demand. This common resource must be managed from a regional perspective to ensure that it remains sustainable as a shared source of supply. Tucson Water needs to be aware of the ground-water utilization plans of other local water providers to meet their growing populations.

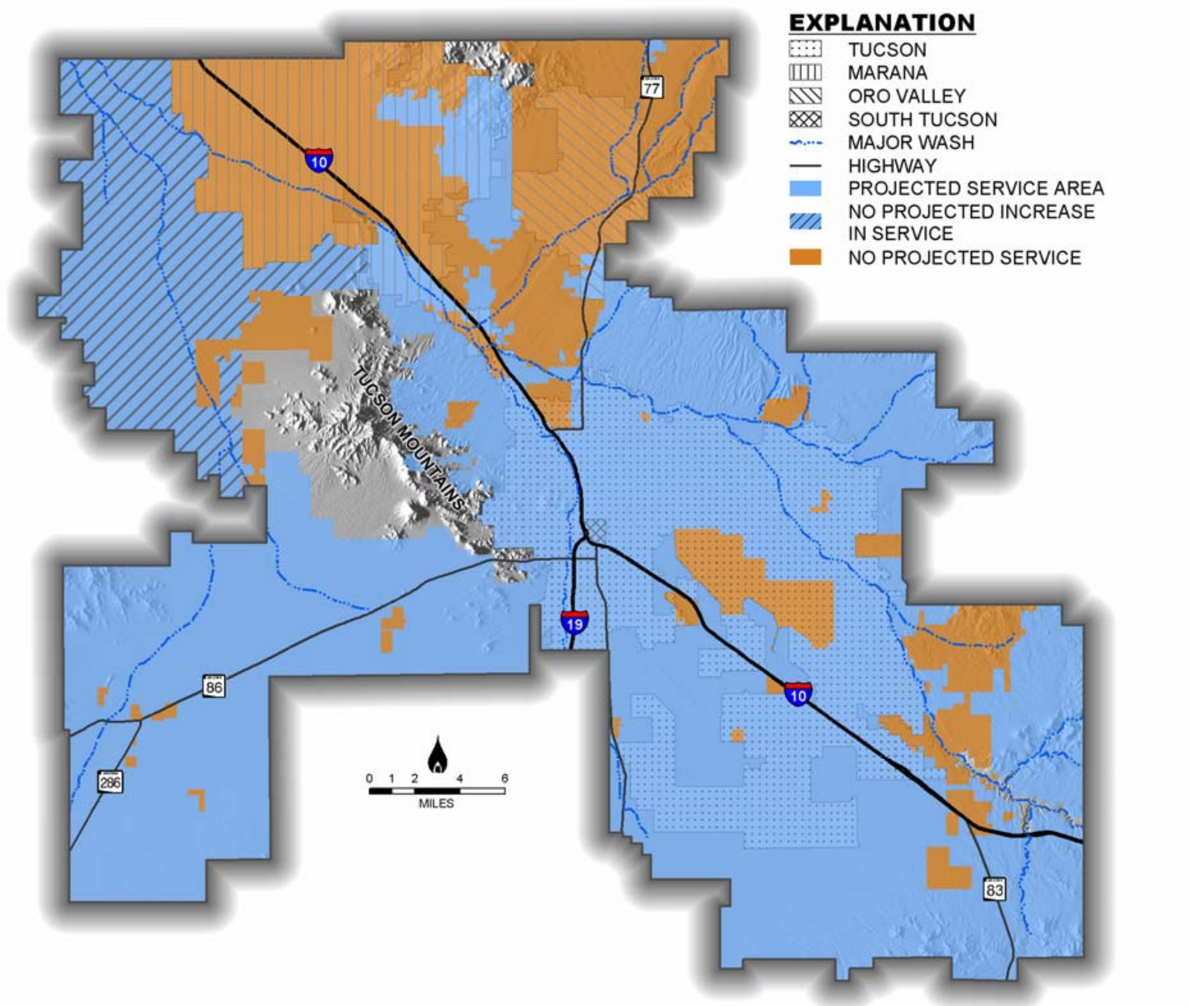



**Figure 3-1:** Long-Range Planning Area.

The populations served by these other water providers were excluded from Tucson Water's resource planning process. However, as the communities served by these providers grow in future years, additional water resources will need to be identified to meet their increasing demands. To provide a more regional perspective, this planning assessment includes population projections through 2050 for all of Pima County, the Long-Range Planning Area, and Tucson Water's projected service area. The projected service area is shown in blue on Figure 3-1. The crosshatched blue area is considered unlikely to require additional Tucson Water service in the future. Nonetheless, this area in Avra Valley is vital to the Utility since it includes City-owned lands that can be used to manage the City's renewable water supplies.

## PROJECTIONS OF POPULATION

Data sets provided by federal, state, and local governmental agencies were used to estimate Tucson Water's projected service area population through 2050. These population projections provide a common basis for all regional planning efforts and are expected to be adopted by PAG's Regional Council in 2005. The starting point for this analysis is Census 2000. The U.S. Census Bureau provided a count of the local population for a 2000 baseline. The Arizona Department of Economic Security, in conjunction with PAG, provided a statewide projection of population for 2030 and 2050 based on historical growth trends and other planning factors. The Arizona Department of Economic Security further refined the projections to provide 2030 and 2050 projected populations for each county within the State. PAG used the projections for Pima County and worked with all local jurisdictions to provide population projections for eastern Pima County (PAG, 2003). The Pima County population projections for 2030 and 2050 are presented in Table 3-1 along with projections for the Long-Range Planning Area and Tucson Water's projected service area.

| Areas | Population | | |
|---|---|---|---|
| | Year 2000 | Year 2030 | Year 2050 |
| Pima County | 843,746[1] | 1,506,673[2] | 1,884,432[2] |
| Long-Range Planning Area | 779,684 | 1,405,799 | 1,483,649 |
| Tucson Water Service Area | 638,936[3] | 1,215,841[4] | 1,275,023[4] |

[1]U.S. Census Bureau.
[2]Pima Association of Governments.
[3]Service area in 2000.
[4]Projected service area.

**Table 3-1:** Population Counts and Projections for *Water Plan: 2000–2050.*

PAG generated a spatially distributed population projection for eastern Pima County for 2030. This is the most detailed data set available and is derived from a transportation-based assessment of "traffic analysis zones." The 2050 projection provided by PAG did not have the same resolution since it was developed at the larger census tract level. However, the projection provided a spatially distributed population based on many of the same updated planning assumptions used in the 2030 projection.

The 2030 and 2050 population projections generated by PAG were used by Tucson Water to generate aggregated projections of population within the Long-Range Planning Area and Tucson Water's projected service area. Annual population projections were estimated by interpolating between 2000, 2030, and 2050. Annually aggregated population projections for Pima County, the Long-Range Planning Area, and the projected Tucson Water service area are shown on Figure 3-2. Review of Figure 3-2 indicates that Pima County's population is projected to increase from 843,746 in 2000 to about 1.5 million by 2030 and 1.9 million by 2050 while the Long-Range Planning Area population is projected to grow from 779,684 in 2000 to about 1.4 million in 2030 and 1.5 million by 2050. This figure also indicates that most of the future growth in Pima County is projected to occur outside of the Long-Range

Planning Area after 2030. The population to be served by Tucson Water is projected to increase from 638,936 in 2000 to about 1.2 million in 2030 and 1.3 million in 2050.

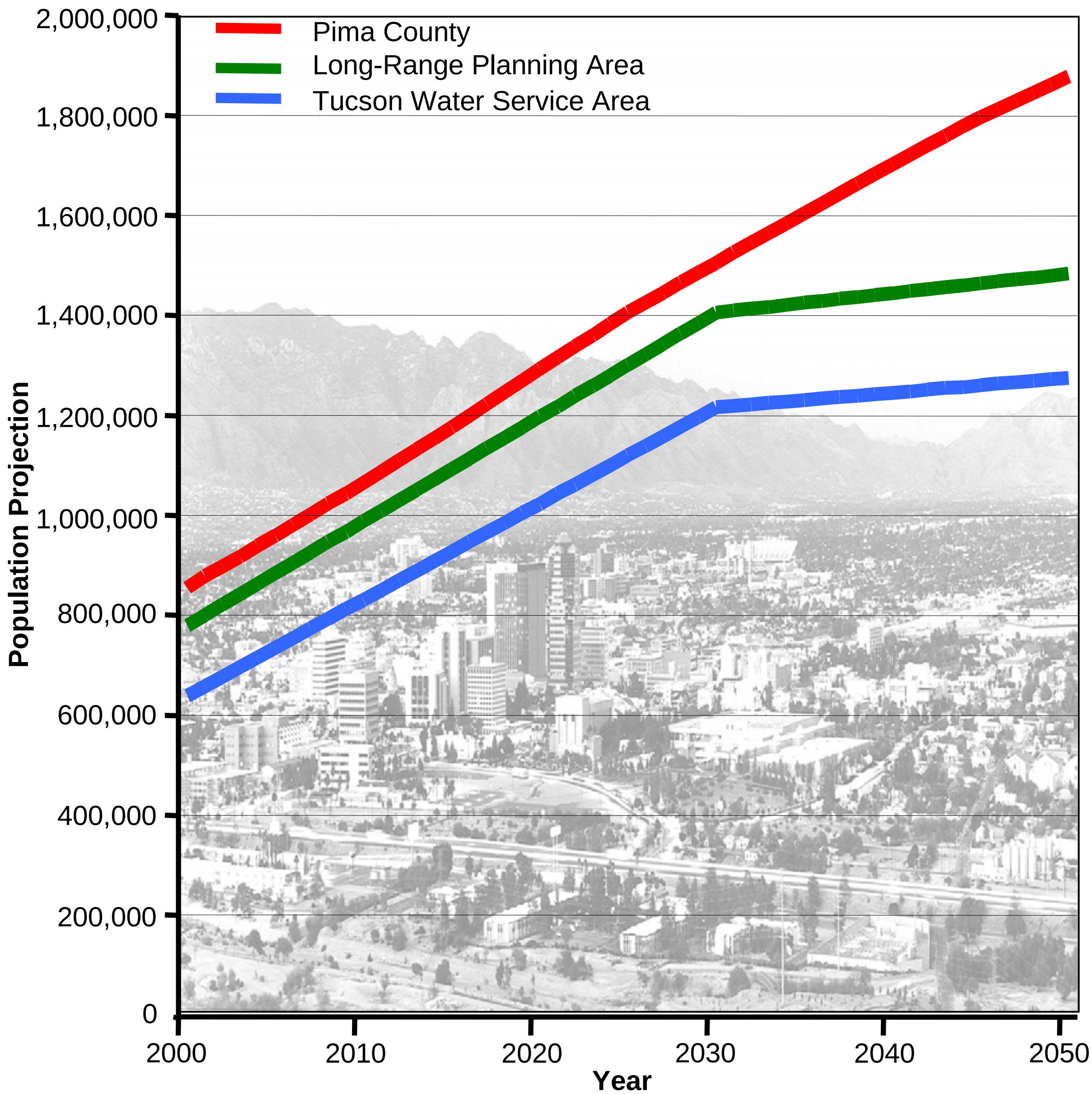



**Figure 3-2:** Population Projections from 2000 to 2050.

In addition to developing annually aggregated projections for population, the spatial distribution of Tucson Water's projected service area population was also derived through this process. Figure 3-3 shows the spatially distributed population of Tucson Water's service area in 2000 while Figure 3-4 depicts the projected population distribution of Tucson Water's service area in 2030. Review of Figures 3-3 and 3-4 indicates that over this 30-year period, significant population growth is projected to occur on the fringes of urban Tucson including the southeast part of the service area. This trend is projected to continue through 2050.

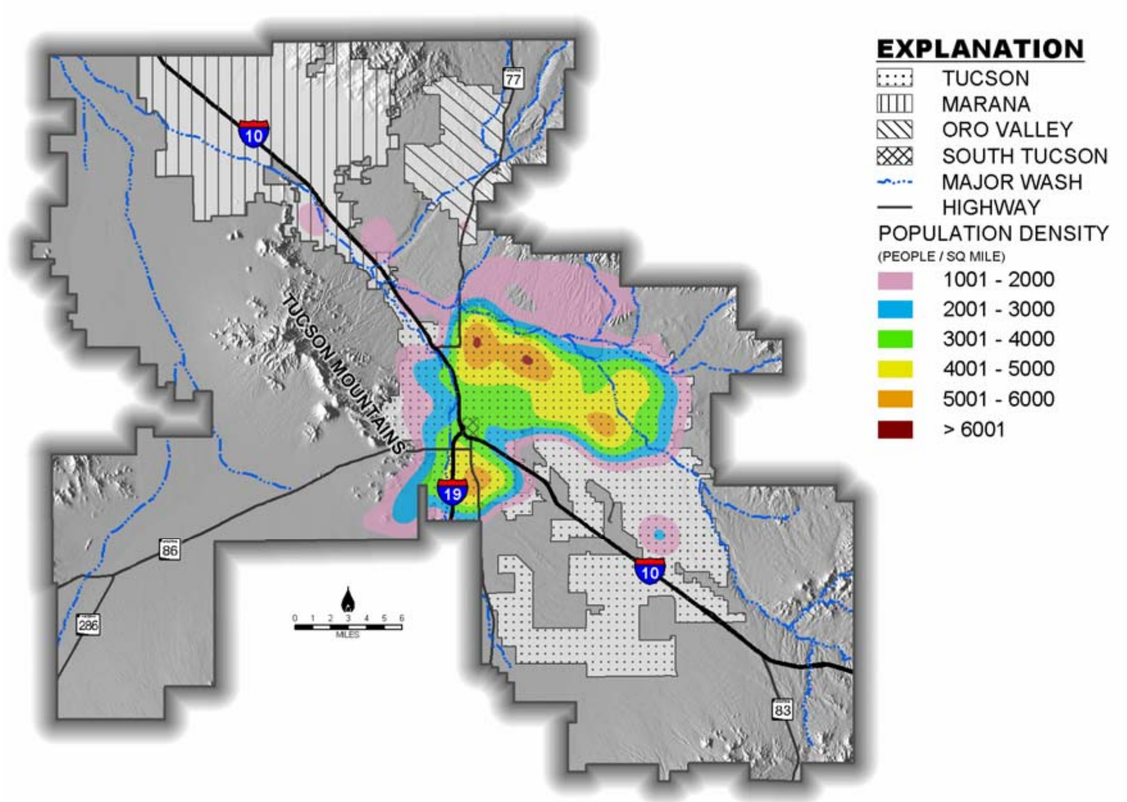



**Figure 3-3:** Tucson Water Service Area Population Distribution, 2000.

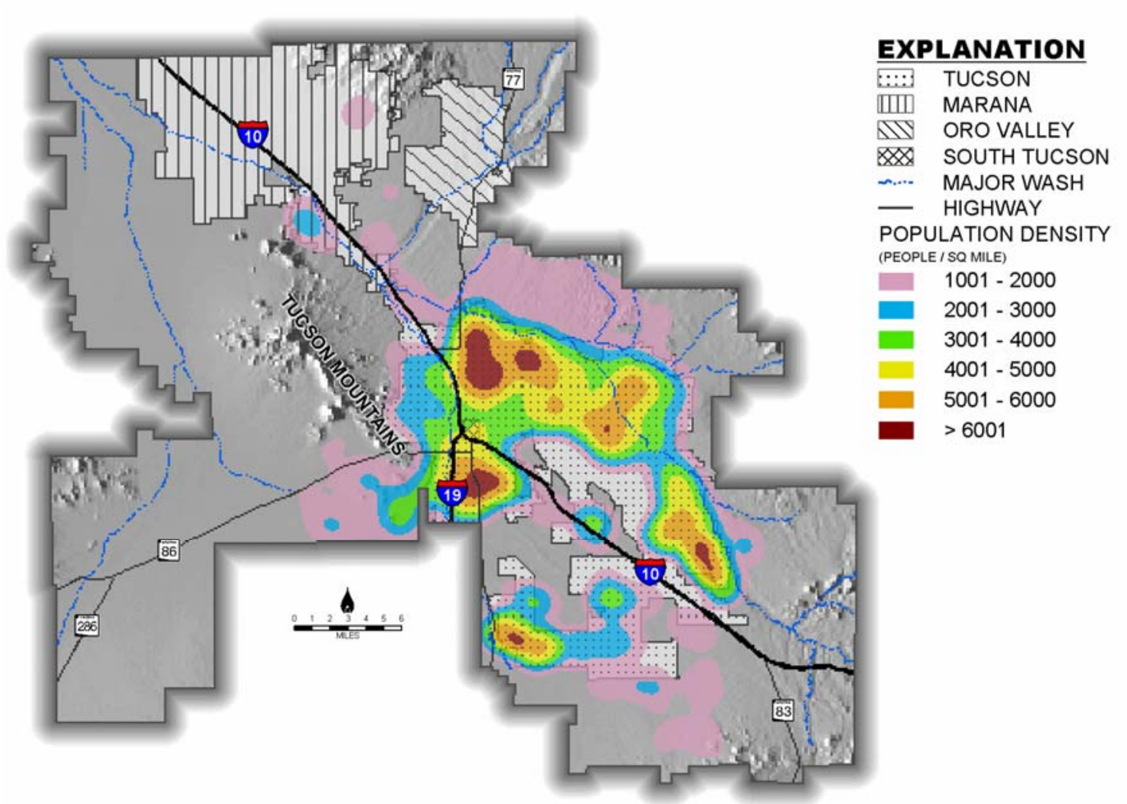



**Figure 3-4:** Tucson Water Service Area Population Distribution, 2030.

## PER CAPITA WATER USAGE RATES

In order to derive a projected total water demand from projections of population, the average amount of per capita water use must be determined. Such water usage is commonly measured in gallons per capita per day (GPCD). The total GPCD water usage rate for Tucson Water's current customer base is 177 GPCD and includes water used to supply both potable and non-potable demands. The total GPCD should not be confused with ADWR's GPCD compliance target which measures only potable per capita water use.

***Xeriscape™ at Tucson Water's Hayden-Udall Treatment Plant** – An example of natural desert vegetation used to create a water-efficient desert oasis.*

The total water usage rate of 177 GPCD includes approximately 14 GPCD of reclaimed water and 163 GPCD for all potable deliveries. Per capita potable water usage can be further broken down into total residential use at 110 GPCD (which combines single-family rates of 120 GPCD and multi-family rates of 100 GPCD), commercial and industrial water use at 35 GPCD, and lost and unaccounted for water at 18 GPCD.

The total water usage rate of 177 GPCD has been relatively consistent over the past 20 years; hence, it is conservatively assumed that it will remain constant throughout the planning period. The potential effectiveness of demand management strategies such as more aggressive conservation programming will be evaluated to determine if GPCD can be further reduced in a cost-effective manner. Once the demonstrated effects of additional demand management initiatives are quantified, the total GPCD assumption may be revised in future planning updates. The relative contributions of reclaimed water use and potable water use are assumed to remain constant within the 50-year planning horizon even though total water use will increase over time.

## PROJECTIONS OF TOTAL WATER DEMAND

The previous sections described the basic elements used to project water demand: a defined geographic area, the current and projected annual service area population at specified points in time, and the anticipated total per capita water usage rate (i.e. total GPCD). The resulting annual total water demands from 2000 through 2050 are presented in Figure 3-5. Tucson Water's annual total demand is projected to grow from 128,521 acre-feet in 2000 to 253,000 acre-feet in 2050. The slower increase in water demand from 2030 to 2050 reflects the shift in population growth to areas outside of Tucson Water's projected service area. At least eight percent of total water demand is projected to be met with reclaimed water and the remaining 92 percent is potable demand.

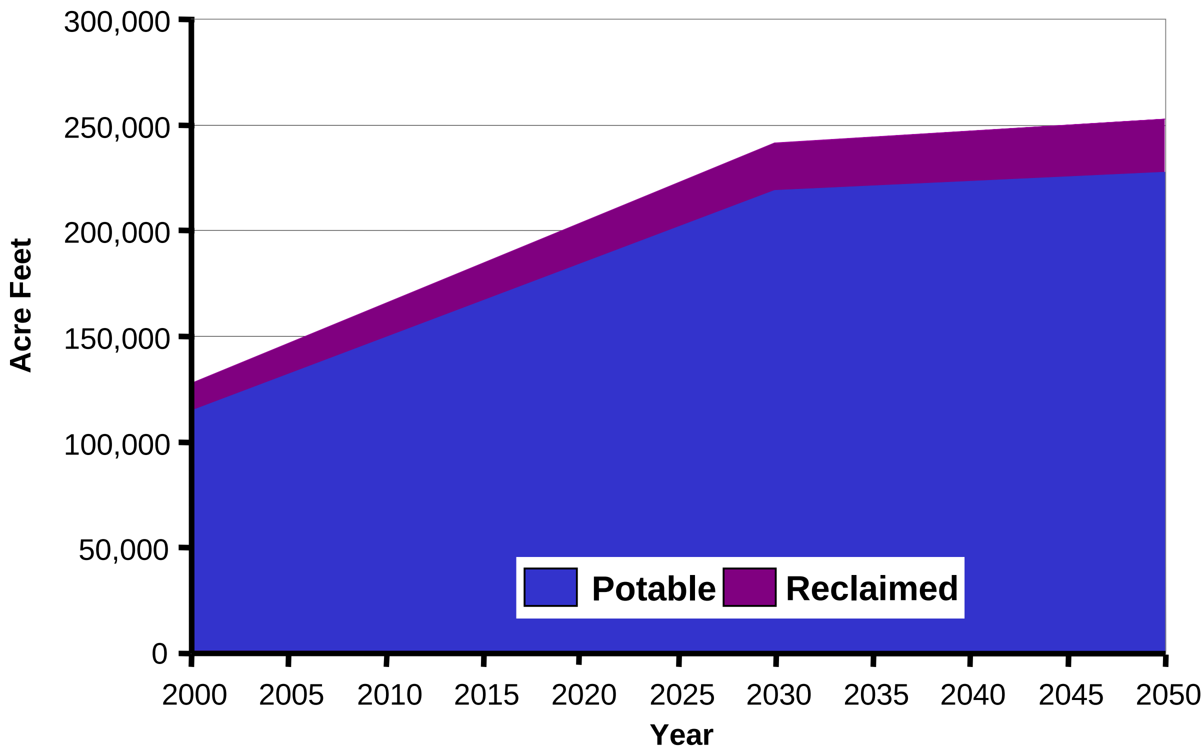



**Figure 3-5**: Tucson Water's Projected Total Annual Water Demand from 2000 to 2050.

One main goal of the current planning process is to identify sufficient water supplies to meet this projected aggregate demand curve. In addition, the spatial distribution of these demands within Tucson Water's projected service area will have a significant impact on the water system upgrades and extensions that must be made over time. The service area populations for 2000 and 2030 were used to generate spatial distributions of potable water demand as shown in Figures 3-6 and 3-7.

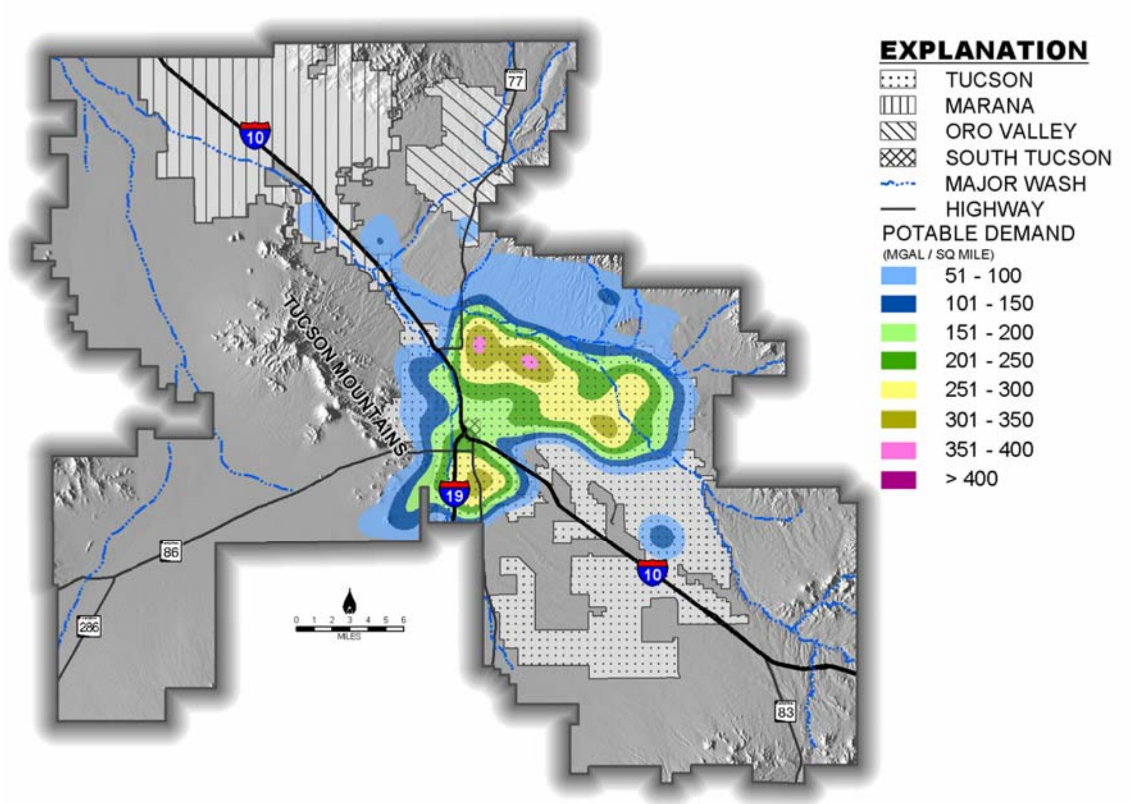



**Figure 3-6:** Annual Potable Water Demand for Tucson Water's Service Area, 2000.

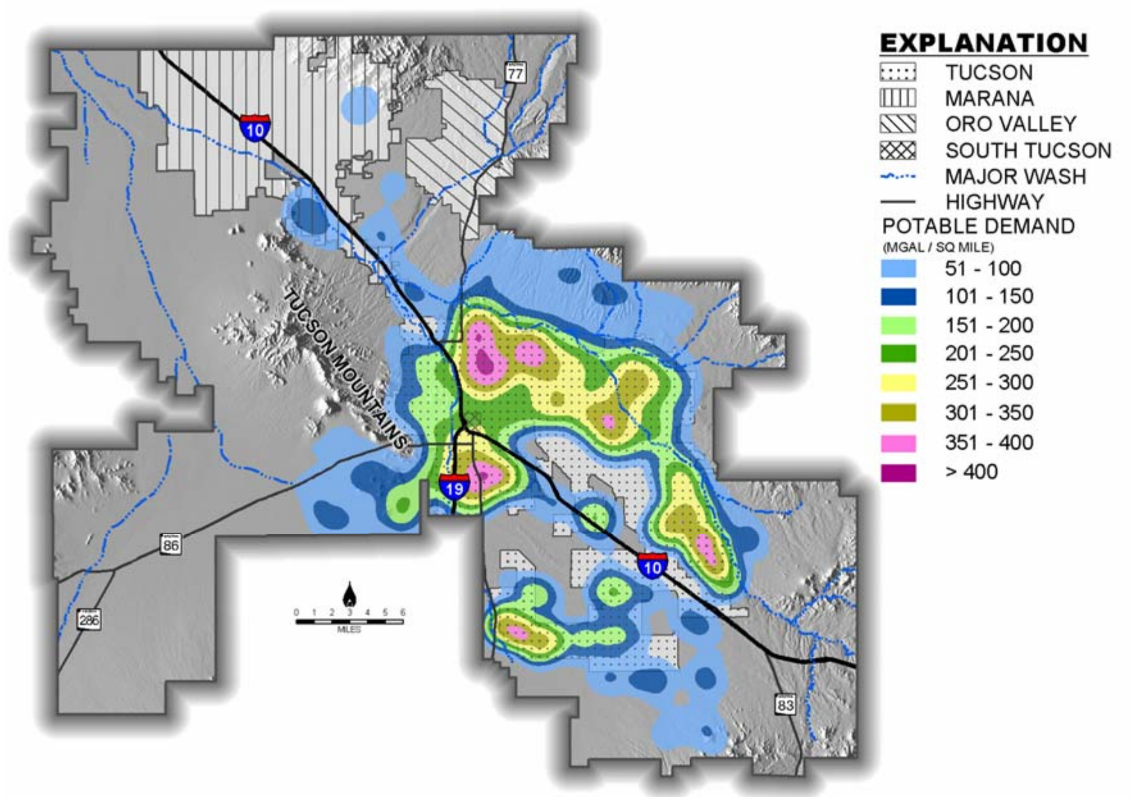



**Figure 3-7:** Annual Projected Potable Water Demand for Tucson Water's Service Area, 2030.

Tucson Water's potable distribution system is divided into a series of "Water Service Areas" which are zones that provide uniform water pressure based on changing land surface elevations and other operational factors. The spatially distributed population projections were merged with the Utility's Water Service Areas to assign water demand to discrete areas within the projected service area. This merger yielded spatial projections of future water demand by water service area, which in turn were used to project water system improvements needed to serve future Tucson Water customers.

Future water demands can vary significantly from those projected in this planning assessment due to many factors which are discussed in the next section. While the curve shown in Figure 3-5 provides a solid foundation from which to build planning pathways to the future, the pathways must be flexible enough to accommodate the uncertainties inherent in projecting future changes in population and therefore total water demand.

## EXTERNAL FACTORS THAT CAN AFFECT FUTURE DEMAND

There are a number of variables that can cause water demand to change over time. Many of these variables are external factors which are beyond Tucson Water's control. Three of these factors are discussed in this section.

### Weather

Long-term weather patterns such as prolonged drought or a long-term warming trend could result in increased customer water use. Conversely, periods of increased rainfall can result in decreased per capita water usage. The current water-use planning assumption of 177 GPCD is based on 20 years of data. This time period was characterized by both wet and dry periods. Therefore, the per capita planning assumption used to make demand projections would be appropriate if similar variations in weather patterns continue into the future. Should there be a marked difference in future patterns resulting in a significant change in per capita water usage, then the per capita planning assumption would be revised accordingly.

### Types of Water Use

Changes in the amount of residential, commercial, and industrial water use within the Long-Range Planning Area could create a change in the community's total per capita water usage rate. The community could shift away from its current desert-landscape ethic toward higher water use landscapes. Some industrial processes use large quantities of water, and per capita water demand could be affected if industrial activity increased significantly in the Tucson area.

### Population

The total water demand projection is driven largely by the rate of population growth in the area. This factor is not under Tucson Water's control; however, it has a profound impact on the demands that must be met. The actual future growth rate will vary from what is currently projected; therefore, the latter will need to be adjusted periodically based on revised population estimates and trends resulting from future census counts.

## DEMAND MANAGEMENT

Demand management initiatives are a critical element in any water-resource plan. The extent to which water demand can be further reduced has a significant bearing on the water resources and system improvements that will be utilized and implemented. Conservation and improving water system efficiency are two major demand management program areas.

### Conservation Programming

Water conservation programming will continue to play an important role in Tucson Water's recommended plan. Because communities differ in their mix of residential, commercial, and industrial demands, residential water use as measured by the single-family residential water usage rate provides a fairly reliable benchmark to evaluate how efficiently a given community uses water in comparison to others. Single-family residential water use was selected as the benchmark for comparison because it is less prone to skewing based on economic and other factors that are specific to each community.

Table 3-2 presents the single-family residential water usage rates for Tucson and other comparable municipalities. Tucson Water's ongoing conservation programs have been effective in maintaining a relatively low water usage rate which has been fostered and maintained for the past 20 years by a largely incentive-based conservation program and extensive educational outreach efforts. These programs will be continued and may even need to be expanded in order to avoid drifting back toward the higher per capita water usage of the past.

| Single-Family Residential GPCD* | Selected Western Cities |
|---|---|
| 114 | El Paso, Texas |
| **120** | **Tucson, Arizona** |
| 123 | Mesa, Arizona |
| 131 | Glendale, Arizona |
| 138 | Albuquerque, New Mexico |
| 140 | Tempe, Arizona |
| 165 | Phoenix, Arizona |
| 169 | Scottsdale, Arizona |
| 230 | Las Vegas, Nevada |
| 236 | Oro Valley, Arizona |
| 242 | Sacramento, California |
| 261 | Fresno, California |

*Source: Data provided by utility representatives except for Las Vegas and Albuquerque which were obtained from Western Resource Advocates (2003).

**Table 3-2:** Comparison of Single-Family Residential Water Usage.

Water saved through conservation programming does not create physical water; hence, conservation is not an additional source of wet-water supply. Instead, it is an important water demand management tool that contributes toward the efficient use of all existing and future water resources.

<u>Tucson Water's Conservation Program – Past to Present</u>

Conservation programming at Tucson Water grew out of early demand management initiatives. In 1903, Tucson Water "appealed to the fair-minded citizens of Tucson" to curb their lawn and garden watering during peak usage hours (Logan, 2002). Similarly, Tucson Water developed the *Beat the Peak Program* in the 1970s to reduce spikes in daily summertime water use. The program urged residents to cut back outdoor watering to every other day and not to water during the peak usage times of day. This program was initially created to provide Tucson Water time to make costly improvements to the water system. Tucson's conservation-minded citizens embraced the program's message so strongly that it came to include a summer water conservation education program.


***Beat the Peak*** *– This conservation program spans three decades.*

From the late 1970s to present-day, Tucson Water's conservation programs have included a number of initiatives such as:

- *Beat the Peak.*
- Rebates and incentives such as the ultra-low-flush toilet rebate program.
- Direct assistance programs such as the *Zanjeros* audit process.
- Targeted educational programs for school children, homeowners, business owners, and landscapers.
- Water-efficiency plumbing code changes and ordinances.
- Water conservation-related research projects.
- Increasing block rate structure.

The increasing block rate structure for residential customers is based on water use where the more water a household uses in a given month, the more expensive the water becomes. Commercial and industrial customers operate on a different rate structure which has additional charges for any water used over that particular customer's "base use" during the winter months.

Ordinances that require water-efficient plumbing fixtures, low water-use landscapes, or that prohibit water waste have been implemented in both the City of Tucson and Pima County. These ordinances have played a key role in managing water use over the past 15 to 20 years.

A more detailed discussion on conservation programming is provided in Appendix B: *Demand Management Program Development.*

Tucson Water's Conservation Program – Future

The current level of conservation programming will continue in order to maintain the per capita water usage rate. Tucson Water will also continue to evaluate existing programs and consider developing others based on program effectiveness, reliability, and cost.

Based on the experience of Tucson Water and conservation program industry experts, a conservation program that would achieve savings above what has already been accomplished would need programs with a mandatory and technological emphasis as opposed to the more voluntary programs and those that seek a change in customer behavior. Mandatory initiatives could include requiring water-saving retrofits of homes upon resale of the property, more aggressive water pricing structures, abolition of certain water uses, and/or mandatory conservation requirements on new and existing developments.

Before recommending more aggressive measures, Tucson Water will evaluate their demonstrated effectiveness in other comparable communities and consider their potential applicability in the Tucson community. Implementation of more aggressive programs would require firm resolve on the part of the community and governing bodies. Such efforts could result in additional decreases in the total GPCD for the community and a corresponding decrease in the projected growth of total water demand in future years.

## Water System Efficiency

Another area in which Tucson Water can exert some control on water demand is by improving the efficiency of its water distribution system by reducing lost and unaccounted for water. The need to more stringently manage water supplies is causing changes in the way utilities are regulated. ADWR has begun statewide enforcement of rules that obligate municipal providers to maintain lost and unaccounted for water at an amount not to exceed 10 percent of total water production. This provides added incentives to water providers to more efficiently manage their systems.

Water losses can be reduced by implementing a cohesive strategy to improve system efficiency. Leak detection and pressure management are maintenance programs which monitor potential water losses. A meter replacement program has been instituted to ensure that older meters that tend to under-report water use are replaced. Tucson Water is presently planning and implementing measures to reduce the amount of water lost through leaks, inaccurate metering, accounting, theft, and other losses. Decreases in the amount of water that is lost will help offset increasing total water demand.

# THE ROLE OF PROJECTED DEMAND IN WATER PLANNING

The projection of water demand through 2050 provides a series of supply targets that must be met in the years to come. To meet these targets, Tucson Water will ensure that sufficient water resources will be available and effective demand management measures will be implemented. Where supply shortfalls are anticipated within the planning period, additional sources of supply will need to be acquired to satisfy any unmet projected need. More aggressive demand management programs may also be required. Finally, the spatial distribution of projected water demands will guide water system upgrades and expansions needed to convey water from its sources to where it will be needed in future years.

*Water resources exist in paper-water and wet-water worlds. Both worlds must be in balance to ensure long-term sustainability.*

# CHAPTER FOUR

# AVAILABLE WATER RESOURCES

Prior to the early 1990s, the Tucson community had relied almost exclusively on ground water to meet water demand. Due to rapidly growing demand associated with population increases following World War II, the regional ground-water system transitioned from one in approximate equilibrium, where a balance existed between ground-water withdrawals and natural recharge, to one of accelerating depletion. Despite implementation of demand management programs and the strong environmental ethic of Tucson residents, ground-water withdrawals continued to increase due to continuing growth through 2000. Rapidly declining water levels in the metropolitan area as well as in surrounding areas have resulted in measurable land subsidence, increased pumping costs, and the gradual loss of natural habitat along local riparian corridors.

The need to develop renewable water supplies in order to meet projected long-term water demand has long been recognized. *Tucson Water Resources Plan 1990-2100* concluded that 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 ground water is limited to sustainable amounts. In *Tucson Water Resources Plan 1990-2100*, Tucson Water's various water resources were quantified based on a set of planning assumptions that were appropriate at that time. As discussed in Chapters Two and Three, some of these assumptions no longer apply and have been revised in this planning assessment.

This chapter briefly describes ADWR's Assured Water Supply (AWS) Program which places restrictions on how water providers utilize their water resources. In addition, the chapter quantifies the three water sources physically available and evaluates the constraints that may affect use of these water sources for potable and non-potable supply. Finally, this chapter discusses the potential opportunities to acquire additional volumes of each water resource. Detailed information on the AWS Program and potential water supply acquisitions is included in Appendix C: *Assured Water Supply Implementation*.

## THE ASSURED WATER SUPPLY PROGRAM

To appreciate how Tucson Water will utilize its water resources, it is critical to understand the rationale underlying the AWS Program managed by ADWR. AWS is the regulatory paradigm for municipal water-resource management in Arizona's Active Management Areas. The program is designed to ensure that the water supplies that support developing communities are sustainable over the long term. In order to accomplish this, all new developments must demonstrate that their existing, committed, and reasonably foreseeable future water demands can be met using renewable water supplies over a 100-year period. Various water resources can be utilized to meet water demand but reducing and eventually eliminating reliance on "mined" ground water is the ultimate goal. This necessitates a shift toward increasing utilization of renewable water supplies. The program also embodies a credit accounting system that tracks all water usage and applies to all water supply sources available to the City of Tucson.

### "Paper Water" versus "Wet Water"

In order to comprehend the importance of the AWS Program as a water management tool, the distinction between "paper water" and "wet water" must be understood. The world of paper water centers on the various rights and credit accounts that together provide Tucson Water with the authority to pump or use water. The world of wet water, on the other hand, is based on the availability and use of physical water. According to ADWR (2001):

> "The process of calculating the basic allocation, the incidental recharge factor, and the extinguishment credits produces an amount of 'paper water.' It may be the case that an existing water provider is entitled to an amount of groundwater on paper that does not exist in the aquifer. It is important to remember that even though an applicant is entitled to a groundwater allocation, the physical availability of the water must be proven."

While paper water and wet water management strategies overlap, they emphasize different aspects of water-resource planning. A water provider may be able to demonstrate the physical availability of a water supply but must also have the legal right to use it. Conversely, while a water provider may have the legal right to use a certain quantity of water, hydrologic availability can place physical constraints on its use. The Utility has set a long-term planning goal of achieving hydrologic sustainability while working within the constraints of the laws and regulations governing water use.

### Water Credit Accounting

Under the AWS Program, all ground-water withdrawals are debited from several potential sources of water credits. This program places a finite cap on the amount of ground water that can be pumped by Tucson Water without incurring a replenishment obligation. This is referred to as allowable ground water. When AWS accounting went into effect at Tucson Water in 2001, the Utility projected that it would have access to approximately four million acre-feet of allowable ground-water credits. Under current regulations, once this volume is exhausted, all ground water that is subsequently withdrawn must be replenished with a renewable supply. Because future dependency on mined ground water is not consistent with the AWS Program, Tucson Water will become increasingly reliant on Colorado River water, municipal effluent, and other potentially available water supplies that may be delivered through the Central Arizona Project.

Tucson Water manages several paper-water credit accounts that can be credited and debited under the AWS Program. These credits include allowable ground water, remedial ground water, annual recharge, and long-term storage. Descriptions of each type of credit and information regarding their requirements and/or limitations are provided in Appendix C: *Assured Water Supply Implementation*. Tucson Water actively manages these water accounts to ensure its compliance with AWS regulations.

While paper-water accounting is a critically important aspect of water resource management, municipal water providers also are concerned with having access to physically available water of sufficient quantity and quality to meet current and projected service area demands. Tucson Water has three water sources of supply currently available: ground water, imported Colorado River water, and municipal wastewater effluent. The current and future availability of these water sources and other potential supplies are discussed in the following sections.

## GROUND WATER

### Physical Availability of Ground Water

The volume of physically available ground water within Tucson Water's projected service area can be estimated using a number of approaches. Two approaches were applied in developing *Water Plan: 2000-2050* with each addressing "physical availability" in different terms. The first approach provides an estimate of the volume of ground water currently in storage that could be potentially withdrawn (depletion model). The second approach provides an estimate of the volume of ground water that is naturally replenished each year (sustainability model).

The depletion model is based on a simple "tank" analysis. The estimate obtained through this analysis was calculated based on three parameters: aquifer area within the projected service area, the thickness of potentially accessible saturated sediments, and the estimated specific yield of these sediments. This analysis ignores natural recharge which seasonally replenishes local aquifers. The tank analysis also assumes that the entire specified thickness of saturated sediments can be dewatered. Using this approach, the volume of ground water potentially available within Tucson Water's projected service area may be about 18.5 million acre-feet. However, even if this total volume were physically recoverable, it is not legally available because withdrawing this water would be contrary to the Arizona Groundwater Management Act of 1980 and its declared goal of "safe yield" for the Tucson AMA. Under the AWS Program, there is a limit to the amount of allowable ground-water credits available for pumping. Arizona law does not allow physical water supplies in the Tucson AMA to be depleted by new growth in the long term.

The sustainability model estimates annually renewable ground water that is physically available for hydrologically sustainable pumping within Tucson Water's projected service area. Under this approach, aquifer depletion is not considered a potentially available source of supply. The average annual volume of renewable ground water available within the projected service area can be approximated in a number of ways using published information and/or by utilizing estimating tools. Tucson Water estimates that renewable ground water may be as much as 50,000 acre-feet per year. For planning purposes, it is conservatively estimated that Tucson Water can withdraw 50,000 acre-feet of ground water each year without causing significant water-level declines within its projected service area. Under the AWS Program, however, the Utility has a finite quantity of ground water credits that it can legally pump to meet both current and future demand.

## Ground-Water Use Constraints

Four potential constraints on the use of ground-water supplies are discussed in this section: ground-water quality concerns, competition for locally available ground water, aquifer stewardship, and legal rights to use ground water.

### Ground-Water Quality Concerns

Ground-water contamination exists in a number of areas within the current Tucson Water service area as well as within the larger Long-Range Planning Area. The presence of contaminants has impacted Tucson Water's ability to efficiently utilize its ground-water resources. Many production wells have been taken off-line over the years due to the presence of contaminant plumes. However, such operational impacts are relatively minor and do not place significant restrictions on the current use of ground water as long as the contaminated ground water is contained and treated. The Tucson Airport Remediation Project pumps contaminated ground water from the aquifer, treats it to drinking water standards, and uses it in the potable distribution system. The potable use of remediated ground water is not expected to grow significantly during the planning period. However, a potential incentive for future use is that such water is not debited from AWS ground-water accounts.

### Competition for Locally Available Ground Water

Ground water that Tucson Water has historically relied upon for supply is in many ways a shared resource. The aquifer system has stresses placed on it not only by Tucson Water but also by other municipal and private water providers, industrial and agricultural operators, and numerous private well owners. For more information on other local ground-water users, refer to Appendix A: *Other Water Users in the Region.*

Tucson Water is currently the only local water provider that is not totally dependent on "wet" ground water as its sole source for potable supply. Management decisions that will be made by Tucson Water to balance its use of this resource must take into account the actions of other ground-water users. Some other municipal water providers in the region are developing plans to utilize Colorado River water in place of mined ground water. However, some small private water companies, agricultural interests, and industrial water users are not required under the Groundwater Management Act of 1980 to cease mining ground water and shift to renewable supplies. A more regional approach in managing the common ground-water resource is needed to ensure that all entities take collective responsibility in managing the local aquifers in an equitable and sustainable manner.

Aquifer Stewardship

Over the past 60 years, the regional aquifers located in the Tucson basin and Avra Valley have been over pumped. This has caused significant water-level declines, associated land surface subsidence, and loss of riparian habitat. In order for ground water to remain a viable water resource for future use, water users must shift from strategies that rely on over pumping to those that use ground water at the rate it is replenished. This is referred to as sustainable pumping. Tucson Water is planning to curb its own ground-water use so that it does not exceed a hydrologically sustainable pumping rate. While Tucson Water is the largest regional water provider, it is only one of many ground-water users in the region. For the Utility's aquifer management efforts to be effective, all local ground-water users must work together as stewards of the Tucson AMA's regional aquifers. Such a coordinated effort would make it possible to stabilize water levels and reduce the potential for continued land subsidence and loss of riparian habitat.

***Pinal County Subsidence Fissure -*** *Settling or cracking of the land surface can result from over-pumping an aquifer.*

Legal Rights to Use Ground Water

Tucson Water has a finite amount of ground water it can legally withdraw. The Utility was granted an initial volume of allowable ground-water credits when it obtained its AWS designation. There are additional ground-water credits that will be added to this account over time (see Appendix C: *Assured Water Supply Implementation*). Once these paper-water credits are exhausted, all ground water that is pumped must be replenished with a renewable water supply. It is projected that if Tucson Water utilizes ground water at a hydrologically sustainable rate, about 50,000 acre-feet per year, then the Utility will eventually deplete its allowable ground-water credit account. At some point in time beyond 2035, the remaining credit balance may not be sufficient to maintain the City of Tucson's AWS designation without acquiring additional renewable water supplies or reducing per capita demand.

## Potential Changes to Ground-Water Availability

The City of Tucson is a member of the Central Arizona Groundwater Replenishment District (CAGRD). Under the terms of the CAGRD contract, the CAGRD has agreed to replenish up to 12,500 acre-feet per year of excess ground water pumped by Tucson Water. This could extend the amount of ground water legally available to the Utility although at a significant cost. If the CAGRD is utilized in this fashion, it will be important to ensure that replenishment occurs in a facility in which Tucson Water has direct recovery capability.

Several communities in Arizona have acquired ground water from less populated areas in the State and are developing plans to convey the water to the more highly developed urban areas. Substantial quantities of ground water might be available from undeveloped basins in western Arizona. Such transfers of ground water could yield an additional water supply in the future or they may be used to augment Colorado River water supplies in shortage years. These supplies could potentially be delivered to the Tucson area by utilizing existing excess capacity in the Central Arizona Project.

The AWS Program does not currently recognize annually renewable ground water that is derived from natural recharge. Without such recognition, Tucson Water's allowable ground-water credits will continue to be debited each year by the amount of ground water pumped. Tucson Water views renewable ground-water as a water resource that should be formally incorporated into ADWR's program. This would require legislative action and/or a regulatory-driven process that would quantify the volume of ground water that could be annually available for sustainable ground-water pumping. Tucson Water should pursue such a change in order to establish that in future years, the appropriate amount of ground water will not only be physically accessible but also legally available as a source of supply. However, *Water Plan: 2000-2050* is based on current law and does not assume that the law will be changed in the future to recognize "renewable ground water."

## COLORADO RIVER WATER

Tucson is located in an arid region where very few stream reaches contain natural perennial flow. At one time, natural stream flow was a significant source of supply along certain channel reaches to historic populations in the Tucson area; however, given the ephemeral nature of most streams, local natural stream flows are no longer a viable source for municipal supply. Colorado River water is the only imported renewable surface-water source available in the Tucson AMA.

### Availability of Colorado River Water

The State of Arizona currently has rights to 2.8 million acre-feet of Colorado River water per year. Water users in California have historically diverted portions of Arizona's allocation that went unused in any given year. In the past four years, however, the Arizona Water Banking Authority (Water Bank) has stored excess Colorado River water in long-term banking facilities to bring the State's full allocation into use.

As shown on Figure 4-1, Colorado River water is delivered to the area via the Central Arizona Project that conveys water from Lake Havasu to its terminus located southwest of Tucson. It is a 336-mile long system of canals, tunnels, pumping plants, and pipelines. The Central Arizona Project is the largest single source of renewable water supply available to the Tucson area.

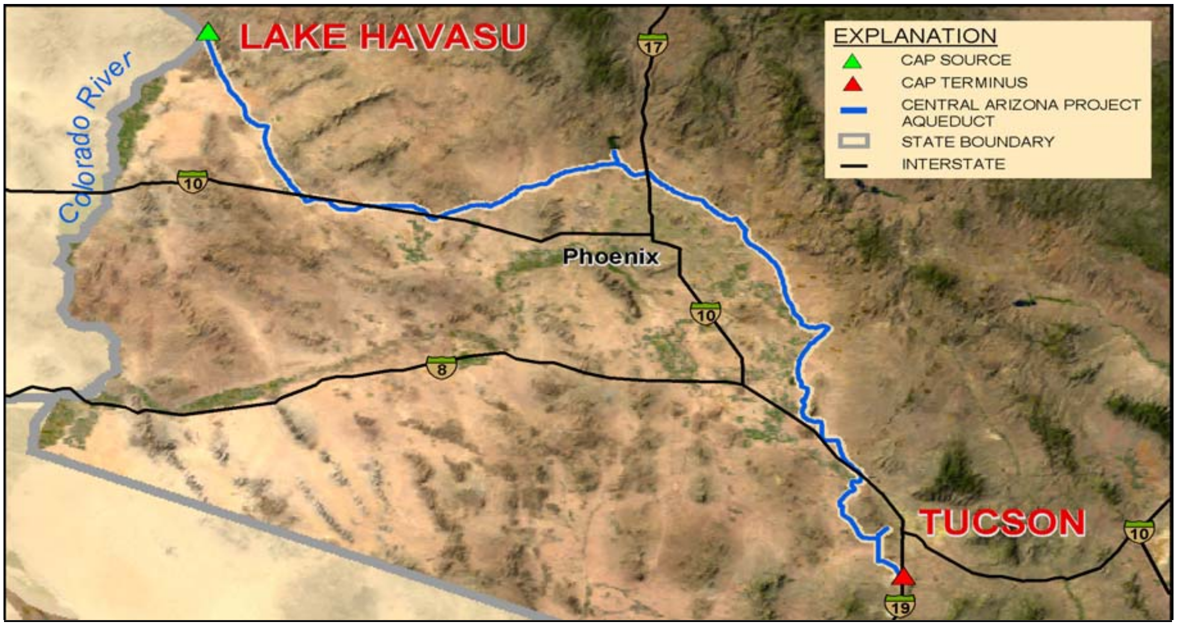



**Figure 4-1:** The Central Arizona Project Aqueduct**.**

The current and pending Central Arizona Project allocations in the Tucson AMA are shown on Table 4-1. The pending reallocations are included in the Arizona Water Settlements Act which has cleared the relevant committees in both houses of Congress and is expected to be enacted soon. Tucson Water's current Central Arizona Project allocation is 135,966 acre-feet per year. Once all pending reallocations are approved, the City's allocation is expected to total 144,172 acre-feet per year. For planning purposes, however, the current annual allocation of 135,966 acre-feet is considered the available Colorado River water supply when making projections within the 50-year planning horizon. The other allocations in the Tucson AMA may be used directly by their holders, may be wheeled to the providers by Tucson Water through future agreements, or may be made available for lease or purchase.

| Allocation Holder | Current Allocations | Pending Reallocations | Future Allocations |
|---|---|---|---|
| City of Tucson | 135,966 | 8,206 | 144,172 |
| Community Water Company (Green Valley) | 1,337 | 1,521 | 2,858 |
| Flowing Wells Irrigation District | 4,354 | 0 | 4,354 |
| Green Valley Domestic Water Improvement District | 1,900 | 0 | 1,900 |
| San Xavier District (Tohono O'odham Nation) | 27,000 | 23,000 | 50,000 |
| Schuk Toak District (Tohono O'odham Nation) | 10,800 | 5,200 | 16,000 |
| Pasqua Yaqui Tribe | 500 | 0 | 500 |
| Town of Marana | 47 | 0 | 47 |
| Metropolitan Domestic Water Improvement District | 8,858 | 4,602 | 13,460 |
| Town of Oro Valley | 6,748 | 3,557 | 10,305 |
| Spanish Trail Water Company | 3,037 | 0 | 3,037 |
| Arizona State Land Department | 14,000 | 0 | 14,000 |
| Vail Water Company | 786 | 1,071 | 1,857 |
| **Total** | **215,333** | **47,157** | **262,490** |

**Table 4-1:** Central Arizona Project Allocations in the Tucson AMA (Acre-Feet).

## Colorado River Water Use Within Existing Constraints

Clearwater Program and the Blend

***Basin Recharge of Colorado River Water –*** *Tucson Water's Central Avra Valley Storage and Recovery Project went into operation in 2001.*

To utilize Colorado River water in compliance with the constraints imposed by a citizens' initiative passed by voters in 1995 that prohibited its direct use, Tucson Water constructed CAVSARP, a large-scale recharge and recovery facility in central Avra Valley. This facility was built to recharge and recover up to 60,000 acre-feet of Colorado River water per year (54 million gallons per day, MGD). The facility consists of 330 acres of recharge basins, 27 recovery wells, a 54-MGD booster station, an 8 million-gallon reservoir, and approximately 25 miles of pipelines. Through the recharge and recovery process, Colorado River water mixes with native Avra Valley ground water to produce a blended water supply. CAVSARP, the Hayden-Udall Treatment Plant, and the 60-million gallon Clearwell Reservoir in the Tucson Mountains form the core infrastructure of the current Clearwater Renewable Resource Facility. These core facilities currently utilize about 45 percent of the City of Tucson's annual Central Arizona Project allocation and make it available for potable supply. The existing and proposed Clearwater Program facilities shown on Figure 4-2 would allow Tucson Water to make full use of its Central Arizona Project allocation. The Clearwater Program has gained wide community support. Regular deliveries of the blended water began in May 2001.

Building upon the success of the Clearwater Program's recharge and recovery facility at CAVSARP, plans have been initiated to assess additional program elements to fully utilize the City's entire Central Arizona Project allocation as soon as possible. Proposed projects shown on Figure 4-2 and described in the following section include:

- Expanding the permitted recharge capacity of CAVSARP.
- Implementing the Southern Avra Valley Storage and Recovery Project (SAVSARP).
- Developing a new well field near Three Points in Avra Valley.
- Constructing the Spencer Interconnect pipeline.
- Augmenting existing pipeline infrastructure.
- Incorporating additional treatment processes at the Hayden-Udall Treatment Plant

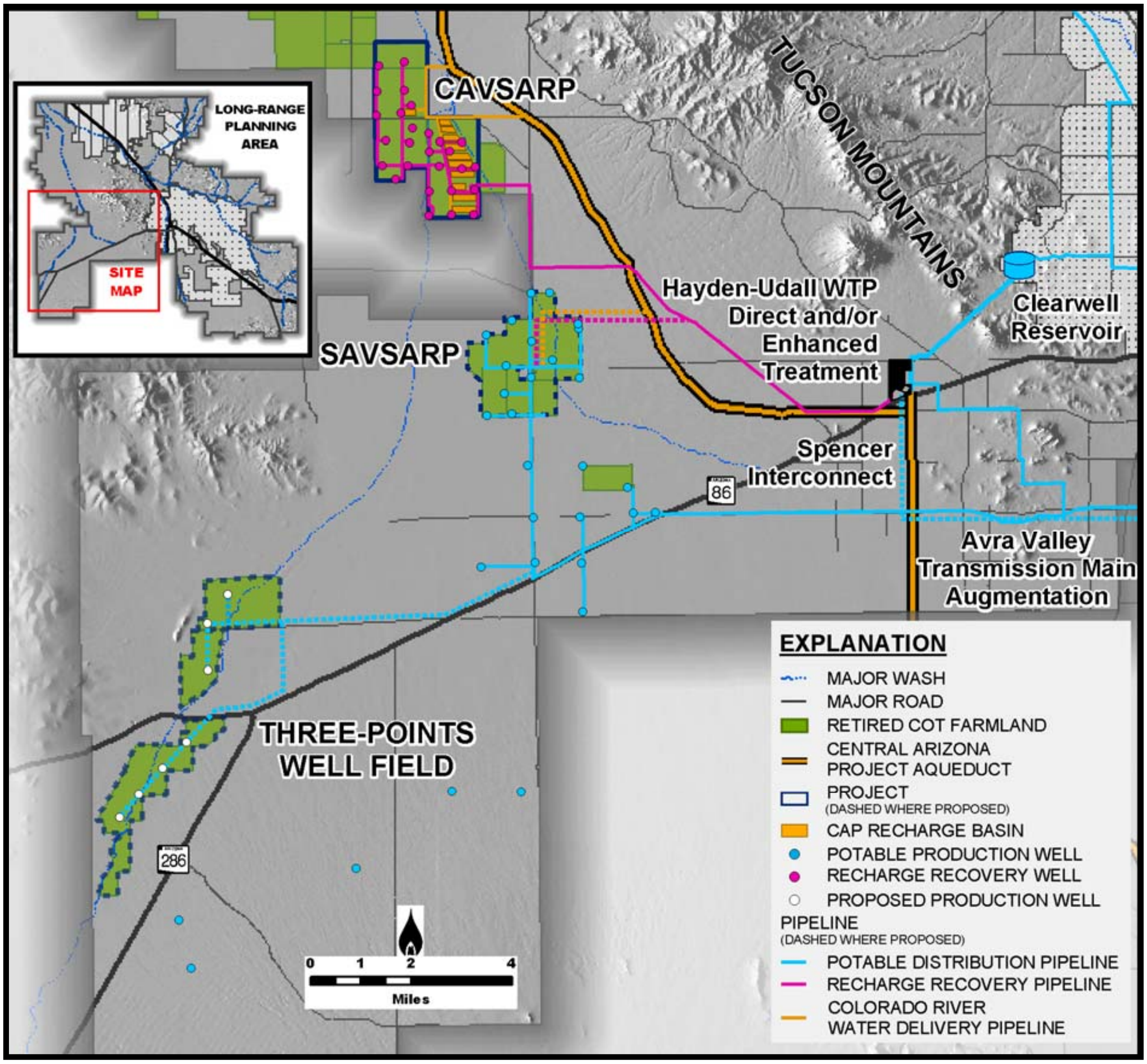



**Figure 4-2:** Existing and Proposed Clearwater Program Facilities.

The CAVSARP facility is currently permitted to recharge and recover up to 60,000 acre-feet of Colorado River water per year. The existing recharge facilities, however, are physically capable of recharging up to 80,000 acre-feet per year. An application to expand the annual permitted recharge capacity to 80,000 acre-feet has been submitted to ADWR to allow additional annual recharge at CAVSARP by 2005.

SAVSARP, another CAVSARP-type facility that may be located several miles to the south, may have sufficient annual capacity to recharge and recover 45,000 to 100,000 acre-feet of Colorado River water. The upper end of this range could provide Tucson Water with the physical ability to fully utilize its annual Central Arizona Project allocation. In addition, it could provide storage capacity to the Water Bank to store excess Colorado River water for use in future years. If this project were implemented, construction efforts would include 200 to 400 acres of recharge basins, 20 to 40 recovery wells, a reservoir/booster station, and many miles of pipelines to convey this additional blended supply to the Hayden-Udall Treatment Plant.

A proposed Three Points Well Field could be constructed in southwestern Avra Valley. This well field may be designed to produce approximately 2,000 to 6,000 acre-feet of ground water per year by adding six to eight new supply wells. This additional ground-water supply would be used to maintain the desired water quality of the Clearwater Program's blend of local ground water and Colorado River water. Ground water from the proposed Three Points Well Field and from an existing southern Avra Valley well field would be conveyed to the Hayden-Udall Treatment Plant for blending via the proposed Spencer Interconnect pipeline.

Modifications to the Hayden-Udall Treatment Plant could include rehabilitation of the existing filtration process, alternative primary and secondary disinfection equipment, and the potential for enhanced treatment of surface water and/or recharged and recovered Colorado River water through membrane filtration. The purpose of enhanced treatment would be to satisfy the water-quality preferences of Tucson Water customers for the Clearwater blend. For any alternative that would include an enhanced treatment component, a method of brine disposal would have to be incorporated. It is currently envisioned that brine disposal would require the construction of many miles of pipeline to convey the waste stream from the Hayden-Udall Treatment Plant to lined evaporation ponds to be located on City-owned property.

Expanding the Clearwater Program to include the proposed projects will allow Tucson Water to fully utilize its Central Arizona Project allocation and will be a key element in Tucson Water's critical path over the next 10 years. Full utilization will be implemented as soon as possible to conserve ground water. When the proposed projects become fully operational, they will bring the Tucson Water service area onto a largely renewable water supply within 10 years. In addition, the expanded Clearwater Program could provide the Water Bank with recharge capacity to store excess Colorado River water at Tucson Water facilities. This would place excess Colorado River water in locations that can provide a direct wet-water input into the Tucson Water distribution system when such supplies are needed.

Indirect Use of Colorado River Water

While the community gradually increases its use of Colorado River water for potable supply, Tucson Water has the ability to accrue recharge (paper-water) credits while preserving ground water at two ground-water savings facilities (GSF) in Avra Valley. In addition, Colorado River water can be stored at the Pima Mine Road Recharge Project located immediately north of Sahuarita.

The GSF projects are farming operations that use Colorado River water to irrigate crops instead of pumping ground water. Recharge credits are granted by ADWR commensurate with the volume of ground water that is saved (not pumped) due to the use of Colorado River water for local farming. However, the ability to ever recover this water from the area where it is stored is uncertain. Without the ability to recover the wet water, the Utility would need to further deplete ground water within its service area in order to gain any direct benefit.

Tucson Water and the Central Arizona Water Conservation District jointly own the Pima Mine Road Recharge Project. The facility, which can recharge up to 30,000 acre-feet of Colorado River water per year, does not have a wet-water recovery component at this time. The facility is, however, adjacent to Tucson Water's Santa Cruz Well Field. This project is currently used to store Colorado River water for use in the future.

## Potential Changes to Colorado River Water Availability

Central Arizona Project Outages and Shortages

Tucson Water is more vulnerable to Central Arizona Project reliability issues than many other subcontractors because it has the largest Central Arizona Project subcontract and it is located at the terminus of the aqueduct. If the Central Arizona Project were to go temporarily off line or if extended drought conditions cause shortages on the Colorado River in future years, Tucson Water's Colorado River water supplies could be significantly reduced for indeterminate periods of time.

Model projections performed by ADWR suggest that in future years, there is an increasing likelihood of periodic shortages on the Colorado River due to significant droughts. Such events would affect the reliability of Tucson Water's supply of Colorado River water since the Central Arizona Project has the most junior right. ADWR (2003a) prepared a Central Arizona Project supply analysis for Tucson Water to assess the potential impacts on the Utility's Central Arizona Project allocation under a variety of reservoir operating assumptions and reservoir levels in 2003. The results of the analysis suggest that shortages could reduce the availability of Colorado River water for Municipal and Industrial (M&I) use between 2015 and 2020. The potential severity of these shortages in any year will depend upon future shortage criteria to be adopted by the Secretary of the Interior.

***Central Arizona Project –*** *This aqueduct brings Colorado River water from Lake Havasu to the Tucson area.*

Beyond 2020, the probability of a shortage in any given year can range from approximately 20 to 60 percent depending on operational assumptions. Many of these assumptions may vary as weather patterns change and the reservoir levels behind dams on the Colorado River fluctuate (ADWR, 2003a). Tucson Water will continue to collaborate with ADWR to obtain updated reliability projections as conditions change over time.

A terminal storage reservoir near Tucson was originally planned to provide the local area with continued access to Colorado River water during short-term operational outages, but it has not been constructed to date. However, recharge projects such as CAVSARP provide storage that can not only be relied upon to accommodate such events but would also provide long-term drought resistance.

Another strategy to help buffer Tucson Water's Colorado River water supplies against canal outages and shortages on the Colorado River is to increase the amount of Colorado River water which Tucson Water controls. Increasing the City of Tucson's annual Central Arizona Project allocation where possible and leasing the allocations of others would provide additional Colorado River water supplies in normal years while ensuring greater source and system reliability in shortage years.

The Water Bank is charged with storing excess Colorado River water to firm Central Arizona Project allocations in future years of shortage. It has set a goal of completing these state-wide activities by 2017. The local firming goal is to store approximately 810,000 acre-feet of Colorado River water within the Tucson AMA. However, the Water Bank might not have sufficient funding to meet this goal. In addition, questions have arisen regarding how this stored water will be delivered to the various water systems. The Utility is working with the Water Bank to provide storage capacity at facilities that have wet-water recovery capabilities. Implementing SAVSARP would further expand Tucson Water's ability to provide the Water Bank with recharge and recovery sites to store excess Colorado River water.

Acquiring Additional Sources of Colorado River Water

The City of Tucson will seek to increase its Central Arizona Project allocation and to access additional Colorado River water over the 50-year planning period. This may be accomplished through reallocation, lease, and transfer.

In the near future, a fixed volume of Colorado River water has been identified for reallocation to Arizona communities, and the City of Tucson has been recommended to receive an additional 8,206 acre-feet per year through this process. This reallocation will occur when the Arizona Water Settlements Act, now pending before Congress, is enacted and becomes enforceable. In addition, as State land is sold and developed in Tucson Water's projected service area, portions of the State's allocation could be transferred to the City. However, there is a discernable risk that the Colorado River water held by the State might in fact be transferred to other entities rather than to the City of Tucson.

The Tohono O'odham Nation currently has a contract for 37,800 acre-feet per year of Central Arizona Project water. The Arizona Water Settlements Act will provide an additional 28,200 acre-feet to the Nation. The U.S. Secretary of the Interior currently administers these allocations. The Tucson area will have first right of refusal to any of the Nation's Central Arizona Project water that may be leased in the future. However, if this option is not exercised, this water could be made available to other water users or providers in the three-county Central Arizona Project service area. In addition, a large volume of Colorado River water has been allocated to the Native American communities located in other areas of Arizona. Over time, Tucson Water could pursue lease agreements to access this potential water supply as well.

Tucson Water can also pursue Colorado River water currently used to support agricultural activities. Agricultural districts on the Arizona side of the Colorado River have higher-priority entitlements than the Central Arizona Project. If this water becomes available, it would be less subject to curtailment during declared shortages on the Colorado River. In addition, there are approximately 80,000 acre-feet of lower-priority agricultural Central Arizona Project water that may be annually available to municipal and industrial users in 10 to 15 years.

## EFFLUENT

Municipal wastewater effluent is a renewable water supply that steadily grows along with population. This recycled water supply can provide an alternative to ground water for urban irrigation and industrial uses through Tucson Water's reclaimed water system. In addition, this water source will be used to augment Tucson Water's ground-water supplies and help meet the area's increasing demand for potable water.

### Availability of Effluent

In 2003, 68,061 acre-feet of effluent were produced from the metropolitan wastewater treatment plants in the Tucson area. As shown on Table 4-2, the City of Tucson had entitlement to a total of 30,739 acre-feet of this effluent. Of this total, 13,121 acre-feet were reused as reclaimed water while the remainder was discharged to the Santa Cruz River. As the population of the Tucson community grows, so will the volume of effluent it generates.

| Entity | Acre-Feet per Year |
|---|---|
| Tucson | 30,739 |
| Secretary of Interior | 28,200 |
| Pima County | 3,986 |
| Metropolitan Domestic Water Improvement District | 3,074 |
| Oro Valley | 2,062 |
| **TOTAL** | **68,061** |

**Table 4-2:** Local Effluent Entitlements in 2003.

Annual effluent availability within the Long-Range Planning Area could approach 121,000 acre-feet by 2030 and 128,000 acre-feet by 2050 based on population growth projections and assumptions regarding per capita water usage, sewer return flow rates, and septic tank usage. Of these totals, it is projected that the City of Tucson would have annual entitlement to approximately 62,000 acre-feet by 2030 and about 66,000 acre-feet by 2050.

assumption is that the reclaimed water system will supply at least eight percent of the projected total demand through 2050. Accordingly, reclaimed water demand is projected to increase from 10,897 acre-feet per year in 2000 to approximately 20,200 acre-feet per year in 2050.

Effluent to Augment the Ground-Water Supply for Indirect Reuse

While treatment technologies exist to achieve potable standards with treated effluent, direct potable use of effluent is not a viable alternative at this time. However, as the population grows and other available potable water supplies become fully utilized, the need for reusing effluent as a critical supply source will grow. Treated effluent will most likely be reused indirectly through a sequenced program of enhanced treatment, recharge, recovery, and blending with other supply sources prior to delivery. Although this concept may not be exercised for many years, preparing for effluent reuse has already begun. Tucson Water considers effluent to be a vital renewable water resource that will be needed to ensure supply sustainability and drought resistance in the long term.

## Potential Changes to Effluent Availability

Tucson Water has entitlement to a large volume of municipal effluent and the Utility may be able to increase its entitlement in the future. This could include agreements to lease or purchase the Secretary of the Interior's effluent entitlement potentially available through SAWRSA as well as others. This would result in greater utilization of the only locally generated renewable supply that grows with the community.

## SUMMARY

The AWS Program is the regulatory paradigm that governs use of the water resources available to Tucson Water. The Utility must, within the legal constraints of the AWS Program, manage its available resources as wet water to ensure supply sustainability over the long term. To achieve hydrologic sustainability within Tucson Water's projected service area, the Utility will seek to limit its ground-water pumping to about 50,000 acre-feet per year. Barring changes in state water law, this rate of pumping will reduce Tucson Water's AWS portfolio of available ground-water credits of approximately four million acre-feet. Once this portfolio is exhausted, additional ground-water withdrawals would need to be replenished with renewable water supplies.

The City of Tucson's current Central Arizona Project allocation is 135,966 acre-feet per year with a pending reallocation of 8,206 acre-feet per year. In addition, the City of Tucson has annual access to 12,500 acre-feet of CAGRD replenishment water. The City of Tucson may be able to further augment its available Colorado River water supplies by implementing an aggressive resource acquisition program.

Tucson Water will also have entitlement to about 66,000 acre-feet per year of effluent by the year 2050. The Utility may purchase additional effluent entitlements within the 50-year planning period to further augment supplies.

In order to meet projected water demand within the 50-year planning period, projects and programs will have to be implemented in the near and mid terms to store (bank) physically available but unused wet-water resources for use beyond 2050. This volume of excess available supply, shown as an uplifted wedge on Figure 4-3, consists of unused Colorado River water and effluent. This volume of excess water availability occurs because potential annual supply exceeds projected annual demand through much of the 50-year planning period. Review of Figure 4-3 indicates that most of the projected excess supply is available in the near and mid terms and that it tapers off later in time. Any unused annual volumes will continue to be irretrievably lost and the excess supply available in the near and mid terms will be unavailable for use beyond 2050 when water demand may exceed available renewable supplies.

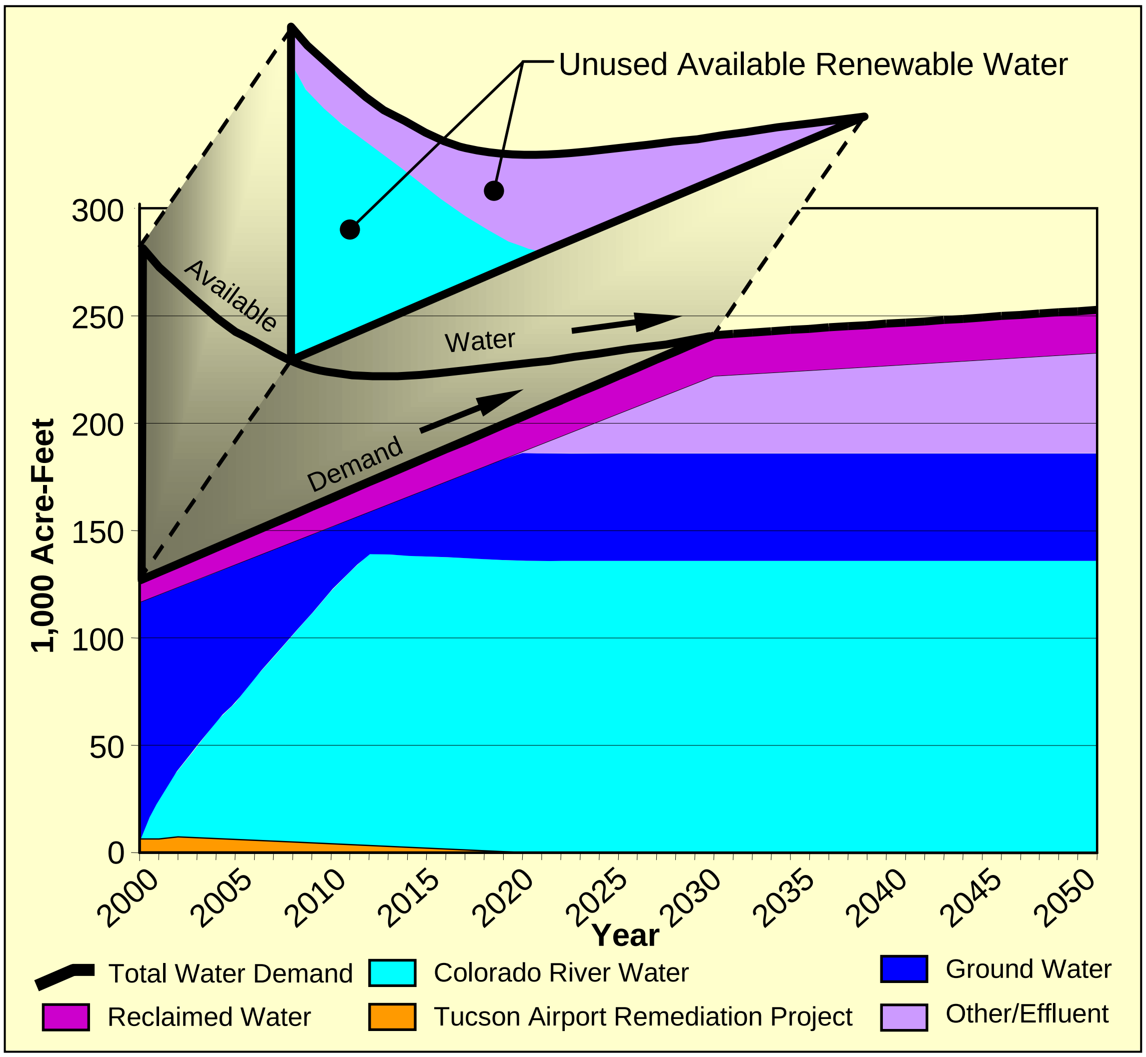



**Figure 4-3:** Projected Demand and Available Sustainable Water Resources, 2000-2050.

The projected availability of unutilized Colorado River water and effluent provides an opportunity to store readily available and relatively inexpensive renewable supplies for later use. This may provide incentive to more fully utilize existing facilities such as the Pima Mine Road Recharge Project and to construct additional underground storage facilities to accommodate excess supply within Tucson Water's projected service area while it is available. What is certain is that acquiring additional water supplies later in time when excess supply is no longer available will be subject to statewide competition. Because of market forces, the cost of acquiring additional supplies in later years will become increasingly expensive. For these reasons, the Utility will seek to secure additional supplies as early as possible.

The Utility's available wet-water resources, if fully utilized, will provide Tucson Water with sufficient supplies to meet demand throughout the 50-year planning period. In order to maintain the City of Tucson's AWS designation beyond 2035, it will be necessary to acquire additional renewable supplies and/or reduce per capita demand by implementing a more aggressive demand management program. Maintaining a diverse water-resource portfolio will provide Tucson Water with greater drought resistance, higher source reliability, and the ability to blend a variety of source waters to provide consistent water quality to customers.

Water source availability is only one piece of the long-term water-resource puzzle. How Tucson Water will access its available water sources and convey sufficient supply to where demands and services are located within its projected service area is another piece and the focus of Chapter Five, *Water Delivery Systems.*

*The spatial distribution of projected water demand will guide water distribution system upgrades and expansions to convey water to where it will be needed in future years.*

# CHAPTER FIVE

# WATER DELIVERY SYSTEMS

The previous chapters discussed the local area's water-resource history, the projected service area population and total water demand, and the water resources available to meet that demand. Another critical component of water-resource planning is determining how the existing supply infrastructure can be upgraded to meet projected water demand within the 50-year planning period. This chapter describes how ground water, Colorado River water, and reclaimed water supplies are conveyed through distribution systems to where they are needed and how those supply systems will be upsized and extended to meet total water demand in future years.

Tucson Water's existing water systems serve as baselines upon which future supply and demand needs are assessed. Such an assessment ensures that the necessary infrastructure will be in place when it is needed and that the water systems will be operated efficiently to maximize service while minimizing costs.

## EXISTING WATER SYSTEMS

Tucson Water operates two types of water systems: a potable system and a reclaimed (non-potable) system. Despite the fact that these are physically separate and distinct systems, both convey water from supply sources through a pressurized hydraulic system to customers situated at different elevations. A water system in its simplest form consists of one or more water resources (such as ground water, Colorado River water, and/or reclaimed water) and the facilities to convey the source water(s) to the user. Tucson Water's systems consist of a complex network of pipes, wells, pumps, reservoirs, valves, automated controls, and treatment facilities.

### Existing Potable Systems

Tucson Water's potable systems are designed and operated so that the following operational and regulatory requirements are met:

- Maintain adequate system delivery pressures.
- Meet the daily peak demand.
- Meet potential fire-flow demands.
- Meet or exceed all primary drinking water standards.
- Maintain adequate system disinfection levels.
- Satisfy customer expectations.

Tucson Water's potable water distribution systems served a population of 638,936 in 2000, and potable demand was 117,624 acre-feet. The potable systems collectively serve a 300 square-mile area.

Potable supply currently comes from more than 200 wells spread over five well fields with a collective pumping capacity of 196 MGD. Figure 5-1 shows the location of the five well fields within the Tucson basin and Avra Valley. The capacities of these well fields include about 93 MGD from the Central Well Field, 31 MGD from the Avra Valley Well Field, 9 MGD from the Southside Well Field (including the Tucson Airport Remediation Project), 9 MGD from the Santa Cruz Well Field, and 54 MGD from the CAVSARP Well Field. Average daily water demand in 2003 was 108 MGD and peak daily demand was 163 MGD.

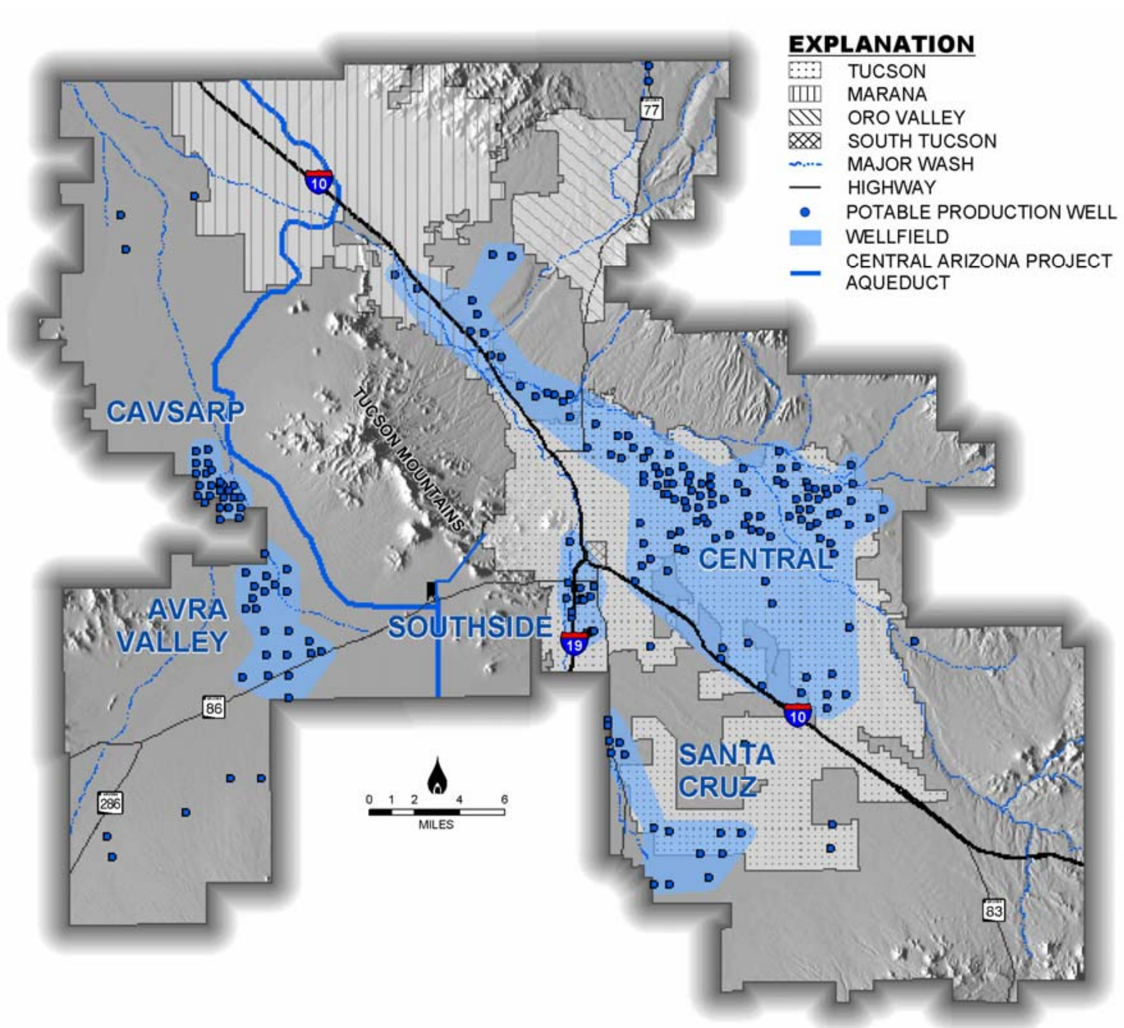



**Figure 5-1**: Tucson Water's Well Fields.

The Central, Avra Valley, Southside, and the Santa Cruz Well Fields pump native ground water for supply. The ground water pumped from these wells is directly discharged to the distribution piping system or to reservoirs. The CAVSARP Well Field, however, produces a blend of recharged Colorado River water and native ground water. Figure 5-2 shows the network of large diameter pipelines in Tucson Water's potable distribution system.

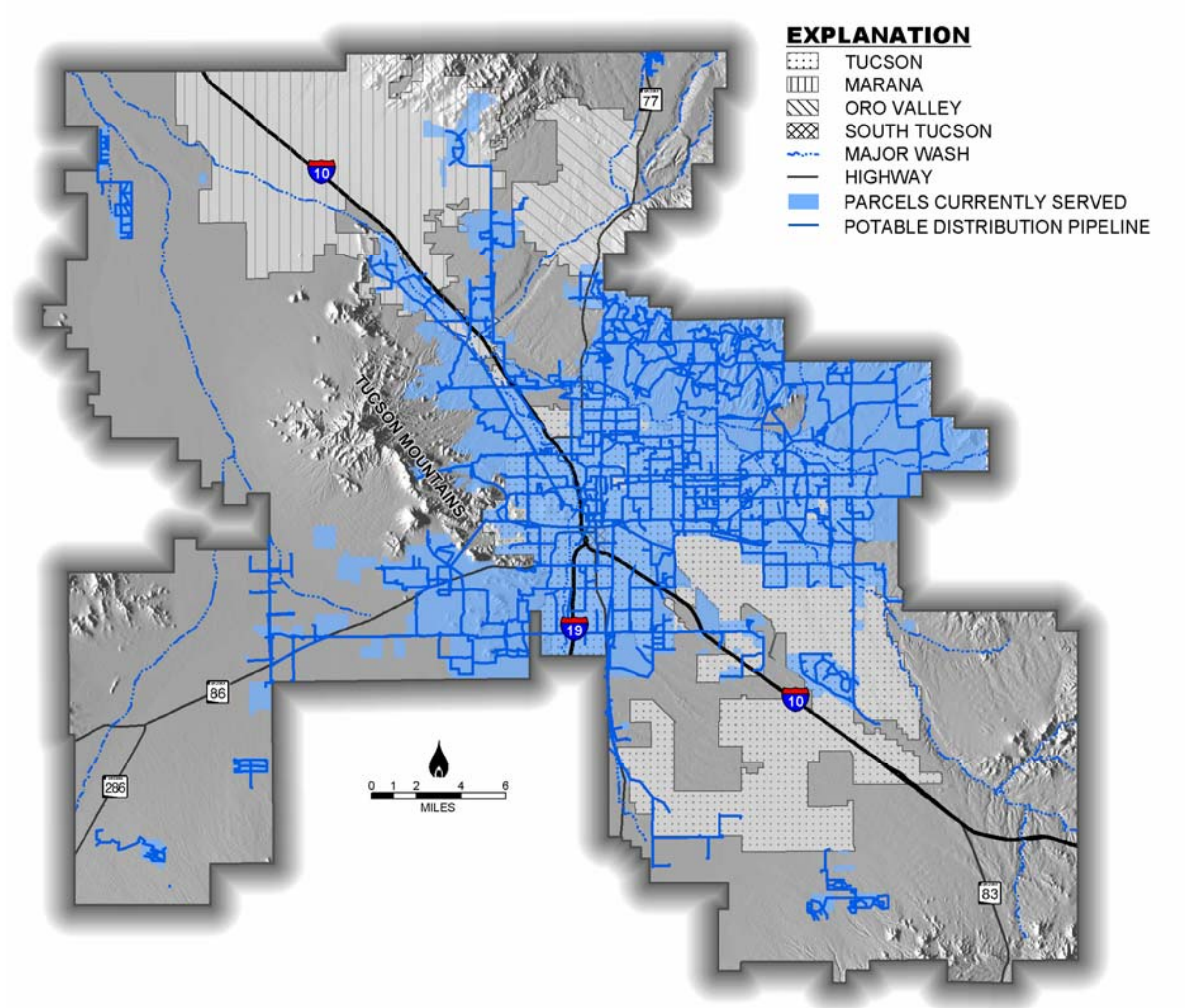



**Figure 5-2:** Tucson Water's Potable Distribution System as of 2000.

At CAVSARP, Colorado River water flows through a pipeline to recharge basins. The water soaks into the ground and percolates through subsurface sediments until it reaches the water table (i.e. recharges the aquifer) where it slowly blends with native ground water. CAVSARP enables Tucson Water to greatly reduce its dependence on ground water by satisfying almost half its current total potable demand with renewable Colorado River water.

CAVSARP is one component of the Clearwater Program (Figure 4-2) which also includes the Hayden-Udall Treatment Plant and the Clearwell Reservoir. The Hayden-Udall Treatment Plant currently chlorinates and controls the pH (acidity) of the blended water recovered at CAVSARP. The treated water is then boosted up to the Clearwell Reservoir, a 60 million-gallon covered storage facility, from where it is delivered to customers for potable supply and fire flow.

About 4,200 miles of transmission mains and distribution pipelines, with diameters ranging from 2 to 96 inches, convey water from the various potable supply sources to more than 200,000 businesses and residences. The distribution system relies on more than 50 fully enclosed reservoirs with individual storage capacities ranging from 15,000 gallons to 60 million gallons; the overall system has a total capacity of 273 million gallons. The system has 124 booster stations used to lift water from lower to higher delivery elevations.

In addition to the large, integrated central distribution system that supplies more than 99 percent of Tucson Water's potable demand, there are eight isolated potable systems supplied by dedicated production wells. Whenever practical, Tucson Water seeks to connect the small isolated systems to the central system to maximize system reliability and flexibility and to minimize operational inefficiencies.

Most of the supply wells and booster pumps are electric-powered with the remainder powered by natural gas engines. Large facilities like CAVSARP are equipped with both electricity and natural gas to ensure reliability and flexibility. Most wells, reservoirs, and booster pumps are connected to a central computer system that is monitored 24 hours a day. This system can remotely operate key elements of the delivery infrastructure and detect system malfunctions.

Tucson Water's service area is divided into 17 pressure zones which take into account the wide range of elevations associated with the many points of delivery. Each pressure zone corresponds to a change in land surface elevation of approximately 105 feet amsl. Tucson Water delivers water over an elevation ranging from 1,900 feet to 3,500 feet amsl. These zones are managed to maintain consistent system delivery pressures. Water can be transported between pressure zones via gravity and pressure reducing valves or by booster stations, both of which help to maintain system pressure. Reservoirs placed at appropriate elevations stabilize pressures in the system within acceptable ranges and provide backup storage for peak-use periods.

Demand varies not only from one day to the next but also within any given day. In addition, water supplies within the system may not be where it is needed at any given point in time; therefore, water must be conveyed from one area to another through the strategic placement of reservoirs, boosters, and wells. The distance between a supply source and the point of use can exceed 20 miles in some areas.

In addition to providing adequate water supply to Tucson Water's customers, a series of emergency system interconnects are located where the Tucson Water system abuts other water providers. These interconnects are used to supply water to other providers when they have system emergencies.

The ground water used by Tucson Water generally meets the applicable federal and state regulatory standards with little treatment. Because the water delivered through the Tucson Water distribution system must be free of pathogens, Tucson Water introduces chlorine at various locations in the system to maintain a residual disinfectant in the water delivered to customers. Areas where ground-water contamination could pose a threat to potable supplies are being managed by controlling ground-water pumping or by pumping and treating to either augment the ground-water system or for direct potable use.

The Tucson Airport Remediation Project was developed in order to treat ground water contaminated with volatile organic compounds. Tucson Water operates the remediation project under an agreement with the EPA and other industrial and governmental agencies that pay for operation of the project and provide the treated potable water at no cost to Tucson Water. The project water treatment plant produces approximately 6.2 MGD of potable supply. During 2002, the plant treated approximately 7,000 acre-feet of water that constituted about six percent of Tucson Water's total potable supply. This intensively monitored potable water source will continue to be available in gradually decreasing amounts until the ongoing ground-water cleanup is completed. The Tucson Airport Remediation Project may continue for another 20 to 30 years.

Tucson Water's *Environmental Monitoring for Public Access and Community Tracking* (*EMPACT* ) program was developed with a grant from the EPA. The *EMPACT* goals include implementing enhanced monitoring of the Utility's potable distribution system, providing the community with near "real-time" water-quality information on Tucson Water's web site (www.cityoftucson.org/water), and creating community partnerships to better inform water consumers about water-quality and resource issues. The water-quality monitoring and data collection tools provided through *EMPACT* also enable the Utility to track and respond to real-time changes in system water quality.

## Existing Reclaimed Water System

Tucson Water's reclaimed (non-potable) system is designed and operated so that the following operational and regulatory requirements are met:

- Meet the daily peak demand.
- Meet or exceed all reuse regulations.
- Maintain adequate system disinfection levels.
- Satisfy customer expectations.

Tucson Water has operated a reclaimed system since 1984. Reclaimed water usage in 2000 was 10,897 acre-feet, which was about eight percent of total water demand. The system takes secondary effluent from Pima County's Roger Road Wastewater Treatment Plant, further treats it to a higher standard, and delivers it for turf irrigation and other non-potable uses. The layout of the reclaimed water system is shown on Figure 5-3. The utilization of reclaimed water for non-potable uses has helped to conserve higher-quality water sources for potable water supply and to relieve some of the demand on the potable system.

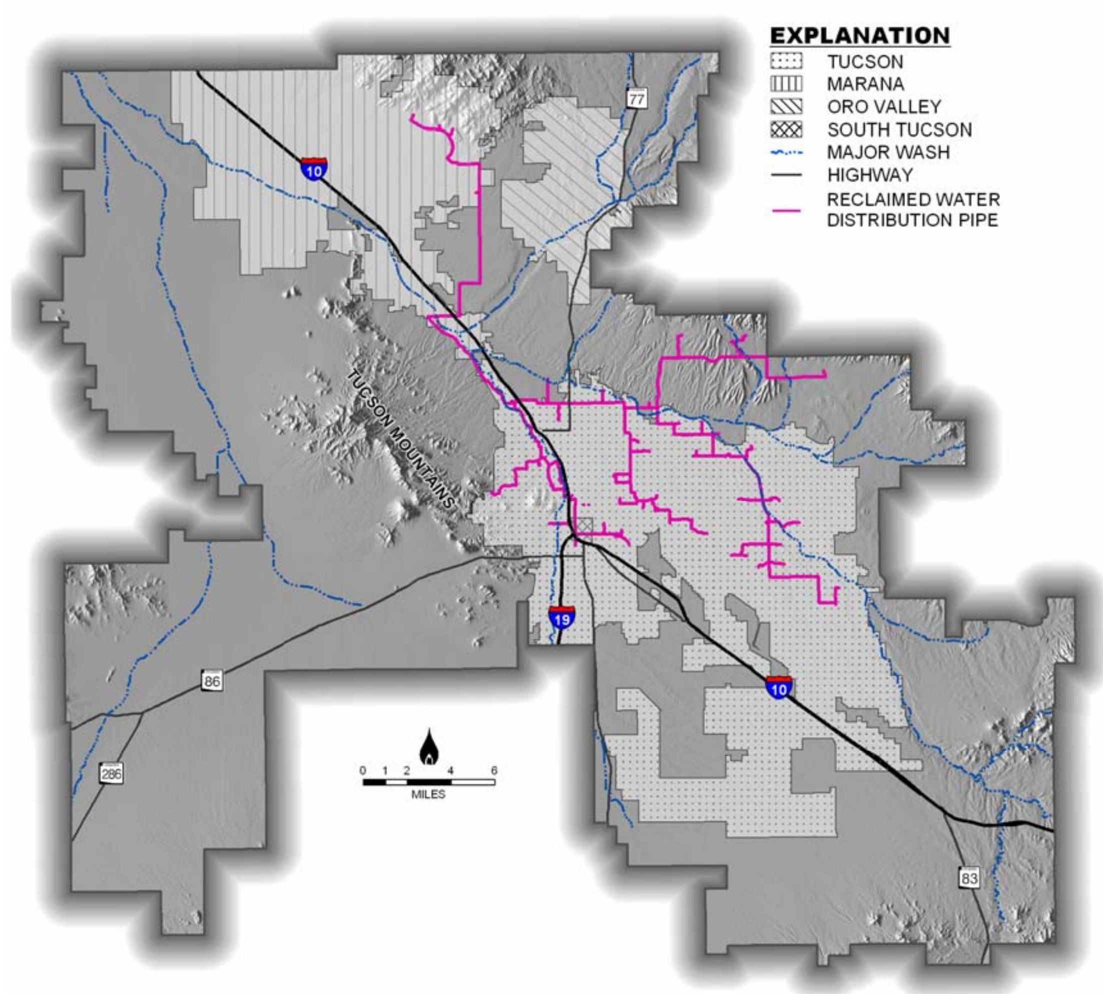



**Figure 5-3:** Tucson Water's Reclaimed Distribution Pipeline System in 2000.

The secondary effluent that is received from Pima County's treatment facilities is either filtered at the Tucson Reclaimed Water Treatment Plant or recharged in a number of facilities. The recharge facilities include the Sweetwater Recharge Facilities, the Santa Cruz River Managed Underground Storage Facility (Santa Cruz Phase I) and the Lower Santa Cruz River Managed Recharge Project (Santa Cruz Phase II) as shown in Figure 5-4. The Santa Cruz Phase I facility is co-owned with the U.S. Secretary of the Interior and the Santa Cruz Phase II facility is jointly owned by multiple parties.

The Tucson Reclaimed Water Treatment Plant is capable of treating up to 10 MGD. The Sweetwater Recharge Facilities are permitted to annually recharge and recover up to 6,500 acre-feet of reclaimed water to meet seasonal peak demand requirements. The recovered effluent is blended with filtered water from the reclaimed plant, disinfected with chlorine, and boosted to customers through the reclaimed water distribution system. The total delivery capacity of blended water from the reclaimed plant and the Sweetwater Recharge Facilities is 27 MGD. Santa Cruz Phase I is permitted to recharge approximately 9,300 acre-feet of effluent annually. The regulations that govern managed recharge facilities award credits for only 50 percent of the effluent that is recharged. The City of Tucson and the Secretary of the Interior evenly share the credits accrued at Santa Cruz Phase I; therefore, Tucson Water can accrue approximately 2,300 acre-feet of recharge credits per year. Effluent recharged under Santa Cruz Phase I is recovered through a well, disinfected, and conveyed through the reclaimed distribution system to customers. Santa Cruz Phase II is co-owned by several local entities and recharges effluent on behalf of Tucson Water as well as others with effluent entitlements. This facility does not currently have a recovery component.

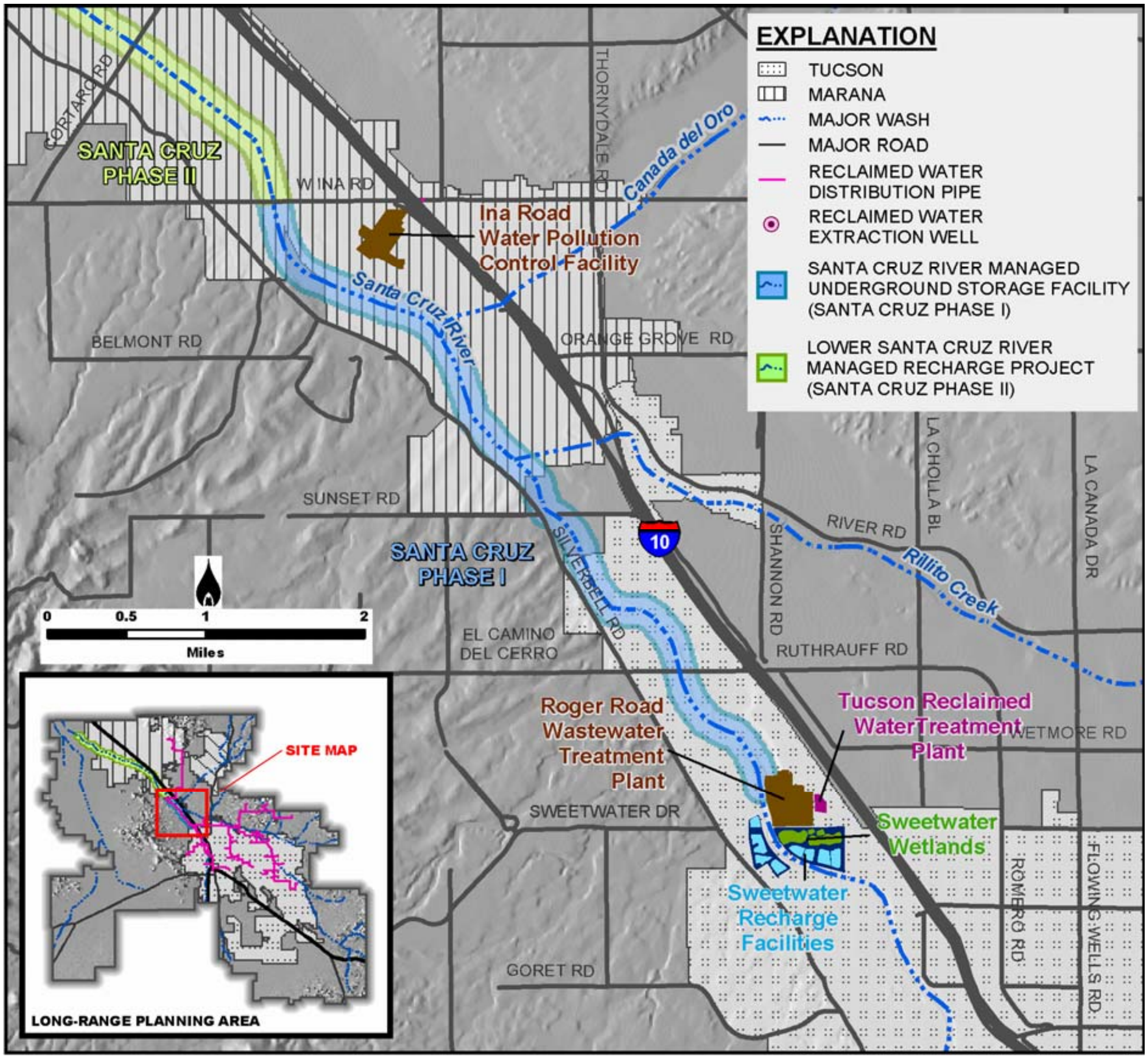



**Figure 5-4:** Sources of Supply to the Reclaimed Water System.

Other reclaimed facilities consist of reservoirs, booster stations, disinfection equipment, and over 135 miles of pipeline. Although less complex than the potable system, the reclaimed system is also monitored 24 hours a day by a centralized computer system and must also meet specific operational criteria and comply with regulations. Reclaimed water system pressures must also be managed but a wider range of pressure fluctuations are more acceptable than in the potable delivery system where delivery pressures are more stringently controlled. Similar to the potable system, the reclaimed system's booster pump stations move water for many miles and over substantial changes in elevation from supply source to points of service. Reclaimed water storage reservoirs ensure that the system can meet peak water demand. The network of pipelines delivers reclaimed water to more than 600 services which include parks, schools, golf courses, commercial and industrial facilities, and some residences.

Water delivered through the reclaimed system must meet Class "A" reclaimed water standards which are designed to protect human health if the public comes into direct physical contact with the water. Tucson Water treats the effluent through filtration and/or through soil aquifer treatment associated with the recharge process.

## IDENTIFYING POTABLE AND RECLAIMED SYSTEM NEEDS

Existing and future water system needs can be identified and evaluated by using computer models to simulate the system. These computer representations of the potable and reclaimed systems are called hydraulic models. These models use software to represent a system's various hydraulic elements such as sources of supply, pipelines, reservoirs, pumps, valves, and so on. To simulate a complex system, the entire distribution network is simplified or "skeletonized." The model consists of mathematical formulas used to calculate the effects of actual and projected supply inputs and demand outputs on system pressures. The results of a modeling assessment are portrayed schematically and are used to assess future potable and reclaimed system improvements.

### Future Potable System Needs

Future potable water system needs are determined by applying a GPCD water use factor to population projections within Tucson Water's projected service area. As described in Chapter Three, population projections are distributed spatially to locate future delivery system needs. Projected water demands are grouped by pressure zone to identify the required capacities of projected storage reservoirs and booster stations. These future facilities are schematically located within the hydraulic model at actual elevations closest to their associated demands. Hypothetical pipelines are laid out between facilities, typically on existing rights-of-way or section lines, to convey water from one to the other. The hydraulic model is used to size the projected pipelines and to ensure there is adequate water supply, storage, and pressure to meet the projected demands in 2030 and 2050. This necessitates adding infill capacity to the existing infrastructure. Extensions of the system to areas currently not served will require new pipelines and facilities as shown in Figure 5-5.

The primary areas for infrastructure expansion are projected to be in the south, southwest, and southeast portions of the Long-Range Planning Area. These are the areas where Tucson Water anticipates providing direct service in the future. Other water providers will be responsible for meeting their own future demands. However, depending on future agreements, their water resources may be treated and delivered (wheeled) to their respective service areas through Tucson Water's potable system.

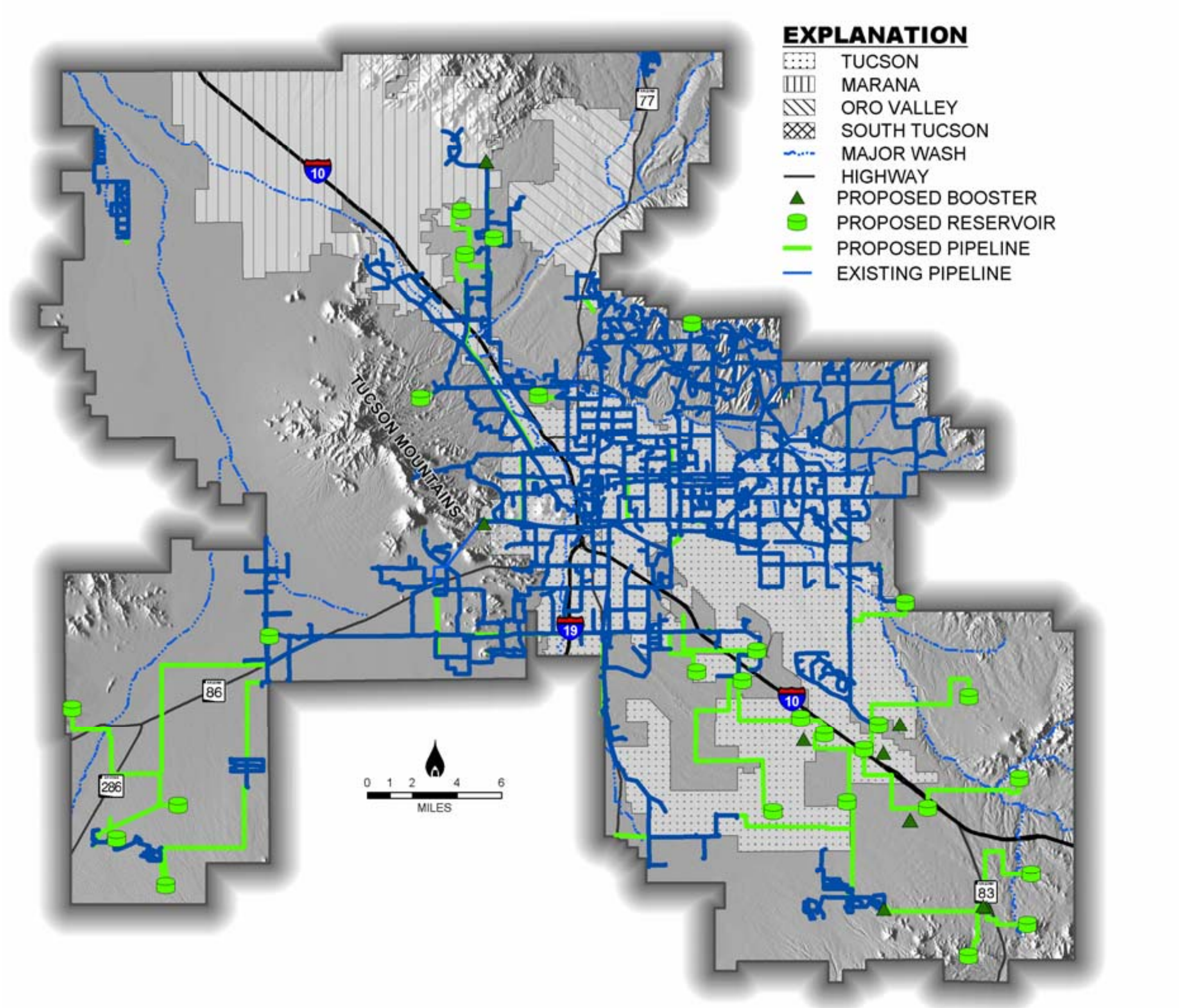



**Figure 5-5:** Potential Expansions of Tucson Water's Potable System through 2050.

Tucson Water's annual potable demand in 2000 was 117,624 acre-feet. This equates to an average demand rate of 105 MGD. Based on the population projections within Tucson Water's projected service area, average potable demands are projected to be 214 MGD (241,000 acre-feet per year) and 227 MGD (253,000 acre-feet per year) for 2030 and 2050, respectively. This equates to projected peak daily demands of 386 MGD in 2030 and 408 MGD in 2050 based on a peak-day planning factor of 1.8 which assumes that 1.8 times more water will be delivered on a peak day than on an average day. The peak daily demand commonly occurs in the month of June.

Cost-estimating functions of the hydraulic model were used to conduct a planning-level assessment of capital costs needed to expand and upgrade the potable distribution system through 2050. As shown in Table 5-1, the capital costs are projected to be almost $500 million by 2030 with an additional $50 million by 2050. The system expansion costs will average about $20 million annually through 2030. This annual rate of capital expenditure will only cover incremental costs for system expansions and does not include other costs required to maintain or replace existing infrastructure or to bring additional renewable water supplies into use.

| Year | Projected Service Area Population | Water Demand (Acre-Feet) | Expansion Cost |
|---|---|---|---|
| 2030 | 1.22 million | 241,000 | $500 million |
| 2050 | 1.28 million | 253,000 | $50 million |
| | | **Total Estimated Cost** | **$550 million** |

**Table 5-1:** Projected Potable System Expansion Costs in 2030 and 2050 (current dollars).

## Future Reclaimed Water System Needs

Reclaimed water for non-potable use has historically remained constant at about eight percent of total water demand. Accordingly, this plan assumes that at least eight percent of the projected total water demand will continue to be met by reclaimed water. At the present time, most reclaimed system customers are large turf facilities such as parks, golf courses, and schools. The capital improvement projects scheduled in the next decade will increase system capacity and water supplies and will improve operational efficiency to meet increasing future non-potable demand.

As with the potable system, it is expected that the bulk of the future growth in reclaimed water demand will occur in the southern portions of Tucson Water's projected service area. In addition to the existing non-potable uses, the reclaimed delivery system could be utilized to convey water to selected recharge locations to augment ground-water supplies during low demand periods.

## PUTTING THE PLANNING PIECES TOGETHER

Developing spatially distributed demand projections for the service area provides the information required for determining where to build new pipelines, boosters, and reservoirs. Water supplies and water treatment needs are based not only on projected water demands but also on the availability of source waters and the acceptability of those sources for supply. The water-resource component of the long-range planning process is described in Chapter Six, *The Planning Process.*

*A scenario planning process was used to develop Water Plan: 2000-2050. Scenario planning results in pathways to multiple, equally possible futures. The commonalities among the pathways provide the Utility with flexibility as it proceeds into the future.*

# CHAPTER SIX

# THE PLANNING PROCESS

In developing *Water Plan: 2000-2050*, Tucson Water used the best information available to create pathways to a range of possible futures. The futures and the pathways leading to them are identified through a rational process taken to its logical conclusion.

## INTEGRATED RESOURCE-PLANNING COMPONENTS

Tucson Water developed *Water Plan: 2000-2050* by evaluating the following components:

1. **Total Water Demand**. This component is based on projections of service area population and per capita water-use rates. As detailed in Chapter Three, *Projections of Population and Water Demand*, Tucson Water's service area population is projected to grow from 638,936 in 2000 to approximately 1.3 million by 2050. This translates into an increase in total annual water demand from 128,521 acre-feet in 2000 to approximately 253,000 acre-feet by 2050.

2. **Available Water Supplies**. Potentially available water supplies and the projects and programs that would be required to utilize them within the 50-year planning period were described in Chapter Four, *Available Water Resources*. Tucson Water's three primary sources of supply are local ground water, Colorado River water, and effluent. Tucson Water's annual water supplies are conservatively projected to include 50,000 acre-feet of hydrologically sustainable ground water, 135,966 acre-feet of Colorado River water, and by the year 2050, 66,000 acre-feet of effluent. While the 50,000 acre-feet per year of ground-water pumping is hydrologically sustainable during the planning period, continued pumping of that quantity would exhaust the City of Tucson's portfolio of ground-water credits before 2100. Without the acquisition of additional water resources, the Utility may not be able to retain its AWS designation after 2035. Additional potential supplies have been identified that may be acquired in order to meet water demands during the planning period and beyond 2050.

3. **Potable Water Distribution System**. Improvements to the potable water system will be required as peak capacity increases from its current level of 196 MGD to an estimated 408 MGD in 2050. The current state of the water system and the tools used to plan for future improvements are discussed in Chapter Five, *Water Delivery Systems*. Tucson Water conducted a conceptual-level assessment of system upgrades and expansions needed to meet spatially distributed increases in projected water demand through 2050.

4. **Estimated Costs**. Costs of water system improvements, water treatment infrastructure needs, and water-resource development projects were estimated for each of the alternative pathways. These costs are discussed in Chapter Seven, *The Recommended Plan*.

These four basic planning components formed the foundation upon which a recommended long-range water-resource plan was developed. This plan will be used to initiate a dialogue with the community regarding the critical decisions that will need to be made over time. The planning process must provide a high degree of flexibility in initiating capital improvements since they will be implemented in a planning environment where conditions and basic assumptions will inevitably change over time. An effective plan has to be adaptable to changing circumstances.

The 50-year planning period is divided into three major timeframes that represent major milestones: near-term (2000-2014), mid-term (2014-2025), and long-term (2025-2050). Primary objectives of the near-term period are to expand the Clearwater Program to fully utilize Tucson Water's annual Central Arizona Project allocation, assess the implementation of a more aggressive demand management program, and pursue the acquisition of additional renewable water resources. Tucson Water has established a system equity fee which is applied to new development to recoup past investments expended to provide additional system capacity to accommodate future demand. This is commonly referred to as a "backward-looking" fee. A "forward-looking" water-resource development fee will also need to be implemented to pay for future system improvements and to purchase additional water resources.

The mid-term period will usher in the need to shift effluent reuse from its current non-potable emphasis to indirect reuse for potable supply. However, if the Utility acquires sufficient additional supplies in the near term and an aggressive demand management program reduces per capita water usage, then the reuse of effluent for indirect potable supply could be delayed. In the interim, effluent would continue to be a viable water resource for other uses such as to offset ground-water pumping and to exchange for other water supplies.

As seen from the present, the long-term period may primarily be concerned with obtaining and developing additional high-cost water supplies for use beyond 2050. The uncertainties, issues, and challenges will become more complex as the region grapples with increasingly limited water resources, an expanding population, and increasing development pressure.

## PLAN DEVELOPMENT PROCESS

Resource planning begins when projected water demand and potentially available supplies are analyzed. This analysis generates a range of resource-management options. Assessment of these options commonly involves selecting a plan that leads to what may be the most-probable or desirable outcome. This process may be appropriate when there are fewer uncertainties in the future. However, when the planning process focuses on only one possible outcome, the ability to cope with an uncertain future could be constrained.

As shown in Figure 6-1, the result of a one-dimensional approach is the selection of what is perceived to be the most-probable or preferable outcome and the development of a pathway that leads directly to it. Such a one-dimensional view of the future could result in reduced planning flexibility and increased vulnerability. Unanticipated changes in conditions or in the planning assumptions could cause the plan to fail. If the failure is significant enough, recovery may come with great expense, organizational trauma, and a loss of public trust.

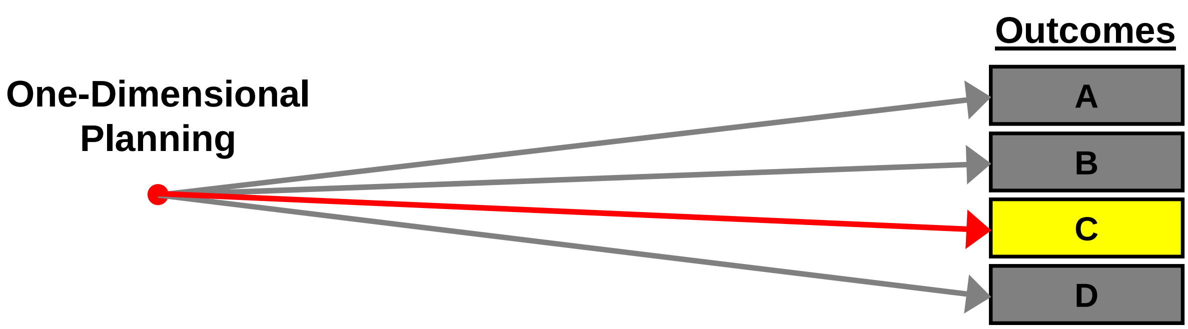



**Figure 6-1:** The One-Dimensional Planning Approach.

To avoid the potential pitfalls of the one-dimensional planning approach, Tucson Water utilized a more flexible planning process by adopting a “scenario planning” approach. This is a multi-dimensional approach that takes into account many possible futures which in turn provides for greater planning flexibility.

### Scenario Planning: Planning for Multiple Futures

Scenario planning gained widespread popularity among private businesses in the 1990s after a publication by Peter Schwartz (1991) titled *The Art of the Long View*. There are many scenario planning methods currently advocated, but Tucson Water adapted the Schwartz model to serve its needs.

Scenario planning provides organizational flexibility by planning for multiple possible futures (scenarios) each of which is considered equally likely to occur. Descriptions of each possible future are developed providing the basis for evaluating the various projects and programs that should be implemented to realize those futures. The resulting series of projects and programs is referred to as the pathway to each future.

Scenario planning is superior to the more one-dimensional planning approach when there are many critical planning uncertainties. Under the scenario planning approach, each possible future is considered equally likely to occur to maintain a multi-dimensional view of the future. The process involves building one-dimensional pathways to each possible future; however, the objective is to identify the common elements that lie on these different pathways. These are the programs and projects (i.e. elements) that are common to each of the identified futures as shown on Figure 6-2. By following the path of common elements, capital investments are directed toward projects that apply to multiple futures providing confidence that the decisions made today will remain viable. This multi-dimensional approach is the essence of scenario planning.

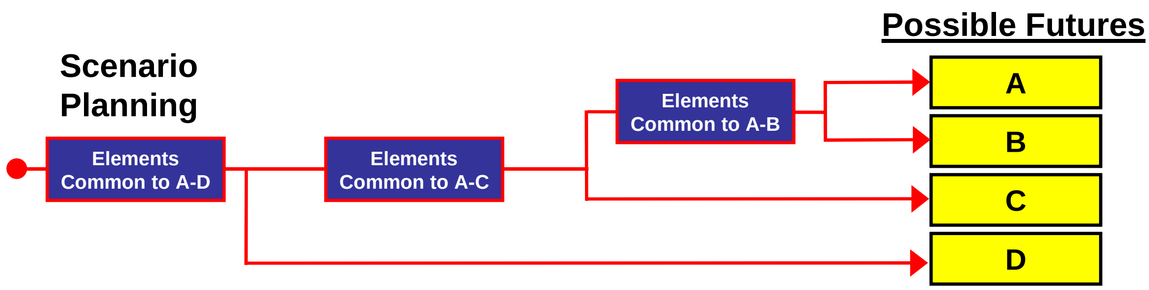



**Figure 6-2:** The Scenario Planning Approach.

There are a number of other factors that are characteristic of scenario planning. One is the consideration of critical uncertainties. Scenario planning is not based solely on what is known about a given subject; rather, it is based upon identified critical uncertainties that could have a major impact on the future and hence on the success of any planning effort. The process enables planners to respond to future issues as they develop and to describe the opportunities and challenges that each future presents (Schwartz, 1991). As the planning environment changes over time, the scenario planning process will be revisited to establish a new baseline of data and assumptions to develop a new range of possible futures.

Scenario planning also ensures that less-tangible but extremely important factors such as political uncertainties and public sentiment are incorporated into the process. The acknowledgement of these variables in the planning process enables planners to develop reality-based pathways to futures. This will ensure that the resulting long-range plan will have sufficient flexibility to identify and respond to changes that will inevitably arise.

In water-resources and system planning, certain elements are less variable and hence more predictable than others. For instance, a water distribution system will require continuous evaluation to ensure that it is upgraded and expanded in concert with increasing demand. Water delivery must be cost-effective, responsive to customer preferences, operationally efficient, and consistent with federal, state, and local regulations. Conversely, developing sustainable sources of supply in arid, rapidly growing areas has to address many variables which may have a high degree of uncertainty. Communities can grow faster or slower than expected, regulations will generally become more stringent, and public sentiment can shift.

## SCENARIO PLANNING FOR *WATER PLAN: 2000-2050*

Tucson Water applied the scenario planning process to assess how best to use its most abundant and currently available renewable water supplies: Colorado River water and municipal effluent. The potential acquisition of additional water resources is uncertain. If additional water resources are successfully acquired in the future, they will be integrated into the planning process. The integration of the scenario planning assessments for the two known renewable water supplies created a matrix of possible futures that formed the basis for the recommended plan. A step-by-step description of the scenario planning process and how it was applied under each assessment are provided in Appendix D: *Planning Methodology*. The outcomes of both scenario planning assessments are presented in this section.

## Outcomes of Scenario Planning for the Clearwater Program

The Clearwater Program was developed to maximize Tucson Water's use of its Central Arizona Project allocation by blending Colorado River water with native ground water. As shown on Figure 6-3, four futures were developed based on the following critical uncertainties:

1. What is the public's threshold for paying for discretionary water-quality improvements to the Clearwater blend?

2. Will the public accept the use of the Hayden-Udall Treatment Plant for direct treatment of Colorado River water?

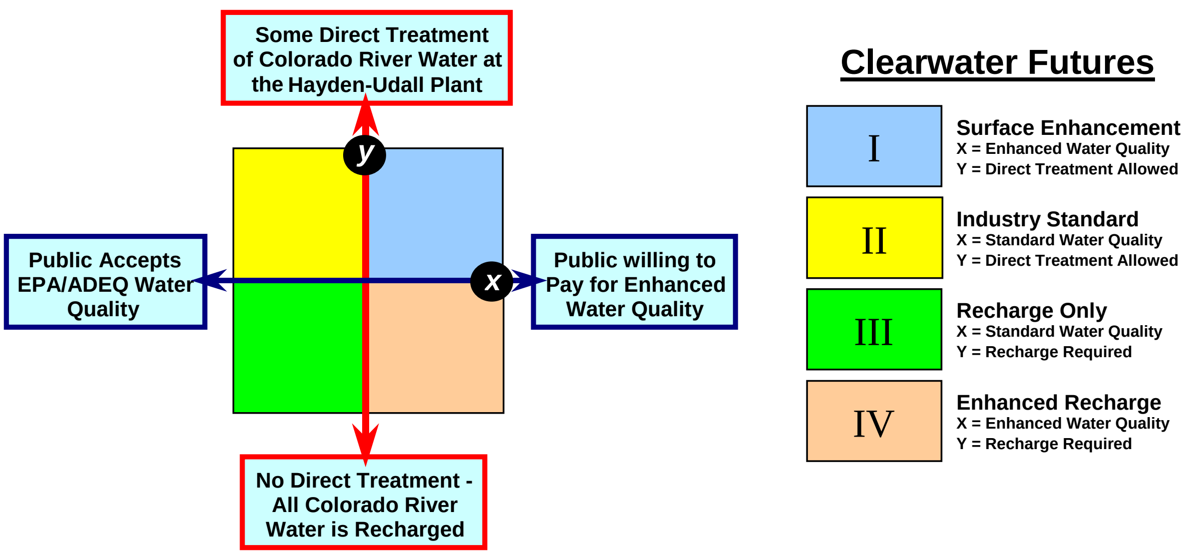



**Figure 6-3:** The Four Scenario Planning Futures Developed for the Clearwater Program.

The first critical uncertainty is portrayed on the *x*-axis. The left side of this axis represents futures where the public would accept a blended water quality that meets EPA and ADEQ primary drinking water standards. The right side of this axis represents the public's willingness to pay for discretionary improvements above and beyond these standards. The second critical uncertainty is portrayed on the *y*-axis. The top of this axis establishes the possibility that the public would accept some direct treatment of Colorado River water at the Hayden-Udall Treatment Plant. The bottom part of the axis represents futures where the public would require that all Colorado River water be recharged prior to use for potable supply. The resulting four quadrants shown on Figure 6-3 correspond to four equally possible futures (I, II, III, and IV) associated with the water-resource management goal of maximizing Tucson Water's use of its Central Arizona Project allocation through the Clearwater Program.

Pathways were developed for each of the four futures defined in Figure 6-3. These pathways consist of the project and program elements that were specified to realize each of the four futures. An analysis was conducted to identify the elements that were common to all four pathways and the critical decision points that occur where pathways branch off over time. Five elements that are common to all pathways prior to the first critical decision point were identified as shown on Figure 6-4. The first critical decision centers on whether the Hayden-Udall Treatment Plant can be used for direct treatment or whether all Colorado River water must be recharged prior to use. As each critical decision is approached or as conditions and assumptions change, the scenario planning process will be revisited to determine whether a new set of possible futures should be developed.

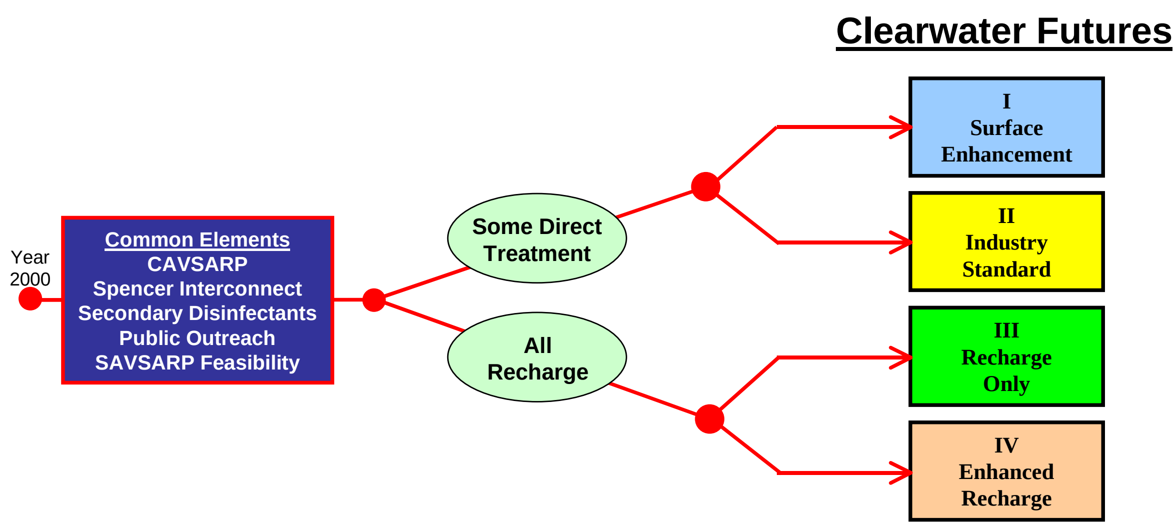



**Figure 6-4**: Clearwater Program Common Elements and Pathways.

## Outcomes of Scenario Planning for Effluent Reuse

Another key water-resource planning challenge was to identify how effluent could be best used as a source of supply. Effluent is the only water supply that increases as the service area population grows. Eight futures were developed based on three critical uncertainties:

1. Will Tucson Water customers accept the use of effluent to augment the potable supply?

2. Should effluent be recharged prior to reuse?

3. Should all effluent be treated to potable standards or should the effluent be treated to standards specific to the type of use?

As shown on Figure 6-5, the first critical uncertainty is portrayed on the *x*-axis. The *Potable Use* end of the axis establishes the possibility that the public would be willing to accept effluent to augment potable supply while the *No Potable Use* end represents futures where the public would reject the use of effluent for potable reuse.

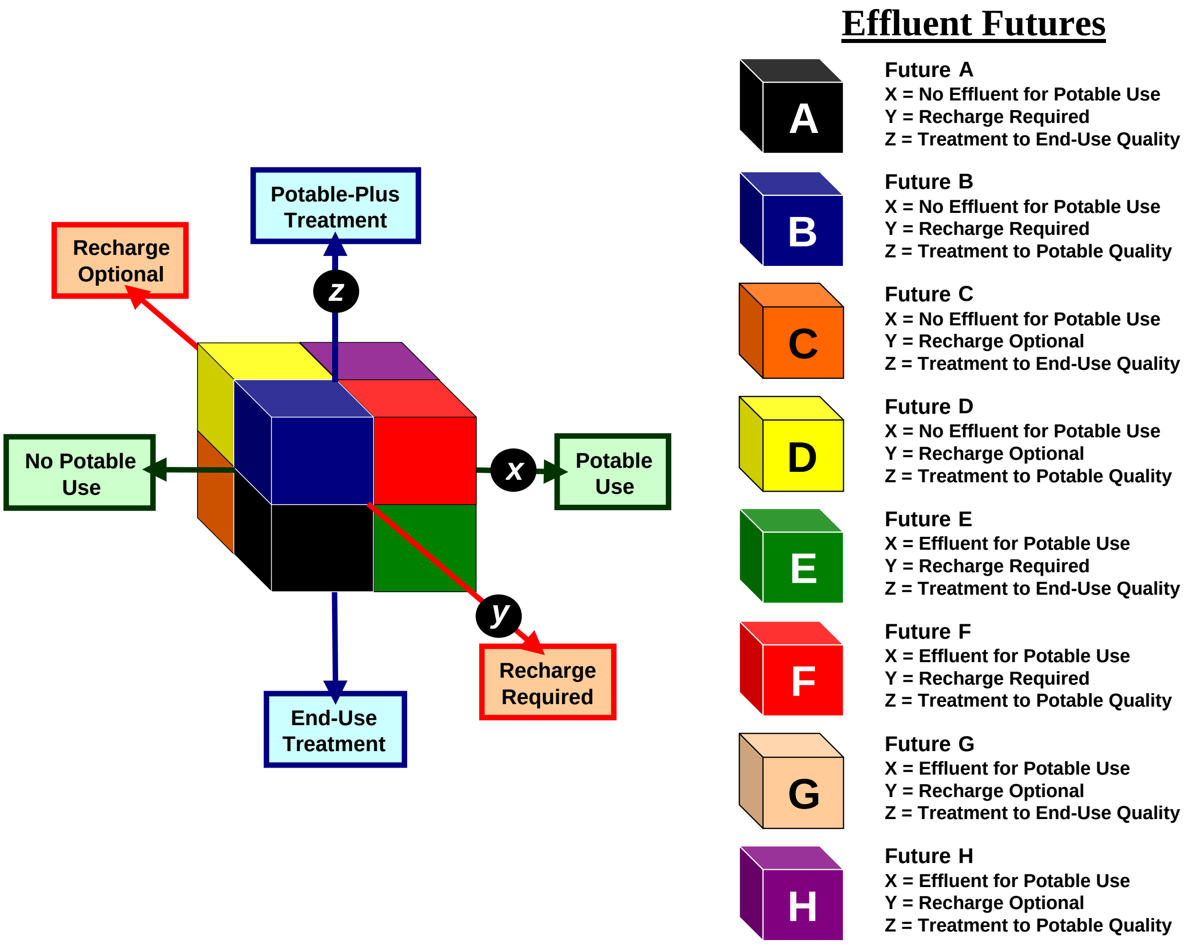



**Figure 6-5:** The Eight Scenario Planning Futures Developed for Possible Effluent Reuse.

The second critical uncertainty is portrayed on the *y*-axis. The *Recharge Optional* end of the axis establishes that the public would be willing to accept some direct treatment of effluent while the opposite *Recharge Required* end represents futures where the public would require recharge prior to potable reuse. Like the Clearwater assessment, the latter means that all effluent would have to be recharged before it could be made available to customers for potable supply.

The third critical uncertainty is portrayed on the *z*-axis. The *Potable-Plus Treatment* end of the axis establishes that all effluent will at minimum be treated to primary drinking water standards or better while *End-Use Treatment* represents futures where effluent would only be treated for the specified end-use. For instance, effluent used for non-potable purposes would only be treated to reclaimed water-reuse standards. The resulting eight boxes shown on Figure 6-5 correspond to eight equally possible effluent-reuse futures (A through H).

Eight pathways were specified to realize each of the futures (Figure 6-6). Review of the project and program elements associated with each pathway indicated that 14 elements (Common Element Set #1) were common to all pathways prior to the first decision point. At this decision point, a critical choice will have to be made about whether to expand the reuse of effluent or continue current effluent disposal practices. If expanded use of effluent is pursued, additional common elements have been identified (Common Element Set #2).

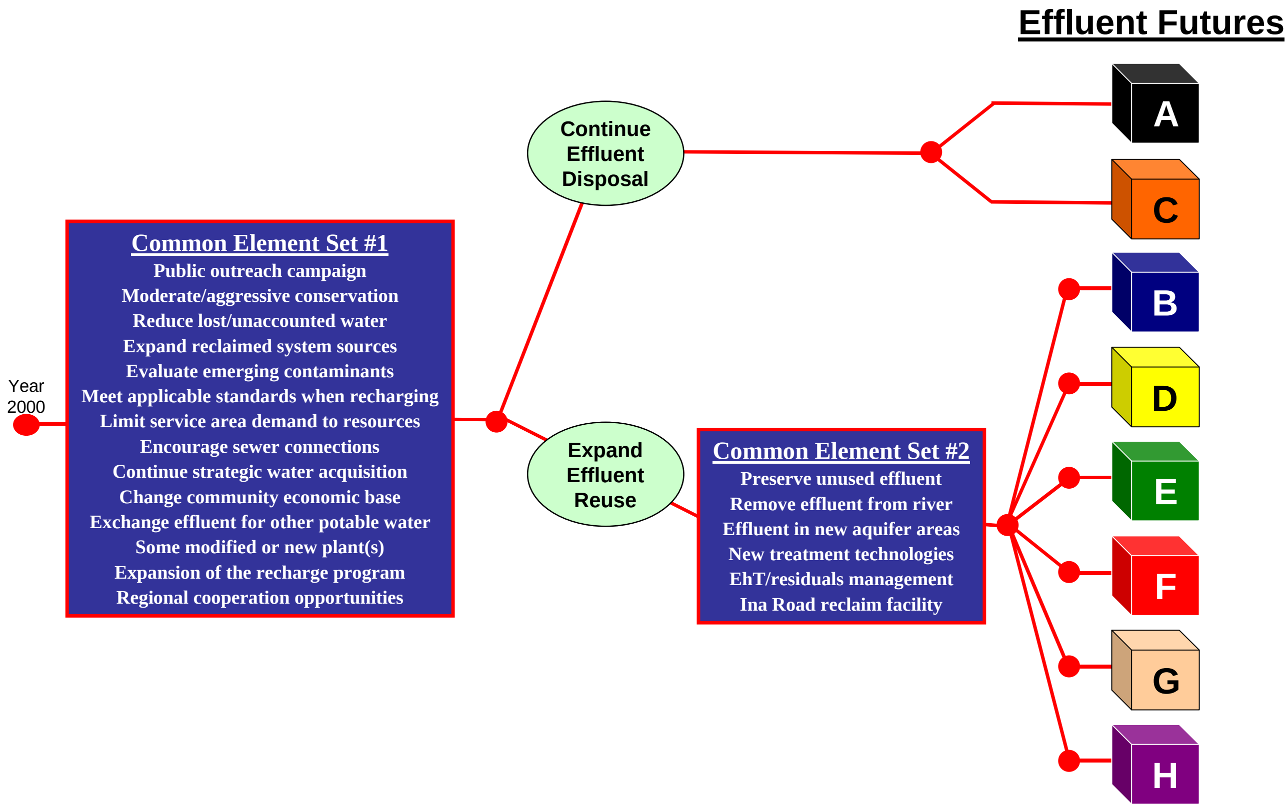



**Figure 6-6:** The Sets of Common Elements for Effluent Reuse.

## COMBINING THE SCENARIO PLANNING ASSESSMENTS

To merge the futures identified for implementing the Clearwater Program and the possibilities associated with effluent reuse, Tucson Water identified the effects that near-term Clearwater Program decisions will have on mid- to long-term options for effluent reuse. Each of the four Clearwater Program futures chronologically precedes all eight of the effluent reuse futures. Futures from within these two sets were uniquely mixed and matched to form a total of 32 "combined futures." These combined futures collectively constitute a wide range of planning possibilities through which to utilize both Colorado River water and effluent. As described in Appendix D: *Planning Methodology*, the 32 combined futures were reduced to 28. The remaining 28 combined futures are defined by 14 sets of paired planning pathways. Each set of pathways presents a choice with regard to the mineral content of the Clearwater blend (Colorado River water and ground water) that define each of the 28 combined futures.

The combined futures and the 14 paired pathways were grouped by their shared characteristics into four Families of Futures. These characteristics include the range of effluent reuse options deemed acceptable, the potential role of recharge, the technologies which may be used to treat Colorado River water and effluent to acceptable levels of quality, and the level of operational flexibility provided under each Family of Futures. Based on shared characteristics, the four Families of Futures were identified:

- *No Effluent for Potable Use*
- *Total Recharge*
- *Combined Technology*
- *Treatment Flexibility*

These Families of Futures represent unique combinations of the four futures associated with Clearwater Program and the eight futures associated with effluent reuse. The four resulting Families of Futures are described below and summarized in Figure 6-7.

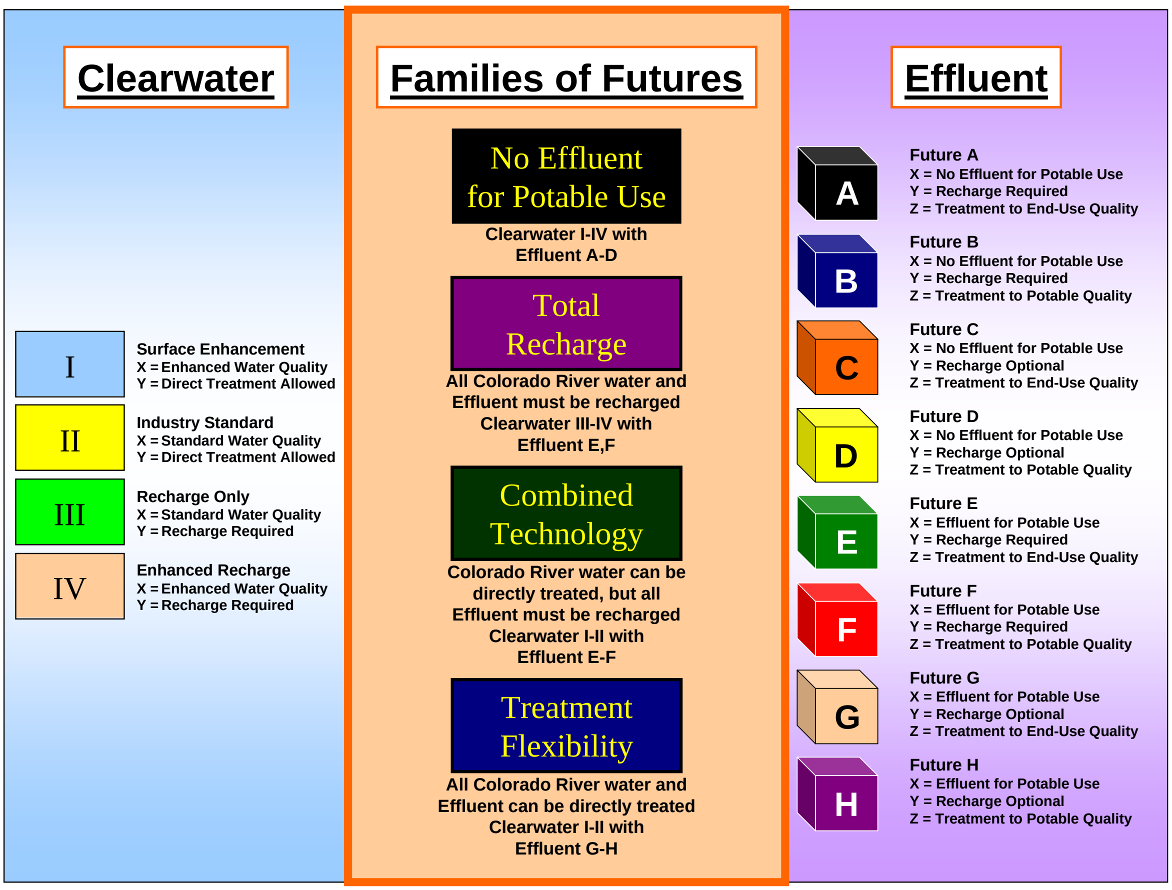



**Figure 6-7:** The Families of Futures.

*No Effluent for Potable Use*

In this Family, no effluent would be used for potable supply. Unless additional supplies are acquired or the per capita water usage rate is reduced through the successful implementation of a more aggressive demand management program, an eventual shortfall in potable supply would likely occur before 2020. This shortfall would result from the finite availability of the City of Tucson's Central Arizona Project allocation and the Groundwater Management Act's programs which preclude overdrafting within the Tucson AMA. This plan assumes that Tucson Water will not pump more ground water annually than is hydrologically renewed in the service area. In this Family, drought resistance is minimal since effluent is not fully utilized to help offset shortfall years on the Colorado River system. This Family includes all four futures developed for the Clearwater Program (I, II, III, and IV) but only four of the eight effluent futures (A, B, C, and D). This accounts for 16 of the 28 combined futures.

Under *No Effluent for Potable Use*, Tucson Water would not be able to retain its AWS designation for growth beyond 2015 without acquiring additional water resources or reducing the per capita water usage rate. This Family could allow the Utility to maintain its AWS designation if effluent is stored to accrue paper-water credits to offset ground-water pumping at rates beyond what is hydrologically sustainable (effluent futures B and D). This would violate a primary planning goal of achieving sustainable pumpage.

*Total Recharge*

Under *Total Recharge*, Tucson Water would be able to make full use of its available Colorado River water and effluent resources through recharge and recovery. Under this Family, all Colorado River water and effluent would be recharged as part of the treatment process prior to being used to satisfy potable demands. The impacts of future drought would be minimal since the total volume of available water supply is larger. This would require an aggressive expansion of Tucson Water's recharge and recovery capabilities. This Family accommodates two Clearwater Program futures (III and IV) and two effluent futures (E and F). This accounts for four of the combined futures.

While this Family could meet projected total demand through 2050, additional supplies would need to be acquired and/or per capita demand would need to be reduced to be sustainable beyond the 50-year planning period. However, without new supplies or a reduction in demand, the City of Tucson's AWS designation would likely not be retained to accommodate growth beyond 2035.

*Combined Technology*

In the *Combined Technology* Family, Tucson Water would again be able to make full use of the available Colorado River water and effluent resources for potable and non-potable supply. The Utility would have the ability to use direct treatment and/or recharge and recovery for Colorado River water supplies. However, all effluent would be recharged prior to being used to satisfy potable demands. The impacts of future drought would be minimal since the total volume of available water supply is larger. All effluent would be recharged resulting in continued expansion of Tucson Water's recharge and recovery capabilities. This Family accommodates two Clearwater Program futures (I and II) and two effluent reuse futures (E and F). This accounts for four of the combined futures.

Again, while this Family could meet projected total demand through 2050, additional supplies would need to be acquired and/or per capita demand would need to be reduced to be sustainable beyond the 50-year planning period. However, without new supplies or a reduction in demand, the City of Tucson's AWS designation would likely not be retained to accommodate growth beyond 2035.

*Treatment Flexibility*

In *Treatment Flexibility*, Tucson Water would not only be able to make full use of the available Colorado River water and effluent source waters, but the manner in which these supplies are treated is completely flexible. Tucson Water could use direct treatment technologies and/or recharge and recovery for all Colorado River water and effluent supplies. Similar to *Total Recharge* and *Combined Technology*, the impacts of future drought would be minimal. This Family accommodates two Clearwater Program futures (I and II) and two effluent futures (G and H). This accounts for four of the combined futures.

As with *Total Recharge* and *Combined Technology*, this Family could meet projected total demand through 2050. Additional supplies would need to be acquired and/or per capita demand would need to be reduced to be sustainable beyond the 50-year planning period and to retain the City of Tucson's AWS designation to accommodate growth beyond 2035.

# PATHWAYS TO 2050

Over the next 50 years, Tucson Water must implement a number of projects and programs to increase the use of renewable water supplies to meet growing water demand. Depending on what the future holds, some projects and programs will continue to be useful while others may not. Tucson Water must plan and prepare for the range of possibilities defined by the four Families of Futures. Scenario planning provides a framework to identify common elements that are applicable under the broadest range of possible futures. To identify these elements, the 14 paired pathway sets containing various programs and projects were developed based on the defining characteristics of the possible futures. One defining characteristic, the mineral content of the Clearwater blend, was used as the "toggle switch" that defined each paired pathway. This toggle switch can be turned to TDS concentrations of either 500 to 650 mg/L or 450 mg/L along each of the 14 pathways. Therefore, 14 pathways cover the full range of possibilities represented by the 28 combined futures. Tucson Water assessed these pathways and identified the projects and programs that lead to multiple futures. The identified sequence of common elements over the 50-year planning period established the foundation of the recommended water-resource plan.

## Pathway Directions

The 14 pathways that lead to the combined futures are presented on Figure 6-8. The pathways are affected first by decisions made regarding the treatment technology used for Colorado River water (direct treatment versus recharge) and the target TDS concentration of the Clearwater blend (450 mg/L versus 500 to 650 mg/L). As the community makes these critical decisions, some of the possible futures will evolve while others may fade away.

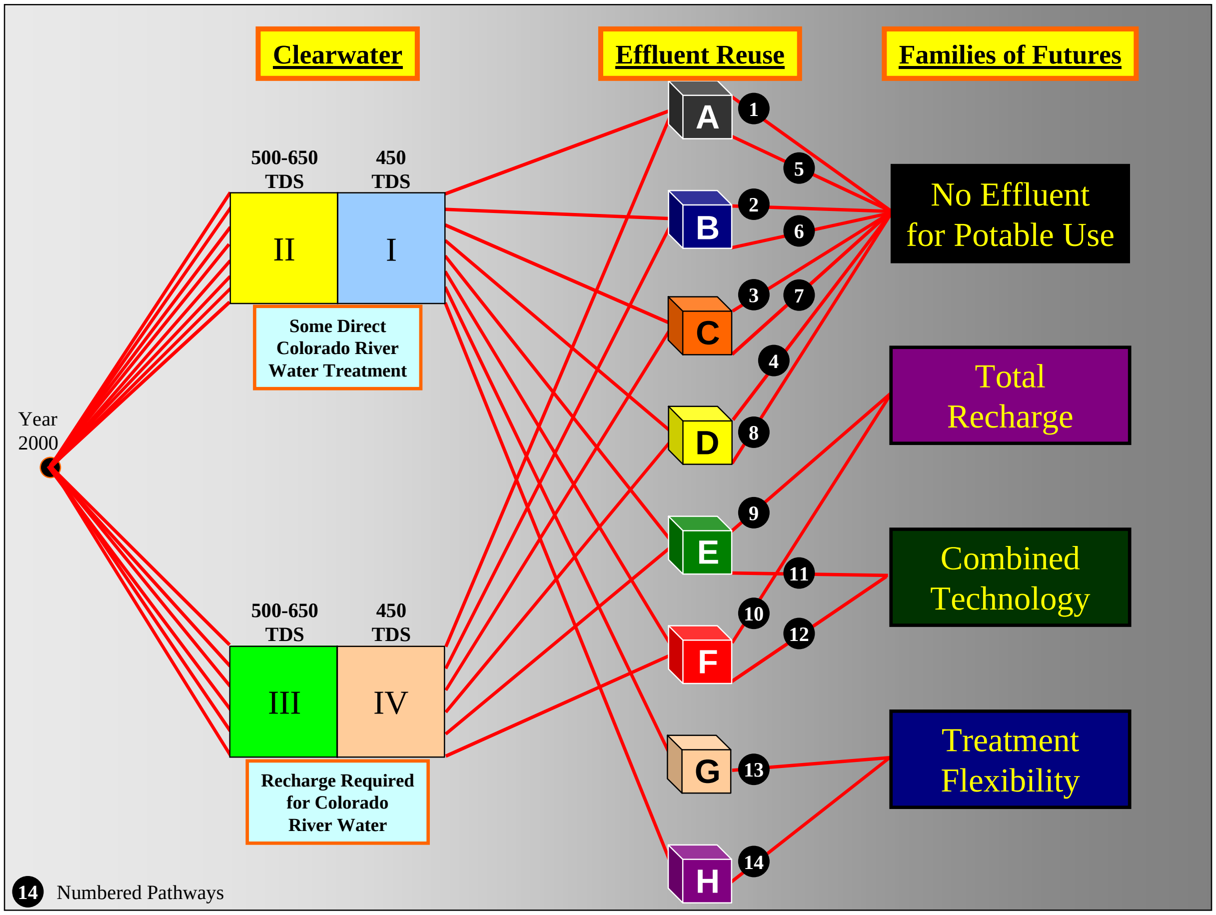



**Figure 6-8:** Pathways to the Families of Futures.

Looking beyond this first critical decision point regarding the use of Colorado River water, decisions on the reuse of effluent will need to be made. To capture the range of possible effluent reuse decisions, pathways were extended from each of the four possible Clearwater futures to each of the eight effluent reuse futures. The Families of Futures are defined by pathways that lead to combined futures which share a similar characteristic such as *No Effluent for Potable Use*.

## Pathway Elements

A set of projects and water supply sources served as a pool of discrete elements from which each of the pathways was assembled. These projects and supply sources fall into three general categories: potable system, reclaimed system, and major pipelines. The elements used in the pathways are described in detail in Appendix D: *Planning Methodology*.

The projects that were used to develop each of the 14 pathways are presented in Table 6-1. Table 6-1 depicts the major pipelines, potable system projects, and reclaimed system projects included in each pathway and the years they would go into service to realize one of the four Families of Futures.

| Pathway | Spencer Interconnect | Avra Valley Main Augmentation | Effluent Pipeline to Avra Valley | Effluent Pipeline to Tucson Basin | Ina Road Interconnect | Expand CAVSARP Recharge to 80k | SAVSARP Phase I | Rehabilitate Hayden-Udall | SAVSARP Phase II | Enhanced Treatment at Hayden-Udall | Effluent Recharge at CAVSARP | Effluent Recharge at Pima Mine Road | Expand CAVSARP Operations to 100k | Sweetwater Enhanced Treatment Plant | Expand CAVSARP Recovery | Effluent Recharge at CAVSARP | Expand Sweetwater Recharge Facilities | Expand Reclaim Plant | Reclaimed System Recharge Project | Clearwater Future(s) | Effluent Reuse Future | Family of Futures |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Major Pipelines | | | | | Potable System | | | | | | | | | | | Reclaimed System | | | | | |
| 1 | 2006 | 2009 | | | | 2005 | | 2009 | | 2011* | | | | | | | 2007 | | 2012 | I/II | A | No Effluent for Potable Use |
| 2 | 2006 | 2009 | 2017 | | 2017 | 2005 | | 2009 | | 2011* | 2017 | | | 2017 | | | 2007 | | 2012 | I/II | B | |
| 3 | 2006 | 2009 | | | | 2005 | | 2009 | | 2011* | | | | | | | | 2007 | | I/II | C | |
| 4 | 2006 | 2009 | 2017 | | 2017 | 2005 | | 2009 | | 2011* | 2017 | | | 2017 | | | | 2007 | | I/II | D | |
| 5 | 2006 | 2009 | | | | 2005 | 2007 | | 2009 | 2011* | | | | | | | 2007 | | 2012 | III/IV | A | |
| 6 | 2006 | 2009 | | 2017 | | 2005 | 2007 | | 2009 | 2011* | | 2017 | | | | | 2007 | | 2012 | III/IV | B | |
| 7 | 2006 | 2009 | | | | 2005 | 2007 | | 2009 | 2011* | | | | | | | | 2007 | | III/IV | C | |
| 8 | 2006 | 2009 | | 2017 | | 2005 | 2007 | | 2009 | 2011* | | 2017 | | | | | | 2007 | | III/IV | D | |
| 9 | 2006 | 2009 | 2017 | | 2017 | 2005 | 2007 | | 2009 | 2011* | 2017 | | 2017 | 2017 | 2025 | | 2007 | | 2012 | III/IV | E | Total Recharge |
| 10 | 2006 | 2009 | 2017 | | 2017 | 2005 | 2007 | | 2009 | 2011* | 2017 | | 2017 | 2017 | 2025 | | 2007 | | 2012 | III/IV | F | |
| 11 | 2006 | 2009 | 2017 | | 2017 | 2005 | | 2009 | | 2011* | 2017 | | | 2017 | 2025 | | 2007 | | 2012 | I/II | E | Combined Technology |
| 12 | 2006 | 2009 | 2017 | | 2017 | 2005 | | 2009 | | 2011* | 2017 | | | 2017 | 2025 | | 2007 | | 2012 | I/II | F | |
| 13 | 2006 | 2009 | | 2017 | 2025 | 2005 | | 2009 | | 2011* | | 2017 | | 2025 | | 2025 | | 2007 | | I/II | G | Treatment Flexibility |
| 14 | 2006 | 2009 | | 2017 | 2025 | 2005 | | 2009 | | 2011* | | 2017 | | 2025 | | 2025 | | 2007 | | I/II | H | |

* This element can be "on" or "off" in all fourteen pathways and serves as the "toggle switch" for the mineral content of the Clearwater Blend.

NOTE: Detailed descriptions of each potential project can be found in Appendix D: Scenario Planning for *Water Plan: 2000-2050* .

**Table 6-1:** Pathways to 2050 – Schedules of Projects.

All pathways assume the annual use of 50,000 acre-feet of Tucson Water's portfolio of ground water through 2050 and full utilization of the City of Tucson's annual Central Arizona Project allocation. However, Tucson Water's effluent resource is used in varying degrees under the 14 pathways. Under four pathways (Pathways 1, 3, 5, and 7), effluent would only be used in the reclaimed system to meet non-potable demands.

In four other pathways (Pathways 2, 4, 6, and 8), effluent not used in the reclaimed system would be banked in long-term storage facilities. The recharge credits accrued through these long-term storage activities could be used to offset additional ground-water pumping in excess of the annual sustainable rate; however, this could cause a shift back toward localized over-drafting of the aquifer and declining ground-water levels. In the remaining six pathways (Pathways 9 through 14), the effluent not utilized through the reclaimed system is used to augment potable water supplies.

## Criteria Assessment – Distinguishing the Pathways

Nine assessment criteria were developed to rate the overall benefits and drawbacks of each of the 14 possible pathways. These criteria were developed from a wide range of factors that could serve as performance measures. Many of these factors could not be used as distinguishing criteria because they were common to all 14 pathways and were considered "neutral." These neutral factors applied equally to all pathways while the nine assessment criteria served to distinguish the pathways. The assessment criteria and the neutral factors are described in detail in Appendix D: *Planning Methodology*.

Each of the nine criteria is assigned to one of three assessment categories: Source Water, Operations, and Environment. The criteria were developed in order to evaluate the overall capability of each pathway to meet Tucson Water's planning goals:

- Meet Projected Total Demand.
- Utilize Renewable Resources.
- Meet Water-Quality Targets.
- Achieve Sustainable Pumpage.
- Manage Costs and Rate Impacts.
- Comply with Assured Water Supply Program.

Each criterion is assigned a rating from one to ten points where the highest score fully expresses the value embodied in any given criterion. The point sum of the ratings is the measure of how well each pathway meets the overall planning goals.

Review of Table 6-2 indicates that Pathways 9 through 14 are rated higher than Pathways 1 through 8. The more highly rated pathways lead to three Families of Futures: *Total Recharge*, *Combined Technology*, and *Treatment Flexibility*. The main element that sets Pathways 9 through 14 above Pathways 1 through 8 was their ability to maximize use of renewable resources with emphasis on effluent utilization.

| Pathway | Colorado River Water Source Acceptance | Effluent Water Source Acceptance | Renewable Supply Utilization | Meeting Projected Water Demand | Source Reliability | Impacts To Recharge Neighbors | Riparian Issues | Salinity Control | Subsidence Prevention | TOTAL | Clearwater Future(s) | Effluent Reuse Future | Family of Futures | Planning Goal Achievement |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | <<<<<Source Water>>>>> | | | <<Operations>> | | <<<<<<<<Environment>>>>>>>> | | | | Overall | | | | |
| 1 | 5 | 10 | 1 | 1 | 1 | 10 | 5 | 4 | 1 | 38 | I/II | A | No Effluent for Potable Use | FAIL |
| 2 | 5 | 10 | 5 | 4 | 1 | 5 | 10 | 1 | 5 | 46 | I/II | B | | FAIL |
| 3 | 5 | 10 | 1 | 1 | 1 | 10 | 5 | 4 | 1 | 38 | I/II | C | | FAIL |
| 4 | 5 | 10 | 5 | 4 | 1 | 5 | 10 | 1 | 5 | 46 | I/II | D | | FAIL |
| 5 | 10 | 10 | 1 | 1 | 3 | 5 | 5 | 4 | 1 | 40 | III/IV | A | | FAIL |
| 6 | 10 | 10 | 5 | 4 | 3 | 1 | 10 | 1 | 5 | 49 | III/IV | B | | FAIL |
| 7 | 10 | 10 | 1 | 1 | 3 | 5 | 5 | 4 | 1 | 40 | III/IV | C | | FAIL |
| 8 | 10 | 10 | 5 | 4 | 3 | 1 | 10 | 1 | 5 | 49 | III/IV | D | | FAIL |
| 9 | 10 | 5 | 10 | 10 | 10 | 1 | 1 | 7 | 10 | 64 | III/IV | E | Total Recharge | PASS |
| 10 | 10 | 5 | 10 | 10 | 10 | 1 | 1 | 7 | 10 | 64 | III/IV | F | | PASS |
| 11 | 5 | 5 | 10 | 10 | 7 | 5 | 1 | 7 | 10 | 60 | I/II | E | Combined Technology | PASS |
| 12 | 5 | 5 | 10 | 10 | 7 | 5 | 1 | 7 | 10 | 60 | I/II | F | | PASS |
| 13 | 5 | 1 | 10 | 10 | 5 | 10 | 1 | 10 | 10 | 62 | I/II | G | Treatment Flexibility | PASS |
| 14 | 5 | 1 | 10 | 10 | 5 | 10 | 1 | 10 | 10 | 62 | I/II | H | | PASS |

**Table 6-2:** Rating of Pathways to 2050.

Increasing use of effluent and fully utilizing Colorado River water are critical factors which contributed to Pathways 9 through 14 realizing four of the planning goals: Meet Projected Total Demand, Utilize Renewable Resources, Achieve Sustainable Pumpage, and Comply with Assured Water Supply Program. The use of effluent has the added benefit of providing greater operational reliability because it is locally generated and immediately available. In addition, Pathways 9 through 14 provide the community the best options to prevent continued subsidence by controlling ground-water withdrawals and stabilizing water levels in the aquifer.

In the one-dimensional planning process, it would be tempting to choose one of these highly rated pathways and follow it without deviation. However, this approach would limit Tucson Water's flexibility in addressing future possibilities. In the planning approach used in this assessment, the most highly rated pathways and their associated futures serve as indicators of the programs and projects that could best achieve the stated planning goals. As the community evolves, these planning goals may change.

Because change is the one certainty, all potential pathways are retained in developing the recommended plan. The common elements in all the pathways provide the direction and the flexibility needed to manage uncertainty and the inevitable challenges which lie ahead. Chapter Seven, *The Recommended Plan,* describes the recommended long-range water-resource plan and the assessment of common elements that led to its development.

*The Recommended Plan will be implemented by following the route of common elements with key decision points providing choices and direction along the way.*

# CHAPTER SEVEN

# THE RECOMMENDED PLAN

The Recommended Plan is the product of the scenario planning process. It consists of common elements (projects and programs) and a series of key decision points specified through time. Implementing the common elements will maintain planning flexibility. Each critical decision will generate a choice between sets of decision-dependent common elements which will in turn lead to a new range of possible futures. The Recommended Plan will be implemented by following the route of common elements with the key decision points providing choices and direction along the way.

Tucson Water initiated development of *Water Plan: 2000-2050* with a set of identified goals:

- Meet Projected Total Demand.
- Utilize Renewable Resources.
- Meet Water-Quality Targets.
- Achieve Sustainable Pumpage.
- Manage Costs and Rate Impacts.
- Comply with Assured Water Supply Program.

The ability to achieve these goals hinges primarily on how Tucson Water utilizes its available water resources. The scenario planning assessments conducted to evaluate the Utility's Colorado River water and effluent supplies provided a framework to develop 14 planning pathways and four Families of Futures that share similar characteristics. The Recommended Plan was created by analyzing the pathways to identify common elements and critical decision points through time.

Within the 50-year planning period, certain choices made at critical decision points will provide Tucson Water with a greater opportunity to achieve the stated planning goals. Other choices will limit the Utility's ability to achieve these goals. The critical decisions and the sets of common elements that comprise the Recommended Plan are discussed in the following sections. A graphical summary of the Recommended Plan (Plate 1) is contained in the back pocket of *Water Plan: 2000-2050*.

## COMMON ELEMENTS AND CRITICAL DECISIONS

There are a number of elements common to all of the pathways that lead to the four Families of Futures. Once initiated, the common projects and programs would contribute toward meeting the planning goals irrespective of the critical planning decisions that will ultimately be made. Hence, these common elements will not constrain any of the identified futures.

The critical decisions that will be made will determine which elements will subsequently be implemented. The sets of decision-dependent common elements will lead to a new range of possible futures. However, the decisions will have financial consequences which need to be understood so that the governing body and the public can make fully informed choices.

### Common Elements: 2000 to 2006

The common elements listed below have either already been implemented or should be initiated by 2006. They include the following programs and projects:

*Programs*

- **Acquire Additional Supplies**. Additional potential sources of supply will be pursued under all scenarios. These supplies may include additional rights to local ground water, additional Colorado River water, rights to other water supplies that may be delivered through the Central Arizona Project, effluent belonging to other parties, and any other water resources that may become available over time. Efforts to acquire additional supplies will continue to be a priority throughout the 50-year planning period.

- **Develop a Salinity Management Program**. An increase in the mineral content of the Utility's blended potable water supply will gradually occur over time as Colorado River water and effluent are utilized. Tucson Water will pursue a program to manage potential increases in salinity in watersheds located within its projected service area. The Utility will continue to participate in research on potential salinity impacts and methods of treatment, reclamation, and/or disposal of the brine waste stream generated during treatment.

- **Encourage Sewer Connections**. In order to provide a greater volume of municipal wastewater effluent for potential reuse, changes in ordinance and/or code should be considered to encourage sewer connections to reduce the number of septic tank systems installed within the projected service area.

- **Evaluate the Effectiveness of Additional Conservation Programming**. A more aggressive conservation program designed to achieve a targeted per capita usage rate will be evaluated by Tucson Water. This program could target all sectors of potable water use including residential, commercial, and industrial customers.

- **Evaluate Emerging Contaminants**. The occurrence, fate, and potential treatment of emerging contaminants in current and future water supplies must be further researched. This research will be increasingly important as the availability of water resources becomes more constrained over time.

- **Expand Public Outreach**. Tucson Water's public outreach program will be expanded to inform the public on a range of issues. These issues include the cost of water treatment options, a reassessment by the community of the targeted mineral content for the Clearwater blend, the benefits of using Colorado River water for potable supply, the use of effluent for non-potable uses, and the benefits of using effluent to augment ground water for banking and indirect potable use.

- **Provide Water-Resource Information to Planning Entities**. Tucson Water will provide information regarding water-resource availability to governmental entities that plan for the future of the community. These efforts will allow those entities to take into account the Utility's ability to provide water service within the context of their planning decisions.

- **Pursue Regional Cooperation**. Tucson Water will seek additional opportunities to work cooperatively with other local governmental entities and water providers. These efforts should include pursuing additional water resources for the region in order to provide sustainable supplies into the future.

- **Reduce Lost and Unaccounted for Water**. Tucson Water will develop and implement a more comprehensive program to reduce its percentage of lost and unaccounted for water. This category includes pipeline leakage, water theft, and un-metered or improperly metered water deliveries.

*Projects*

- **Conduct SAVSARP Feasibility Assessment**. A technology-based assessment of the potential recharge capacity of the SAVSARP project will be conducted. Under the Clearwater Program, this facility would help maximize utilization of Tucson Water's Central Arizona Project allocation.

- **Construct Spencer Interconnect Pipeline**. The Spencer Interconnect will be constructed to provide flexibility in providing ground water to the blended water program and to provide an alternate route to deliver potable water from the Clearwater Renewable Resources Facility to urban Tucson.

- **Design SAVSARP Facilities.** The SAVSARP project may be implemented in two phases with a maximum recharge rate of approximately 100,000 acre-feet per year. Phase I will be designed with provisions for Phase II.

- **Expand Recharge Capacity of CAVSARP**. The CAVSARP facility will be re-permitted to recharge up to 80,000 acre-feet per year of Colorado River water. This additional capacity will be made available to the Water Bank in the near-term for Colorado River water firming activities. This capacity could be used in the future to recharge more of the City of Tucson's Central Arizona Project allocation, other Colorado River water supplies, and/or for the eventual recharge of effluent.

- **Study Secondary Disinfectants**. The effectiveness and potential by-products of alternative disinfectants as well as the conditions that might trigger their use will be studied. The results of such an assessment will determine the most appropriate use for alternative disinfectants in Tucson Water's potable systems in the future.

- **Upgrade the Distribution System**. There will be a continuing need to upgrade and extend the distribution system to meet growing demand. These system expansions will be implemented throughout the 50-year planning period.

## Common Elements: 2006 to 2014

In addition to the projects and programs initiated by 2006, a second set of common elements should be initiated during this period. Once implemented, these elements will allow the Utility to effectively address the priorities and challenges in the mid-term (2014-2025) and long-term (2025-2050) planning periods.

*Programs*

- **Achieve Full Colorado River Water Utilization**. Regardless of which final project is selected (SAVSARP Phase II or the rehabilitation of the Hayden-Udall Treatment Plant for direct treatment), Tucson Water will achieve full utilization of its current Central Arizona Project allocation by 2012.

- **Achieve Sustainable Ground-Water Pumping**. As the City of Tucson brings its Central Arizona Project allocation into full utilization, its reliance on ground water will decrease. The Utility will seek to reduce its ground-water pumping to a hydrologically sustainable rate within the near-term. In addition, a legislative change and/or a change in the AWS rules could be pursued to recognize hydrologically sustainable ground-water pumping as a renewable water supply under ADWR's AWS Program.

- **Evaluate Effluent Exchanges**. Tucson Water will pursue opportunities to market unused effluent supplies for lease or exchange with other water users within the Tucson AMA.

*Projects*

- **Augment Avra Valley Main**. The Avra Valley Transmission Main Augmentation will be constructed to provide increased operational flexibility and to provide another route to bring blended water into urban Tucson.

- **Construct New Reclaimed Supply Sources**. As reclaimed system demand grows in the future, additional projects will be implemented to provide the treatment required. The paths differ as to whether the additional supply will be met through expanded recharge and soil-aquifer treatment or constructed treatment plants. Because both treatment approaches are effective and have been accepted by the community, the Recommended Plan does not express a preference. The types of projects ultimately implemented will be decided when reclaimed demand requires new sources of supply.

- **Construct and Operate SAVSARP Phase I**. This project will be sized to have an annual recharge capacity of approximately 45,000 acre-feet per year. Recovery wells will be constructed to provide a blended water supply. SAVSARP Phase I is identified as a common element since it provides needed drought resistance and expanded long-term storage capacity.

## Critical Decisions and Dependent Elements: 2006 to 2014

In 2006, two critical resource-management decisions will be made regarding the use of Colorado River water:

Decision #1 - What is an acceptable long-term mineral content target for the Clearwater blended water program?

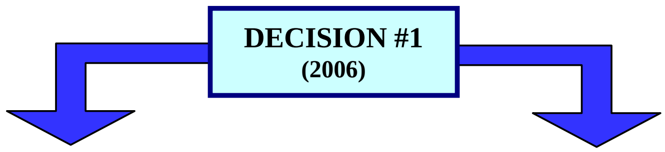
Decision #2 - Should Tucson Water expand the Clearwater recharge program by building SAVSARP to maximum capacity or rehabilitate the Hayden-Udall Treatment Plant to perform direct treatment?

Decisions #1 and #2 must be made by 2006. The choices will determine which decision-dependent elements will be subsequently implemented. In addition, these decisions will significantly impact the overall cost of providing water service.

Decision #1 will determine the targeted TDS concentration of the Clearwater blend. The water recovered from the CAVSARP Well Field will maintain a mineral content at or below the targeted TDS concentration of 450 mg/L through approximately 2009 (Errol L. Montgomery Associates, 2004). Tucson Water has access to sufficient ground water in Avra Valley to blend with the water recovered from CAVSARP to maintain this TDS target for many years. However, as additional Colorado River water is utilized over time either through direct treatment or expansion of the recharge program at SAVSARP (Decision #2), the ability to maintain this TDS target through ground-water blending cannot be sustained and enhanced treatment will be required.

A decision to maintain a lower TDS concentration would be primarily for aesthetic reasons since the lower pH of Colorado River water, and not its higher mineral content, was the principal cause of the pipeline problems experienced with direct delivery in the early 1990s.

The new elements associated with Decision #1 are described as follows:




**Mineral Content between 500 and 650 mg/L**

No further action required.

**Mineral Content of 450 mg/L**

**Implement Enhanced Treatment**

Tucson Water would need to install enhanced treatment trains at the Hayden-Udall Treatment Plant.

**Implement Residuals Management**

Evaporation ponds would be constructed to dispose of the brine waste stream.

**Implement Three-Points Well Field**

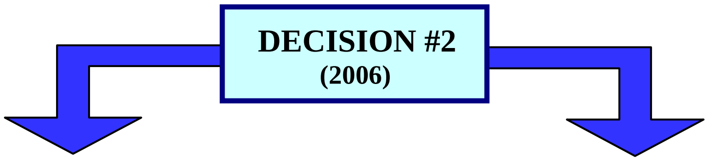
Construct new well field in the Three-Points area to provide additional ground water for blending.

If the public elects to maintain the Clearwater blend at the targeted TDS concentration of 450 mg/L, the Hayden-Udall Treatment Plant would be upgraded to perform enhanced treatment on only that volume of water necessary to achieve the target. This could be performed on directly treated or recharged and recovered Colorado River water.

A by-product of enhanced treatment is a brine waste stream currently estimated to be approximately 15 percent of the water that is treated. The current option is to construct large evaporation basins to dispose of the waste stream. However, ongoing research is being conducted to explore other methods and technologies to process and dispose of the waste stream at lower costs and to recover a higher percentage of the residual water (Bureau of Reclamation, 2003).

The choice under Decision #2 is either to expand SAVSARP by implementing Phase II or rehabilitate the Hayden-Udall Treatment Plant for direct treatment of Colorado River water. Either option under Decision #2 would allow for TDS management to be conducted pursuant to the choice made under Decision #1. If the Hayden-Udall Treatment Plant is rehabilitated, alternative primary disinfectants will be evaluated to determine the most effective option. By 2012, Tucson Water plans to achieve full utilization of its Central Arizona Project allocation. This is the critical first step toward attaining water-resource sustainability for the community.

The new elements associated with Decision #2 are described as follows:




**Expand Clearwater Recharge Program**
**Design, Construct & Operate SAVSARP Phase II**
Expand SAVSARP capacity to 100,000 acre-feet per year of recharge with 80,000 acre-feet per year of recovery. This could provide additional recharge capacity for use by the Water Bank.

**Implement Direct Treatment**
**Rehabilitate Hayden-Udall Treatment Plant**
Directly-treat 50,000 acre-feet per year of Colorado River water and add to the blend.

**Study Primary Disinfectants**
The effectiveness and potential by-products of alternative disinfectants (e.g. UV, chlorine, ozone) should be studied.

## Critical Decisions and Dependent Elements: 2014 to 2025

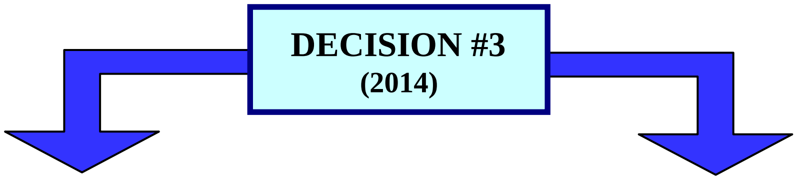
Additional resource-management decisions will need to be made by 2014 to maintain flexibility in utilizing effluent as a water supply and to define its role within the long-range plan. Effluent will continue to be used to meet non-potable demands which are estimated to be at least eight percent of projected total demand. This leaves a large volume of effluent available to augment the potable supply. Two critical decisions must be made regarding the future use of effluent:

Decision #3 – Should current effluent disposal practices continue or should Tucson Water maximize the use of effluent as a water supply?

Decision #4 - If the use of effluent is to be maximized, should it be stored in long-term banking facilities or should it be used to augment the potable water supply?

Decision #3 presents the opportunity to provide future supply for the growing community based on the water resources that are currently owned or controlled by the City of Tucson. Without the expanded use of effluent or acquiring additional water resources, Tucson Water would only have ground water credits and its current Central Arizona Project allocation available to meet future potable demand. Because Tucson Water has set a goal of limiting ground water use to a hydrologically sustainable rate, the Utility could have a shortfall in supply as early as 2020 unless alternative water resources are acquired or per capita demand is reduced. Decision #3 should be made by 2014 to allow sufficient time to put effluent to full reuse by 2017.

The new elements associated with Decision #3 are described as follows:




**Use Effluent Resource**

**Augment Recharge Program**
Evaluate location to recharge effluent based on end use and other factors

**Construct Effluent Pipeline**
A pipeline to convey highly-treated effluent to points of storage or reuse in Avra Valley or the Tucson basin should be constructed.

**Construct Ina Road Interconnect**
A pipeline to convey Tucson Water's effluent from the Ina Road Water Pollution Control Facility to the Sweetwater Enhanced Treatment Plant should be constructed to maximize the effluent available for reuse.

**Construct Sweetwater Enhanced Treatment Plant**
Tucson Water should construct a new treatment plant at Sweetwater Drive for enhanced effluent management.

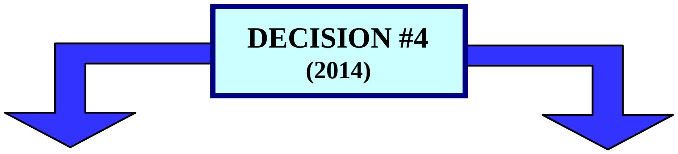
**Develop Treatment Technology**
The eventual treatment technologies used to prepare the effluent for its end use must be evaluated.

**Involve the Community**
Removing all of Tucson Water's effluent from the Santa Cruz River will have impacts on neighboring communities. These impacts must be assessed through a community outreach process.

**Continue Effluent Disposal**
No further action required.


Under Decision #4, the choice to bank effluent in long-term recharge facilities but not use it to augment potable supply would provide the opportunity to preserve the water resource for use beyond 2050. This decision would allow for the accrual of paper-water credits to pump additional ground water. However, storing effluent outside the area where pumping occurs would result in a resumption of ground-water mining within the Utility's service area; this in turn would cause renewed water-level declines and would increase the risk of additional land subsidence. If ground-water mining is resumed to meet increasing projected demand, the magnitude of pumping by 2040 would more than double the hydrologically sustainable rate. However, the choice to reuse effluent for indirect potable supply provides Tucson Water with the highest potential to meet projected demand through 2050 and offers the greatest opportunity for long-term sustainability. Decision #4 should also be made by 2014.

The new elements associated with Decision #4 are described as follows:




**Effluent to Augment Potable Supply**

**Initiate Effluent Enhanced Treatment**
For effluent to be used to augment potable supply, it must undergo extensive treatment.

**Initiate Effluent Residuals Management**
Evaporation ponds would be constructed to dispose of the brine waste stream.

**Effluent for Long-Term Banking**
No Further Action Required.


As Decisions #3 and #4 are made, Tucson Water will develop options to increase effluent reuse while seeking to acquire additional water resources. The construction of effluent transmission pipelines would depend on the eventual end use of this water resource. Effluent may be taken to existing recharge facilities or may require construction of new ones. Effluent could be taken to Avra Valley and/or to the Tucson basin for recharge; these areas could be used to bank paper-water credits or to augment potable supply.

## A Bridge to the Future: 2025 to 2050

As Tucson Water strives to meet future water demand, all currently available and newly acquired water supplies must be put to their optimal use. To utilize these resources, Tucson Water will need to implement additional projects and programs in the long term (2025-2050). Choices associated with effluent will need to be made with regard to the level of treatment that will be required at the Sweetwater Enhanced Treatment Plant as well as when and where effluent could be recovered from recharge projects. These decisions will be outlined in subsequent plan updates. The costs associated with these projects will be detailed at that time.

Choices made in the near term (2000-2014) and the mid term (2014-2025) will affect the range of available options and possible futures in the long term. Subsequent comprehensive updates to this plan will revisit the scenario planning process to identify decisions that will be required in the long term and to prepare for the community's supply needs beyond 2050.

## PLAN RECOMMENDATIONS

The Recommended Plan consists of sets of common elements that are determined by decisions made at specified points in time. The choices made at each critical decision point will bring the community toward certain Families of Futures while others will lose their relevance. Implementing the Recommended Plan means following the route of common elements with the key decision points providing choices and direction along the way. As the planning environment changes over time, the scenario planning process is revisited to establish a new baseline of data and assumptions that will again be used to reassess and develop a new range of possible futures.

In this section, Tucson Water provides a range of recommendations many of which address the critical decision points previously identified. Tucson Water believes that implementing these recommendations will allow the Utility to achieve all of the specified planning goals while retaining maximum flexibility. These recommendations take into account the laws and regulations that govern the Utility as described in Appendix E: *Federal, State, and Local Regulations and Policies*. The conclusions and recommendations summarized below are based on Tucson Water's best professional judgment regarding the most effective ways to meet the projected potable and non-potable needs of the community. The recommendations will be used to initiate a dialogue with Tucson Water's customers and other community stakeholders. Tucson Water's customers, in concert with the City of Tucson's Mayor and Council, will make the critical decisions that provide direction to Tucson Water for plan implementation.

### 1. Emphasize Physical Water Management Strategies

**Conclusion:** The best approach to maintain a sustainable future for the community is to ensure the physical availability of renewable water supplies. The community's sustainable future ultimately depends on maintaining a physical link between renewable water sources and the infrastructure needed to convey those waters to customers within the projected service area. A paper-water management approach that is not hydrologically constrained cannot be sustained in the long term.

**Recommendation:** The programs and projects called out in the Recommended Plan emphasize the physical availability of water supplies. These elements should be implemented in as timely a manner as possible to ensure that renewable water supplies will be available to Tucson Water's customers in the long term.

### 2. Utilize Renewable Ground Water

**Conclusion:** From a hydrologic perspective, a limited but quantifiable amount of ground water is naturally recharged each year from precipitation and surface-water runoff. Ground-water withdrawals that do not exceed these replenishment processes should be considered hydrologically sustainable ground-water pumping. Tucson Water plans to limit its ground water withdrawals at or below this sustainable level in order to ensure the long-term viability of the aquifer within the Utility's service area. This concept was identified as a long-term source of water supply in *Tucson Water Resource Plan 1990-2100*. Currently, no mechanism is in place within ADWR's AWS Program to obtain annual credit for this renewable supply.

**Recommendation:** The amount of natural recharge that annually occurs represents a hydrologically renewable ground-water supply that is not legally available. Tucson Water recommends that regulatory recognition of renewable ground water, based on hydrologically sustainable ground-water pumping, be incorporated into ADWR's AWS Program. This supply could then be credited as an annually renewable water resource that would not be debited against any long-term storage account. This would require changes in the AWS rules and/or a change in legislation.

### 3. Reassess the Water-Quality Target for Colorado River Water

**Conclusion:** Colorado River water currently has an average TDS concentration of 650 mg/L. In contrast, the TDS concentration of ground water provided by Tucson Water averages 280 mg/L. Based on the results of studies and public input associated with the *At the Tap Program*, Tucson Water's customers have accepted a blend of ground water and Colorado River water with a TDS concentration of about 450 mg/L. The choice of 450 mg/L was based on a taste test that was used to establish an aesthetic preference for the blended water. There was no comparative cost analysis done as a consideration for maintaining this preference in the future. All of the planning pathways have the ability to include projects to achieve a TDS concentration of 450 mg/L in the Clearwater blend. However, maintaining this TDS concentration would eventually require some form of enhanced treatment which would be expensive in both capital outlays and annual O&M costs. Customer preferences need to be reassessed by linking costs with potential water-quality targets. Customers would then be able to make an informed choice by considering both aesthetic water-quality preferences and the added incremental cost they would have to pay to maintain that level of mineral content.

**Recommendation:** With regard to Decision #1, Tucson Water recommends that the TDS water-quality target under the Clearwater Program be allowed to increase gradually until it reaches a point of equilibrium. The point of equilibrium would be less than 650 mg/L. It is anticipated that this point of equilibrium would occur sometime between 2015 and 2030. This recommendation would be the most cost-effective way to provide this renewable resource to the community. It eliminates the need to build an enhanced treatment plant to control TDS concentration as part of the Clearwater Program. In addition, it would preserve more of the available Colorado River water supply by avoiding the estimated 15 percent loss in water volume associated with enhanced treatment and costs associated with brine management and disposal. Should the community decide to maintain the 450 mg/L water quality target, *Water Plan: 2000-2050* can also accommodate that choice. Even though Tucson Water recommends that the mineral content of the Clearwater blend should be allowed to rise to a state of equilibrium, the overall salinity balance of Tucson Water's potable supplies under any scenario will nonetheless require management at some point in the future. Salinity management can occur when enhanced-treated effluent is used to augment future ground-water supplies.

**4. Fully Utilize Colorado River Water**

**Conclusion:** In 1999, the community initiated the move toward full utilization of Colorado River water by accepting a blended water supply under the Clearwater Program. The Clearwater Program could provide the City of Tucson the physical ability to fully utilize its entire annual Central Arizona Project allocation by 2010 and provide for full wet-water recovery by approximately 2012. Currently, the CAVSARP project is operational and provides the capacity to use 60,000 acre-feet per year of Colorado River water. This project is being re-permitted to recharge up to 80,000 acre-feet per year. The SAVSARP Phase I project will be constructed to take delivery of approximately 45,000 acre-feet of Colorado River water per year by about 2007. In order to achieve full utilization of the City of Tucson's Central Arizona Project allocation, Tucson Water can either rehabilitate the Hayden-Udall Water Treatment Plant for direct delivery or build SAVSARP Phase II for indirect use.

**Recommendation:** Tucson Water recommends that by 2006, a design be initiated for SAVSARP Phase II that will be fully compatible with SAVSARP Phase I. The overall SAVSARP project should be designed with an ultimate annual recharge and recovery capability of 80,000 to 100,000 acre-feet. The facility will be constructed so that an initial annual recharge capacity of at least 45,000 acre-feet is in place by 2007 (SAVSARP Phase I). Implementing SAVSARP Phase I is identified as a common element since it provides needed drought resistance and expanded long-term storage capacity. With regard to Decision #2, Tucson Water recommends that under SAVSARP Phase II, a total annual recharge capacity of 80,000 to 100,000 acre-feet be constructed by 2010. With CAVSARP and SAVSARP, Tucson Water would have excess recharge capacity to allow the Water Bank to store large volumes of surplus Colorado River water at these facilities for firming. These facilities could also provide short- and long-term storage reliability. Banked Colorado River water would firm the City of Tucson's annual Central Arizona Project allocation at locations where Tucson Water has recovery capabilities.

**5. Fully Utilize Effluent for Future Supply**

**Conclusion:** Tucson Water currently uses reclaimed effluent to meet non-potable water demand. Reclaimed water use accounts for approximately eight percent of total water demand. The remaining two thirds of the effluent that is currently owned and controlled by the City of Tucson is discharged into the Santa Cruz River and passively accrues water credits at a rate of 50 percent of the total volume recharged in managed underground storage facilities. If this method of effluent use continues, this renewable water resource cannot be efficiently used to maximize long-term banking or to augment the ground-water system for eventual potable reuse. Tucson Water is projected to have a shortfall in potable water supply by 2020 unless one or more of the following initiatives are successfully implemented: acquisition of additional water supplies, a more aggressive demand management program, full utilization of effluent, and/or the resumption of ground-water mining. However, the latter would cause additional declines in water levels, increase the potential for additional subsidence, and accelerate the rate at which the Utility's allowable ground-water account would be debited.

**Recommendation:** With regard to Decision #3, Tucson Water recommends that by 2014 a commitment should be made to no longer discharge the City's effluent that is not used in the reclaimed system to the Santa Cruz River. Instead, the resource-management goal would be to maximize the future use of effluent through recharge.

### 6. Utilize Effluent as a Wet-Water Resource

**Conclusion:** Adopting a paper-water management approach means that the location where the effluent is recharged and where it is recovered may not be hydrologically related. In the short term, this approach would permit additional ground-water pumping in Tucson Water's existing well fields. However, continued pumping of ground water at rates that exceed hydrologic sustainability will eventually result in a resumption of ground-water level declines and an increase in the potential for additional land subsidence in the Tucson area. The only viable long-term approach is to recover the effluent where it is recharged.

**Recommendation:** With regard to Decision #4, Tucson Water recommends that effluent be used to support the reclaimed system, for banking, and/or for eventual indirect potable use. Unless additional water supplies are acquired in the near term, the Sweetwater Enhanced Treatment Plant and an effluent pipeline to convey the highly treated effluent to Tucson Water recharge facilities should be operational by 2017. The recharged water would eventually be recovered and blended with other supplies for potable use. Decision #4 must be preceded by an intensive outreach effort to inform the public of the water-resource challenge that will soon be facing the community and hence the need to indirectly reuse effluent for potable supply to ensure long-term sustainability. The effluent would be treated to remove a wide range of constituents and would allow for managing the mineral content of the water before it is recharged and blended with other source waters for potable supply. Review of demand projections indicates that without the acquisition of additional supply, the indirect reuse of effluent for potable use may need to be initiated by 2025 to avoid a supply shortfall within Tucson Water's service area before 2040.

### 7. Acquire Additional Water Supplies

**Conclusion:** Other metropolitan areas in Arizona have recently been active in acquiring additional long-term water supplies. As a result, City of Tucson needs to implement an aggressive program to pursue potentially available supplies even though it has a substantial Central Arizona Project allocation and ground-water portfolio. Water resources will become increasingly limited both locally and statewide. Municipal water providers as well as other water users will be competing to acquire additional water resources. The limited availability of potential sources of supply could make the acquisition of additional resources both expensive and uncertain. Potential supply sources might include additional Central Arizona Project allocations, leased or purchased Colorado River water, local and imported sources of ground water, and local effluent.

**Recommendation:** Tucson Water recommends that an aggressive program of identifying and pursuing the acquisition of additional water sources be undertaken in the near term. This program needs to be continued throughout the 50-year planning period.

### 8. Manage Water Demand

**Conclusion:** Tucson Water is currently pursuing a number of avenues to manage demand including conservation programming, reducing lost and unaccounted for water, encouraging the practice of water harvesting, and providing public information programs. Additional demand management efforts should be evaluated to further reduce per capita water use. An extended period of monitoring and evaluation of these programs will be needed to demonstrate actual water savings.

**Recommendation:** Tucson Water should develop a comprehensive program to reduce the annual volume of lost and unaccounted for water in its potable systems. The Utility will also continue an ongoing historical review of the conservation program to assess its effectiveness in reducing potable and total per capita water usage rates. In addition, an assessment will be conducted to evaluate the potential to further reduce potable and total per capita water usage rates by implementing more aggressive conservation programs.

### 9. Implement a Water-Resource Impact Fee

**Conclusion:** The cost of growth is to be paid through a combination of impact fees and rate increases. The cost to expand the system and develop additional water supplies to meet future growth should continue to be shifted from existing to future customers as they become part of the system.

**Recommendation:** Tucson Water will develop a financial plan that continues to shift the cost burden of growth to new customers as they are added to the system. The Utility has implemented a system equity fee as an important step in this continuing process. This fee requires new customers to pay for the existing excess system capacity that exists today; the fee is the financial vehicle used to recover the costs already expended to provide the capacity needed to meet the water demands they bring as new customers. As a result, this fee is referred to as a backward-looking fee. As Tucson Water looks to the future, a forward-looking fee should be developed to cover the development of additional water resources and system expansions required to meet future growth.

### 10. Expand Regional Cooperation

**Conclusion:** Many of Tucson Water’s current uncertainties and challenges are similar to those of other water providers in the region. A mix of short-term actions and long-term planning will be needed to address current issues as well as new ones that arise over time. Such issues can be most effectively addressed if cooperation can be achieved among local water providers in eastern Pima County. If a cooperative structure can be established in the near term, Tucson Water would coordinate its efforts with the other members to work collectively in acquiring additional sources of supply, implementing an integrated regional salinity control program, and making arrangements to wheel renewable resources within the region.

**Recommendation:** Steps should be taken toward establishing a regional cooperative with other water providers in eastern Pima County. The cooperative should focus on setting guidelines for members to act in a unified and cooperative manner. If a cooperative structure can be established in the near term, Tucson Water would coordinate its efforts with the other members to address regional water issues.

## COSTS

Costs will play a significant role in the decision-making process relating to which elements of the Family of Futures pathways are considered and eventually implemented. Meeting the specified long-range planning goals will demand substantial investment for infrastructure and associated ongoing O&M costs.

The costs presented below are "present worth" costs developed using standard engineering assumptions. Present worth costs are calculated to provide a basis for comparison that accounts for the variability in the timing of implementation of pathway projects. Under a present worth analysis, project costs are estimated in today's dollars and are discounted for each future year until the facility is constructed. Therefore, these costs are presented for comparison of the relative costs of the various pathways and are not reflective of the actual costs to construct and operate the facilities. In addition, these conceptual capital costs are estimated at a level of accuracy that is considered suitable for long-range planning purposes. The Association for the Advancement of Cost Engineering (2000) defines a conceptual cost estimate to be within minus 30 percent and plus 50 percent of actual cost.

## Capital Costs

The capital cost estimates include construction costs, non-construction costs such as investigation studies and design, environmental and archeological studies, and right-of-way acquisition costs; they do not include land acquisition costs. Capital unit costs were estimated for pipelines, pump stations, and reservoirs.

## Operations and Maintenance Costs

O&M covers a wide range of activities that are conducted in order to sustain a level of service and to maintain the capital assets of the Utility. These costs are associated with the daily management of the water system. O&M costs include power costs associated with pumping water or operating treatment plants, costs to maintain equipment, and all labor costs required to manage, operate and maintain the Utility. Costs for the purchase of Colorado River water have not been included. O&M costs are estimated on an annual basis assuming 365 days of operation per year unless otherwise indicated.

## Recommended Plan Cost Analyses

The 14 pathways discussed in Chapter Six and listed on Table 6-1 have been evaluated using various cost estimating tools available to the Utility. In order to present the pathways in a comparative fashion, present worth analyses of both capital and O&M cost were conducted. For relative cost comparison purposes, the unit costs (dollars per thousand gallons) required to develop renewable water supplies specified in each pathway were calculated through the year 2030. Because the costs to produce hydrologically sustainable ground water are the same for each pathway, those costs and the associated volume of ground water are not included in this analysis. Table 7-1 presents the results of both the present worth and resulting unit cost analyses of each pathway. Detailed tables of the individual cost runs are presented in Appendix F: *Cost Information*.

| Family of Futures | Pathway | Combined Future | 2030 Average Flow (MGD)[1] | Unit Cost ($/1000 gallons)[2] | Total Present Worth ($) |
|---|---|---|---|---|---|
| No Effluent for Potable Use | 1 | I-A | 116.2 | $0.70 | $427,300,000 |
| | | II-A | 123.0 | $0.25 | $158,700,000 |
| | 2 | I-B | 150.9 | $0.95 | $750,000,000 |
| | | II-B | 156.5 | $0.58 | $474,700,000 |
| | 3 | I-C | 116.2 | $0.70 | $427,300,000 |
| | | II-C | 123.0 | $0.25 | $158,700,000 |
| | 4 | I-D | 150.9 | $0.95 | $750,000,000 |
| | | II-D | 156.5 | $0.58 | $474,700,000 |
| | 5 | III-A | 130.0 | $0.33 | $227,900,000 |
| | | IV-A | 115.1 | $0.90 | $541,400,000 |
| | 6 | III-B | 156.2 | $0.53 | $431,700,000 |
| | | IV-B | 149.9 | $0.93 | $734,700,000 |
| | 7 | III-C | 130.0 | $0.33 | $227,900,000 |
| | | IV-C | 115.1 | $0.90 | $541,400,000 |
| | 8 | III-D | 156.2 | $0.53 | $431,700,000 |
| | | IV-D | 149.9 | $0.93 | $734,700,000 |
| Total Recharge | 9 | III-E | 154.6 | $0.71 | $577,400,000 |
| | | IV-E | 153.1 | $1.10 | $882,000,000 |
| | 10 | III-F | 154.6 | $0.71 | $577,400,000 |
| | | IV-F | 153.1 | $1.10 | $882,000,000 |
| Combined Technology | 11 | I-E | 154.6 | $0.95 | $772,000,000 |
| | | II-E | 154.6 | $0.60 | $486,100,000 |
| | 12 | I-F | 154.6 | $0.95 | $772,000,000 |
| | | II-F | 154.6 | $0.60 | $486,100,000 |
| Treatment Flexibility | 13 | I-G | 154.6 | $0.91 | $737,300,000 |
| | | II-G | 154.6 | $0.62 | $502,800,000 |
| | 14 | I-H | 154.6 | $0.91 | $737,300,000 |
| | | II-H | 154.6 | $0.62 | $502,800,000 |

[1]The 2030 Average Flow is only that water made available for use by implementing each pathway.

[2]The Unit Cost is based upon the annualized capital and O&M costs divided by the 2030 Average Flow. It represents the cost for every 1000 gallons of new water supply put to use under each pathway.

**Table 7-1**: Cost Comparisons.

Under *No Effluent for Potable Use*, the present worth unit cost of water per 1,000 gallons ranges from $0.25 to $0.95 while total present worth ranges from about $159 million to approximately $750 million. While this Family of Futures includes some of the lowest cost scenarios and represents more than half of all the pathways evaluated in this assessment, none of the eight pathways has the capability of meeting all of the specified long-range planning goals. All eight of these pathways fail in terms of their ability to provide sufficient sustainable supply to meet projected demands through 2050. If additional water resources can be acquired and/or if per capita water usage can be reduced, these pathways will be revisited with regard to the adequacy of future water supplies.

The three remaining Families of Futures: *Total Recharge*, *Combined Technology* and *Treatment Flexibility* have present worth unit costs per 1,000 gallons which range from $0.60 to $1.10 with total present worth estimates ranging between $486 million and $882 million.

Tucson Water's recommendations are closely aligned with Pathway Nine in the *Total Recharge* Family of Futures. The total present worth presented under Combined Future III-E is $577,400,000 with a present worth unit cost of water of $0.71 per 1,000 gallons. Tucson Water's recommendations meet all of the long-range water-resource planning goals.

## Impacts on Tucson Water's Financial Plan

Providing the financial resources required to construct and operate new facilities will be a major focus of the Utility over the next decade. Tucson Water uses three primary mechanisms to fund operations and capital improvements: water sales, issuance of debt, and development type fees. Currently, the Utility covers capital costs through a combination of revenues from water sales and proceeds from the sale of water revenue bonds. Operating costs, including debt service on bond issuances, are covered by water revenues. These revenues currently include the Water System Equity Fee that is charged for new customer connections. Meeting the financial requirements of the selected pathway will likely utilize a combination of all three funding sources.

While the present worth values presented in Table 7-1 may provide a general cost relationship between the various pathways, they cannot be overlaid on Tucson Water's financial models to generate projected revenue impacts. These financial models require:

- Costs allocated to specific fiscal years over a defined planning period; and
- O&M and capital costs allocated to a given fiscal year and stated in non-discounted dollars for the period.

In addition, the financial planning models will attempt to capture certain costs not included in the present worth values presented in Table 7-1. For example, the present worth costs do not include the annual cost to purchase Colorado River water. However, every pathway will require the eventual use of all of the Utility's Central Arizona Project allocation. In calendar year 2005, the Utility plans on purchasing approximately 61,000 acre-feet of Colorado River water at a commodity rate of $79 per acre-foot ($4.8 million). By 2009, the Central Arizona Water Conservation District projects its charge for Colorado River water will be $97 per acre-foot. At that rate, charges for the Utility's full allotment of 135,966 acre-feet will be nearly $13.2 million. It is anticipated that the rate per acre-foot will continue to increase thereafter.

To provide estimates on the potential revenue increases that will be required to fund the various pathways, the Utility is creating a 20-year Financial Plan. The Financial Plan will incorporate the specific financing needs (timing and dollar amounts) for the capital and operating elements of representative pathways. This analysis is expected to be completed during November 2004. While it is anticipated that general revenue increase conclusions will be made from the Financial Plans results, the potential for large variances in capital costs (cost estimates within minus 30 percent/plus 50 percent of actual cost) and the resulting impact on required revenue increases must be considered. In addition, further discussions and analysis will be necessary to determine the source of revenue increases from among monthly water rates, development type fees, or some combination of the two.

## SUMMARY

While the Recommended Plan developed through the scenario planning process is built upon sets of common elements that can lead to multiple futures, Tucson Water's recommendations focus on meeting all of the stated planning goals set forth in Chapter One. The recommendations are based on a fiscally responsible use of Colorado River water as part of the Clearwater blend together with the full utilization of treated effluent water to indirectly augment the potable water supply through recharge and recovery. Review of Table 7-2 indicates that Tucson Water's recommendations (highlighted in yellow) meet all six of the long-range planning goals and will ensure the retention of the City of Tucson's AWS designation through 2035. The "Potable Use of Effluent" pathway under the Clearwater Program with an aesthetic TDS of 450 mg/L also meets all planning goals but at an increased cost of about 50 percent.

| | Clearwater Program 500-650 TDS; Recharge and/or Direct Treatment | | | Clearwater Program 450 TDS; Recharge and/or Direct Treatment | | |
|---|---|---|---|---|---|---|
| **Planning Goals:** | **Potable Use of Effluent** | **Long-Term Banking of Effluent** | **Disposal of Effluent** | **Potable Use of Effluent** | **Long-Term Banking of Effluent** | **Disposal of Effluent** |
| Meet Projected Total Demand | YES | YES | NO | YES | YES | NO |
| Utilize Renewable Resources | YES | NO | NO | YES | NO | NO |
| Meet Water-Quality Targets | YES | YES | YES | YES | YES | YES |
| Achieve Sustainable Pumpage | YES | NO | NO | YES | NO | NO |
| Manage Costs and Rate Impacts | YES | YES | YES | YES | YES | YES |
| Comply with Assured Water Supply Program | YES | YES | NO | YES | YES | NO |

**Table 7-2**: Meeting the Planning Goals.

In addition, treating the effluent to a higher standard to manage salinity and to eliminate any other potential unregulated chemicals presents the Utility with an environmentally responsible way to approach future needs. Providing a very high-quality effluent water supply through an enhanced level of treatment will also offer the option of blending with reclaimed water which will create a wider range of possible non-potable uses for the reclaimed system.

The *Total Recharge* component of Pathway Nine will also place the Utility in a better operational position to respond to demand management issues associated with long-term drought and system outages on the Central Arizona Project canal. While Tucson Water's recommendations generally follow Pathway Nine without enhanced treatment of the Clearwater blend (Combined Future III E), Tucson Water is also committed to the scenario planning process which seeks to maintain planning and pathway flexibility as the future unfolds. Review of the Recommended Plan Summary (Plate 1) indicates that several critical decisions should be made by 2014. Tucson Water will work with the community over the next eight to ten years in order to maximize utilization of available renewable water supplies and to ensure that the planning goals will be met in the long term.

Projected water-resource utilization under the Recommended Plan is shown on Figure 7-1. Throughout the 50-year planning period, reclaimed water for non-potable use (solid magenta color) is assumed to meet at least eight percent of total demand. The remaining 92 percent of total demand is potable demand and is indicated by the dashed white line on Figure 7-1.

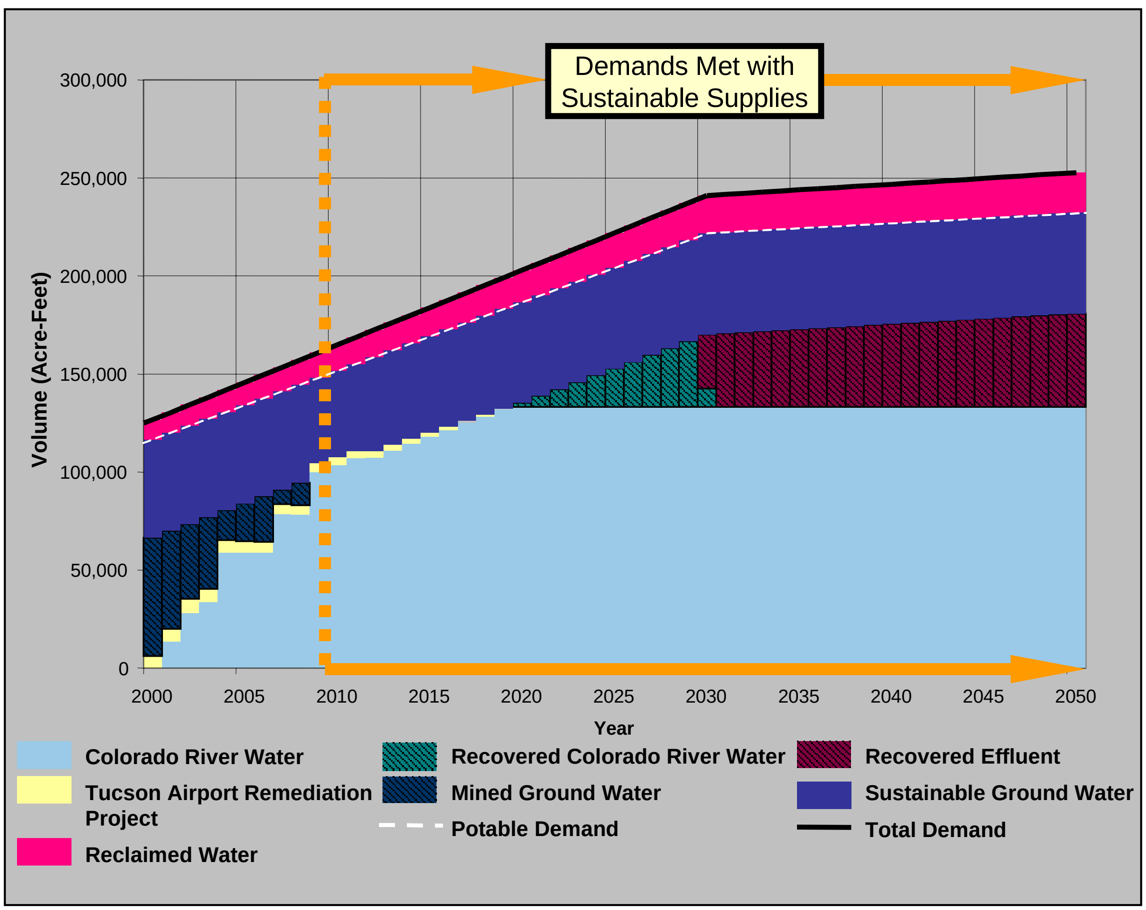



**Figure 7-1:** Projected Total Demand and Use of Resources for the Recommended Plan.

The Tucson Airport Remediation Project (yellow color) will continue meeting a small amount of the Utility's potable demand until about 2020. From 2000 through 2008, mined ground water (hatched dark blue color) will be used in limited quantities to meet potable demand as Tucson Water's Clearwater Program is brought into full operation. From 2009 through 2026, the Utility's Colorado River water (solid and hatched light blue color) and hydrologically sustainable ground water (solid dark blue color) supplies will be sufficient to meet potable demand. By 2017, highly treated effluent will be used to augment ground water in order to meet projected potable demand by 2030 (hatched magenta color). The Utility's sustainable ground water, Colorado River water, and effluent supplies can be used to meet the community's growing demand for water from 2009 through 2050. However, the Recommended Plan may not assure that the City's AWS designation will be retained to accommodate growth beyond 2035 unless additional supplies are acquired or the per capita water usage rate is reduced.

*As the present unfolds into the future, change is the only certainty. This reinforces the need for continuous planning to ensure wise water management.*

# CHAPTER EIGHT

# FUTURE ISSUES AND CHALLENGES

The scenario planning process described in Chapters Six and Seven was used to identify the range of possible futures and to develop pathways to realize those futures. Tucson Water analyzed the pathways to identify common elements and decision points within the 50-year planning horizon. This chapter focuses on the issues that will shape the future course of events and the challenges that lie ahead.

The recommended plan will periodically be reassessed and revised as planning assumptions and circumstances change over time. New possible futures will materialize while those currently envisioned may evolve or fade away. Tucson Water will continue to update and improve the planning tools that were developed to support this planning process. These tools will allow the Utility to annually update planning projections and to complete comprehensive revisions in an expeditious manner. Future comprehensive revisions to this plan may be initiated by the following:

- Significant change in PAG's updated, spatially distributed population projections.
- Significant changes in the current or projected availability of water resources.
- Advent of new technologies that could alter costs and/or the technical effectiveness of planning elements.
- Marked changes in the regulatory environment in terms of water-quality and/or water-use requirements.
- Major shifts in the preferences of Tucson Water customers.
- Specific direction provided by the City of Tucson's Mayor and Council.

## LEGAL/REGULATORY ISSUES

Complying with federal, state, and local laws and regulations is among the most critical planning priorities of water providers. The legal and regulatory environment is in a constant state of flux as governing statutes and rules undergo continuous revision. Legal and regulatory uncertainties are among the greatest challenges that water providers will have to face in the coming years. More information on the regulatory framework under which the Utility operates appears in Appendix E: *Federal, State, and Local Regulations and Policies.*

### Increasing Stringency of Water-Quality Regulations

Water-quality regulations are established and enforced at the federal, state, and local levels to protect the quality of source waters and to ensure the safety of potable and non-potable water systems. Many of the primary drinking-water and aquifer water-quality regulatory requirements have become more stringent over the years. This increasing stringency is partly being driven by recent advances in technology that have greatly improved the ability of laboratories to quantify the presence of substances at increasingly small concentrations. In most cases, potential human health risks posed by the presence of constituents at such low levels of detection have yet to be determined. Further research will be needed to guide regulators in determining which substances require treatment.

There is inherent uncertainty and complexity in balancing the various regulatory requirements with one another. The uncertainty increases when the requirements are moving targets. When one regulatory requirement changes, compliance with other regulations is often affected as well. Changes and additions to existing regulatory rules are currently in progress at the state and federal levels with regard to the Enhanced Surface Water Treatment Rule, the Disinfectants/Disinfection Byproducts Rule, and the Total Coliform Rule. Assuming the trend of more stringent regulation will continue, costly water-quality treatment programs of proven effectiveness may have to be implemented. This trend could also have unintended consequences. Water resources that are currently considered “available” may no longer be utilized unless sufficient funds or practical remedial technologies are in place to address increasing regulatory stringency.

### Emerging Contaminants of Concern

Constituents that have recently been detected in water sources may become regulated substances in the future. These constituents include currently unregulated chemical compounds, microbiological organisms, and radiological substances. As new information becomes available through the development of increasingly sensitive analytical tools, concerns are being raised about the potential health risks and the seeming proliferation of these substances.

There are many emerging constituents of potential concern. Among the more prominent are organic wastewater contaminants that include pharmaceuticals and personal care products. These constituents have been detected in surface waters that receive effluent discharges from municipal wastewater treatment plants as well as in ground water downgradient from these facilities. The potential health risks of these substances at such small concentrations are not known. For regulators and water providers alike, there is considerable uncertainty regarding the significance of analytical data currently being generated. As constituents become regulated substances over time, Tucson Water will comply with these new requirements. This is occurring at a time when water-resource planners across the nation are looking at municipal effluent as an increasingly important source for future potable supply. It is prudent to treat effluent to a higher standard than required to meet regulations if it is utilized for indirect potable supply. An enhanced level of treatment will be necessary to remove any future constituents of concern.

## Protection of Endangered Species

Adding to the array of institutional considerations is the issue of protecting the habitats of endangered species. The Endangered Species Act (ESA) of 1973 was passed by Congress "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved." There are many sections of the ESA that apply to the development of public works projects such as recharge and recovery facilities. Section 10 of the ESA specifies processes for landowners to develop and implement an approved "habitat conservation plan." Section 7 allows for individual projects to proceed based on case-by-case consultations. These processes enable development of lands inhabited by endangered species under certain conditions. Entities with proposed development projects that are approved by the U.S. Fish and Wildlife Service receive an "incidental take" permit that allows project implementation to proceed.

The City of Tucson has begun work on a habitat conservation plan that will provide a pre-determined path that project planners can use to mitigate potential harm caused to an endangered species. However, these plans may not provide mitigation for species declared as endangered in future years. Such plans may provide Tucson Water with only limited certainty and assurance when adding expensive capital improvements to its supply infrastructure.

## Gila River Adjudication and Conflicting Water Rights

The Gila River Adjudication is an ongoing proceeding initiated in Maricopa County Superior Court in 1974 to determine the relative priorities of rights to use surface water in the Gila River System. The Santa Cruz River is in one of the seven major watersheds that are the focus of the Adjudication. Sixteen Native American reservations also are involved. The appropriative allocations at stake are among the most coveted in Arizona. Historically, Tucson Water has relied on ground water as its sole source for municipal supply. The outcome of the Gila River Adjudication may bring some water that was formerly considered ground water within the purview of the Adjudication Court. This could hinder the Utility's ability to withdraw water from certain well fields in order to protect water users with senior appropriative rights.

# PUBLIC ACCEPTANCE OF RENEWABLE SOURCES OF SUPPLY

Public acceptance also shapes water-resource-planning decisions. Water quality must meet or exceed all federal, state, and local standards. The public may also require even stricter discretionary local standards for aesthetic reasons that could require levels of treatment well beyond those specified in regulations.

## Meeting Discretionary Water-Quality Standards for Colorado River Water

Aesthetic drinking water-quality standards for TDS, hardness, sulfate, and other constituents are not regulated and are left to the discretion of water providers and the communities they serve. Portions of Tucson Water's service area received directly treated Colorado River water deliveries from 1992 to 1994. Water delivery problems occurred and were traced to the pH level of the new source water. The water reacted with potable distribution system mains and customer plumbing. The water's higher mineral content was not a factor (Malcolm Pirnie, Inc., 1998). Tucson Water returned to ground water as the sole source of supply until these problems were resolved.

Based on the results of studies and public input associated with the *At the Tap Program*, Tucson Water's customers have indicated that a blend of ground water and Colorado River water with a TDS concentration of about 450 mg/L would be aesthetically acceptable to most people as opposed to the 650 mg/L concentration of Colorado River water. Meeting this discretionary standard in the long term means that some form of enhanced treatment would eventually be required at significant expense to Tucson Water customers

It may not be necessary to incur the added expense of treating Colorado River water to a discretionary potable standard if the mineral content of effluent is reduced via enhanced treatment prior to recharging the aquifer. The subsequently blended water would have a TDS concentration significantly lower than Colorado River water and may satisfy the aesthetic requirements of Tucson Water customers. Because enhanced treatment will have to be utilized for future effluent reuse to augment ground-water supplies, the focus on mineral content management should be addressed in the same treatment process. In this way, only one enhanced treatment plant would be required to meet the water supply needs of Tucson Water customers.

## The Community's Acceptance of Effluent as a Source of Supply

The community has supported the use of tertiary-treated effluent (reclaimed water) for non-potable uses since the early 1980s. However, local public acceptance of effluent to supplement the potable supply remains uncertain even though highly treated effluent is being used by several communities in this fashion (Water Environmental Federation, American Water Works Association, 1998). Tucson Water's scenario planning process identified this issue as a critical uncertainty. The extent to which effluent can be more fully utilized in the future will help limit Tucson Water's vulnerability to extended periods of drought on the Colorado River and to limited ground-water availability.

## Chlorine vs. Chloramines as Secondary Disinfectants

Chlorine is added to the drinking water supply at well sites, reservoirs, and other facilities to ensure that water in the delivery system remains free of microbiological contamination. Chloramine, an alternative secondary disinfectant, is created when chlorine and ammonia are simultaneously introduced into a water supply. Tucson Water is studying the potential use of chloramine instead of chlorine as a disinfectant. Chloramine may be more appropriate as Tucson Water shifts from reliance on ground water to renewable water supplies. The use of chloramine may require a more complex operating system, new safety requirements, and added monitoring. Tucson Water is currently evaluating the use of each type of disinfectant in its potable systems.

# RESOURCE MANAGEMENT ISSUES

Tucson Water has identified a number of water-resource issues whose uncertainties could impact planning decisions in the years ahead. Changes in water chemistry, climatic change, and policy shifts are resource-management issues that are being taken into account.

## Managing Salinity

Accumulations of dissolved minerals in water supplies could become an issue if steps are not taken to manage the higher dissolved mineral content in Colorado River water and effluent. Ground water and Colorado River water are currently used in Tucson Water's service area for potable supply. Colorado River water delivered through the Central Arizona Project has an average TDS concentration of 650 mg/L; this is higher than local ground water which averages 280 mg/L. Effluent produced from the use of these potable source waters has a TDS concentration that is about 250 to 300 mg/L greater than the original potable sources (Bureau of Reclamation, 2003; PAG, 1994). Managing the salinity of Colorado River water and effluent will be necessary since the subsequent recycling and blending of these source waters could boost the TDS concentration in water supplies. Tucson Water's recommended plan would manage TDS when effluent is treated for indirect potable use.

## Planning for Droughts and Colorado River Water Shortages

A prolonged drought in the Colorado River basin could have a detrimental effect on the statewide availability of Colorado River water and on the City of Tucson's annual Central Arizona Project allocation. A long-term shortage could tax Tucson Water's available but limited ground-water resources. Shortages on the river will eventually occur and will cause Tucson Water as well as other Central Arizona Project water users to rely more heavily on "banked" (stored) Colorado River water, ground-water pumping, and locally generated effluent. If effluent is fully integrated into Tucson Water's portfolio of available water resources, its customers will be less vulnerable to droughts in the Colorado River basin and to shortfalls in the supply of Colorado River water.

## Storing and Recovering Colorado River Water for Firming

The Arizona Legislature created the Water Bank in 1996 to store unused portions of Arizona's allocation of Colorado River water to firm (secure) local supplies in times of emergency or shortage. When and where additional water is recharged and stored in the Tucson AMA as well as within the State is the subject of ongoing discussion. It is Tucson Water's position that firming water must be readily recoverable from local recharge facilities with integrated recovery capabilities such as CAVSARP and the proposed SAVSARP project.

The Water Bank has established a goal of storing 810,000 acre-feet of Colorado River water for firming within the Tucson AMA by 2017. The Water Bank has four potential sources of funding to pay for this activity: an *ad valorem* property tax; a portion of ground-water withdrawal fees obtained in the Tucson, Phoenix, and Pinal AMAs; general fund appropriations; and interstate banking activities. However, the Water Bank currently projects only enough funding to store about 600,000 acre-feet in the Tucson AMA by 2017. If the Water Bank does not achieve its goal, the future availability of Colorado River water will be less secure in times of shortage. Tucson Water will continue to partner with the Water Bank to ensure that its originally established firming goal for the Tucson AMA can be achieved.

## The Case for Sustainable Ground-Water Pumping

The AWS Program administered by ADWR is intended to ensure that providers and communities limit aquifer overdraft and shift from mining ground water to utilizing renewable water sources for supply. Tucson Water chose to obtain an AWS designation for a number of reasons, one of which was its consistency with the community's goal of long-term sustainability. However, the AWS Program does not currently recognize the existence of annually renewable ground water. Hydrologically, a certain amount of ground water is naturally recharged each year; in addition, a volume of ground-water underflow annually enters into the service area. A conservative estimate of annually renewable ground water that is available for sustainable pumping in Tucson Water's projected service area is about 50,000 acre-feet. The City of Tucson views hydrologically sustainable ground-water pumping as an important source of renewable supply that should be incorporated into ADWR's AWS Program. This approach would replace the "allowable groundwater" portfolio program in the current AWS regulations and would extend indefinitely the time that ground water would be legally available as a resource in the future.

Even without this regulatory change, pumping ground water within the projected service area at or below the hydrologically sustainable rate is the most prudent long-term ground-water management approach. From a wet-water management perspective, sustainable ground-water pumping would ensure that water-level declines would stabilize and that they would even recover in some areas. This in turn would reduce the potential for additional aquifer compaction and associated land subsidence in the metropolitan area.

## Conservation Programming as Demand Management

Tucson Water's conservation program has held per capita water usage constant over the past 20 years. A more aggressive conservation program designed to achieve a targeted per capita usage rate will be evaluated by Tucson Water. This assessment should target all sectors of potable water use including residential, commercial, and industrial customers and could include technology-oriented, quantifiable, and possibly mandatory conservation efforts. Conservation programming will require continuing reassessment of its effectiveness to document potential water savings.

## Stewardship of the Regional Aquifer

Tucson Water has set a planning goal of managing ground-water withdrawals from the regional aquifer to ensure that this water resource will be available in the long term as a hydrologically sustainable source of supply. An emphasis on aquifer stewardship within the Tucson AMA means that the locations of water storage and recovery should be based on wet-water management strategies. Such efforts will not be successful in a regional context if other ground-water users do not similarly adhere to the same principles of stewardship. Ground-water users within the Tucson AMA must work together to hydrologically balance wet-water withdrawals with natural and artificial recharge. Tucson Water will work with ADWR to promote hydrologically based principles of aquifer stewardship in the Tucson AMA.

# JURISDICTIONAL ISSUES

Jurisdictional issues present their own unique set of challenges some of which are intertwined with the future actions of other water providers or users in the region. Examples of these potential issues are discussed below.

## Matching Tucson's City Limits with the Projected Service Area

The City of Tucson operates Tucson Water as a municipal utility under charter authority from the State which allows the City to operate the Utility both within and outside the City limits. Tucson Water is subject to the authority of the City of Tucson Mayor and Council and all fees, rates, and charges for water service are subject to its approval. Tucson Water does not provide exclusive service within the City limits and is under no obligation to expand its service area outside the City of Tucson. Within Tucson Water's service area, the Utility is obligated to provide service to the public at reasonable rates and under reasonable conditions.

Tucson Water's system has expanded over the years to areas inside and outside the jurisdictional boundaries of the City of Tucson. This expanded system has allowed for favorable economies of scale and opportunities to make water management decisions of a more regional nature. This expansion has also resulted in a department of the City of Tucson serving customers who live outside the City and who cannot directly shape future policy by voting in City elections. Future City annexations of unincorporated areas served by Tucson Water would give such customers direct input on Mayor and Council deliberations and on the direction the governing body provides to the Utility.

## Wheeling Agreements with Other Water Providers

Tucson Water is one of many water providers in the Tucson AMA with an annual allocation of Colorado River water delivered through the Central Arizona Project; however it is the only one currently with direct access to this water source for potable supply. Tucson Water also is the only water provider with a reclaimed water system that treats and delivers tertiary effluent to its customers for non-potable uses. Other water providers in proximity to Tucson Water's service area may not find it economically feasible to build facilities for treatment and delivery of their own allocations of Colorado River water and/or recycled effluent. For instance, the Town of Oro Valley is planning to begin receiving reclaimed water wheeled to its own reclaimed water distribution system through Tucson Water's system in June 2005.

Similarly, Tucson Water could partner with other local water providers by treating and delivering (wheeling) their Central Arizona Project and/or effluent allocations through Tucson Water's distribution systems. Contractual relationships between Tucson Water and other providers would have to be established to formalize responsibilities and commitments among the parties. This would ensure each provider would be able to take full advantage of its available renewable supplies. These relationships should be established so that the Utility can plan and implement wheeling agreements that equitably benefit all interested parties.

## The Need for a Regional Water Cooperative

The supply uncertainties that Tucson Water must address are in many ways similar to those of other water providers in the region. A mix of short-term actions and long-term planning will be needed to meet these and other challenges that will undoubtedly surface. The extent to which such issues can be addressed may depend on regional cooperation among water providers.

As water resources become increasingly limited locally and statewide, water providers and other water users will compete for future supplies. Given that the competition will be statewide in scope, local water providers would have greater leverage if they banded together to form a regional water cooperative.

Such a cooperative could also provide for coordinated water management and conservation programs within the region. It could set guidelines for members to act in a unified manner with respect to Colorado River issues such as reallocations of Central Arizona Project water and main stem Colorado River water, the acquisition of other additional sources of supply, implementation of an integrated regional salinity control program, and the wheeling of renewable resources. Despite the potential gains to be had, establishing a regional water cooperative may prove challenging. The long-standing competition between local interests should be replaced with a more collaborative ethic to ensure long-term sustainability in the greater Tucson area. While working with other local water providers to establish a more cooperative water-management approach, the City of Tucson's efforts to pursue additional water resources will proceed. If these efforts are successful, they could benefit all cooperating entities.

## BEYOND 2050

Tucson Water currently has access to sufficient water supplies to extend its AWS designation to 2035 and to meet projected annual water demands through 2050. There may also be opportunity to augment existing supplies by acquiring additional water sources in the future. Such "potentially available" sources can range from the likely to what may currently seem improbable. The likely sources could be long-term Central Arizona Project water leases with Native American communities or purchases of high-priority Colorado River water from agricultural interests located along the Colorado River. The currently improbable sources of supply might include the desalinization of sea water, weather modification to increase local precipitation, watershed modification to increase runoff and basin recharge, and of course iceberg harvesting among others. Where the practical end of the spectrum grades into the improbable is not clear and cost may not be a limiting factor if there is a great enough need.

There may be a theoretical limit on the number of people who can sustainably reside in the Tucson area. To expand beyond this limit is to cross the critical threshold from a community growing with sustainable water resources to one that depends on gradual resource depletion. Taking full advantage of all water resources currently available, obtaining access to additional sources of supply, and/or developing a more aggressive conservation program to manage water demand could move that critical threshold further out in time well beyond 2050. Conversely, a decision to ignore any available water resources, such as municipal effluent for indirect potable reuse, could limit future options and bring that threshold closer in time.

Current water demand projections indicate that failure to acquire additional water resources and/or not utilizing effluent in a timely manner means that Tucson Water would have to deplete its finite paper-water allotment of ground-water credits to satisfy near- and mid-term demands. As a result, Tucson Water's AWS designation could be put in jeopardy in the mid and long terms. By following the recommended plan outlined in Chapter Seven, Tucson Water can establish a foundation for long-term sustainability. For this foundation to be stable beyond 2050, Tucson Water must fully utilize its Central Arizona Project allocation, locally available effluent, and any additional water supplies it can acquire. This also requires responsible use of Tucson Water's ground-water supply with emphasis on establishing wet-water management and aquifer stewardship as primary operating goals.

*Water Plan: 2000-2050* will be updated in the years ahead. As the present unfolds into the future, change is the only certainty. This recognition reinforces the need for continuous planning and wise water management.

# REFERENCES

Arizona Department of Water Resources, 1999. *Third Management Plan for Tucson Active Management Area 2000-2010*.

Arizona Department of Water Resources, 2001. *Assured Water Supply Program*, Information Pamphlet.

Arizona Department of Water Resources, 2002. *Decision and Order No. 26-000001 – City of Tucson Designation of Assured Water Supply*.

Arizona Department of Water Resources, 2003a. *Central Arizona Project Supply Analysis for Tucson Water,* Colorado River Management Division.

Arizona Department of Water Resources, 2003b. Electronic correspondence to obtain information on other Tucson AMA water users for year 2000.

Association for the Advancement of Cost Engineering, 2000. Cost Estimate Classification System as Applied in Engineering, Procurement, and Construction for the Process Industries, *AACE International Recommended Practice No. 18R-97.*

Baker, Lynn D., 2000. *Tucson Water History: A Reference Book,*Vol. 1.

Betancourt, Julio L., 2003. United States Geological Survey, Desert Laboratory, Electronic communication.

Betancourt, Julio L., 2004. United States Geological Survey, Desert Laboratory, Electronic communication.

Black & Veatch, 1995. *Cooling Tower Management and Efficiency Survey.*

Bureau of Reclamation, 2003. *Central Arizona Salinity Study, Phase I Final Report.* Prepared in partnership with the 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, and Brown and Caldwell.

Central Arizona Groundwater Replenishment District, 2004. *Plan of Operation (First Draft),* September 2004.

CH2M Hill, 1989. *Tucson Water Resources Plan 1990-2100,* Prepared in cooperation with the City of Tucson Water Department.

City of Tucson, 1975. *Mayor & Council Resolution #9408.*

Davidson, E.S., 1973. *Geohydrology and Water Resources of the Tucson Basin*. United States Geological Survey, Water Supply Paper.

Driscoll, Fletcher G., 1986. *Groundwater and Wells, Second Edition*, Johnson Division.

Errol L. Montgomery & Associates, 2004. *Second Update of Projections of Changes in Groundwater Levels and Groundwater Quality, Central Avra Valley Storage and Recovery Project (CAVSARP), Pima County, Arizona*. Prepared for Tucson Water.

Graft, Marty, 1997. *Draft Summary of Landscape Survey Results*, University of Arizona, Department of Hydrology and Water Resources.

Inter Tribal Council of Arizona, 2003. Web site: http://www.itcaonline.com/tribes_tohono.html/.

Lewis, M. Byron, 2004. *Arizona Prior Appropriation Law: History and Recent Developments*, Arizona Water Law, 12th Annual Conference, CLE International.

Logan, Michael F., 2002. *The Lessening Stream: An Environmental History of the Santa Cruz River*, University of Arizona Press, Tucson.

Malcolm Pirnie, 1996. *Tucson Water Department, Application for Designation of Assured Water Supply*.

Malcolm Pirnie, 1998. *Central Avra Valley Storage and Recovery Project, Task 6: Water Quality Management Program Iron Release Testing Results.*

McPherson, E.G., and Haip, R.A., 1989. *Emerging Desert Landscape in Tucson, Geographical Review*, Vol. 79, No. 4.

Metropolitan Domestic Water Improvement District (MDWID), 2003. Web site: http://www.metrowater.com/.

National Weather Service, 2004. Web site: http://www.wrh.noaa.gov.

Pima Association of Governments, 1994. *CAP Water Salinity Impacts on Water Resources of the Tucson Basin*, prepared for Tucson Water.

Pima Association of Governments, 2003. *DRAFT PAG Census Tract Forecasts 2000-2050, Year 2000 Transportation Analysis Zone Dataset, Year 2030 Transportation Analysis Zone Dataset.*

Schaedler, Nathan, and Othmer, Edward, 1999. *Understanding Water Acquisition, Preservation, and Restoration through Water Rights Principles and Environmental Legislation, National Paralegal Reporter*, National Federation of Paralegal Associations.

Schwalen, H.C., and Shaw, R.J., 1957. *Water in the Santa Cruz Valley,* University of Arizona, Agricultural Experiment Station.

Schwartz, Peter, 1991. *The Art of the Long View, Planning for the Future in an Uncertain World,* Doubleday.

Tucson Water, 2003. *Documentation: Committed Demand Analysis*, Technical Memorandum.

Tucson Water, United States Geological Survey, and Arizona Department of Water Resources, 1998. *Status of the Aquifer.*

U.S. Census Bureau, 2002. *2000 Census of Population and Housing, Summary Population and Housing Characteristics*, PHC—1-4, Arizona. Washington DC.

Water Environmental Federation and American Water Works Association, 1998. *Using Reclaimed Water to Augment Potable Resources.*

Water Resources Research Center, 1999. *Water in the Tucson Area: Seeking Sustainability*, University of Arizona.

Western Resource Advocates, 2003. *Smart Water, A Comparative Study of Urban Water Use Across the Southwest.*

# *WATER PLAN: 2000-2050*

# GLOSSARY

**Acre-foot:** A unit of water volume measurement. One acre-foot of water will cover an area of one acre to a depth of one foot and equals 43,560 cubic feet, 1,233 cubic meters, or 325,851 gallons. An acre-foot is enough water to meet the needs of three average Tucson families for one year.

**Active Management Area (AMA):** A geographical region in Arizona subject to regulation under the Groundwater Management Act. Five active management areas currently exist in the State.

**Areal:** Pertaining to an area, as an *areal map.* Not to be confused with *aerial.*

**Aquifer:** A body of rock or sediments that is sufficiently permeable to conduct ground water and to yield economically significant quantities of water to wells and springs.

**Arizona Department of Environmental Quality (ADEQ):** A department of state government responsible for ground-water quality protection, water quality standards, and wastewater reclamation and reuse permits.

**Arizona Department of Water Resources (ADWR):** A department of state government responsible for water management and administration of water-related programs within the State.

**Arizona Water Banking Authority (Water Bank):** A department of state government established in 1996 by the Legislature to help secure the State's full entitlement of Colorado River water through the Central Arizona Project. The Water Bank recharges and stores Colorado River water to develop long-term storage credits for times of shortage on the Colorado River, meet the management plan objectives of the Arizona Groundwater Code, assist in the settlement of Native American water rights claims, and exchange water to assist Colorado River communities.

**Assured Water Supply (AWS) Program:** An ADWR requirement that all new developments in Active Management Areas must demonstrate a 100-year water supply that is of adequate quality, continuously available, consistent with the management plan and management goal of the AMA, and that there is financial capability to construct the water facilities available for the proposed use. For more information, see Appendix E.

**At the Tap:** A 1997 Tucson Water program that involved extensive research and taste tests in preparation for the use of Colorado River water.

**Beat the Peak:** A Tucson Water public information and awareness program that was originally developed in 1977 to reduce the Utility's peak hour water demands during the peak use months of June, July, and August. Ratepayers supported the program so strongly that *Beat the Peak* came to include a summer water conservation education program.

**Block Rates:** A form of water rate design in which the price per unit of water increases in a stair-step fashion according to the level of usage.

**Booster Station:** A facility within a water distribution system that pumps water to a higher elevation.

**Brine:** Water that has a high dissolved mineral content.

**Ccf:** A water billing unit that equals 100 cubic feet or 748 gallons.

**Central Arizona Groundwater Replenishment District (CAGRD):** Created by the State Legislature in 1993 to replenish ground water in Pima, Pinal, and Maricopa counties. CAGRD's purpose is to provide a mechanism for water providers and landowners to demonstrate an Assured Water Supply. The Central Arizona Water Conservation District operates the CAGRD. (See also *Central Arizona Water Conservation District, CAWCD*.)

**Central Arizona Project:** A federal water project designed to bring water from the Colorado River to central and southern Arizona. The Central Arizona Project includes 336 miles of canal and pipeline and 14 pump stations.

**Central Arizona Water Conservation District (CAWCD):** The State's contracting agent with the U.S. Department of the Interior for Central Arizona Project water supply. Responsibilities include operation and maintenance of the Central Arizona Project system and repayment of capital costs.

**Citizens' Water Advisory Committee (CWAC):** An advisory group appointed by the City of Tucson Mayor and Council and City Manager to make policy recommendations to Tucson Water on water issues.

**Class "A" Reclaimed Water:** Treated wastewater that meets the "A" designation established by the Arizona Department of Environmental Quality. Class A water is suitable for outdoor watering and certain industrial uses.

**Colorado River Water:** For purposes of *Water Plan: 2000-2050*, the term "Colorado River water" is used for all water that is currently delivered to Tucson Water via the Central Arizona Project.

**Conservation:** Techniques for saving water that reduce demand.

**Conservation Effluent Pool:** A quantity of effluent set aside each year pursuant to an intergovernmental agreement between the City of Tucson and Pima County in 2000 for use in riparian restoration projects. The initial 5,000 acre-feet of effluent set aside by the agreement expands over time to a total of 10,000 acre-feet. Use of the conservation effluent pool is subject to specific terms that are under negotiation by the City and the County.

**Direct Treatment:** Process through which Colorado River water is diverted from the Central Arizona Project and is then directly treated and served to customers for potable supply. This process is in contrast to indirect treatment where Colorado River water is diverted from the Central Arizona Project, recharged at underground storage facilities, and then recovered before being delivered to customers for potable use.

**Disinfection:** The treatment of water to inactivate, destroy, and/or remove disease-producing bacteria, viruses, and other microorganisms to make it safe for human consumption.

**Effluent:** Treated municipal wastewater.

**Enhanced Treatment:** Additional treatment measures to further improve water quality above the capabilities of conventional water treatment plants.

**Emerging Contaminants:** Constituents of potential concern from a water-quality perspective that are not currently regulated.

**EMPACT:** *Environmental Monitoring for Public Access and Community Tracking* program is intended to provide public access to clearly communicated, time-relevant, useful, and accurate environmental monitoring data to assist the public in day-to-day decision-making about their health and the environment.

**Environmental Protection Agency (EPA):** A federal agency formed by Congress in 1970 in response to growing public demand for cleaner water, air, and soil.

**Firming:** The act of securing Colorado River water supplies by recharging and storing available excess supply in order to meet anticipated future declared shortages on the Colorado River.

**Groundwater Management Act of 1980 (GMA):** Landmark legislation that established the Arizona Department of Water Resources as well as rules and policies that govern water usage within the state with special emphasis in Active Management Areas.

**Ground Water:** That portion of water beneath the surface of the earth that can be recovered with wells or that flows naturally to the earth's surface via seeps or springs.

**Ground-Water Overdraft:** The condition that occurs as a result of withdrawing more ground water than is replenished through natural, incidental, or artificial recharge.

**Ground-Water Savings Facility (GSF):** A facility, commonly a farm, where a renewable water supply is used in lieu of pumping ground water.

**Incidental Recharge:** Water that infiltrates the aquifer from routine losses from a water distribution system.

**Indirect Potable Reuse:** Use of treated effluent that has been recharged, recovered, and treated to potable water-quality standards.

**Intergovernmental Agreement (IGA):** An agreement authorized by state statute between two or more government entities that provides for joint action or joint exercise of governmental powers.

**Lost and Unaccounted for Water:** A comparison of a water user's annual production to its annual water deliveries. The difference is considered lost and unaccounted for water. Sources of lost and unaccounted for water may include meter error, leaks, and theft.

**Management Plan:** A document produced by Arizona Department of Water Resources in accordance with the requirements of the 1980 Groundwater Management Act. It addresses water supply augmentation, water quality, and water conservation plans for all agricultural, municipal, and industrial users in an Active Management Area.

**Milligrams per Liter (mg/L):** A unit of measure that equates to parts per million.

**Mined Ground Water:** Ground water that is pumped from the aquifer and is not replenished.

**Non-Potable Reuse:** Treated municipal effluent that receives additional filtration and disinfection to meet state water-quality standards for irrigation and certain industrial applications. This use conserves higher quality sources of supply for potable use. See also *Reclaimed Water*.

**Potable Water:** Water that meets the U.S. Environmental Protection Agency and/or the State’s drinking water (water-quality) standards.

**Present worth:** An engineering economic analysis that converts all cost calculations to a common point in time. Present worth costs are calculated in *Water Plan: 2000-2050* to provide a basis for comparison that accounts for the variability in the timing of implementing projects.

**Recharge:** Water that replenishes an aquifer by surface infiltration or by other natural or induced means.

**Reclaimed Water:** Treated effluent that is used for turf irrigation and certain industrial uses.

**Renewable Ground Water:** The amount of ground water naturally replenished that could be annually withdrawn without causing significant water-level declines.

**Renewable Supply:** A water source that is continuously replenished. Renewable supplies currently available for use in the Tucson Active Management Area are Colorado River water and effluent.

**Resource Development Fee:** See *Water-Resource Development Fee.*

**Riparian:** Pertaining to or situated on the bank of a body of water, especially a river.

**Safe Yield:** A management goal of the 1980 Groundwater Management Act intended to balance ground-water withdrawals with natural and artificial recharge in selected Active Management Areas.

**Soil-Aquifer Treatment:** Use of the physical, chemical, and/or microbiological properties of the soil and the aquifer to provide treatment of water introduced into the ground-water system.

**Southern Arizona Water Rights Settlement Act (SAWRSA):** 1982 federal legislation enacted to settle water-rights claims of the Tohono O'odham Nation against the City of Tucson and several other parties.

**Spatial-Distribution:** Within this document, spatial-distribution refers to how population and/or water demand is distributed over a specific geographic area.

**Specific Yield:** An estimate of the amount of recoverable ground water in an aquifer.

**Surface Water:** Water that is on the Earth's surface, such as in a stream, river, lake, or reservoir.

**System Equity Fee:** A fee that is charged to new ratepayers to recoup prior expenditures used to expand Tucson Water's potable system in anticipation of increasing demand. A fee of this type is considered a "backward-looking" fee.

**Total Demand:** The volume of water a water provider is required to produce to meet the needs of all potable and nonpotable customers.

**Total Dissolved Solids (TDS):** A term that expresses the quantity of dissolved material in a sample of water measured in milligrams per liter (mg/L).

**Total Gallons per Capita per Day:** A measure of average water usage calculated by dividing the total water deliveries by a provider's service area population.

**Tucson Active Management Area (Tucson AMA):** One of the original areas in Arizona that were designated for regulation by Arizona Department of Water Resources.

**Water Bank:** See *Arizona Water Banking Authority*.

**Water Harvesting:** The process of intercepting stormwater from a surface such as a roof, parking area, or land surface, and putting it to beneficial use.

**Wheeled Water or Water Wheeling:** Water transferred between two agencies whereby one agency uses its system infrastructure to treat and/or convey water that is owned by the receiving agency.

**Water-Resource Development Fee:** A fee implemented to pay for future Tucson Water system improvements and/or acquisition of additional sources of supply. This type of fee is known as a "forward-looking" fee.

**Zanjero:** The zanjero, or "water master" as he was known in pioneer times, was a powerful person who controlled the allotment of water to fields. Tucson Water's *Zanjero Program* offers free residential water audits to ratepayers to help them eliminate waste and to reduce water bills.

# APPENDIX A

# OTHER WATER USERS IN THE REGION

Although Tucson Water is the largest municipal water provider in southern Arizona, the Utility is but one of many providers and water users in the Tucson AMA. Two domestic water improvement districts, smaller municipal providers, private water companies, irrigation districts, and industrial and agricultural users that have their own ground-water rights all draw water supplies from the same regional aquifer. This appendix briefly summarizes who the other water users are in the Tucson AMA. For more information about AMAs, refer to Appendix E: *Federal, State, and Local Regulations and Policies.*

## HISTORICAL PERSPECTIVE

Water use in the Tucson AMA has changed over time. Municipal water use has increased since 1940 and by 1985 replaced agriculture as the largest water-using sector. In 2000, the total reported volume of ground water used in the AMA was 326,103 acre-feet of which about half was municipal water use. Industrial use, which includes mines and sand and gravel facilities, has remained fairly constant since 1975 (ADWR, 1999).

The number of water providers in the Tucson AMA has also changed over time. Prior to the 1940s, there were many small potable water providers serving from a dozen services up to several thousand. The City of Tucson has acquired more than 100 of these companies and their wells over the past 60 years. These small systems have been acquired for a number of reasons including expansion of the City's boundary, requests by the water providers to be taken over, and opportunities to consolidate water services in order to increase efficiencies and improve the quality of service. Purchases continue to this day on a case-by-case basis.

Tucson Water's first formal long-range planning process resulted in the *Tucson Water Resources Plan 1990-2100* which was completed in 1989. The initial planning effort was driven by regulatory requirements created by Arizona's 1980 Groundwater Management Act and local concerns about how available water resources including Colorado River water would be utilized.

The Northwest Area Agreement of 1979 was drafted in anticipation of the Tucson region receiving Colorado River water from the Central Arizona Project and to help address area providers' concerns regarding long-term, sustainable supplies. The agreement committed Tucson Water to provide treated Colorado River water to three private utilities: Metropolitan Water Company (now Metropolitan Domestic Water Improvement District—MDWID), Cañada Hills Water Company (subsequently purchased by the Town of Oro Valley), and the Rancho Vistoso Water Company (also purchased by the Town of Oro Valley). In return, these private water companies agreed to utilize Colorado River water as their base supply, provide well pumping data, and help pay for construction of the system that would supply the imported water. This multi-party agreement positioned Tucson Water to become the regional municipal water provider.

Tucson Water's role in the regional water picture has changed since the Mayor and Council approved the *Tucson Water Resources Plan 1990-2100* in 1989. This long-range plan, like the Northwest Area Agreement, was created with the idea that Tucson Water would be the regional water provider. In the years since the plan was adopted, three new municipal water providers, with their own governing bodies, have been created.

By the early 1990s, purchases of the private water companies by government entities led to agreements that dissolved the Northwest Area Agreement; as a result, Tucson Water was no longer in the position to become the regional water provider. Subsequent agreements have been made between the City of Tucson, MDWID, and the Town of Oro Valley. An intergovernmental agreement in 1998 between MDWID and the City settled a legal dispute between the parties over the terms of the Northwest Area Agreement. This agreement turned over 9,500 acre-feet of the City's Central Arizona Project allocation to MDWID (where 642 acre-feet of this amount was transferred to the Town of Oro Valley for a portion of the original Metropolitan Water Company located within the Town boundaries). MDWID paid the City $11.5 million for past capital costs on the Central Arizona Project allocation and to be released from the Northwest Area Agreement. In late 2001, the City's annual Central Arizona Project allocation was reduced another 4,454 acre-feet due to a settlement between the City of Tucson and the Town of Oro Valley. In addition, the Town of Oro Valley paid the City of Tucson $3.8 million to be released from the Northwest Area Agreement.

## WATER PROVIDERS IN THE TUCSON AMA

As of 2000, more than 40 potable water providers in addition to Tucson Water were located in the Tucson AMA as shown on Table A-1 (ADWR, 2003b). Tucson Water is the largest provider in the Tucson AMA with a service area population of 638,936 in 2000. The next largest in terms of population served is 15 times smaller than Tucson Water. After Tucson Water, the next four largest providers are MDWID, the Town of Oro Valley, the Flowing Wells Irrigation District, and Community Water Company of Green Valley.

### Metropolitan Domestic Water Improvement District

The Metropolitan Domestic Water Improvement District (MDWID) was created by the Pima County Board of Supervisors in 1992 and is the second largest water provider in the Tucson

| User Name | Estimated 2000 Population | 2000 Pumpage (Potable) (Ac-ft) | Central Arizona Project Allocation | Service Agreement with Tucson Water | Effluent Allocation | Assured Water Supply Designation |
|---|---|---|---|---|---|---|
| MDWID [1] | 44,029 | 8,633 | 8,858 | Interconnect | Yes | Yes |
| Town of Oro Valley [1] | 34,153 | 9,085 | 6,748 | | Yes | Yes |
| Community Water of Green Valley | 15,286 | 2,448 | 1,337 | | | |
| Flowing Wells Irrigation District | 15,109 | 2,879 | 4,354 | | | |
| Lago del Oro | 8,225 | 2,220 | | | | |
| Avra Water Co-op | 7,020 | 1,027 | | | | |
| Davis-Monthan Air Force Base | 6,187 | 1,423 | | | | |
| University of Arizona | 5,014 | 1,516 | | | | |
| Ray | 4,830 | 668 | | | | |
| Green Valley Water Company | 4,757 | 2,225 | 1,900 | | | |
| Arizona Water Company | 4,140 | 379 | | | | |
| Hub Water Company | 4,056 | 1,105 | | | | |
| Arizona State Prison Complex | 3,990 | 653 | | | | |
| Marana Municipal Water System | 3,591 | 544 | 47 | Interconnect | | Yes |
| Las Quintas Serenas | 3,080 | 442 | | | | |
| Vail Wtr. Co. (formerly Del Lago) | 2,537 | 296 | 786 | | | Yes |
| Voyager Wtr. Company | 2,415 | 279 | | | | |
| Farmers Wtr. Company | 2,390 | 538 | | | | |
| Marana Domestic Water Improvement District | 1,847 | 326 | | | | |
| Forty Niners Water Company [2] | 981 | 742 | | Interconnect | | |
| Los Cerros | 924 | 165 | | | | |
| Rancho del Conejo | 830 | 105 | | | | |
| Thim Utility | 758 | 102 | | | | |
| Spanish Trail | 720 | 130 | 3,037 | | | Yes |
| Sandario | 640 | 119 | | | | |
| Rincon Ranch Estates | 627 | 123 | | | | |
| E&T | 623 | 20 | | | | |
| Winter-haven | 593 | 221 | | | | |
| Lazy "C" | 480 | 56 | | | | |
| Honea | 460 | 68 | | | | |
| Saguaro | 420 | 46 | | | | |
| Diablo Village | 417 | 10 | | | | |
| Rillito | 315 | 32 | | | | |
| I.M. | 255 | 25 | | | | |
| Mesaland | 235 | 87 | | | | |
| Halcyon | 203 | 65 | | | | |
| Sahuarita Village | 176 | 33 | | | | |
| Three Points | 162 | 22 | | | | |
| Lyn Lee | 139 | 26 | | | | |
| Mirabell | 110 | 25 | | | | |
| Rancho Sahuarita | 85 | 16 | | | | Yes |
| Worden | 46 | 9 | | | | |
| Despoblado | 14 | 1 | | | | |
| Rincon Creek | 4 | 8 | | | | |
| Midvale [3] | N/A | N/A | 1,500 | Interconnect | | |
| **TOTAL Pumpage (Acre-Feet)** | | **38,942** | | | | |

1. Central Arizona Project and effluent allocations are a result of agreements between the City of Tucson and the provider(s). The amount of effluent will vary based on how much potable water is delivered in a given year.
2. This provider has since been purchased by Tucson Water.
3. Tucson Water has become the succession in interest for Midvale's Central Arizona Project allocation.

**Table A-1:** Other Water Providers in the Greater Tucson Region, Tucson Active Management Area Year 2000 (ADWR, 2003b).

AMA (MDWID, 2003). In 2000, MDWID provided 6 percent of all reported domestic water usage in the Tucson AMA. Prior to 1992, MDWID was operating as the privately owned Metropolitan Water Company. In the early 1990s, Tucson Water negotiated a purchase agreement to acquire the Metropolitan Water Company. However, because the service area was outside the jurisdictional boundary of the City of Tucson, there was an interest on the part of some Metropolitan Water Company customers to form a domestic water improvement district to retain local control. The City of Tucson agreed to complete its purchase of the Metropolitan Water Company and re-sell it to MDWID on the same day.

MDWID covers a 26 square-mile area in the northwest portion of the Tucson metropolitan area and includes portions of the Town of Marana, the Town of Oro Valley, and unincorporated Pima County. Review of Table A-1 indicates that MDWID served 8,633 acre-feet of water to 44,029 residential and commercial customers in 2000. An elected Board of Directors provides management oversight to MDWID.

In 2001, an Intergovernmental Agreement Relating to Effluent between MDWID and the City of Tucson allocated a portion of the City's effluent to MDWID. The amount of effluent owned by MDWID in any given year will vary depending on its service area deliveries (excluding water delivered for turf irrigation such as on golf courses) and other factors.

MDWID obtained an AWS designation from ADWR (see Appendix C: *Assured Water Supply Implementation* for more information about the AWS Program). By the end of 2003, MDWID had stored all of its Central Arizona Project allocation in recharge facilities located outside of its boundaries. Through paper-water accounting, however, MDWID is recovering a portion of its storage credits through ground-water pumping within its service area.

## Town of Oro Valley

The Town of Oro Valley is located six miles north of the City of Tucson and covers a 24 square-mile area. It is one of the fasting growing communities in the region. The Town of Oro Valley's population for the year 2000 was 34,153; the service area pumped 9,085 acre-feet of ground water to meet water demand. The community has a town manager form of government with a mayor, vice-mayor, and town council. The local governing body purchased Cañada Hills Water Company and Rancho Vistoso Water Company in the 1990s, and these two former water companies constitute the core of the Town's water system.

In 2001, an Intergovernmental Agreement Regarding Potable Water and Effluent between the City and the Town of Oro Valley assigned the Town effluent derived from wastewater return flows that are associated with Oro Valley's potable water deliveries. This agreement is subject to the provisions of the 1979 Intergovernmental Agreement Relating to Effluent and 2000 Supplemental Intergovernmental Agreement Relating to Effluent between the City of Tucson and Pima County (see Appendix E: *Federal, State, and Local Regulations and Policies* for more information.). Like the MDWID effluent agreement, the amount of effluent owned by the Town of Oro Valley will vary annually depending on how much potable water they deliver in any given year; however, it does not include water delivered for turf irrigation such as on golf courses.

The Town of Oro Valley has an AWS designation. By the end of 2003, the Town had stored 12,000 acre-feet of its Central Arizona Project water allocation at a groundwater savings facility but to date has not recovered its storage credits.

## Flowing Wells Irrigation District

The Flowing Wells Irrigation District dates back to the 1890s. The District's service area covers about four square miles, and it is partially located within the City of Tucson's boundary. The District pumped 2,879 acre-feet of ground water in 2000 and served a population of 15,109. The District has a Central Arizona Project allocation of 4,354 acre-feet but does not currently use its allocation. The District has not obtained an AWS designation.

## Community Water Company of Green Valley

Community Water Company of Green Valley (Community) is located in the Tucson AMA about 40 miles south of Tucson in Green Valley. It was formed almost 30 years ago and is the larger of the two providers that serve the area. Community pumped 2,448 acre-feet of ground water in 2000 and served a population of about 15,286. It has a Central Arizona Project allocation of 1,337 acre-feet per year. Community currently does not have an AWS designation, so it is not eligible to accrue long-term storage credits. Community would need a recovery well permit to recover its existing credits; however, it can transfer credits to other entities. Even though it does not have an Assured Water Supply, Community continues to expand its service area by having new developments enroll as member lands of the CAGRD.

# MINING FACILITIES AND AGRICULTURAL USERS

## Mining Facilities

ADWR regulates water use at mining facilities that use or have the potential to use more than 500 acre-feet per year. Water is used in almost all steps of the mining process. ADWR has conservation requirements to help mining facilities reduce overall consumption. Mineral extraction processes also have been modified in recent years to use water more efficiently. Ground-water use at these mines in 2000 was just under 43,000 acre-feet.

Three active mining operations extract copper, molybdenum, and silver in the Tucson AMA from open pit facilities. The ASARCO Mission Mine is located south of Tucson in the Sierrita Mountains. The Cyprus-Sierrita operation is located in the Sierrita Mountains south of the Mission Mine and west of Green Valley. The ASARCO Silver Bell mine is located in the northwest portion of Avra Valley in the Silverbell Mountains.

Mining companies in the Tucson region purchased farmland in the 1970s to secure water rights. The mines collectively have rights to pump 62,000 acre-feet of ground water per year in the Tucson AMA. The mines do not have Central Arizona Project allocations and are therefore dependent upon ground water to support their operations. Ground-water use varies from year to year based on conditions in the metals market.

## Agricultural Users

ADWR regulates agricultural users by encouraging efficient irrigation practices. Agriculture in the Tucson AMA used about 100,000 acre-feet of water in 2000, and most of the water utilized was ground water. Other water sources included treated effluent and Colorado River water provided through the Central Arizona Project. Major regional farming operations in the Tucson AMA are located in the Cortaro Marana Irrigation District, Avra Valley Irrigation Drainage District, and Farmers Investment Company. The Cortaro Marana Irrigation District and Avra Valley Irrigation Drainage District are located in the Marana area while Farmers Investment Company is located near Green Valley. Major crops in these areas include cotton, barley, pecans, alfalfa, pasture grasses, sorghum, and wheat.

ADWR's Ground-Water Savings Program allows water providers to accrue storage credits at ground-water savings facilities where Colorado River water or effluent is used in lieu of ground water. Tucson Water has had agreements and storage permits with local agricultural users to provide Colorado River water for irrigation through this program. Other water providers also have participated in the ground-water savings program and have accrued paper-water storage credits which will be utilized later to support municipal uses.

# CONCLUSION

Water use by sector has shifted over time in the Tucson AMA. Municipal use has replaced agriculture as the region's largest water user. Industrial use has remained fairly constant since the mid-1970s. More than 40 municipal and private potable water users rely on the same regional aquifer in the Tucson AMA. Tucson Water is the largest municipal provider and at one time, through special agreements with other water companies, was positioned to become the regional water provider. Upon becoming municipal providers, MDWID and the Town of Oro Valley have elected to manage their own water supplies.

Tucson Water is no longer in position to be a regional water provider within the Tucson AMA. The Utility has modified its assumptions regarding water resources and service commitments based on the actions taken by MDWID and the Town of Oro Valley regarding the Northwest Area Agreement and the stated position of these parties and the Town of Marana that they wish to become water providers. Most of the areas that Tucson Water currently includes in its projected potential service area are located to the south of the City. To this end, it becomes more important for the City's future boundary and the water service boundary to become the same to the greatest extent possible. The City has an obligation to consider not only the interests of Tucson Water's existing customers but also future residents. It is important for the City to work toward making the service area boundaries of the Utility match as closely as possible the jurisdictional boundaries of the City.

There will be a shared competition for additional supplies as water resources become increasingly limited. Local providers would have greater leverage in acquiring additional supplies if they formed a regional water cooperative. The long-standing competition between local interests should be replaced with a more collaborative ethic to ensure that water providers in the greater Tucson area have long-term water-resource sustainability.

# APPENDIX B

# DEMAND MANAGEMENT PROGRAM DEVELOPMENT

## PURPOSE AND BACKGROUND

The driving forces for establishing water demand management programs vary from community to community. The needs may be based on resource scarcity, distribution system limitations, and/or efforts to manage operating costs. Responses to such needs can range from a conservation strategy that preserves available supplies to a resource-management strategy that can reduce water demands placed on the water system. A comprehensive demand management program should be a balance between various strategies that meet the overall needs of the community.

Demand management has been one of the core components of Tucson Water's water-resource planning efforts since the early 1970s. The focus of demand management over the last 30 years has shifted from an initial strategy based on resource-management to one with a conservation-driven focus. For Tucson Water, management of available water resources is critical to the community's long-term sustainability. Conservation programs seek to promote efficiency in the use of available water resources. A conservation-based program does not produce additional water resources above and beyond what is physically available. Instead it preserves currently available water supplies by increasing water-use efficiencies and therefore reducing per capita consumption. Conservation programming is an important element in any comprehensive demand management program.

To be effective, the conservation components of a demand management program should provide an equitable distribution of benefits to all customer classes, employ a targeted mix of methods to achieve desired results, and be continuously evaluated to optimize program performance. A range of programs has been developed over the years to accomplish this.

- **General public information programs** are designed to promote awareness of conservation and to develop a low-water-use ethic through the use of pamphlets and brochures, public presentations, and public service announcements.

- **Education and training programs** are designed to increase knowledge and understanding of various issues, practices, and technologies that affect water-use efficiencies. These programs target specific uses or classes of water users and are presented in workshop or classroom settings. The reliability of water savings increases when education and training programs result in the application of more efficient technologies and practices.

- **Incentive programs** are designed to encourage changes in habits or the use of new technologies as a means of increasing efficiencies in water use. Water rates, rebates, and recognition programs are examples of such efforts.

- **Direct assistance programs** are designed to facilitate best-management practices to achieve reductions in water use. This can be accomplished by transfers of technology, such as retrofitting existing fixtures with more efficient ones, or providing direct technical assistance by conducting water audits to identify and prioritize measures for reducing water consumption.

- **Regulatory measures** are designed to ensure long-term efficient use of water through prescriptive requirements. Plumbing code requirements and local landscape ordinances based on Xeriscape™ design principles are examples. Regulatory measures are low-cost and reliable from the Utility's perspective.

## CHRONOLOGY OF TUCSON WATER'S DEMAND MANAGEMENT PROGRAM

Prior to 1880, the primary water source for the Tucson basin was surface water, most of which came from the Santa Cruz River. In the 1880s, advances in pumping technology increased the accessibility to ground water as a source of supply. These technological advances brought changes in how ground water was used in the community. With access to the largely untapped ground water reservoir, agricultural development expanded as did outside urban water use. This increase in outside urban water use supported the increasing introduction of non-native water-loving plants in local landscapes (McPherson and Haip, 1989). During the first half of the 20$^{th}$ century, continued growth in the municipal and agricultural sectors in the Tucson area relied on ground water to meet increasing water demand. Over time, ground water utilization began to exceed the natural replenishment of local aquifers, and ground water mining became an increasing concern. Urban growth during the 1950s and 1960s spurred the expansion of municipal well fields; coupled with rapid growth in agriculture and industrial/commercial water usage, the regional aquifers were increasingly depleted and ground water levels declined at an increasing rate. In response, Tucson Water began developing demand-management programs in the early 1970s and many of those early practices are still being used today.

### Demand Management in the 1970s

In 1973, annual potable per capita water use reached an all-time high, and the extremely hot summer of 1974 led to a near crisis for the Utility. Tucson Water's distribution system was overtaxed and the Utility could not guarantee domestic service or adequate fire-protection flows to all customers in higher elevations. Tucson Water recognized that to meet peak demand and extend the timetable needed to make critical capital improvements, a demand management program had to be initiated.

In 1974, Tucson Water instituted an increasing block-rate structure for residential customers which established increasing charges within designated blocks of delivered water. In 1977, water rates were increased and seasonal surcharges were added. The higher charges during the months of greatest water use helped limit water use during peak summer demand periods and reduced overall demand on the water delivery system. The *Beat the Peak* program was initiated as a resource management tool to reduce demand on the water system during the peak daily usage period between 4 and 8 p.m. and delayed the need for expensive new production and distribution facilities. Customers responded favorably to *Beat the Peak* and peak daily usage was reduced. However, the popular *Beat the Peak* program also became a key component in establishing a strong water-conservation ethic in the community. The success of these early demand management efforts is reflected in the subsequent shift in the community's landscape preference from non-native, high water use plants in the 1970s to the increasing use of drought-tolerant desert plants and reduced turf usage by most residential and commercial users.

## Demand Management in the 1980s

Decades of growth in the metropolitan areas resulted in aquifer overdraft in many parts of the State. In response to ground water depletion and federal requirements for funding the Central Arizona Project, the state legislature passed the 1980 Groundwater Management Act which established conservation requirements for municipal users. With this legislative mandate, Tucson Water's demand-management program became more focused on conservation to comply with regulatory water-usage requirements.

Throughout the 1980s, the Utility's demand management program continued to emphasize public information campaigns that promoted changes in water-use habits and encouraged the use of newer, more efficient technologies to conserve water. Tucson Water also partnered with other local agencies to provide funding and staff support for various public information campaigns including *Slow the Flow* and *Make Every Drop Count*. Tucson Water also collaborated with other organizations in projects such as the *Casa del Agua* (a conservation research and demonstration site), *A Sense of Water* (an in-school education program), and the *Xeriscape™ Demonstration Garden* at the Tucson Botanical Gardens.

In 1982, the City of Tucson and Pima County adopted the revised *Universal Plumbing Code* which required all new construction to install fixtures with reduced-flow requirements. The *Water Waste and Theft Ordinance* was approved in 1984 and authorizes City employees to issue citations for instances of waste resulting from water running off the property of origin. Also in 1984, Tucson Water began delivering reclaimed water to meet a portion of the community's non-potable demand. The reclaimed system continues to expand, providing non-potable water to irrigate parks, schools, golf courses, and other large turf properties. Residential, commercial, and industrial sites throughout the community use reclaimed water.

*Revised Uniform Plumbing Code* requirements were adopted in 1989. This code required all new construction to include fixtures with even higher water-use efficiency standards. With adoption of the new code, Mayor and Council authorized the *Ultra-Low-Flush (ULF) Toilet Rebate Program* designed to create a financial incentive for existing homeowners to replace older toilets with ULF fixtures.

## Demand Management in the 1990s

The City of Tucson's *Landscape Ordinance* was approved in 1991 and requires adherence to Xeriscape™ design principles in new residential and commercial developments. Educational programs were expanded for residential and commercial customers. A Youth Education Program began providing formal classroom programming to elementary and middle school grades. The free *Water Smart Workshop* series was developed to provide homeowners with intensive two-hour sessions designed to teach proper landscape design, installation, and management techniques. Similarly, a *Smartscape Workshop* series was launched to provide landscape professionals and commercial property managers with the knowledge and skills needed to manage landscape for increased efficiency of water use. *Landscape Water Audit Training* was also introduced in 1992 to institute evapotranspiration-based irrigation scheduling and efficient use of irrigation systems.

Several programs providing direct assistance to commercial customers were also instituted during this time. The *LOW 4 Program*, a joint effort between the City of Tucson and Pima County's Cooperative Extension staff, resulted in contacts with over 400 multi-family and commercial water users and landscape water audits of multi-family and commercial properties. The *Business, Industry and Government Program (B/I/G)* conducted audits of some of the highest water-use nonresidential sites. Information developed through this program was used to identify the most water-intensive uses within the commercial sector - cooling and landscaping.

In 1993, residential assistance programs began with Tucson Water's participation in the *Southern Arizona Seniors Program* with Southwest Gas Corporation which provided water and energy conservation services to qualifying fixed-income senior citizens. In addition, while the original *ULF Toilet Rebate Program* was discontinued, a modified assistance program was developed to provide ULF toilets to low-income homeowners at no cost.

The *Zanjero Program*, a residential water-audit customer assistance program, was established in 1996. The *Zanjeros*, or water auditors, provide customers with a personalized indoor and outdoor water use profile along with suggestions to use water more efficiently. This program, in conjunction with all of the direct assistance programs, provided baseline data for assessing residential conservation potential.

In 1998, a *Teacher Internship Program* was introduced that provides high school teachers and students with opportunities to learn more about local water issues. This program includes a two-week internship for middle- and high-school faculty and provides opportunities for teachers to interact with Utility staff to discuss water-resource management issues facing the community. Teacher intern graduates are asked to develop water-related projects in their classrooms within the school year. More than 200 teachers have participated in the program.

## Demand Management in the 2000s

Demand management must remain a strong component of an effective long-range water resource program. Seasonal resource-management needs and regulatory requirements continue to play a role in the structure and direction of Tucson Water's demand management program. The program's current focus is to reinforce the community's conservation ethic and to produce benefits for all levels and classes of water users.

Review and revision of educational outreach efforts will ensure that program content remains current and is integrated with other initiatives. Monitoring residential and commercial water-audit programs allows for the continuing reassessment of the audit process and the criteria used to estimate water savings. In 2003, Tucson Water helped fund research by the University of Arizona's Water Conservation Alliance of Southern Arizona (Water CASA) to study the effectiveness and cost benefit of various water conservation strategies. These assessments will provide a better understanding of the programs' effectiveness and will highlight areas in need of improvement.

A *Commercial Conservation Recognition Program* has been developed to target commercial-class customers. Elements of this program include identification and confirmation of best practices for various commercial users, identification of qualifying business locations, and establishment of an awards program to provide recognition to program participants. These incentives are balanced with efforts to enhance enforcement of the revised water-waste ordinance with stricter follow-up procedures to ensure resolution of problems.

ADWR established a new per capita potable system target for Tucson Water at 167 GPCD for calendar years 2000 to 2004. Public information, educational outreach, and maintaining compliance with this per capita target is the primary focus of the current conservation program. Tucson Water also is in the process of identifying other demand management efforts to reduce the per capita potable water use. The Utility is developing a program to reduce lost and unaccounted for water as part of the long range planning effort. Under this effort, a meter replacement program has been implemented, a leak detection program is being developed, and a water audit will need to be conducted.

# PROGRAM EVALUATIONS AND PER CAPITA WATER USE TRENDS

## Program Cost Versus Program Reliability

The Utility has adopted a broad-based approach to demand management that utilizes conservation and resource-management strategies. *Beat the Peak*, which started out as a resource-management tool in the late 1970s, has become a key element of the Utility's demand management conservation efforts. The reclaimed water system has become an increasingly important resource-management program because it replaces some previously potable ground water usage with recycled municipal wastewater which is appropriate for non-potable uses such as turf irrigation. These projects, like all the projects developed under the demand management program, range from low to high cost and from low to high reliability. A project's reliability refers to the expected water savings or effectiveness of the project in meeting its goals. The relationship between project cost and reliability is shown in

Table B-1 where General Public Information Programs and Incentives and Rebates are evaluated using cost and reliability for ranking purposes. The public information program has a relatively low implementation cost but is difficult to evaluate with respect to actual water savings while incentives and rebates have high cost but water savings can be quantified. Other programs such as Education and Training, Direct Assistance, and Regulatory Measures can also be evaluated on a cost versus reliability basis.

| Level | | Program Reliability | | |
|---|---|---|---|---|
| | | Low | Medium | High |
| Program Cost | Low | General Public Information Programs | | Regulatory Measures |
| | Medium | | Education and Training | |
| | High | | Direct Assistance | Incentives and Rebates |

**Table B-1:** Demand Management Program Cost Versus Reliability.

Reliability can be measured in terms of the volume of water saved or it may be inferred by measuring changes in attitudes or habits. Projects resulting in a change in technology, such as installing lower-volume fixtures, lend themselves more readily to actual measurement of water saved. Changes in attitudes or habits, the expected outcomes of information and educational outreach programs, can also be evaluated using survey techniques to compare differences between study and control populations. Conservation projects that are primarily informational or educational in nature are more easily evaluated in terms of public awareness and acceptance than actual water savings.

## Per Capita Water Use

One of the primary variables employed to project total demand in future years is per capita water usage. The overall measure of water-use efficiency is total gallons per capita per day (Total GPCD) which represents the average total daily volume of water used over a given year divided by the total population served during the year (for both potable and non-potable reclaimed water usage). Total GPCD can be further broken down into component parts each of which provides information about per capita water use and about various water use classes. Over the years, the Total GPCD within Tucson Water's service area has remained relatively constant at around 177 GPCD as shown on Figure B-1.

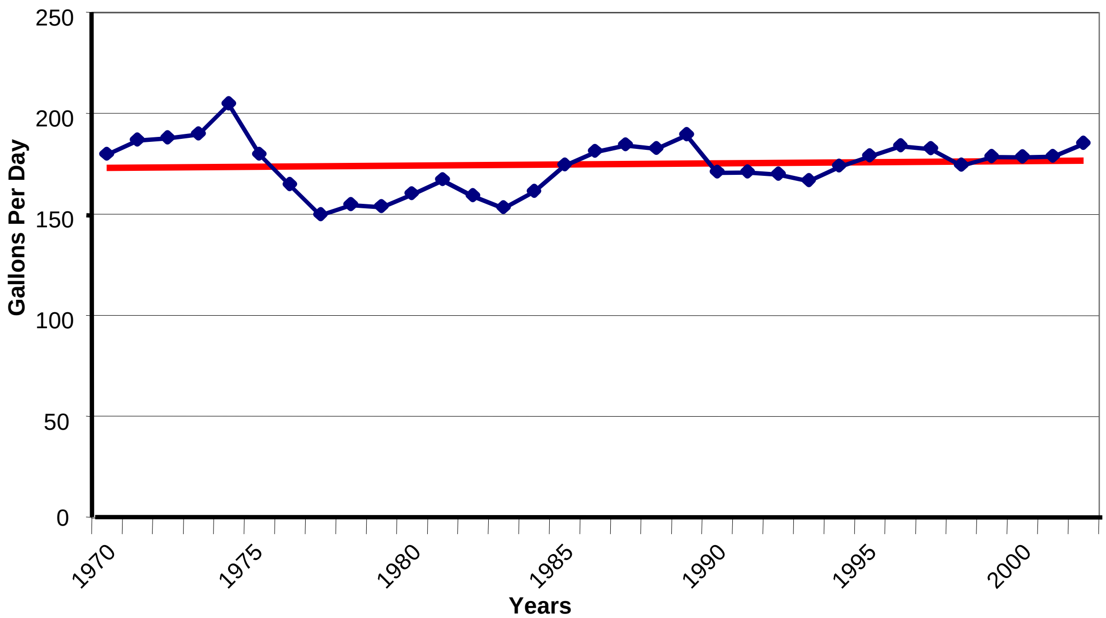



**Figure B-1:** Average Daily Per Capita Total System Demand 1970-2002.

Potable GPCD, a component of Total GPCD, represents the Tucson Water service area's per capita water-use for potable water only. The Potable GPCD has been used by ADWR to assess compliance with its per capita requirements since enforcement of its *Total GPCD Program* began in 1987. The Potable GPCD shows a slight downward trend from 1970 to 2000 as shown on Figure B-2.

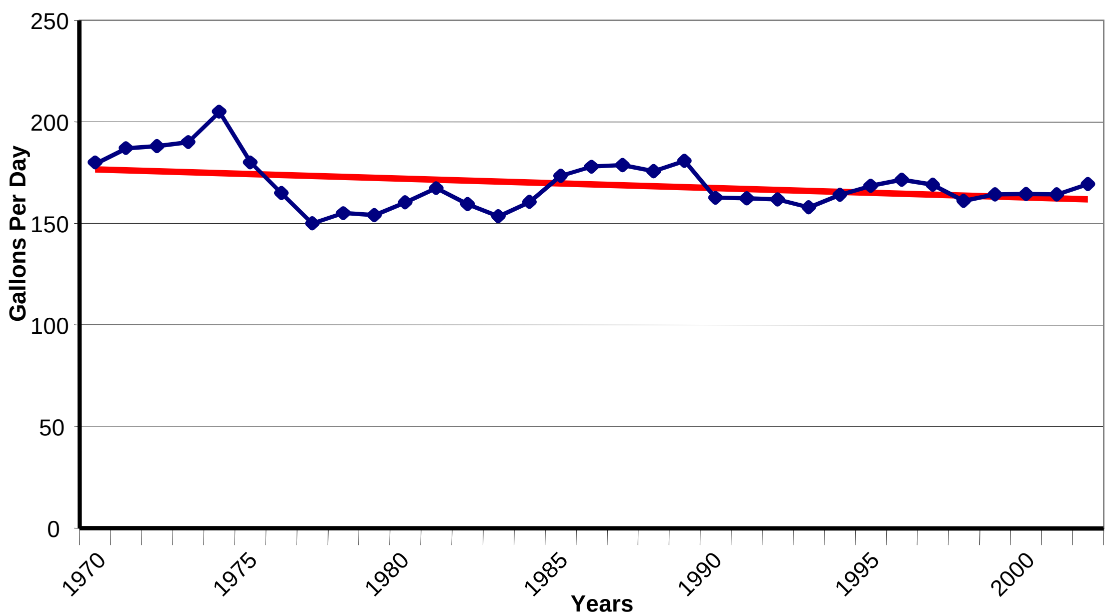



**Figure B-2:** Average Daily Per Capita Potable System Demand 1970-2002.

Since 1984, Total GPCD has included potable and non-potable reclaimed water usage. Figure B-3, which partitions potable and reclaimed system water use rates after 1984, suggests that increasing reclaimed water use has largely offset the decline in Potable GPCD.

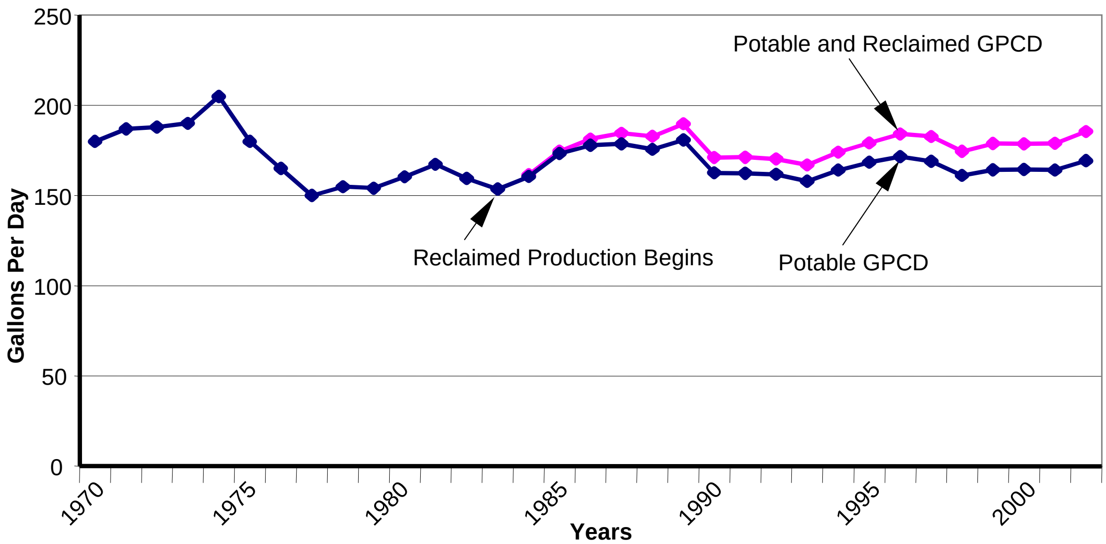



**Figure B-3:** Average Daily Per Capita Potable and Reclaimed System Demand 1970-2002.

<u>Residential Potable Per Capita Water Use</u>

Just over 50 percent of all potable system demand is delivered to the single-family residential class and about 25 percent is utilized by the multi-family residential class. Thus, total residential usage accounts for about 75 percent of total potable demand. The average single-family residential use is 120 GPCD while total residential demand accounts for 110 GPCD. Residential water use has historically been an important focus of Tucson Water's conservation program.

There has been a reduction in the average GPCD for the single-family residential class over the last 15 years, but the reasons for the reduction in water use are difficult to determine. It was anticipated that the plumbing ordinances requiring use of efficient plumbing fixtures would reduce interior demand and result in lower per-service usage. Interior water usage can be compared from year to year by looking at winter-month water use patterns which reflect interior water usage. However, most of the residential water use reduction has occurred almost entirely during the summer months. Possible explanations for this water use trend may be related to the positive impacts associated with the increasing block rate structure and the continuing emphasis on reducing summer demand through the *Beat the Peak* program. There may also be changes in residential cooling patterns (where more air conditioning systems and fewer evaporative coolers have been installed in the last 10 years) that might also contribute to the documented decline in single-family residential usage per service. Another significant contributing factor to the observed trend may also be related to the increasing use of drip irrigation systems as opposed to less-efficient hand/sprinkler watering.

Commercial and Industrial Potable Per Capita Water Use

The commercial and industrial customer classes account for about 25 percent of all potable system deliveries. These deliveries include all non-residential customers ranging from schools to manufacturing. The current non-residential potable GPCD is 35, which has been on a downward trend since 1980. This reduction in usage is mainly attributed to the conversion of customers from the potable system to the reclaimed system.

## Conservation Potential by Customer Class

The future role of conservation in a demand management program should be assessed in terms of its potential for making improvements in the various customer classes. Program reliability needs to be considered in terms of cost. Conservation-based demand management has focused on the interior and exterior water use for the three primary customer classes:

- Single-family residential
- Multi-family residential
- Commercial.

Tucson Water's service area currently has a relatively low potable GPCD of 163 gallons and an overall single-family residential GPCD of about 120. This single-family usage rate is one of the lowest in the urban Southwest as shown on Table B-2 and is commonly used as an indicator to compare the relative effectiveness of conservation programming between similar communities. The overall potential for additional reduction in residential water usage is relatively low given current programming. Given the low to moderate conservation potential in this sector, cost to further reduce water consumption in this customer class would be high.

| Single-Family Residential GPCD* | Selected Western Cities |
|---|---|
| 114 | El Paso, Texas |
| **120** | **Tucson, Arizona** |
| 123 | Mesa, Arizona |
| 131 | Glendale, Arizona |
| 138 | Albuquerque, New Mexico |
| 140 | Tempe, Arizona |
| 165 | Phoenix, Arizona |
| 169 | Scottsdale, Arizona |
| 230 | Las Vegas, Nevada |
| 236 | Oro Valley, Arizona |
| 242 | Sacramento, California |
| 261 | Fresno, California |

*Source: Data provided by utility representatives except for Las Vegas and Albuquerque which were obtained from Western Resource Advocates (2003).

**Table B-2:** Comparison of Single-Family Residential Water Usage.

Conservation Potential in the Single-Family Residential Sector

Single-family residential customers have individual meters and include condominiums, single detached housing units, and mobile homes. They comprise roughly 80 percent of Tucson Water's service connections and about 50 percent of the service area's overall potable water use. The conservation potential in the single-family sector is relatively low for interior water use and moderate for exterior use.

An effective way to reach these customers is through continuous public information campaigns that stress the importance of reducing demand for the good of the community and the environment as well as for their own financial benefit. By continuously reminding single-family customers to conserve water, additional small reductions in per-household use could result in large cumulative savings. Such reminders are also needed to reduce risk that customers will become complacent with their water usage.

Interior conservation programming in the residential sector typically involves the replacement of inefficient fixtures with efficient ones. This is relatively straightforward and can result in permanent reductions since the program is technologically based and does not require a change in customer behavior. Important considerations for any mandatory or retrofit program are the state and national fixture-efficiency requirements and local plumbing codes requiring the use of efficient fixtures. As a result of these standards, water-efficient fixtures are installed in all new homes; over time the older housing stock will be retrofitted with the new efficient fixtures. Lastly, fixing leaks in residential plumbing, regardless of improvements in fixture efficiency, will remain one of the best demand management practices.

Exterior conservation programs are much more complicated than those for the interior because there are other variables that impact exterior demand. Where interior conservation is characterized as utilitarian, exterior water use is more commonly associated with quality of life issues and these are more difficult to address.

One of the most significant trends in the single-family exterior water use is the growing use of drip irrigation systems and the widespread adoption of low-water-use-landscapes. In a 1992 survey, Tucson Water noted that 27 percent of single-family customers had drip irrigation systems and approximately 50 percent of those were on timers. Ten years prior to this survey, relatively few homes had drip irrigation systems. A residential survey of homes that were constructed from 1992 to 1997 indicated that 83 percent had drip irrigation systems (Graft, 1997).

Another significant change in decreased exterior demand is that fewer evaporative coolers are being installed in new homes. In Tucson, nearly 96 percent of new homes have air conditioning and 85 percent have air conditioning only. In ADWR's 1992 survey, only 40 percent of the homes had air conditioning and only 19 percent had air conditioning only. New homes should annually use approximately 10,400 gallons of water less than the average home in 1992 based on this change alone.

## Conservation Potential in the Multi-Family Residential Sector

Water use in the multi-family sector is a hybrid between the commercial/industrial and the residential sectors. Interior water use is essentially the same as in single-family residences while external water use patterns more closely resemble those observed in the commercial/industrial sector. However, there are some potential economies of scale in this sector not available in the single-family residential sector. Multi-family customers represent about 25 percent of all Tucson Water deliveries.

As a general rule, the interior conservation potential at most multi-family complexes is low. Interior use at multi-family sites is similar to those in single-family residences. The primary difference is the lack of clothes washing facilities in many units. Most large multi-family facilities do have on-site laundry facilities. These are potential sites where conversion to more efficient horizontal axis washers could be very cost-effective. Small complexes constructed prior to 1983 are expected to offer the greatest conservation potential due to aging laundry facilities.

The same issues discussed in the following commercial/industrial sector apply to the multi-family sector's exterior water-usage conservation potential. Landscape water-management education and training is considered the most effective method for improving overall efficiency of exterior water use in the multi-family sector.

## Conservation Potential in the Commercial/Industrial Sector

Non-residential water use represents approximately 25 percent of total water deliveries in the Tucson Water service area. With the exception of a handful of large users, most commercial customers are low-volume water users. There is relatively little industrial process-water usage in the Tucson Water service area. Except for cooling towers, the types of water usage at most commercial facilities is similar to that observed in the residential sector but on a larger scale.

Targeting the commercial sector offers opportunities to make changes in water use with a relatively modest conservation program. A single commercial site can easily use as much water as 100 single-family homes. Rather than dealing with many individual homeowners, the non-residential and multiple-family residential sectors provide the possibility of working with property management companies who can make decisions that impact a large number of sites. Similarly, there are programmatic efficiencies when working with on-site managers or facility engineers who can influence all the water use at a single large site.

There has been a significant increase in the commercial use of reclaimed water throughout the service area. Fourteen of the eighteen golf courses located within the Tucson Water service area are using reclaimed water for outside watering. Of the four that still rely on ground water, one will convert to reclaimed water by the end of 2005, two rely on privately owned grandfathered water rights, and the fourth is located in an area where no alternative supplies are available. There are now 34 parks and 34 schools that have converted from ground water to reclaimed water for landscape irrigation. In 2003, nearly 13,000 acre-feet of reclaimed water was delivered throughout the Tucson Water service area.

Data collected in a local survey of 26 large cooling facilities in 1995 found that about 30 percent of the facilities' total water consumption was used for cooling (Black and Veatch, 1995). The institutional relationships between the chemical vendors/maintenance companies and the managers at commercial sites as well as aging systems tend to make change in this area difficult even though it can be demonstrated that significant water savings can occur. Commercial property owners do not need technical details of water chemistry and instrumentation to understand the cost-effectiveness of cooling tower management. However, for persons directly involved with day-to-day cooling tower operations, a series of seminars presented by knowledgeable professionals (such as water treatment vendors) could lead to improved efficiency. A financial incentive program may help promote water efficiency among cooling tower users.

Tucson Water's commercial conservation programming efforts have focused on education and training in an effort to raise the overall level of professionalism in the landscape industry and cooling tower managers. These efforts should lead to improvement in irrigation management and cooling tower operation. The summer surcharge that is part of the commercial/industrial rate structure also charges a premium for summertime exterior water use which should keep exterior demand from significantly increasing in the summer.

## FUTURE DEMAND MANAGEMENT PLANNING

Total per capita water use in Tucson Water's service area has on average been predictable and stable for the last few decades. When local per capita residential water use is compared with other comparable southwestern urban communities, Tucson Water is at the lower end of the use spectrum. Tucson Water's average Total GPCD of 177 was used for projecting future demand in *Water Plan: 2000 – 2050*. With the present level of effort and expenditures, the Utility can reasonably assume the current trend in water usage will continue. If the current level of demand management programming is not maintained, water-use efficiency could decay and the per capita water usage demand could rise.

With a modest increase in effort and costs, there are opportunities for increased water-use efficiency and demand reduction. Some residential customers still have low-efficiency fixtures and would benefit from improved plumbing maintenance. The same can be said for multi-family customers. There also are opportunities for water savings in the commercial sector. Some commercial customers could benefit from converting cooling tower use to reclaimed water. Others have such high water usage that even a small improvement in efficiency might save significant amounts of water.

Many communities in the southwest have enacted ordinances for emergency water-use reduction. The City of Tucson has codified its own emergency response procedures in case of a water emergency. These measures are functional and necessary for emergency response but would not be effective in reducing water use in the longer term. Further water savings and increases in efficiency are matters for planning.

The present Total GPCD is the result of actions taken by both the Utility and its customers, through both mandatory and voluntary programs. The success of new or expanded demand management programs will also require the support of customers. The potential effectiveness of more aggressive conservation programming as part of future demand management activities at Tucson Water will be evaluated to determine if GPCD can be further reduced in a cost-effective manner. The evaluation process will answer the following questions:

- Does the program address local demographics and historical water use?
- Will the program benefit all customer classes?
- What personnel resources will be needed for program implementation/maintenance?
- What are the rate consequences of the program?
- What processes are included for input/commitment from customers and stakeholders?
- Does the strategy strengthen and complement the Utility's water resource plan?

## SUMMARY

For the past 30 years, Tucson Water's evolving water conservation program has proven to be an effective demand management tool for reducing overall water usage and creating a community conservation ethic. This ethic, along with an increasing use of reclaimed wastewater for irrigation and industrial purposes, has resulted in a steady reduction in per capita potable consumption and a consistent Total GPCD. Continued support for existing programming is necessary to maintain a stable Total GPCD in future years. Expansion of existing programs or implementation of new strategies may provide opportunities for further reduction to the Total GPCD figure, and should be evaluated as part of Tucson Water's long term water resource planning process.

# APPENDIX C

# ASSURED WATER SUPPLY IMPLEMENTATION

## INTRODUCTION

ADWR’s Assured Water Supply (AWS) Program is the prevailing regulatory paradigm for municipal water-resource management in Arizona’s Active Management Areas. The program is designed to ensure that the water supplies that support developing Arizona communities are sustainable over the long term. In order to accomplish this, all new developments must demonstrate that their existing, committed, and reasonably foreseeable future water demands can be met using renewable water supplies over a 100-year period. Various water resources can be utilized to meet water demand but the ultimate goal is to reduce, and by 2025 eliminate, reliance on “mined” ground water. This forces a shift toward expanded utilization of renewable water supplies in order to meet the projected increase in water demand. The program also embodies a credit accounting system that tracks all water usage and applies to all three water supply sources currently available to the City of Tucson.

Prior to the advent of the AWS Program, water-resource and supply management consisted of distinct initiatives with objectives that were occasionally in conflict. These included ground-water resource development, demand management, effluent reuse, service area expansion, and resource planning. Under the AWS Program, these disparate initiatives are being managed with increasing coordination in order to achieve the ultimate goal of long-term sustainability.

The City of Tucson acquired its “Designation as Having an Assured Water Supply” (AWS designation) in 1998 for several reasons. Having an AWS designation is consistent with the community’s goal of long-term sustainability. Ensuring that the community’s water needs will be continually met into the future is an important reassurance to a growing population. This long-term commitment is essential to prospective business ventures that seek to locate in the Tucson area. In addition, while water providers are not required to obtain an AWS designation, those that do not are effectively prohibited from serving continued growth within their service areas. And perhaps most important, if Tucson Water did not provide an

Assured Water Supply for its expanding service area, growth would still occur in any area where a 100-year supply of ground-water is available. This could occur if developers obtained a Certificate of Assured Water Supply by joining the Central Arizona Groundwater Replenishment District (CAGRD). As described later in this Appendix, the type of growth made possible by the CAGRD is not founded upon the hydrological-based management principle of aquifer stewardship.

## "PAPER WATER" VERSUS "WET WATER"

The world of paper water centers on the various rights and credit accounts that together provide Tucson Water with the authority to pump or use water. The world of wet water, on the other hand, is based on the availability and use of physical water.

Paper- and wet-water management strategies focus on different aspects of water-resource management and each has its own priorities and use. Tucson Water uses paper-water accounting to optimize its operational flexibility. However, the Utility also emphasizes wet-water management to ensure consistency with its long-range water-resource management goals. In the short term, it is possible for a water provider to primarily engage in paper-water accounting to avoid the large potential costs associated with wet-water management. In the long term, however, failing to address wet-water management could result in localized water level declines.

The distinction between paper and wet water can be illustrated by examining the accrual (crediting) and use (debiting) of paper-water recharge credits. Under Arizona law, a water provider can physically recharge a renewable water supply such as Colorado River water in one location and physically recover ground water at a different location within the same AMA. This approach maintains a balance of "paper" Colorado River water to offset the "wet" ground water pumped in the AMA. However, this paper-water accounting does not maintain a wet-water balance in the local area where the ground-water withdrawals occurred. Ground-water pumping that is not being hydrologically offset by recharge within the same area where the pumping occurred can result in significant water-level declines which in turn can increase the potential for land subsidence in that area. A resource-management approach which primarily depends on paper-water accounting may not be hydrologically sustainable in the longer term.

Tucson Water has sought to maintain a wet-water balance at both Colorado River water and effluent recharge projects in order to avoid the hydrologic impacts which can occur when there is a local wet-water imbalance. Over the long term, both the paper-water and wet-water worlds must be in balance for water supplies to be sustainable.

## OBTAINING AN AWS DESIGNATION

To obtain an AWS designation, a community must demonstrate that a 100-year water supply is physically, legally, and continuously available. According to ADWR (2001), this supply must satisfy the following conditions:

- Adequate water quality.
- Use consistent with the AMA management goal.
- Use consistent with the AMA management plan.
- The community must have the financial capability to satisfy these conditions.

For the City of Tucson, these requisite conditions were provided in its original AWS application filed with ADWR (Malcolm Pirnie, 1996). In its application, the City outlined its portfolio of available water supplies. In addition, the City enrolled in the CAGRD in order to ensure acquisition of the AWS designation. Since its first issuance in 1998, the City's AWS designation has been modified and the current version became effective in 2002.

## The Role of the Central Arizona Groundwater Replenishment District

The CAGRD provides the opportunity for developers and water providers to obtain paper-water access to renewable resources without having to construct the infrastructure necessary to physically convey those resources to new developments. In effect, the developer or water provider need only install a local ground-water system to supply the wet-water needs of the development. The CAGRD is not mandated to hydrologically balance local ground-water withdrawals with aquifer replenishment. Instead, the CAGRD relies on paper-water accounting that allows ground-water pumping in one area of an AMA to be offset by the recharge of Colorado River water in another area of the same AMA. Growth which solely depends on the CAGRD to obtain an AWS designation would result in a paper-water balance of ground water withdrawals with ground water replenishment. Utilizing the CAGRD in this fashion is not consistent with Tucson Water's planning because reliance on paper-water accounting would circumvent the hydrologic-based principle of aquifer stewardship. This principle is the overall ground-water management goal of Tucson Water.

When the City of Tucson first applied for its AWS designation, the City was effectively prohibited by local initiative from delivering treated Colorado River water within its service area for potable use. In order to obtain issuance of its AWS designation in the time before alternative delivery mechanisms were completed, the City of Tucson entered into a membership agreement with the CAGRD. This contract was structured to provide legal availability of the City's Colorado River water supplies with the intent that Tucson Water would eventually construct its own infrastructure. However, the City's contract with the CAGRD allows for the long-term access to 12,500 acre-feet per year of replenishment water above and beyond the City of Tucson's own entitlement to Colorado River water. In other words, the City of Tucson can only rely on the CAGRD to supply up to 12,500 acre-feet of water of additional water beyond the City's Central Arizona Project allocation to assist in demonstrating an assured water supply in the future.

## The City of Tucson's Assured Water Supply Portfolio

Under the modified AWS designation issued in 2002, the City of Tucson's 100-year supply of water that meets all of the AWS criteria is 15,646,507 acre-feet. Divided over the 100-year time period, this equates to an annual supply of water of 156,465 acre-feet as shown in Table C-1. This current portfolio is based solely on the City's physically available ground water and effluent supplies. The City of Tucson is indirectly credited with its Colorado River water supplies through its membership in the CAGRD.

**Current Assured Water Supply Designation Summary by Program Criteria (acre-feet)**

| | Physical Availability | Legal Availability | Continuous Availability | Water Quality | Financial Capability | Consistency with Plan (Conservation) | Consistency with Goal (Safe Yield) |
|---|---|---|---|---|---|---|---|
| **Colorado River Water** | 0 [1] | CAP Contract | None | OK | OK | OK | 0 |
| **Effluent** | 1,580,000 [2] | Inter-Governmental Agreements | Reclaimed Plant and Sweetwater Recharge Facilities | OK | OK | OK | 1,580,000 |
| **Ground Water** | 14,066,507 [3] | Service Area, Type I, and Type II Rights | Groundwater system with 196 MGD capacity. | OK | OK | OK | 17,476,488 [4] |
| **100-year Total** | **15,646,507 AF** | | | | | | **19,056,488 AF** |
| **Annual Total** | **156,465 AF/yr** | | | | | | **190,565 AF/yr** |

AF = acre-feet; AF/yr = acre-feet per year.

[1]Physical Availability of Colorado River Water:

0 AF since, as of the City of Tucson's current designation, Colorado River water was not considered to be physically available.

[2]Physical Availability of Effluent:

650,000 AF based the annual capacity of the Sweetwater Recharge Facilities (6,500 AF/yr) times 100 years.
930,000 AF based the annual capacity of the Reclaimed Plant (9,300 AF/yr) times 100 years.

[3]Physical Availability of Ground Water:

12,066,507 acre-feet based on tank analysis for the Tucson basin.
2,000,000 acre-feet based on MODFLOW analysis for Avra Valley.

[4]Groundwater Consistency with AMA Management Goal (Safe Yield):

14,842,000 acre-feet based on City of Tucson's Central Arizona Project allocation* of 148,420 AF/yr times 100 years and use of the CAGRD.
1,682,070 acre-feet of Allowable Ground-Water credits.
791,000 Incidental recharge over 100 years based on 4 percent of total annual demand.
161,418 acre-feet based on use of Remediated Ground Water (TARP) at 8,495.7 AF/yr from 2001 through 2019.

*At the time of designation (prior to the dissolution of the *Northwest Area Agreement*), the City of Tucson's Central Arizona Project allocation was 148,420 AF/yr.

**Table C-1:** Current Assured Water Supply Portfolio.

The current designation is limited by physical availability since Colorado River water was not physically accessible for supply at the time of application. This renewable source of supply was only made available to replenish ground-water withdrawals. Therefore, the designation is limited by the volume of ground water that the Utility was able to demonstrate as existing within its service area. The annual total of 156,465 acre-feet was sufficient to meet current and committed demands for several years; however, the Utility is currently approaching this limit and will soon have to update its water-resource portfolio in order to maintain its AWS designation.

## MAINTAINING AN ASSURED WATER SUPPLY

ADWR reserves the right to periodically review and require modification of the AWS designation as conditions warrant. The designation can be revoked if the facts and conclusions of law that originally led to its issuance are no longer valid. In addition, ADWR (2002, 2001) requires that Tucson Water annually submit the following information in order to demonstrate continuing compliance with the AWS Program:

- Estimated future demand of platted, undeveloped lots located in Tucson Water's service area (Committed Demand).
- Projected volume of water demand at build-out of customers with which Tucson Water has entered into a notice of intent to serve agreement in the calendar year (Committed Demand).
- A report regarding Tucson Water's compliance with water-quality requirements.
- Depth-to-static water level of all wells from which Tucson Water withdrew water during the calendar year.
- Any other information requested by the Director of ADWR to determine whether to continue Tucson's designated status.
- Current demands as reported in the Annual Ground Water Withdrawal and Use Report.

The most basic measure of Tucson Water's AWS compliance is the comparison of its approved AWS portfolio (156,465 acre-feet per year) to its current and committed demands that are submitted to ADWR each year. Current demands are based on the total water production for the current calendar year. The method of calculating committed demands involves estimating the future demand of recorded (platted) undeveloped lots in Tucson Water's service area (Tucson Water, 2003). In order to maintain its AWS designation, the Utility's must demonstrate that it has sufficient renewable water resources, continuously available over the next 100 years, to supply current and committed demands plus at least two years of additional projected growth.

In 2003, Tucson Water determined that its current and committed demands were approaching its currently approved 100-year AWS supply portfolio. Tucson Water submitted to ADWR a request to modify its AWS portfolio to include CAVSARP, a recharge and recovery facility which delivers Colorado River water to Tucson Water's potable system. Bringing CAVSARP on line makes a portion of Tucson's Central Arizona Project allocation physically available. It is anticipated that Tucson Water's AWS portfolio will be expanded and that this will extend the City of Tucson's AWS designation for up to ten additional years. Under this modification, the City of Tucson would retain its ability to utilize the CAGRD to provide and replenish up to 12,500 acre-feet per year of Colorado River water to offset ground water pumping. This volume is in addition to the City's own Central Arizona Project allocation.

In order to maintain its AWS designation in future years, the City of Tucson must successfully acquire additional water supplies. There are several potential opportunities to expand the AWS portfolio including the acquisition of additional imported and local supplies.

Additional water supplies may be available outside the Tucson AMA for purchase and delivery to Tucson Water. A number of Phoenix-area cities have already entered into 100-year leases of Central Arizona Project water from Native American tribes as part of their respective water claims settlements. The cities of Phoenix, Scottsdale, Peoria, and Goodyear leased a total of 41,000 acre-feet per year of such water as part of the Gila River Indian Community water claims settlement. The Phoenix-area cities consummated additional 100-year leases with the Ft. McDowell, San Carlos and Salt River Pima Maricopa tribes as part of their respective water claims settlements. While the Tohono O'odham Nation was unwilling to enter into a long-term water lease as part of its water claims settlement with the City of Tucson and others, the settlement allows for long-term Central Arizona Project water leases and provides a right of first refusal to lessees located within the Tucson AMA.

The City of Tucson may also have opportunity to purchase a significant quantity of Colorado River water from Arizona agricultural districts which have high-priority entitlements to more than a million acre-feet of Colorado River water. The United States previously purchased a quantity of this Arizona agricultural water entitlement as part of its water claims settlement with the Ak Chin Native American Community. This water was in turn leased to the community of Anthem located north of Phoenix.

The CAGRD (2004) completed a survey of long-term water supplies potentially available for purchase or lease within the State. The resulting report concluded that if 20 percent of the Native American Colorado River water and 20 percent of the water currently in agricultural use along the Colorado River could be purchased or leased, the quantity available would be over 450,000 acre-feet per year. In addition, up to 145,000 acre-feet of ground water per year might be available from basins in western Arizona such as Butler Valley.

If additional imported supplies can be acquired, they would need to be brought to the City of Tucson. The Central Arizona Project aqueduct has the capacity to deliver 1.8 million acre-feet of water from the Colorado River and western Arizona. Since the Central Arizona Project is entitled to a total of 1.5 million acre-feet per year of Colorado River water, the aqueduct has 300,000 acre-feet of excess annual capacity. About 100,000 acre-feet of this capacity has been tentatively set aside for delivery of ground water and surface water purchased by Phoenix, Scottsdale and Mesa. Another 100,000 acre feet of capacity has been set aside for the CAGRD. This leaves 100,000 acre-feet of uncommitted capacity that might be made available to deliver additional imported supplies to the City of Tucson.

Local supplies that might be acquired include additional legal authority to pump ground water and the lease or purchase of additional effluent entitlements. The AWS Program does not currently recognize annually renewable ground water that is derived from natural recharge. Without this recognition, Tucson Water's allowable ground-water credits will continue to be debited each year by the amount of ground water pumped even though additional physical ground water may be present. Tucson Water views renewable ground water as a potentially viable, hydrologically sustainable water resource that should be incorporated into ADWR's program. This would require legislative action and/or a regulatory-driven process that would quantify the volume of ground water that could be annually available for sustainable ground-water pumping. Tucson Water should pursue such a change in order to establish that in future years, a hydrologically sustainable amount of ground water will not only be physically accessible but also legally available as a source of supply. *Water Plan: 2000-2050*, however, is based on current law and does not assume that there will be changes in law that will recognize renewable ground water.

Finally, Tucson Water has entitlement to a large volume of municipal effluent and the Utility may be able to increase its entitlement in the future. This could include agreements to lease or purchase the Secretary of the Interior's effluent entitlement as well as other effluent entitlements. This would result in greater utilization of the only locally generated renewable supply that grows with the community.

## WATER CREDIT ACCOUNTING AND REPORTING

Renewable water supplies that are directly used are considered to be compliant with the AWS Program. Such efforts reduce ground water pumpage and contribute to the overall goal of achieving safe yield. Under the AWS Program, all ground-water withdrawals are debited from several potential sources of water credits. This program places a finite cap on the amount of ground water that can be pumped by Tucson Water without incurring a replenishment obligation. Under current regulations, once this volume is exhausted, all ground water that is subsequently withdrawn must be replenished with a renewable supply. Because future dependency on mined ground water is not consistent with the AWS Program, Tucson Water will become increasingly reliant on Colorado River water and municipal effluent to meet water demand. As a result, local ground water will no longer be the predominant water source for municipal supply.

Tucson Water initiated its AWS accounting process in 2001. The Utility must submit to ADWR an annual report that documents its ability to meet near-term projected growth and the debiting of each year's ground-water pumpage against its AWS credits. Each source of credits is described below, and information regarding requirements and/or limitations is summarized.

### Allowable Ground Water

Under the AWS Program, designated water providers are granted a volume of allowable ground water to provide credits for a finite amount of ground-water withdrawals without incurring a replenishment obligation. This volume was considered a phase-in allowance to assist water providers in shifting from reliance on mined ground water to renewable supplies. The City of Tucson was credited with 1,682,070 acre-feet of allowable ground water credits at the start of the AWS Program. This allowance was based on 15 years of ground-water pumpage at the 1994 water usage rate of 112,138 acre-feet.

Allowable ground water can also be credited over time. An annual incidental recharge credit is accrued based on 4 percent of the total potable and reclaimed water produced in the previous calendar year. In addition, 314,000 acre-feet of ground-water credits have been granted by the State in exchange for Tucson Water's extinguishment of a Type II water right associated with the Santa Cruz Well Field. These "unassigned credits" have not yet been added to Tucson Water's AWS portfolio, but they can be added as allowable ground water in the future. Finally, by 2025, the City of Tucson will have access to two million acre-feet of additional ground water credits as a result of A.R.S. 45-463 F. These credits were assigned to the City of Tucson in recognition of its efforts to purchase and retire Avra Valley farmlands in the 1970s to preserve the ground-water resource.

## Remedial Ground Water

The City of Tucson has an additional source of ground-water credits that will not be debited from allowable ground water. This resource is associated with Tucson Airport Remediation Project, a ground-water remediation project where contaminated water is pumped from a defined aquifer zone within urban Tucson and treated to potable standards. The treated water is subsequently discharged into Tucson Water's potable distribution system under agreement with the EPA. A total of 161,418.3 acre-feet of Tucson Airport Remediation Project credits exist based on the projected use of approximately 8,495.7 acre-feet per year from 2001 through 2019.

## Annual Storage

Under the AWS Program, renewable water supplies that are not used directly can be used to accrue storage credits and recovered within the same calendar year, a process called annual storage and recovery. This type of renewable resource use complies with the goal of attaining safe yield as ground-water withdrawals are offset by the storage of renewable supplies. Renewable water supplies can either physically recharge the ground-water system or be utilized in lieu of ground water at approved locations. In either circumstance, a recharge credit is granted for the volume of renewable resource that is recharged or used in lieu of ground water. These credits can either be recovered from wells located at the point of recharge or from more distant wells. Tucson Water has access to significant volumes of Colorado River water and effluent to generate such credits. Under annual storage, water providers are allowed to pump, without paying any fees to ADWR, a volume of water equal to that which was stored within the same calendar year.

## Long-Term Storage

Long-term storage credits are accrued when renewable water supplies are recharged to the aquifer for recovery in a subsequent year. The accounting for long-term storage differs slightly from annual storage. For Colorado River water, only 95 percent of the water that is placed into long-term storage is made available for recovery. In addition, a fee payable to ADWR is required for the recovery of any effluent or Colorado River water long-term storage credits.

# THE FUTURE OF ASSURED WATER SUPPLY

The City's AWS designation must be renewed at intervals of ten years or less and is currently under re-negotiation with ADWR. At each renewal, the City must update the projected water demand and water availability data to reassess its future compliance with the AWS Program.

As the City acquires additional water supplies or puts currently available source waters to use, the City will include these water supplies to expand its AWS portfolio.

The AWS Program does not currently recognize annually renewable ground water that is derived from natural recharge. No mechanism to obtain credit for annually renewable ground water is included in ADWR's AWS Program. Without such a mechanism, Tucson Water's allowable ground-water credits will continue to be debited at an excessive rate each year. Tucson Water views renewable ground water as a water resource that should be formally incorporated into ADWR's program. This would require legislative action and/or a regulatory-driven process that would quantify the volume of ground water that could be annually available for sustainable ground-water pumping. Tucson Water has an interest in pursuing such a change in order to ensure that in future years, ground water will not only be physically accessible but also legally available as a source of supply. However, *Water Plan: 2000-2050* is based on current law and does not assume that state law will be changed to establish the use of renewable ground water.

# APPENDIX D

# PLANNING METHODOLOGY

Tucson Water used a scenario planning process to provide a framework for exploring the driving forces and critical uncertainties that will impact water-resource utilization over the next 50 years. Scenario planning provides organizational flexibility by planning for multiple futures (scenarios). Instead of relying on what is known and certain when preparing for the future, scenario planning emphasizes the critical uncertainties. The ability to address future uncertainty will determine the success of any long-range planning effort.

The task of developing sustainable sources of supply in arid, rapidly growing areas has to address a wide range of variables many of which have a high degree of uncertainty. Communities can grow faster or slower than expected, regulations will change, and public sentiment can shift. Tucson Water applied the scenario planning process to address how best to maximize utilization of the Utility's most abundant renewable water supplies: Colorado River water and locally generated municipal effluent.

The planning process was applied to the water resources currently owned and/or controlled by the City of Tucson in order to define how far these supplies can carry the Utility into the future. It is necessary for the City of Tucson to establish a foundation upon which to build a flexible water-resource portfolio for the future. This planning process identifies supply scenarios based on the current water-resource portfolio and also indicates where supplies may fail to meet projected water demands. Understanding how far existing supplies can be used to meet future demands will help the community in its decision-making process regarding demand management issues as well as the uncertainties associated with acquiring additional water supplies.

## PLANNING FOR MULTIPLE FUTURES

The concept of scenario planning gained widespread popularity among private businesses in the 1990s after publication of *The Art of the Long View* by Peter Schwartz (1991). There are many scenario planning methods currently advocated; Tucson Water adapted the Schwartz model to serve its needs. Scenario planning provides organizational flexibility by planning for multiple, equally possible futures (i.e. scenarios). Each future is a unique combination of the identified critical uncertainties. Descriptions of each possible future are developed and provide the basis for identifying and sequencing various projects and programs that would be implemented to realize them. The resulting series of chronologically ordered projects and programs is referred to as the pathway to each future.

Scenario planning is superior to the more one-dimensional planning approach when there are many planning uncertainties. Under the scenario planning approach, each possible future is considered equally likely to occur to maintain a multi-dimensional view of the future. The process involves building pathways to each possible future. However, the overall objective is to identify the common elements that lie on these different pathways. These are the programs and projects (i.e. elements) that are common to the identified futures as shown on Figure D-1.

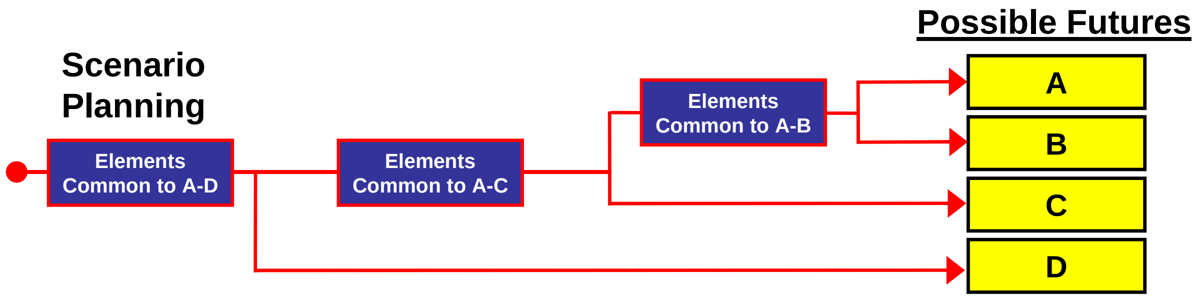



**Figure D-1:** The Scenario Planning Approach.

By following the path of common elements, capital investments can be directed toward projects that apply to multiple futures providing confidence that the decisions made today will remain viable in future years. As the planning environment changes over time, the scenario planning process is revisited to establish a new baseline of data and assumptions that will again be used to reassess and develop a new range of possible futures. This multi-dimensional approach is the essence of scenario planning.

Tucson Water applied the scenario planning process to assess how to best utilize its currently available water resources by maximizing the use of its most abundant renewable supplies: Colorado River water and municipal effluent. Integration of these two scenario planning assessments created a matrix of possible futures. Related futures were grouped together into four Families of Futures which in turn formed the basis for developing the recommended plan. A step-by-step description of the scenario planning process and how it was applied under each assessment are summarized in the following sections.

## THE SCENARIO PLANNING ROAD MAP

Scenario planning can be approached in a number of ways. The steps of the scenario planning process utilized by Tucson Water in developing its long-range water-resource plan are summarized on Figure D-2. A step-by-step overview of the process is provided in this section. For detailed guidance regarding the process, refer to Schwartz (1991).

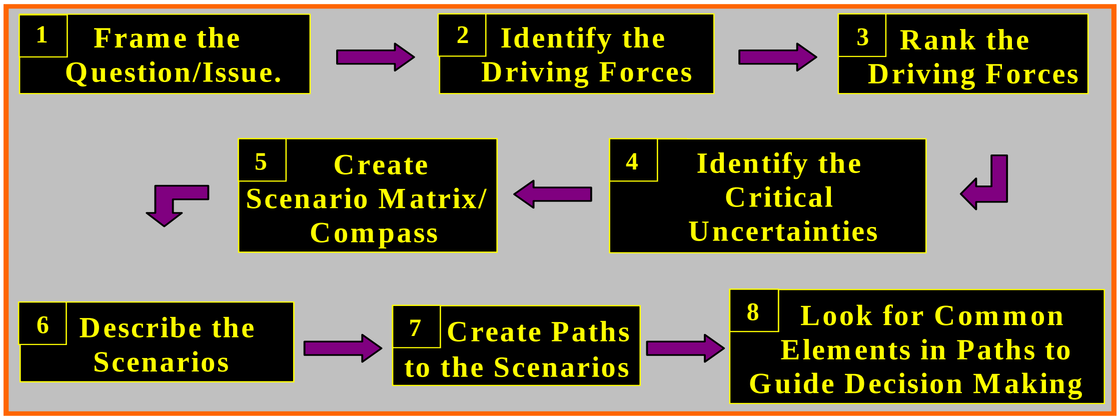



**Figure D-2:** The Scenario Planning Road Map (after Schwartz, 1991).

## Step 1: Frame the Question/Issue

The initial step is to identify the central question or issue that will be assessed. This is accomplished by conducting a brainstorming session with the planning group to generate a list of important issues. The planning group then discusses the various issues to arrive at consensus agreement on the central issue that needs to be addressed.

## Step 2: Identify the Driving Forces

A second brainstorming session is held to generate a list of driving forces that have a bearing on the central question. Many of the driving forces are related to the various questions identified in Step 1 while others become evident through the group's discussions. One key is to initially capture all ideas without trying to gauge their relative importance at this stage of the process. The planning group seeks to generate as complete a list as possible.

## Step 3: Rank the Driving Forces

Once the list of driving forces is established, the planning group evaluates each one. The driving forces are ranked based upon their relative importance versus their relative uncertainty with respect to the central issue. Each driving force is plotted on a graph of these characteristics as shown on Figure D-3. The driving forces of greatest interest are those that are both very important and highly uncertain; this quadrant is marked by the star.

## Step 4: Identify the Critical Uncertainties

By the end of Step 3, a number of driving forces have been identified that are both highly uncertain and critically important. The next task for the group is to review these forces to determine which ones will become the critical uncertainties used to frame the scenario matrix. This step forms the fundamental basis for the balance of the scenario planning assessment. In theory, almost any number of critical uncertainties could be identified and used. However, as the number of critical uncertainties increases, the number of resulting future scenarios increases exponentially. Therefore, the planning group must be careful to be selective and focus on things that are of the greatest importance and uncertainty. Trying to work with more than three critical uncertainties becomes difficult to manage.

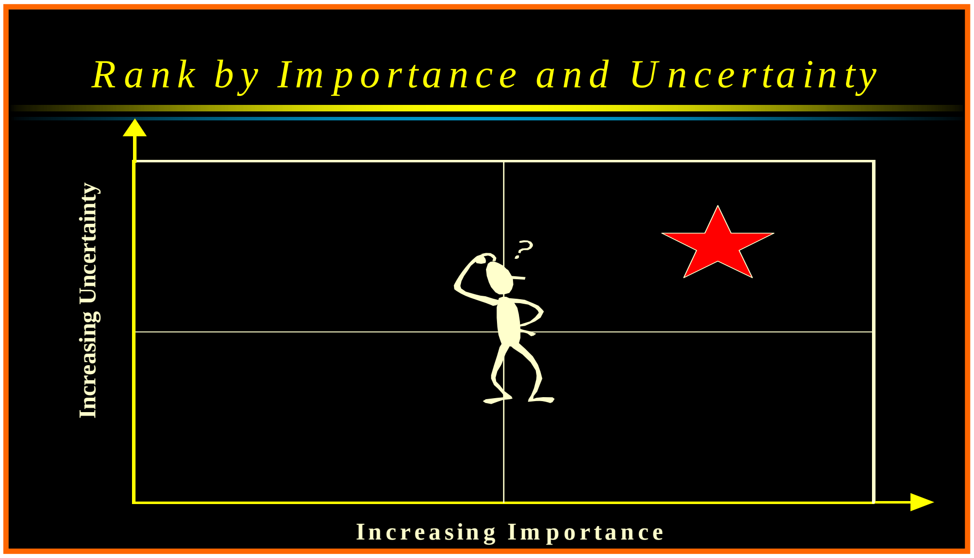



**Figure D-3:** Plotting the Driving Forces Assessing Their Importance and Uncertainty.

## Step 5: Create the Scenario Matrix/Compass

Two or three critical uncertainties are used to create a matrix of possible futures. This is accomplished by identifying the polar extremes of each critical uncertainty. For example, a particular uncertainty could be answered by "yes" or "no" while another could be "aggressive" or "relaxed". The uncertainties are not viewed as representing a range or spectrum of relative values. They are instead viewed as end-point extremes. The critical uncertainties are then used to create a two- or three-dimensional matrix as shown on Figure D-4. The quadrants defined by the combinations of the critical uncertainties are the possible futures or scenarios to be assessed.

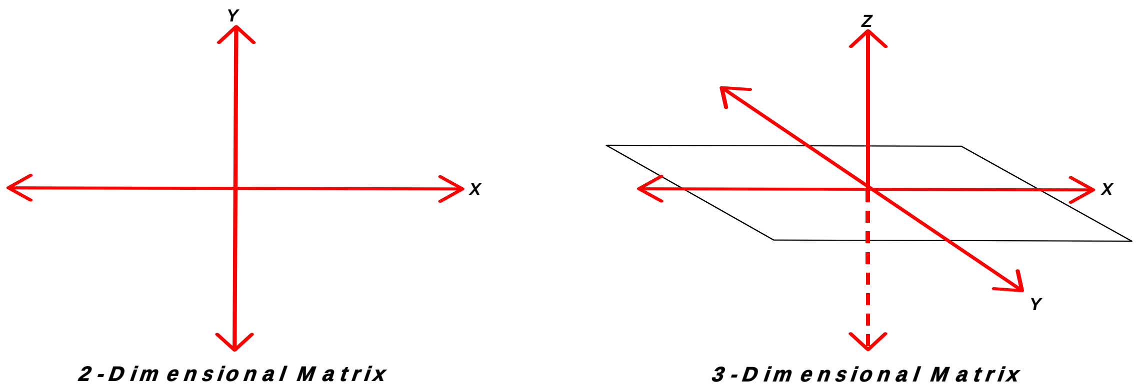



**Figure D-4:** Basic Scenario Matrix Types.

## Step 6: Describe the Scenarios

Once the scenario matrix is created, the planning group must envision each of the possible futures identified. This begins with developing a description of each. This step is one of creativity and imagination. Each scenario must be framed and described to be unique and clearly understood by all participants. The group can prepare lists of characteristics which characterize each scenario and should identify the potential issues that must be managed or overcome given the uncertainties involved. This sets the stage to begin planning for the future.

### Step 7: Create Paths to the Scenarios

Each characterized scenario is a future that could come to pass. The planning group plots a pathway to each of these futures based upon its specific characteristics and issues. The pathways include individual elements such as public, political, and research/technological programs as well as various construction projects that need to be sequenced over time to achieve the envisioned future. The pathways are developed independently from one another and are based solely on realizing each unique future. Nonetheless, similarities and overlaps do occur among the individual pathways developed. This commonality among the pathways is the essence of the final step.

### Step 8: Identify the Common Elements

The ultimate result of the scenario planning process is the identification of common elements. These are projects and programs that are present on all or many of the individual scenario pathways. This commonality indicates that such projects and programs will be useful under a wide range of possible futures. As a result, such elements are more likely to be viable as the future unfolds.

## SCENARIO PLANNING FOR *WATER PLAN: 2000-2050*

Many potential questions and issues were considered during Step 1 of the scenario planning process. After reviewing the list and noting that many of the identified issues were in fact small parts of something larger, the central over-riding issue readily became apparent. Tucson Water's central planning issue was to identify how best to utilize its most abundant renewable water resources: Colorado River water and municipal effluent. A scenario planning assessment of the Clearwater Program addressed how to maximize use of imported Colorado River water. An analogous but separate assessment evaluated how to maximize the Utility's use of locally generated municipal effluent.

The processes associated with the two scenario planning assessments are summarized in the following sections. These summaries are followed by a description of the process used to integrate these two assessments which resulted in a matrix of possible combined futures that formed the basis for the recommended plan.

### Scenario Planning for the Clearwater Program

The Clearwater Program was developed to maximize Tucson Water's use of its Central Arizona Project allocation by blending Colorado River water with native ground water. However, this could be accomplished in a number of ways. After developing a list of driving forces, variables, and uncertainties associated with the central issue (Step 2 shown on Figure

D-5), they were individually ranked in terms of their relative importance and uncertainty (Step 3 shown on Figure D-6).

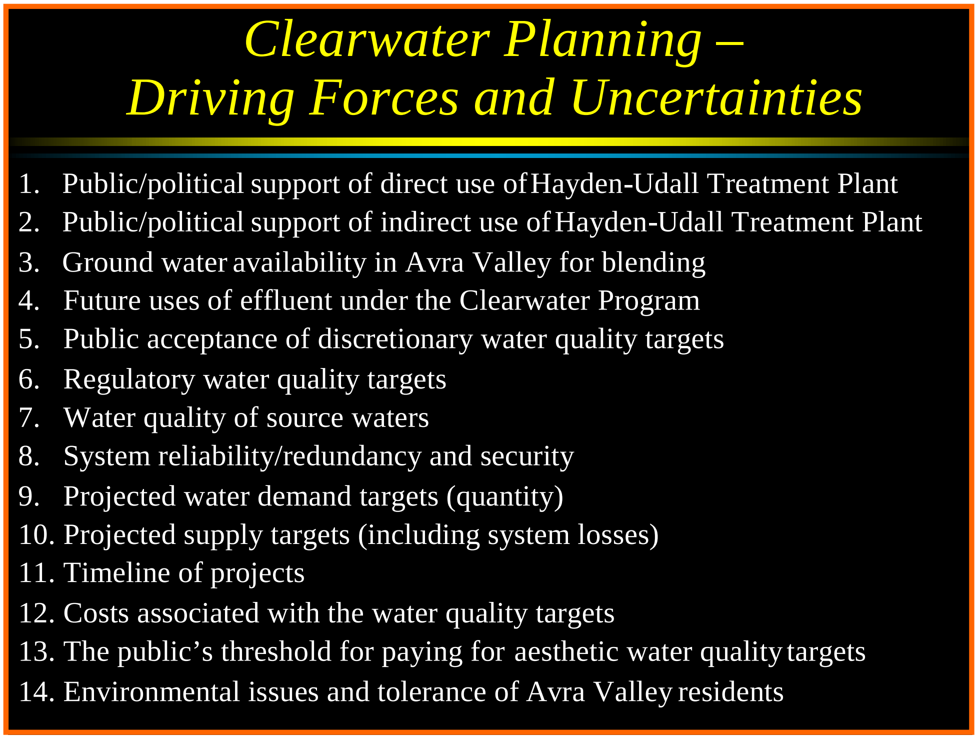



**Figure D-5:** Clearwater Driving Forces.

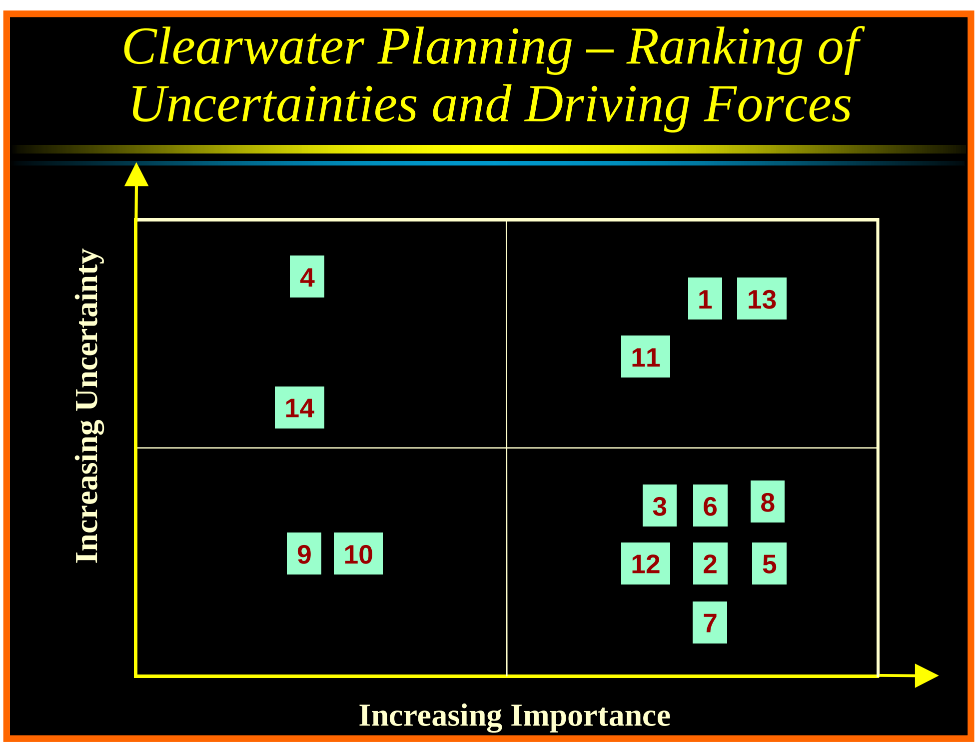



**Figure D-6:** Clearwater Ranking of Importance and Uncertainty.

The ranking process was followed by an assessment of those items identified as having the greatest importance and the highest uncertainty (Step 4). Of the three driving forces that were found to be both highly important and highly uncertain, #11 was determined to be more a result of the planning process than a critical driving force. Therefore, #1 and #13 were identified as the two most critical uncertainties and were further defined:

1. What is the public's threshold for paying for discretionary water-quality improvements to the Clearwater blend?

2. Will the public accept the use of the Hayden-Udall Treatment Plant for direct treatment of Colorado River water?

Under Step 5, these two critical uncertainties were then oriented on a two-dimensional matrix as shown on Figure D-7. The first is portrayed on the *x*-axis. The left side of this axis represents futures where the public would accept a blended water quality that meets EPA and ADEQ primary drinking water standards. The right side represents the public's willingness to pay for discretionary improvements above and beyond these standards. The second critical uncertainty is portrayed on the *y*-axis. The top of this axis addresses possible futures where the public would accept some direct treatment of Colorado River water at Tucson Water's potable treatment facility, the Hayden-Udall Treatment Plant. The bottom part of the axis represents futures where the public would require that all Colorado River water be recharged prior to use for potable supply.

The resulting four quadrants shown on Figure D-7 correspond to four equally possible futures (I, II, III, and IV). The four futures represent the range of possibility associated with the water-resource management goal of maximizing Tucson Water's use of its Central Arizona Project allocation through the Clearwater Program.

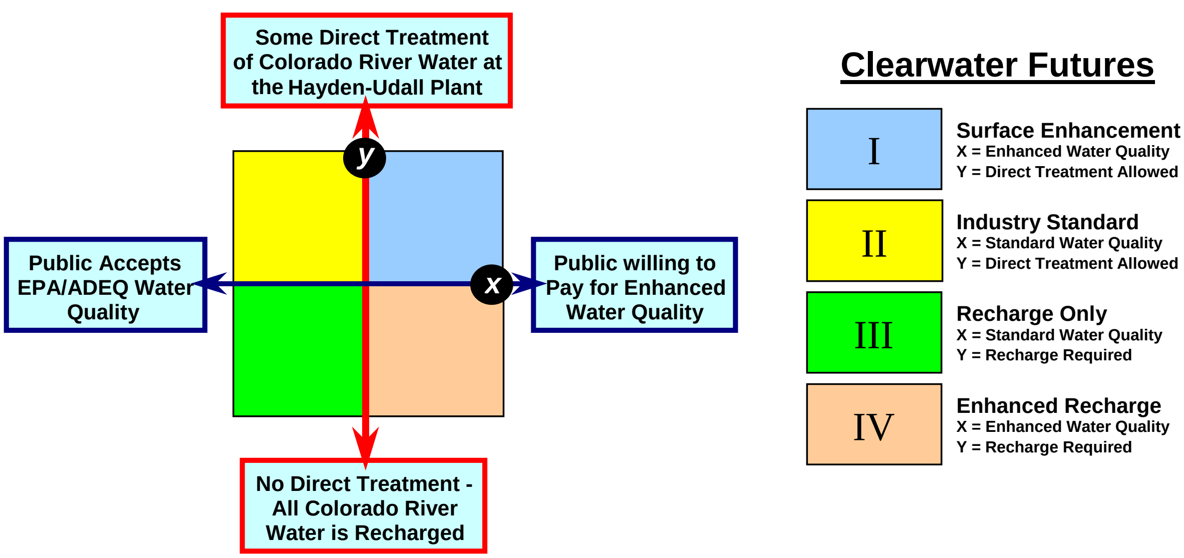



**Figure D-7:** The Four Scenario Planning Futures Developed for the Clearwater Program.

The objective of Step 6 was to characterize each of the four Clearwater futures. The task was to clearly distinguish each unique future from the others so that independent pathways could be developed to each. The descriptions included defining characteristics and significant issues associated with each future. The characteristics and issues of each were socio-political, technical, logistical, environmental, and economic to mention a few.

Under Step 7, pathways were developed to each of the four futures and these are schematically depicted on Figure D-8. The four pathways consist of the appropriate project and program elements that have been sequentially ordered to realize each of the four futures. These elements were selected from a common pool of potential programs and projects that could become part of the Clearwater Program.

The objective of Step 8 was to identify the elements that were common to all four pathways and the critical decision points where the pathways branch off from one another over time. Five elements that are common to all pathways prior to the first critical decision point were identified and are shown on Figure D-8. The first critical decision centers on whether the Hayden-Udall Treatment Plant can be used for direct treatment or whether all Colorado River water must be recharged and subsequently recovered prior to use.

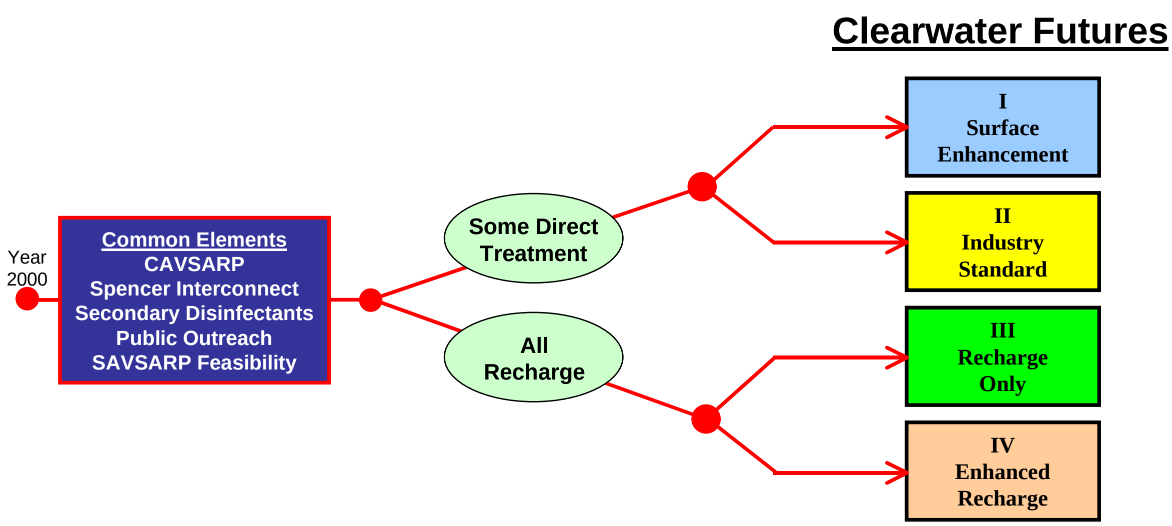



**Figure D-8**: Clearwater Program Common Elements and Pathways.

As each critical decision is approached at each juncture or as conditions and assumptions change, the Clearwater Program's scenario planning process will be revisited to determine whether a revised set of possible futures should be developed and reassessed.

## Scenario Planning for Effluent Reuse

The other central water-resource planning issue was to identify how best to use the City of Tucson's effluent in a manner that would be acceptable to Tucson Water customers. Locally generated effluent is the only water supply that increases as the service area population grows. As shown on Figure D-9, sixteen driving forces were identified (Step 2).

## Effluent Planning -
## Driving Forces and Uncertainties

1. Quality of secondary effluent as a source water (future)
   - Who would be responsible for the treatment of the effluent to potable standards?
   - Who would pay for the needed treatment system?
2. Amount of available effluent (City of Tucson entitlement)
   - How much of the conservation effluent pool will be used?
   - What are some of the constraints of Tucson Water using effluent?
   - What are the effects of taking all City effluent out of the Santa Cruz River?
3. Treatment technologies (recharge and/or plant treatment)
4. How does the Utility produce the desired quality of effluent for the various reuse types
   - Is recharge (indirect reuse) assumed, or can a plant be used for potable treatment?
   - Are there synergistic health effects of emerging contaminants?
   - Can the Hayden-Udall Treatment Plant be used to treat effluent for potable supply?
   - Future potable and non-potable water quality standards
   - When should different levels of treatment be implemented?
5. Effluent priority to meet highest beneficial use(s)
   - What is the highest beneficial use? (potable, non-potable, restoration)
   - What percent of total potable demand will be met by non-potable reclaimed water?
   - If effluent is treated to a higher standard, should the non-potable system continue?
6. Public perceptions and/or acceptance of effluent for potable use (groundwater augmentation)
   - Reassurance about health effects (consumer safety) from potable reuse of effluent
   - Tap into the national initiatives on the topic
   - How do we present information to our customers to help them make choices?
   - How do we frame the crisis versus reacting to the crisis when it comes?
7. Timing of effluent use for potable supply
   - Driven by Assured Water Supply, aquifer impacts, cost, and/or public acceptance
8. Regulatory and permitting issues
   - What permits and/or changes in law will be needed to use effluent for potable?
   - Lead time to acquire the needed permits to begin accruing long-term storage credits
   - Potential changes to the Assured Water Supply rules (renewable groundwater)?
9. Salinity control – what alternatives are available (where do we put highly saline water)?
10. Availability of alternative potable water supplies
11. Regional cooperation on water issues, Regional Water Cooperative
12. Stakeholder involvement
13. The Community's vision of a sustainable future for Tucson Water
14. Locations of effluent sources/treatment plants in the future
15. Cost of treatment technology prior to use
16. Public cost threshold for using effluent

**Figure D-9:** Effluent Driving Forces.

The effluent reuse driving forces were plotted on the scenario planning graph of relative importance and uncertainty (Step 3 shown on Figure D-10.) As the planning work sessions proceeded, it was evident that driving force #4, "How does the Utility produce the desired quality of effluent for the various reuse types", was actually a combination of two distinct concepts. The planning group decided to break driving force #4 into its component parts as distinct driving forces as follows:

#4A – What type of treatment should be used for effluent?
#4B – What level of treatment should be provided for effluent?

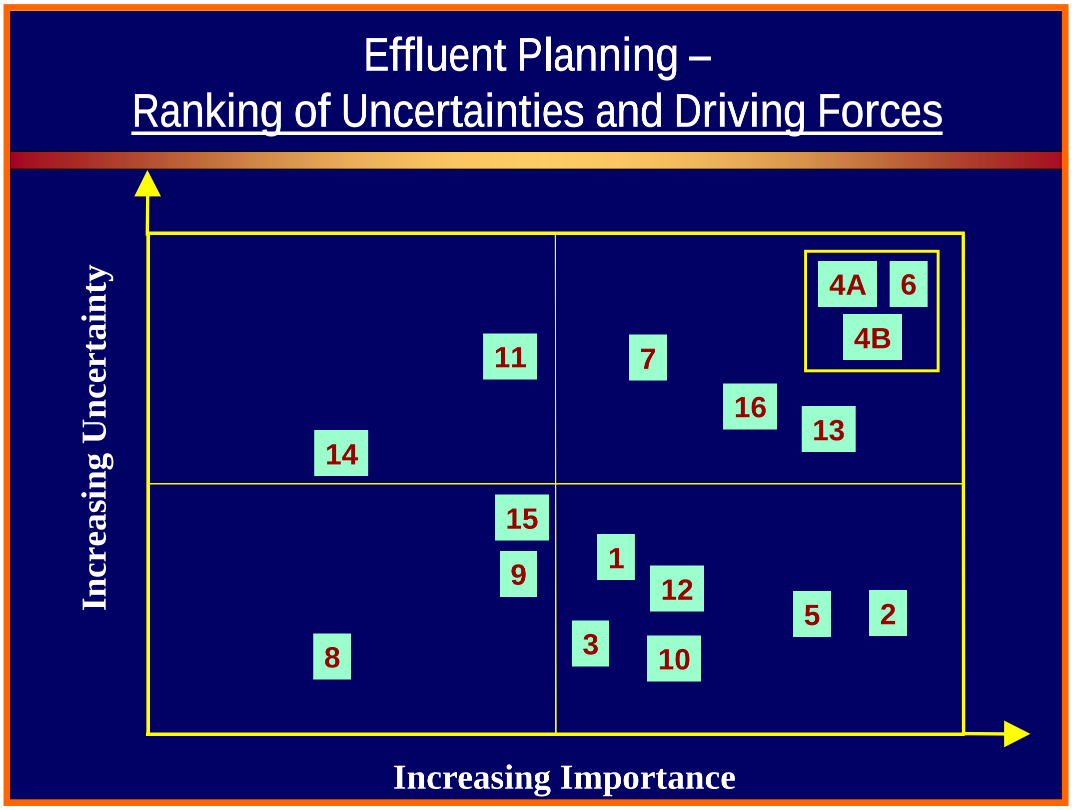



**Figure D-10:** Ranking of Importance and Uncertainty for Effluent Reuse.

Eight futures were developed based on three critical uncertainties (Step 4):

1. Will Tucson Water customers accept the use of effluent to augment the potable supply?

2. Should effluent be recharged prior to reuse?

3. Should all effluent be treated to potable standards or only treated to standards specific to the type of use?

The first critical uncertainty is portrayed on the *x*-axis (Step 5 shown on Figure D-11.) The *Potable Use* end of the axis establishes the possibility that the public would be willing to accept effluent to augment potable supply while the *No Potable Use* end represents futures where the public would reject the use of effluent for potable reuse.

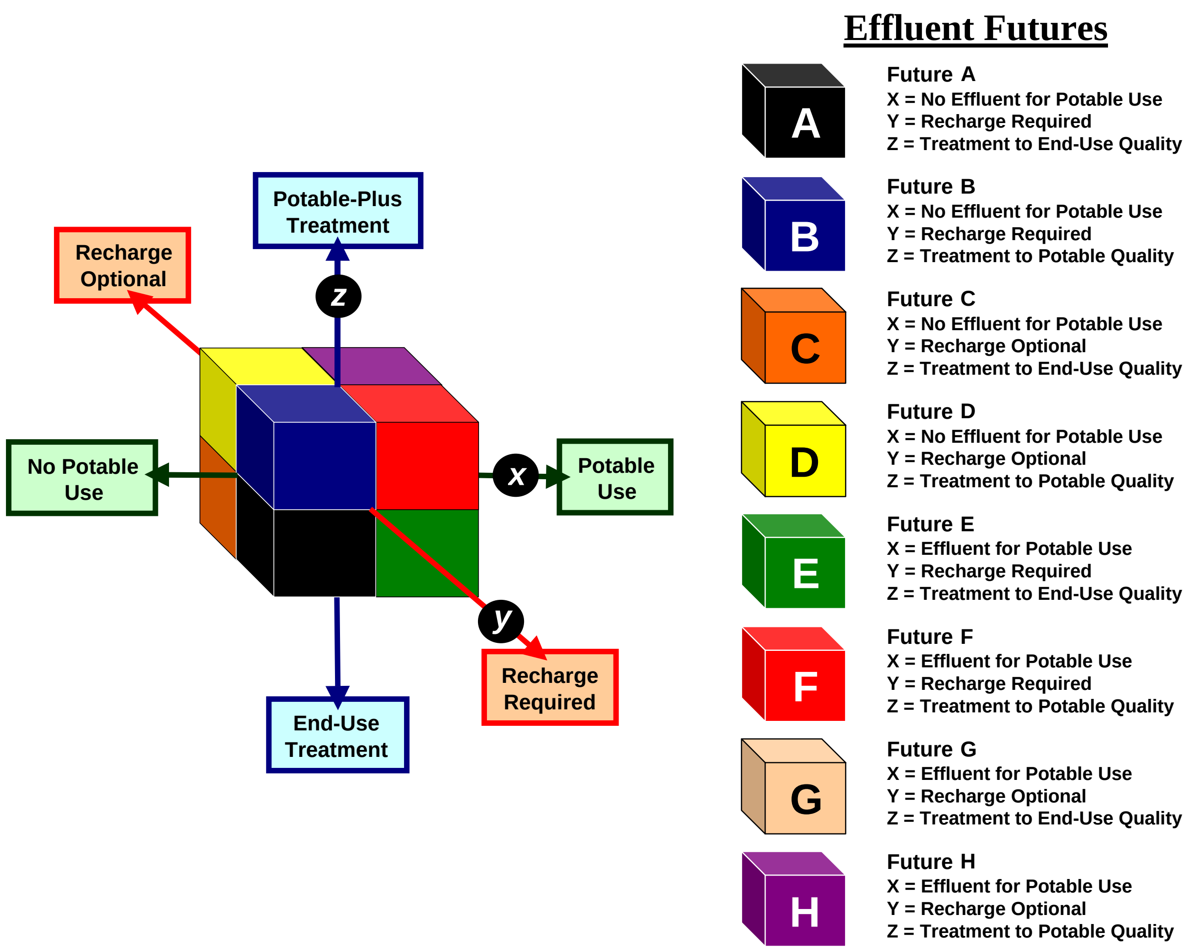



**Figure D-11:** The Eight Scenario Planning Futures Developed for Possible Effluent Reuse.

The second critical uncertainty is portrayed on the *y*-axis. The *Recharge Optional* end of the axis establishes that the public would be willing to accept some direct treatment of effluent while the opposite *Recharge Required* end represents futures where the public would require recharge prior to potable reuse. Like the Clearwater assessment, the latter means that all effluent would have to be recharged before it could be made available to customers for potable supply.

The third critical uncertainty is portrayed on the *z*-axis. The *Potable-Plus Treatment* end of the axis represents futures where all effluent will at minimum be treated to primary drinking water standards or better while *End-Use Treatment* establishes futures where effluent would only be treated to the level required for the specified use. For instance, effluent used for non-potable purposes would only be treated to reclaimed water-reuse standards. The resulting eight boxes shown on Figure D-11 represent eight equally possible effluent-reuse futures.

As with the Clearwater Program scenario planning assessment, the objective of Step 6 was to characterize each of the eight effluent reuse futures. The descriptions included defining characteristics and significant issues associated with each future.

Pathways were specified to realize each of the effluent-reuse futures (Step 7) as shown on Figure D-12. Review of the project and program elements associated with each pathway (Step 8) indicated that fourteen elements (Common Element Set #1) were common to all pathways prior to the first decision point. At this point, a critical choice will have to be made on whether to expand the reuse of effluent or continue current effluent disposal practices. If expanded use of effluent is pursued, additional common elements have been identified (Common Element Set #2).

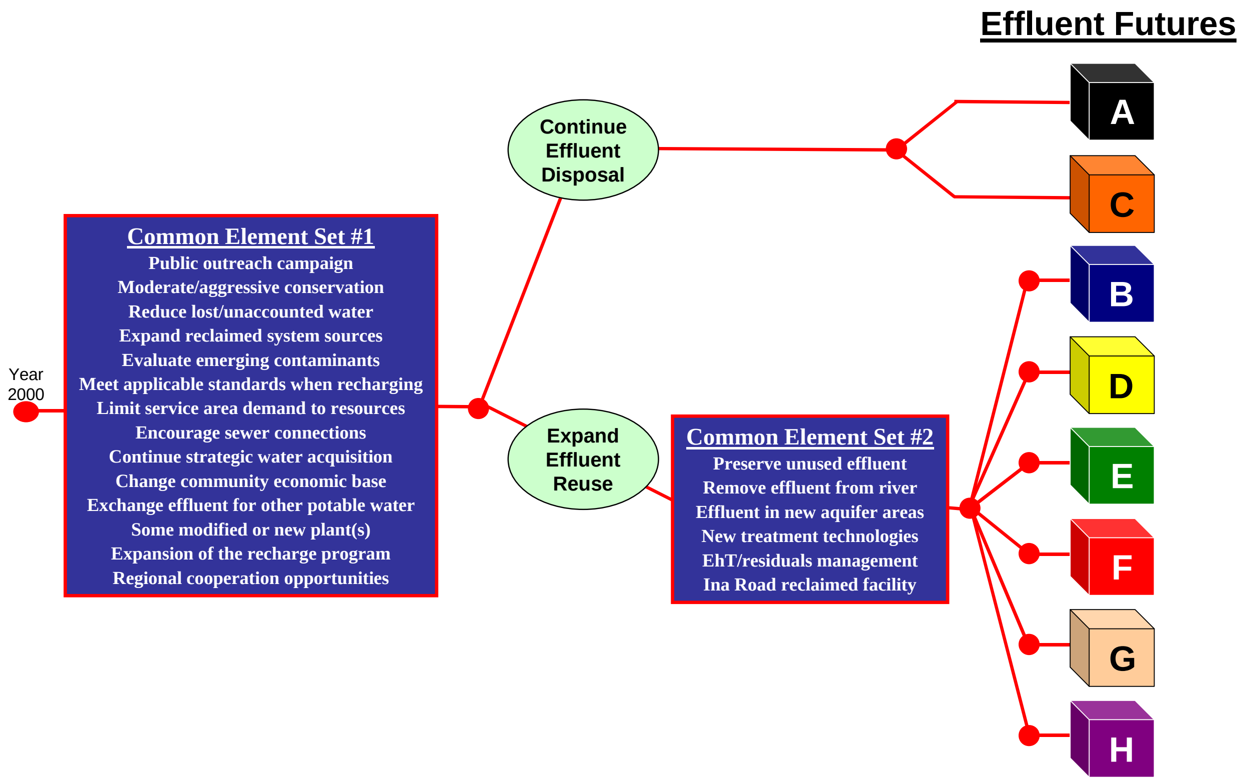



**Figure D-12:** The Sets of Common Elements for Effluent Reuse.

## INTEGRATING THE OUTCOMES

To merge the futures identified for implementing the Clearwater Program and the possibilities associated with effluent reuse, Tucson Water identified the effects that near-term Clearwater Program decisions will have on mid- to long-term options for effluent reuse. Each of the four Clearwater Program futures chronologically precedes all eight of the effluent reuse futures. Futures from within these two sets were uniquely mixed and matched to form a total of 32 "combined futures." These combined futures collectively constitute a wide range of planning possibilities which utilize both Colorado River water and municipal effluent. Four combined futures were eliminated since they would have allowed for the direct treatment and reuse of effluent, but recharge would be required for Colorado River water supplies. Such a combination of treatment types was determined to be highly unlikely to occur; therefore, these futures were excluded from the remaining analysis.

The remaining 28 combined futures are defined by 14 sets of paired planning pathways. The mineral content of the Clearwater blend was used as the "toggle switch" that defined each paired pathway. This toggle switch can be turned to TDS concentrations of either 500-650 mg/L or 450 mg/L along each of the 14 pathways. Therefore, the 14 pathways cover the full range of possibilities represented by the 28 combined futures.

As with the individual assessments, the scenario planning process was employed to identify the common elements that apply to the combined futures each of which constitutes a unique combination of critical uncertainties. In addition, critical decision points were identified through time that will determine future directions.

## Families of Futures

The combined futures and the 14 paired pathways were grouped by their shared characteristics into four Families of Futures. These characteristics include the range of effluent reuse options deemed acceptable, the potential role of recharge, the technologies which may be used to treat Colorado River water and effluent to acceptable levels of quality, and the level of operational flexibility provided under each Family. Based on shared characteristics, four Families of Futures were identified:

- *No Effluent for Potable Use*
- *Total Recharge*
- *Combined Technology*
- *Treatment Flexibility*

These Families represent unique combinations of the four futures associated with Clearwater Program and the eight futures associated with effluent reuse. The four resulting Families are described below and summarized in Figure D-13.

*No Effluent for Potable Use*

In this Family, no effluent would be used for potable supply. As a result, drought resistance is minimal since effluent is not fully utilized to help offset shortfall years on the Colorado River system. An eventual shortfall in potable supply would likely occur before 2020 due to the finite availability of both Colorado River water and ground water unless additional renewable water supplies were acquired or ground-water pumping was increased above hydrologically sustainable levels. This Family includes all four futures developed for the Clearwater Program (I, II, III, and IV) but only four of the eight effluent futures (A, B, C, and D). This accounts for 16 of the 28 combined futures.

*Total Recharge*

Under *Total Recharge*, Tucson Water would be able to make full use of its available Colorado River water and effluent resources through recharge and recovery. Under this future, all Colorado River water and effluent would be recharged as part of the treatment process prior to being used to satisfy potable demands. The impacts of future drought would be minimal since the total volume of available water supply is larger. This would require an aggressive expansion of Tucson Water's recharge and recovery capabilities. This Family accommodates two Clearwater Program futures (III and IV) and two effluent futures (E and F). This accounts for four of the combined futures.

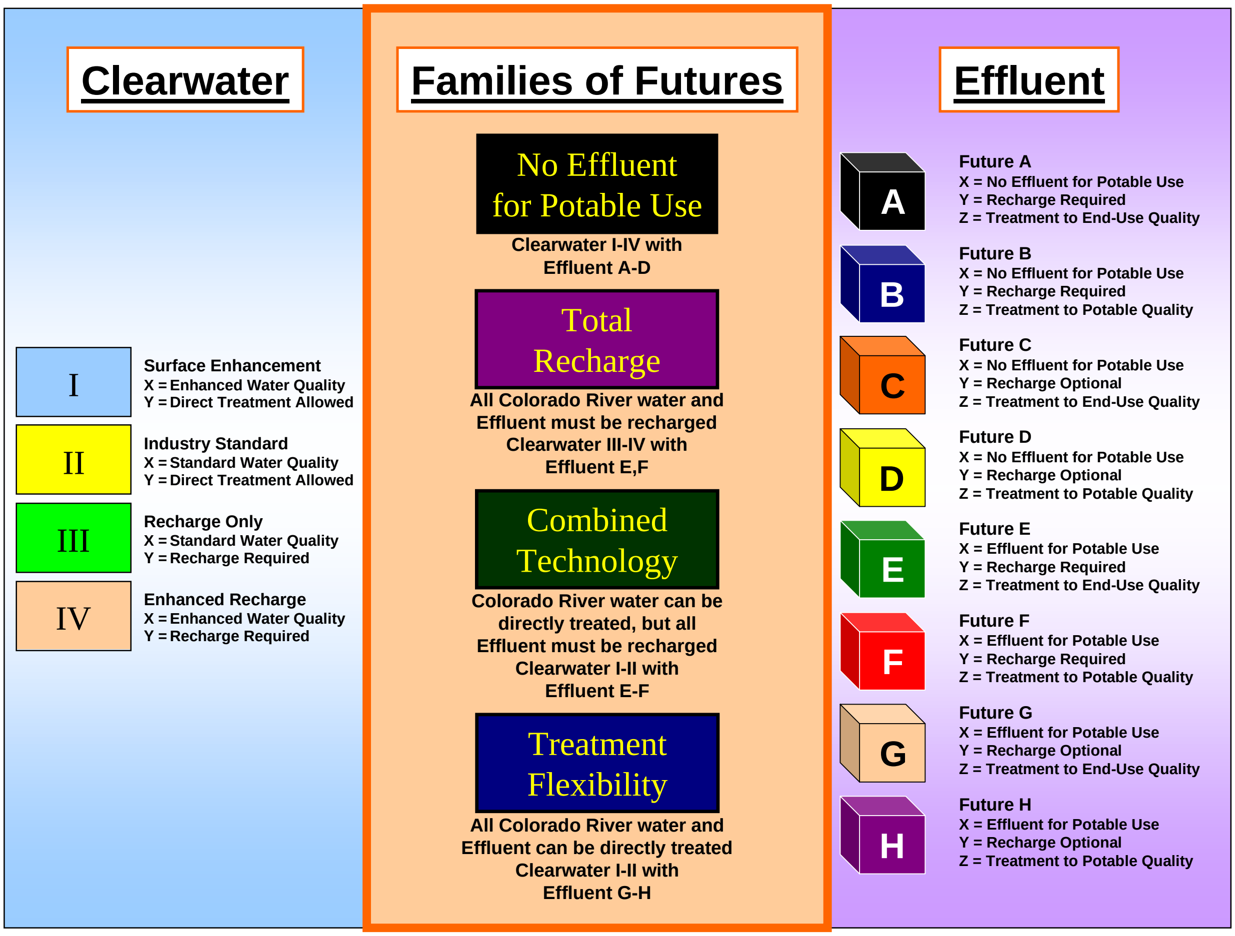



**Figure D-13:** The Four Families of Futures.

*Combined Technology*

In the *Combined Technology* Family, Tucson Water would again be able to make full use of the available Colorado River water and effluent resources for potable and non-potable supply. The Utility would have the ability to use direct treatment and/or recharge and recovery for Colorado River water supplies. However, all effluent would be recharged prior to being used to satisfy potable demands. The impacts of future drought would be minimal since the total volume of available water supply is larger. The type of Colorado River water treatment would not be restricted. All effluent would be recharged resulting in continued expansion of Tucson Water's recharge and recovery capabilities. This Family accommodates two Clearwater Program futures (I and II) and two effluent reuse futures (E and F). This accounts for four of the combined futures.

*Treatment Flexibility*

In *Treatment Flexibility*, Tucson Water would not only be able to make full use of the available Colorado River water and effluent source waters, but the manner in which these supplies are treated is completely flexible. Tucson Water could use direct treatment technologies and/or recharge and recovery for all Colorado River water and effluent supplies. Similar to *Total Recharge* and *Combined Technology*, the impacts of future drought would be minimal. This Family accommodates two Clearwater Program futures (I and II) and two effluent futures (G and H). This accounts for four of the combined futures.

## Pathways to 2050

Over the next 50 years, Tucson Water must implement a number of projects and programs to increase the use of renewable water supplies to meet growing water demand. Depending on what the future holds, some projects and programs will continue to be viable while others may not. Scenario planning provides a framework to identify common elements that are applicable under the broadest range of possible futures. The 14 pathways that lead to the 28 combined futures are presented on Figure D-14.

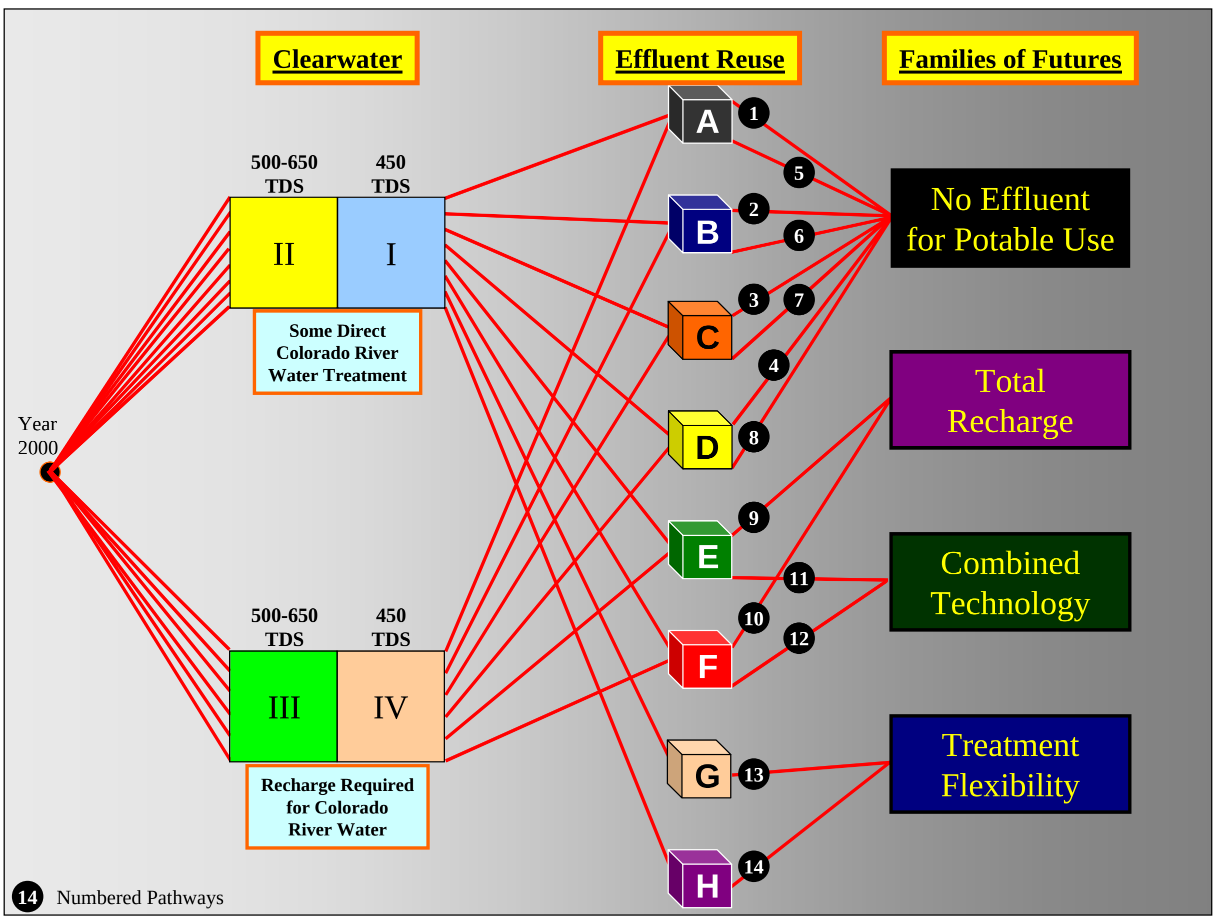



**Figure D-14:** Pathways to the Four Families of Futures.

The pathways are impacted by critical decisions made regarding the treatment technology used for Colorado River water (direct treatment versus recharge) and the TDS concentration of the Clearwater blend (450 mg/L versus 500-650 mg/L). Looking beyond this first critical decision point regarding Colorado River water, subsequent decisions addressing the reuse of effluent will need to be made. To capture the range of possible effluent reuse decisions, pathways were extended from each of the four possible Clearwater futures to each of the eight effluent reuse futures. The Families of Futures are defined by pathways that lead to combined futures which share a similar characteristic. For instance, all the combined futures under the *No Effluent for Potable Use* Family share this characteristic. However, each of the combined futures within this family has one or more other characteristics which makes it unique.

## Pathway Elements

A set of projects and water supply sources served as a pool of discrete elements from which each of the pathways was assembled. These projects fall into three general categories: potable system, reclaimed system, and major pipelines. The supply sources include currently available ground water, Colorado River water, and effluent. Should additional water supplies be acquired or if future demand management programming significantly reduces per capita water use, a reassessment of pathway elements may be necessary.

<u>Potable System Projects</u>

Potential improvements to the potable system could include expansions of existing recharge projects and/or the construction of new recharge facilities. The existing CAVSARP facility can be expanded to increase Colorado River water recharge and/or recovery capacity. In addition, the CAVSARP facility could be made available to recharge effluent for long-term banking or indirect potable use. The SAVSARP facility could be constructed to expand Colorado River water recharge. This facility would consist of two phases where the first would have the capacity to recharge 45,000 acre-feet per year of Colorado River water while the second would expand the facility up to 100,000 acre-feet. Tucson Water could also deliver treated effluent to the Pima Mine Road Recharge Project for long-term banking.

Potable system improvements could also include the construction of direct and/or enhanced treatment plants. Direct treatment plant options include the potential rehabilitation of the Hayden-Udall Treatment Plant for the direct treatment of Colorado River water and the potential construction of the Sweetwater Enhanced Treatment Plant near Roger Road. Each of these facilities could be upgraded to perform enhanced treatment (mineral content removal) if elected by the public. In addition, the Sweetwater Enhanced Treatment Plant could potentially be equipped to treat effluent to potable standards as a contribution to the blended water supply.

<u>Reclaimed System Projects</u>

There are two main ways to provide treated effluent for use in the reclaimed water system: plant treatment and soil-aquifer treatment via recharge. As demand for reclaimed water grows into the future, Tucson Water's sources of reclaimed water must be expanded. The pathways to 2050 include either expansion(s) of the Tucson Reclaimed Water Treatment Plant or expansion(s) of its effluent recharge and recovery program. Constructed recharge can be expanded at the existing Sweetwater Recharge Facilities up to 10,000 acre-feet per year. This would require the construction of additional recharge basins. In addition, new constructed effluent recharge facilities can be built to recharge and recover additional effluent as needed to satisfy reclaimed water demand through 2050.

Pipeline Projects

Tucson Water must construct pipelines to convey Colorado River water and effluent to treatment and/or recharge facilities. Additional pipelines could be constructed to convey potable water into the distribution system. The Spencer Interconnect would provide the ability to bring additional ground water into the Hayden-Udall Treatment Plant for blending as well as provide another route to deliver finished water from the Hayden-Udall Treatment Plant to Tucson Water customers. The Avra Valley Transmission Main Augmentation would increase the volume of water that can be delivered into Tucson via the Martin Reservoir. This would provide a back-up route for the blended water supply to enter urban Tucson.

A pipeline from the potential Sweetwater Enhanced Treatment Plant to the CAVSARP facility would provide the opportunity to recharge effluent in Avra Valley under certain pathways. The Ina Road Interconnect would provide Tucson Water access to effluent from the Ina Road Water Pollution Control Facility for reuse. Finally, a pipeline from the potential Sweetwater Enhanced Treatment Plant to Pima Mine Road (Tucson basin pipeline) would provide the ability to convey effluent to the Pima Mine Road Recharge Project or other locations east of the Tucson Mountains for long-term storage.

Currently Available Supply Sources

As described in previous chapters, there are three current water supplies available for use by Tucson Water: ground water, Colorado River water, and effluent. For the planning pathways, the minimal ground water usage was assumed to be equal to the pumping rate that can be hydrologically sustainable within Tucson Water's projected service area. For planning purposes, it is conservatively assumed that an annual ground water withdrawal of 50,000 acre-feet can be produced from within the projected Tucson Water service area without causing significant water level declines. Under ten paired pathways, ground water production is limited to this volume. However, under four paired pathways, effluent that is not available for potable use will be banked in long-term storage facilities. In these latter pathways, the recharge credits granted for the banking activities can be used to offset additional ground water pumping, although, this could cause a shift back toward localized over-drafting of the aquifer and declining groundwater levels.

Tucson Water's full Central Arizona Project allocation is assumed to be fully utilized under all pathways. The current allocation of 135,966 acre-feet per year is assumed to be available under all years. Tucson Water's effluent supply is used to varying degrees under the 14 pathways. The one base assumption is that effluent will continue to be used via the reclaimed water system to offset 8 percent of total demand. This usage rate assumes that 20,200 acre-feet of reclaimed water would be used in 2050 and the annual volume of effluent not used through the reclaimed system could total 46,000 acre-feet.

Under four pathways (Pathways 1, 3, 5, and 7), effluent would only be used in the reclaimed system to meet non-potable demands. In four other pathways (Pathways 2, 4, 6, and 8), effluent not used in the reclaimed system would be banked in long-term storage facilities. The recharge credits accrued through these long-term storage activities could be used to offset additional ground-water pumping in excess of the annual sustainable rate; however, this could cause a shift back toward localized over-drafting of the aquifer and declining ground-water levels. In the remaining six pathways (Pathways 9 through 14), the effluent not used through the reclaimed system is used to augment potable water supplies. The projects that were used to develop each of the 14 pathways are presented in Table D-1.

## DISTINGUISHING THE PATHWAYS

Nine assessment criteria were developed to rate the overall benefits and drawbacks of each of the 14 possible pathways. These criteria were developed from a wide range of factors that could serve as assessment performance measures. Many of these factors could not be used as distinguishing criteria because they were common to all 14 pathways and hence were considered non-discriminating or "neutral." These neutral factors applied equally to all pathways while the nine assessment criteria served to distinguish the pathways. Each of the nine criteria is assigned to one of three assessment categories: Source Water, Operations, and Environment. The criteria were developed in order to evaluate the overall capability of each pathway to meet the following Tucson Water planning goals:

- Meet Projected Total Demand.
- Utilize Renewable Resources.
- Meet Water-Quality Targets.
- Achieve Sustainable Pumpage.
- Manage Costs and Rate Impacts.
- Comply with Assured Water Supply Program.

Each criterion is assigned a rating from one to ten points where the highest score fully expresses the value embodied in any given criterion. The point sum of the ratings is the measure of how well each pathway meets the overall planning goals.

### Neutral Ground – Similarities Among the Pathways

There are a number of characteristics that are included on all of the pathways. These include factors over which Tucson Water has no control, which apply under all future scenarios, and which are not affected by the projects selected under each path. The commonality of these factors does not lessen their importance; in fact, many will likely be critical driving forces in the future. However, since they apply to all pathways, they cannot be used as distinguishing criteria to rate the relative effectiveness of the pathways to achieve the overall planning goals. Several of these neutral but important factors are discussed in this section.

| Pathway | Spencer Interconnect | Avra Valley Main Augmentation | Effluent Pipeline to Avra Valley | Effluent Pipeline to Tucson Basin | Ina Road Interconnect | Expand CAVSARP Recharge to 80k | SAVSARP Phase I | Rehabilitate Hayden-Udall | SAVSARP Phase II | Enhanced Treatment at Hayden-Udall | Effluent Recharge at CAVSARP | Effluent Recharge at Pima Mine Road | Expand CAVSARP Operations to 100k | Sweetwater Enhanced Treatment Plant | Expand CAVSARP Recovery | Effluent Recharge at CAVSARP | Expand Sweetwater Recharge Facilities | Expand Reclaim Plant | Reclaimed System Recharge Project | Clearwater Future(s) | Effluent Reuse Future | Family of Futures |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Major Pipelines | | | | | Potable System | | | | | | | | | | | Reclaimed System | | | | | |
| 1 | 2006 | 2009 | | | | 2005 | | 2009 | | 2011* | | | | | | | 2007 | | 2012 | I/II | A | No Effluent for Potable Use |
| 2 | 2006 | 2009 | 2017 | | 2017 | 2005 | | 2009 | | 2011* | 2017 | | | 2017 | | | 2007 | | 2012 | I/II | B | |
| 3 | 2006 | 2009 | | | | 2005 | | 2009 | | 2011* | | | | | | | | 2007 | | I/II | C | |
| 4 | 2006 | 2009 | 2017 | | 2017 | 2005 | | 2009 | | 2011* | 2017 | | | 2017 | | | | 2007 | | I/II | D | |
| 5 | 2006 | 2009 | | | | 2005 | 2007 | | 2009 | 2011* | | | | | | | 2007 | | 2012 | III/IV | A | |
| 6 | 2006 | 2009 | | 2017 | | 2005 | 2007 | | 2009 | 2011* | | 2017 | | | | | 2007 | | 2012 | III/IV | B | |
| 7 | 2006 | 2009 | | | | 2005 | 2007 | | 2009 | 2011* | | | | | | | | 2007 | | III/IV | C | |
| 8 | 2006 | 2009 | | 2017 | | 2005 | 2007 | | 2009 | 2011* | | 2017 | | | | | | 2007 | | III/IV | D | |
| 9 | 2006 | 2009 | 2017 | | 2017 | 2005 | 2007 | | 2009 | 2011* | 2017 | | 2017 | 2017 | 2025 | | 2007 | | 2012 | III/IV | E | Total Recharge |
| 10 | 2006 | 2009 | 2017 | | 2017 | 2005 | 2007 | | 2009 | 2011* | 2017 | | 2017 | 2017 | 2025 | | 2007 | | 2012 | III/IV | F | |
| 11 | 2006 | 2009 | 2017 | | 2017 | 2005 | | 2009 | | 2011* | 2017 | | | 2017 | 2025 | | 2007 | | 2012 | I/II | E | Combined Technology |
| 12 | 2006 | 2009 | 2017 | | 2017 | 2005 | | 2009 | | 2011* | 2017 | | | 2017 | 2025 | | 2007 | | 2012 | I/II | F | |
| 13 | 2006 | 2009 | | 2017 | 2025 | 2005 | | 2009 | | 2011* | | 2017 | | 2025 | | 2025 | | 2007 | | I/II | G | Treatment Flexibility |
| 14 | 2006 | 2009 | | 2017 | 2025 | 2005 | | 2009 | | 2011* | | 2017 | | 2025 | | 2025 | | 2007 | | I/II | H | |

* This element can be "on" or "off" in all fourteen pathways and serves as the "toggle switch" for the mineral content of the Clearwater Blend.

**Table D-1:** Pathways to 2050 – Schedules of Projects.

Demand Management

Reducing per capita water demand applies to all futures. Conservation programming is one way to manage demand. Because many conservation programs rely on voluntary actions or behavioral changes on the part of customers, demonstrating a quantifiable improvement can be problematic. Emphasizing mandatory technologically based conservation programs that result in measurable water savings and continuing broad-based public education efforts would be necessary to further reduce per capita water demand. An extended period of monitoring and evaluation of these programs would be needed to demonstrate quantifiable water savings. In addition to conservation programs, Tucson Water will continue to improve the efficiency of its distribution system to further reduce water demand.

Full Utilization of Colorado River Water

Fully utilizing the City of Tucson's annual Central Arizona Project allocation is critical toward maximizing the use of renewable supplies in Tucson Water's service area. The community currently accepts the indirect use of Colorado River water where it is recharged and recovered through the Clearwater Program prior to delivery for potable use. Over the next 10 years, this program will be expanded to achieve full utilization. While the pathways differ as to what projects would be constructed to accomplish this goal, the full use of Tucson Water's Central Arizona Project allocation is a priority common to all pathways and futures.

Reclaimed System

Also common to all pathways is that effluent will continue to be used in the reclaimed system to offset at least eight percent of total demand. This usage rate assumes that 20,200 acre-feet of reclaimed water would be used to satisfy non-potable water demands by 2050.

Blended Water Quality

All of the pathways can provide enhanced water quality for the blended water supply. Tucson Water's customers would have to pay the incremental costs to make discretionary improvements in water quality. The most common measure of the blended water quality is TDS which refers to the concentration of dissolved minerals present virtually in all water supply sources. The renewable Colorado River water supply being imported into the Tucson area differs in mineral content from the native ground water to which Tucson Water's customers have grown accustomed. Customers may be willing to pay for the enhanced treatment of the blended water supplies to maintain a mineral content below that of untreated Colorado River water. The *At the Tap Program* established a targeted TDS concentration of approximately 450 mg/L. If this mineral content were to be sustained over the long-term, then enhanced treatment would eventually be required. Enhanced treatment could be performed on directly treated or on recharged and recovered Colorado River water. This would require a significant capital and annual operations and maintenance investment that would then be incrementally added to all 14 pathways.

Water Treatment Flexibility

The ability to effectively treat all available potable water sources is an important factor in water-resource planning. This will become more critical in the future as drinking water standards become increasingly stringent. However, since each of the pathways places a premium on establishing central points of control where renewable water supplies would be treated before entering the distribution system, this factor is considered well-managed under each pathway and cannot serve to distinguish one pathway from another. Central points of control allow for a greater degree of treatment flexibility since additional treatment train components can be efficiently added at centralized treatment locations as needed.

Hydrologically Sustainable Ground-Water Pumping

Sustainable ground-water pumping was identified as a long-term source of supply in *Tucson Water Resource Plan 1990-2100* and is a resource-management strategy that will continue to be pursued. However, the current AWS rules do not grant credits for annually renewable ground water. Regulations will need to be modified in order to recognize this important renewable resource. Under current regulations, almost all ground-water usage is currently classified as “mined” ground water with no allowance given to natural recharge. Instead current regulations assigned a portfolio of ground-water credits and a 4 percent incidental recharge allowance to municipal providers which limits the amount of ground water that can be legally pumped. The key to sustainable ground-water use is to balance ground-water withdrawals with this natural level of replenishment. Hydrologically sustainable ground-water pumping would be an indefinite source of renewable supply. Pursuing changes to the AWS Program to allow for sustainable pumping is common to all of the combined futures.

Supply Augmentation

In any future, the more water supplies Tucson Water owns or controls, the better positioned it will be to meet future demands. The City of Tucson will seek to acquire additional Colorado River water and effluent supplies under any future or pathway that satisfies all of the long-range resource-planning goals. If local water providers work cooperatively, the chances of successfully acquiring additional supplies would be greater. These additional supply sources might include additional Central Arizona Project allocations, leased or purchased Colorado River water, and possibly ground water from basins in western Arizona.

Regulatory Compliance

Compliance with all applicable regulatory standards is required for any pathway to the future. In all cases, regulatory compliance will become more challenging in the future as requirements become increasingly stringent. Hence, this factor cannot be used as a distinguishing characteristic when analyzing the various pathways and futures.

## Assessment Criteria

Source Water Criteria

*Criterion 1: Colorado River Water Source Acceptance*

Tucson Water's customers currently accept basin recharge as the primary type of treatment of Colorado River water. However, other communities have had success with direct treatment processes, and these might eventually become accepted in Tucson as well. This criterion was evaluated based on how far each pathway departs from what is presently being done because current practice is the baseline against which customer preference is measured.

- Colorado River water is rejected in the future for potable supply. 1 Pt.
- Direct treatment technologies are used to treat Colorado River water. 5 Pts.
- All Colorado River water is recharged before being used for potable supply. 10 Pts.

*Criterion 2: Effluent Water Source Acceptance*

The community currently accepts using effluent for non-potable needs. As water resources become increasingly limited in the future, effluent use will likely be expanded to meet increasing water demand. However, the level of customer acceptance of expanded effluent use is not yet known. This criterion was developed based on how far each pathway departs from what is presently being done since current practice is the baseline against which customer preference is measured.

- Effluent is directly treated for potable supply. 1 Pt.
- Effluent is used to augment groundwater for potable supply. 5 Pts.
- Effluent is only used to meet non-potable demands. 10 Pts.

*Criterion 3: Renewable Supply Utilization*

Maximizing use of all currently available water supplies and being able to acquire additional sources of supply will ensure that the community is sustainable over the long-term. All of the paths assume that full utilization of Tucson Water's Central Arizona Project allocation is a critical component in achieving that sustainability. However, the paths differ on how and to what degree the effluent resource is used. The use of effluent to augment potable and non-potable supplies provides the highest level of renewable supply utilization. In lieu of using effluent to help meet potable demands, banking it at long-term storage (recharge) facilities would at least preserve this resource for the future and would allow for the accrual of recharge (paper-water) credits to offset ground-water pumping.

- Neither potable use nor long-term banking of effluent. 1 Pt.
- No potable use, but construction of long-term banking projects for effluent. 5 Pts.
- Maximize use of effluent for non-potable and indirect potable uses. 10 Pts.

Operations Criteria

*Criterion 4: Meeting Projected Water Demand*

Each pathway makes use of a certain volume of available water supply which can support the growing community until some point in the future. The longer in time each pathway can meet projected wet-water demand, the more highly it is rated.

- Shortfall in wet-water supply is projected to occur before 2020. 1 Pt.
- Shortfall in wet-water supply is projected to occur between 2020 and 2030. 4 Pts.
- Shortfall in wet-water supply is projected to occur between 2030 and 2050. 7 Pts.
- Wet-water supply is sustainable through 2050. 10 Pts.

*Criterion 5: Source Reliability*

This criterion evaluates the ability to deliver water under adverse conditions such as during extended drought, unplanned canal outages, and Colorado River shortages. Greater use of recharge and recovery projects to utilize Colorado River water and effluent resources increases the reliability of these supplies since the recovery component of recharge facilities can still provide wet-water supply despite changing weather patterns or system outages. In contrast, total dependence on direct treatment plants has less reliability since there would not be a water-resource buffer in place to make up a reduction in wet-water supply.

- No potable use of effluent with direct treatment and delivery of Colorado River water. 1 Pt.
- No potable use of effluent with recharge of Colorado River water prior to delivery. 3 Pts.
- Direct treatment and delivery of both effluent and Colorado River water. 5 Pts.
- Direct treatment of Colorado River water with recharge of effluent for indirect potable use. 7 Pts.
- Recharge of both effluent and Colorado River water prior to delivery. 10 Pts.

Environmental Criteria

*Criterion 6: Impacts to Recharge Neighbors*

Constructing recharge projects can have local impacts on immediately surrounding areas. These include construction nuisances and/or changes in local ground-water quality resulting from recharge activities. Under this criterion, minimal construction of additional recharge projects will result in minimal impacts to neighbors living in close proximity.

- Recharge of all renewable supplies; maximum recharge impacts. 1 Pt.
- Combination of recharge and direct treatment plants for renewable supplies. 5 Pts.
- Minimal construction of new recharge projects; minimal recharge impacts. 10 Pts.

*Criterion 7: Riparian Issues*

As water availability becomes increasingly limited in the future, effluent supplies will most likely be more widely utilized. The degree to which effluent is put to use will have an adverse impact on riparian habitats that could otherwise be supported by the in-channel disposal of unused effluent.

- Effluent not used for non-potable purposes used to augment potable supply. 1 Pt.
- Effluent not used for non-potable purposes placed in banking facilities. 5 Pts.
- Effluent not used for non-potable purposes discharged to channel. 10 Pts.

*Criterion 8: Salinity Control*

The control of salinity is a growing concern in the arid west. Salts will be imported to Tucson and other central Arizona communities via the Central Arizona Project. In addition, the imported salts incrementally increase the salt concentration in municipal effluent. All of the alternative pathways are considered equivalent to one another for their potential to manage salinity in imported Colorado River water supplies. Hence, the level of salinity treatment/control that is applied to Colorado River water is considered an option that applies equally to all pathways. However, the way in which the community uses and/or disposes of its effluent and its associated build up of salts are evaluated in this criterion.

- Effluent is recharged but not recovered (salts distributed). 1 Pt.
- Effluent continues to flow down the Santa Cruz River (salts concentrated). 4 Pts.
- Effluent is put in recharge and recovery project (salts managed). 7 Pts.
- Effluent is treated through enhanced treatment technologies (salts removed). 10 Pts.

*Criterion 9: Subsidence Prevention*

The degree to which Tucson Water reduces its reliance on mined ground water will determine how well the Utility can manage the local aquifer to address declining water levels and the associated potential for additional land subsidence.

- Minimal use of renewable supplies; maximum mined ground-water use. 1 Pt.
- Preservation of effluent for future use; moderate mined ground-water use. 5 Pts.
- Use of effluent for indirect potable supply; minimal mined ground-water use. 10 Pts.

## Assessment Results

Review of Table D-2 indicates that Pathways 9 through 14 are rated higher than Pathways 1 through 8. The more highly rated pathways lead to three Families of Futures: *Total Recharge*, *Combined Technology*, and *Treatment Flexibility*. The main element that sets Pathways 9 through 14 above Pathways 1 through 8 was their ability to maximize use of renewable resources with emphasis on effluent utilization. Increasing use of effluent and fully utilizing Colorado River water are critical factors which contributed to these pathways realizing four of the planning goals: Meet Projected Total Demand, Utilize Renewable Resources, Achieve Sustainable Pumpage, and Comply with Assured Water Supply Program.

| Pathway | Colorado River Water Source Acceptance | Effluent Water Source Acceptance | Renewable Supply Utilization | Meeting Projected Water Demand | Source Reliability | Impacts To Recharge Neighbors | Riparian Issues | Salinity Control | Subsidence Prevention | TOTAL | Clearwater Future(s) | Effluent Reuse Future | Family of Futures | Planning Goal Achievement |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | <<<<<Source Water>>>>> | | | <<Operations>> | | <<<<<<<<Environment>>>>>>>> | | | | Overall | | | | |
| 1 | 5 | 10 | 1 | 1 | 1 | 10 | 5 | 4 | 1 | 38 | I/II | A | No Effluent for Potable Use | FAIL |
| 2 | 5 | 10 | 5 | 4 | 1 | 5 | 10 | 1 | 5 | 46 | I/II | B | | FAIL |
| 3 | 5 | 10 | 1 | 1 | 1 | 10 | 5 | 4 | 1 | 38 | I/II | C | | FAIL |
| 4 | 5 | 10 | 5 | 4 | 1 | 5 | 10 | 1 | 5 | 46 | I/II | D | | FAIL |
| 5 | 10 | 10 | 1 | 1 | 3 | 5 | 5 | 4 | 1 | 40 | III/IV | A | | FAIL |
| 6 | 10 | 10 | 5 | 4 | 3 | 1 | 10 | 1 | 5 | 49 | III/IV | B | | FAIL |
| 7 | 10 | 10 | 1 | 1 | 3 | 5 | 5 | 4 | 1 | 40 | III/IV | C | | FAIL |
| 8 | 10 | 10 | 5 | 4 | 3 | 1 | 10 | 1 | 5 | 49 | III/IV | D | | FAIL |
| 9 | 10 | 5 | 10 | 10 | 10 | 1 | 1 | 7 | 10 | 64 | III/IV | E | Total Recharge | PASS |
| 10 | 10 | 5 | 10 | 10 | 10 | 1 | 1 | 7 | 10 | 64 | III/IV | F | | PASS |
| 11 | 5 | 5 | 10 | 10 | 7 | 5 | 1 | 7 | 10 | 60 | I/II | E | Combined Technology | PASS |
| 12 | 5 | 5 | 10 | 10 | 7 | 5 | 1 | 7 | 10 | 60 | I/II | F | | PASS |
| 13 | 5 | 1 | 10 | 10 | 5 | 10 | 1 | 10 | 10 | 62 | I/II | G | Treatment Flexibility | PASS |
| 14 | 5 | 1 | 10 | 10 | 5 | 10 | 1 | 10 | 10 | 62 | I/II | H | | PASS |

**Table D-2:** Rating of Pathways to 2050.

The use of effluent has the added benefit of providing greater operational reliability because it is locally generated and hence always immediately available. In addition, Pathways 9 through 14 provide the community the best options to prevent continued subsidence by controlling ground-water withdrawals and stabilizing water levels in the aquifer.

In the planning approach used in this assessment, the most highly rated pathways and their associated futures serve as indicators of the programs and projects that could best achieve the stated planning goals. As the community evolves, these planning goals may change. Because change is the one certainty, all potential pathways are retained in developing the recommended plan. The common elements represented in the 14 pathway pairs provide the direction and the flexibility needed to manage uncertainty and the inevitable challenges which lie ahead.

# APPENDIX E

# FEDERAL, STATE, AND LOCAL REGULATIONS AND POLICIES

Federal, state, and local regulations and policies play an important role when making water service and long-range water-resource planning decisions. Water-resource planning requires an understanding of water-related regulations that present opportunities and challenges to managing available water supplies. Tucson Water must also be aware of potential regulatory changes in order to plan for the future. This appendix briefly summarizes the most pertinent federal, state, and local regulations and policies which must be taken into account when planning to meet the community's increasing demand for water.

## FEDERAL REGULATIONS

Federal regulations apply to a wide range of water-related activities including water-resource utilization, compliance with water-quality standards, and environmental protection.

### Federal Water-Resource Regulations

There are many federal water-resource obligations that can influence Tucson Water's operations and planning activities. Two of the most important include regulation of the Colorado River including Arizona's Colorado River water rights and Native American water rights.

<u>Law of the Colorado River</u>

The *Colorado River Compact of 1922* is the foundation of the "Law of the River." The Compact apportioned 7.5 million acre-feet of surface water annually to each of the Upper and Lower Colorado River Basins. A small part of Arizona is in the Upper Basin, but its primary water interests are in the Lower Basin, which also includes California and Nevada.

The Compact did not become effective until passage of the *Boulder Canyon Project Act of 1928* which was ratified in 1929 by six of the seven Upper and Lower Basin States; Arizona refused to ratify the Compact. The *Boulder Canyon Project Act* authorized construction of Hoover Dam and the All-American Canal which diverts Colorado River water to California. The Act also specified annual allocations of waters apportioned among the Lower Basin States: 2.8 million acre-feet to the State of Arizona, 4.4 million acre-feet to the State of California, and 300,000 acre-feet to the State of Nevada. Each of the Lower Basin States was also allocated percentages of any annual surplus that might occur in a given year. Arizona eventually ratified the Compact in 1944.

The *Colorado River Basin Project Act of 1968* authorized construction of the Central Arizona Project as well as five Upper Basin projects. The Central Arizona Project has rights to 1.5 million acre-feet of Arizona's 2.8 million acre-feet per year apportionment. The Act provides that the 1963 Decree in *Arizona v. California*, which further buttressed Arizona's rights, will be administered so that in shortage years diversions for the Central Arizona Project will be junior to California's annual apportionment of 4.4 million acre-feet, Nevada's 300,000 acre-feet, and Arizona's mainstream allocation of 1.3 million acre-feet.

The Secretary of the Interior administers Colorado River water allocations for the Lower Basin States. The Central Arizona Water Conservation District (CAWCD), formed in 1971, contracts with the Secretary for delivering a portion of Arizona's apportioned share of Colorado River water and, in turn, subcontracts with relevant entities within Arizona to formalize Central Arizona Project allocations. CAWCD also operates the Central Arizona Project delivery system and maintains the canals. CAWCD is authorized to levy a property tax in Pima, Pinal, and Maricopa Counties to repay construction and operation and maintenance costs of the Central Arizona Project.

The City of Tucson adopted a subcontract with CAWCD in 1988 to obtain a CAP allocation. The City of Tucson's current Central Arizona Project allocation is 135,966 acre-feet. In the near future, a fixed volume of Colorado River water has been identified for reallocation to Arizona communities, and Tucson has been recommended to receive an additional 8,206 acre-feet per year through this process. The proposed reallocation of Central Arizona Project water to municipal providers is included in the Arizona Water Settlements Act currently pending before Congress and expected to be approved within the next two years. If the Act is approved, ADWR will receive an allocation of approximately 80,000 acre-feet of non-Indian agricultural priority Central Arizona Project water which it will allocate for M&I use over the next 30 years. In addition, as State-owned land is sold and developed in Tucson Water's projected service area, portions of the State's allocation could be transferred to the City.

Native American Tribes

The greater Tucson region is home to the Tohono O'odham Nation and the Pasqua Yaqui Tribe.

*Tohono O'odham Nation*

The Tohono O'odham Nation is located on approximately 2.8 million acres in south central Arizona. The Nation's total population in 2000 was approximately 24,000 people (Inter Tribal Council of Arizona, 2003). The largest community is Sells and the second largest is the San Xavier District, located on 72,000 acres south of Tucson.

In 1975, the United States, on behalf of the Tohono O'odham Nation, filed suit against the City of Tucson and other major water users in the area seeking to protect the water resources of the Nation's San Xavier District. The City and the other water users negotiated a settlement which Congress ratified as the *Southern Arizona Water Rights Settlement Act of 1982* (SAWRSA). The San Xavier and Eastern Schuk Toak Districts of the Nation have a contract with the United States for 37,800 acre-feet per year of Central Arizona Project water. The Secretary of the Interior also is obligated under SAWRSA to provide an annual total of 28,200 acre-feet of effluent to the Nation.

The City of Tucson entered into an agreement with the Secretary of the Interior to implement SAWRSA the following year. The City agreed to annually deliver 28,200 acre-feet of effluent for the Secretary's use in support of the settlement. The agreement will terminate if the lawsuit is not dismissed. Motions for dismissal are still pending subject to another act of Congress that would package SAWRSA amendments with other Native American water claims and Central Arizona Project-related settlements. The Secretary is obligated under SAWRSA to annually provide 23,000 acre-feet of water suitable for agricultural use to the Tohono O'odham Nation at the San Xavier District and 5,200 acre-feet of such water to the Eastern Schuk Toak District.

*Pasqua Yaqui Tribe*

The Pasqua Yaqui are descendants of the ancient Toltecs who once ranged from northwestern Mexico, southern Colorado, and California. Pasqua Yaqui tribal lands are located on 222 acres about 15 miles southwest of Tucson. Tribal population in 2000 was approximately 9,000 people (Inter Tribal Council of Arizona, 2003). The Pasqua Yaqui have a Central Arizona Project allocation of 500 acre-feet per year.

## Federal Water-Quality Regulations

Water-quality regulations often originate from federal legislation. Two major federal laws that govern potable water supply delivery are the Safe Drinking Water Act and the Clean Water Act.

### Clean Water Act

Congress established the EPA in 1970 in response to growing public demand for cleaner water, air, and land. The intent of the Clean Water Act (CWA), formerly the Federal Water Pollution Control Act of 1972, was to restore the chemical, physical, and biological integrity of the nation's water supplies. The CWA's primary regulatory mechanism is a permit that governs the discharge of pollutants to "waters of the United States." In practice, the waters of the United States include the Santa Cruz and Rillito River channels and the washes in the Tucson area that drain the Santa Cruz and Rillito watersheds.

Section 404 of the CWA outlines wetlands regulations and requires the United States Army Corps of Engineers, with the concurrence of the EPA, to issue permits for activities that disturb the "Waters of the United States." For the purposes of Section 404, waters of the United States include most Arizona streams, stream channels and wetlands. Section 404 is intended to prevent the unlawful filling of wetlands and would apply to any channel modification Tucson Water would implement to support in-channel underground storage facilities.

Safe Drinking Water Act

The Safe Drinking Water Act (SDWA) was enacted in 1974 and authorizes the EPA to set national health-based standards for potable water. SDWA rules are based on identifying and regulating contaminants that pose potentially serious public health risks. The Act requires the EPA to determine if a contaminant has an adverse effect on public health and that regulation of this contaminant presents a meaningful opportunity for health risk reduction before a drinking water regulation is established. This process includes setting a "Maximum Contaminant Level" (MCL) and a MCL "goal." A MCL is the highest level of a contaminant that is allowed in drinking water. A MCL goal is the level of a contaminant in drinking water below which there is no known or expected health risk. Tucson Water's MCLs are either identical to EPA's or are even more restrictive.

Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as Superfund, was enacted by Congress in 1980. This law creates a tax on chemical and petroleum industries that is used to fund the cleaning up of abandoned or uncontrolled hazardous waste sites. EPA administers this program.

Tucson Water operates a federal Superfund program known as the Tucson Airport Remediation Project under a consent order (agreement) with EPA and other industrial and governmental agencies. In 1981, volatile organic compounds were found in ground water in southwest Tucson. The TARP treatment plant was completed in 1994 and consists of a pump and treat system with air stripping towers that remove the ground-water contaminants. The treatment plant produces about 6.2 million gallons per day of potable supply.

## Other Federal Regulations

Tucson Water is also subject to regulations administered by agencies whose missions include protection of plant and animal species. The most important of these is the Endangered Species Act.

*The Endangered Species Act* (ESA) was enacted in 1973 to address concerns that many of the nation's plants and animals were in danger of becoming extinct. The ESA consists of several sections, many of which can apply to public works projects. Section 10 of the ESA provides a process for landowners to develop and implement an approved "habitat conservation plan" while Section 7 allows for individual projects to proceed based on case-by-case consultations. These processes enable development of land inhabited by endangered species. Entities with proposed development projects that are approved by U.S. Fish and Wildlife Service receive an "incidental take" permit that allows project implementation to proceed. The City of Tucson has begun work on a habitat conservation plan that will provide a pre-determined path which project planners can use to mitigate harm caused to an endangered species. However, the ability of such plans to provide mitigation against species declared as endangered in future years is currently in question. Such plans may only provide the City of Tucson and Tucson Water with limited certainty and assurance when adding expensive capital improvements to its supply infrastructure**.**

## STATE REGULATIONS

Enforcement of federal regulations is often delegated to states. The State of Arizona plays an important role in the implementation of federal legislation.

### State Water-Resource Regulations

<u>Arizona Groundwater Management Act of 1980</u>

The Arizona Groundwater Management Act (GMA) was passed by the Arizona Legislature in 1980. The GMA established ADWR and created Active Management Areas (AMAs) within the State where more stringent water-resource regulations apply. Boundaries of the AMAs are primarily based on locations of ground-water basins but also take into account water use patterns. The ground-water management program established for AMAs limits ground-water withdrawals, prohibits development of new irrigated farmland, requires new subdivisions to have long-term dependable supplies, and requires ground-water withdrawals to be measured and reported. The five AMAs currently account for about 75 percent of the groundwater pumping in Arizona and contain over 80 percent of the State's population.

The Tucson AMA is one of the original AMAs designated for regulation by ADWR. The Tucson AMA includes eastern Pima County and parts of Pinal and Santa Cruz counties. The Tucson AMA was established because of ground-water depletion within the Upper Santa Cruz and the Altar-Avra Valley subbasins (ADWR, 1999).

The GMA specified that ADWR establish management plans for each AMA to achieve AMA goals, established a statutory system of ground-water rights within AMAs to be administered by ADWR, and changed the rules for permitting and operating new wells within AMAs.

Tucson AMA Management Plans

The GMA established five management periods between 1980 and 2025 to achieve the management goals of the AMAs. For the Tucson AMA, management plans are developed prior to each management period by the Tucson AMA director and ADWR staff. The main components of each management plan are water supply augmentation, water quality, and water conservation plans for agricultural, municipal, and industrial users and providers in the Tucson AMA. For water providers, the conservation plans specify per capita water use targets. Only potable water is included in calculating per capita use; reclaimed water is not included in the calculation in order to provide an incentive for its use. Failure to comply with ADWR target use rates could result in fines or other punitive actions.

The management goal of the Tucson AMA is to attain "safe yield" by 2025. This is to be achieved by implementing water conservation by all water users, utilizing renewable water resources such as Colorado River water and effluent, retiring agriculture with advancing urbanization, and by purchasing and extinguishing grandfathered ground-water rights.

Rights to Withdraw Ground Water in the Tucson AMA

Tucson Water primarily withdraws ground water pursuant to non-irrigation grandfathered ground-water rights and its service area right.

*Grandfathered Rights*

On the date that an AMA is established, all existing non-municipal uses of ground water are capped and are accorded grandfathered ground-water rights (GFRs). This is a marked departure from the reasonable use doctrine which still applies to ground-water users outside AMAs. A provider can also withdraw ground water outside of its service area pursuant to GFRs. With few exceptions, GFRs cannot be restricted by ADWR to achieve safe yield.

The Type I non-irrigation GFRs apply to farmland retired from irrigation after January 1, 1965 in anticipation of eventually using those rights for municipal supply. A Type I right allows a right-holder to pump three acre-feet of ground water per acre of land retired from irrigation. Type I rights are tied to the land and cannot be transferred to another location. Tucson Water has Type I rights totaling 47,116 acre-feet per year as a result of the Avra Valley agricultural land retirement program.

Type II non-irrigation GFRs apply to non-irrigation withdrawals of ground water in existence as of June 12, 1980. Type II rights are not tied to specific lands and hence may be transferred from one location to another. Tucson Water has 9,203 acre-feet of Type II rights.

*Service Area Right*

Under its service area right, Tucson Water may withdraw and transport as much ground water from within its service area as may be required to serve customers within that area, subject to applicable ADWR water conservation and also AWS requirements. The GMA defines the service area of a city, town, or private water company as the area of land served by a water provider and any additional areas that contain an operating distribution system owned by the provider that is used primarily for the delivery of non-irrigation water. Tucson Water has established its service area in accordance with ADWR regulations and annually submits maps to the agency that show service area extensions.

Underground Water Storage, Savings, and Replenishment Act

The *Underground Water Storage, Savings, and Replenishment Act* of 1994 expanded the recharge program established by the *Groundwater Recharge and Underground Storage Act of 1986.* Recharge, storage, and recovery of all classes of water including nonpotable water are regulated. The Act integrated the various underground water storage programs adopted since 1986 into a single, unified program. This more streamlined process was intended to facilitate development of recharge projects. Its intent also was to improve the recharge permitting system and address the assignment of long-term storage credits. Tucson Water has recognized the potential for using artificial recharge to help achieve its water management goals and has instituted water recharge programs to accomplish those goals. Tucson Water must have a recovery well permit issued by ADWR to recover storage credits. Recovery must not harm other land and water users as described in ADWR's recovery well spacing and impact rules.

Arizona Groundwater Transfers Bill

The *Arizona Groundwater Transfers Bill* (Senate Bill 1055) was passed and formally became ARS § 45-463 in 1991 and was established to regulate Type I non-irrigation GFRs associated with retired irrigated land. The bill added provisions for certain non-irrigation GFRs to be included in the calculation of Assured Water Supply for a city. Credits were granted to the City of Tucson in recognition of the water savings gained from purchase and retirement of irrigated land in the Avra Valley. A total of 9,570 acres were being irrigated when the City of Tucson purchased them thereby obtaining a 1984 Certificate of Grandfathered Rights for 28,710 acre-feet per year. The 9,570 acres that were under irrigation when purchased by the City of Tucson per the 1984 Certificate of GFR for 28,710 acre-feet per year can be exchanged for the maximum allowable 2 million acre-feet of ground water credits.

ADWR's Assured Water Supply Rules

The AWS Rules were established as a component of the 1980 Groundwater Management Act; however, the rules under which the program is currently governed did not become effective until 1995. The rules tighten the conditions under which ground water can be pumped by municipal providers in AMAs. For more information regarding the City of Tucson's AWS designation, refer to Appendix C: *Assured Water Supply Implementation.*

Arizona Water Banking Authority

The Arizona legislature established the Water Bank in 1996 to coordinate the off-stream delivery, storage, and transfer of storage credits relating to Arizona's 2.8 million acre-foot apportionment of Colorado River water. The Water Bank is staffed by ADWR employees and is tasked with increasing the State's utilization of its annual allocation to firm Arizona water users against future Colorado River water supply shortages. The Water Bank also can enter into storage contracts with California and Nevada to store unused Colorado River water in Arizona to help meet the future water-supply needs of these states. Other potential benefits cited at the time of its establishment include drought protection, enhanced water management through replenishment, and a possible means to settle Native American water rights settlements. The majority of funding for the Water Bank comes from a $.04 property tax levied by CAWCD in Maricopa, Pinal, and Pima counties to pay for the storage of Colorado River water to firm deliveries to Central Arizona Project M&I subcontractors during shortages. The Water Bank is authorized to obtain tax funds through 2017.

### State Water-Quality Regulations

State water-quality standards have been established for ground water, surface water, and reclaimed water. These standards are enforced by ADEQ through the *Environmental Quality Act of 1986.* The Act established ADEQ to regulate water quality, air quality, hazardous waste, and solid waste. State water-quality regulations for ground water match the MCLs established by the EPA. Surface-water quality standards have been developed for various uses including full-body contact, partial-body contact, fish consumption, agricultural irrigation, and livestock watering. The EPA has also delegated to the State the responsibility of issuing Arizona Pollutant Discharge Elimination System (AZPDES) permits that regulate water discharges from primarily municipal and industrial water users under the CWA.

### Ongoing State Proceedings

The Gila River Adjudication is a comprehensive ongoing court proceeding in Maricopa County Superior Court to determine the nature, extent and priority of surface water rights in the Gila River system. Initiated in 1974, the proceedings involve seven major watersheds (including the Santa Cruz River) and 16 Native American reservations. The appropriative allocations at stake are among the most coveted in Arizona. Historically, Tucson Water has relied on ground water as its sole source for municipal supply. The outcome of the Gila River Adjudication may bring some water that was formerly considered ground water within the purview of the Adjudication Court. This could hinder the Utility's ability to withdraw water from certain well fields in order to protect water users with senior appropriative rights.

## LOCAL AGREEMENTS OR POLICIES

Agreements with other entities and locally generated policies play a key role in Tucson Water's day to day operations. A few of the more critical agreements and policies are described below.

## Local Effluent Management Agreements

Municipal wastewater effluent is a water supply that steadily grows along with population. This supply can provide an alternative to ground water for irrigation and industrial uses through a reclaimed water system. In addition, this supply could have future use to help meet the increasing demand for potable water.

<u>City-County Effluent Intergovernmental Agreements</u>

On June 25, 1979, the City of Tucson entered into an Intergovernmental Agreement (IGA) Relating to Effluent with Pima County. The IGA transferred ownership of the City's sewage treatment plants and conveyance system to Pima County. The City retained the right to use 90 percent of the effluent (after the Secretary of the Interior's proportionate share under the Southern Arizona Water Rights Settlement Act) treated at the metropolitan treatment facilities. The County quitclaimed all rights to effluent from the metropolitan treatment plants but is entitled to use up to 10 percent of the effluent treated in these facilities (after the Secretary's share). Under the terms of the IGA, Pima County is required to treat metropolitan effluent to state and federal water quality standards for discharge whether or not the water is actually discharged. The City of Tucson retained unilateral control of all effluent discharged from Pima County treatment plants outside the metropolitan area.

The City of Tucson and Pima County entered into a Supplemental Intergovernmental Agreement Relating to Effluent (Supplemental IGA) in early 2000 to resolve issues related to recharging effluent in the Santa Cruz River. The Supplemental IGA contained numerous agreements including: (1) the City of Tucson and Pima County agreed to established a Conservation Effluent Pool for use on riparian projects, (2) the City and Pima County agreed to cooperatively plan and establish recharge projects to store effluent, (3) effluent from the new treatment facility at Ina Road would be divided among the parties in the region with contractual rights to effluent, (4) the City would no longer control effluent from existing non-metropolitan plants, and (5) the County could use its allocation of effluent for any public use.

Subsequent agreements between the City of Tucson and the Metropolitan Domestic Water Improvement District (MDWID), and the City and the Town of Oro Valley assigned those water providers with effluent allocations based on their wastewater return flows from potable water deliveries. The amounts of effluent owned by the entities vary, depending on how much potable water is delivered in any given year. Both agreements are subject to the provisions of the effluent IGAs between the City of Tucson and Pima County.

<u>Hydraulically Connected Riparian Areas</u>

In 1990, Mayor and Council directed Tucson Water to commence a special well operation policy in the Tanque Verde area in northeast Tucson in response to water-table declines and perceived impacts on the adjacent riparian area. This "hydraulically connected riparian area" policy restricts the pumpage of a group of northeast wells to an annual total of 8,711 acre-feet, the amount that they pumped in 1987. Five wells are operated on a "last-ones-on" (during the summer) and "first-ones-off" basis. Pumpage from Avra Valley and CAVSARP is used to offset the reduced pumping capacity due to restrictions placed on the use of these wells.

Water Consumer Protection Act

Tucson Water began delivering Colorado River water to portions of its service area in 1992. The Colorado River water corroded water mains and customers' private plumbing at higher rates than ground water due to the pH level of the new source water. As a consequence of this water-quality issue, the Mayor and Council directed Tucson Water to return to ground water as the sole source of supply. The Water Consumer Protection Act of 1995 was a subsequent citizen initiative that restricted the City from directly delivering Colorado River water for the next 5 years unless it was treated to the same water quality parameters as Avra Valley ground water.

A subsequent citizen initiative placed on the City ballot that would extend the timeline of provisions of the Water Consumer Protection Act was defeated in 1999. As a consequence of this defeat, most of the terms and conditions of the Act expired in 2000. Some components of the Act that require Tucson Water to replenish ground-water pumping in the Central Well Field may remain in effect.

Mayor and Council Water Policies

Tucson Water is a municipal water provider owned and operated by the City of Tucson. The Utility is subject to the authority of the City of Tucson Mayor and Council. The Mayor and Council Water Policies cover a broad range of issues (water rates, water supply, recharge, conservation, water quality, and effluent use, reclaimed water use) and are reviewed annually by the CWAC. The CWAC is a 15-member group of local residents appointed by the City Manager and Mayor and Council.

# APPENDIX F

# COST INFORMATION

Tucson Water utilized various cost estimating procedures to produce planning level cost estimates of each planning pathway. Detailed information regarding these cost estimates is provided in a series of tables in this appendix. Table F-1 is a summary of all of the cost information contained in this appendix. It presents the total present worth and resulting unit costs of each planning pathway.

Present worth cost estimates and water resource utilization charts were prepared for each planning pathway. This appendix includes 28 tables which present detailed costs for all of the Clearwater Program elements for each of the 28 pathways. Certain pathways include projects where effluent would eventually become a part of the Clearwater blend (i.e. pathways that include Effluent Reuse futures “E” and “F”); for these pathways, the volume of effluent generated is included in the Total Clearwater Production Average Flow in Target Year. However, these tables do not include the costs of utilizing effluent through the Clearwater Program. Therefore, the unit costs presented on these tables will not reflect the total costs of the pathway. To find the total estimated unit costs for all elements of each pathway, refer to Table F-1.

On the facing page of each detailed cost estimate, a water-resource utilization chart is presented. The charts present the projected potable water demand, the water supplies to meet demand, and the estimated mineral content of the Clearwater blend for each combined future through the year 2050. Reclaimed water usage is estimated at eight percent of total demand and is not shown on the charts. The primary *“y”* axis (left side of each chart) is the annual volume of each water source in acre-feet. The secondary *“y”* axis (right side of each chart) is the projected mineral content of the Clearwater blend as measured by TDS concentration in mg/L. The stacked bars on the graphs are the annual volumes of each water supply. These supplies are color coded and listed by abbreviation in the legend located to the right of each chart. A key to these abbreviations is provided in Table F-2. The green line on each graph represents the estimated mineral content of the Clearwater blend. In combined futures that include a TDS concentration target of 450 mg/L, this limit is depicted by a solid red line.

## **Table F-1:** Water Plan: 2000-2050 - Present Worth Costs of the Planning Pathways

NOTE: Annualized Costs in $1,000 except where noted.

| | | Water Flow | Annualized Costs | | | | | | | | | | | | | | | Unit Costs | | Total Present Worth | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pathway | Combined Future | 2030 (Target Year) Average Flow (MGD)* | Hayden-Udall Capital | Hayden-Udall O&M | EhT of CAP Capital | EhT of CAP O&M | CAVSARP Capital | CAVSARP O&M | SAVSARP Capital | SAVSARP O&M | Other Capital | Other O&M | Effluent Capital | Effluent O&M | Total Capital | Total O&M | Total Annualized Costs | Unit Cost ($/1,000 Gal) | Unit Cost ($/AF) | Clearwater Cost Tool Total Present Worth | Effluent Present Worth Capital | Effluent Present Worth O&M | Grand Total Present Worth |
| 1 | I-A | 116.2 | $ 492 | $ 2,913 | $ 14,193 | $ 4,398 | $ - | $ 5,906 | $ - | $ - | $ 1,434 | $ 390 | $ - | $ - | $ 16,118 | $ 13,607 | $ 29,725 | $ 0.70 | $ 228.35 | $427,304,963 | $0 | $0 | $427,304,963 |
| | II-A | 123.0 | $ 493 | $ 2,815 | $ - | $ - | $ - | $ 5,906 | $ - | $ - | $ 1,434 | $ 390 | $ - | $ - | $ 1,926 | $ 9,112 | $ 11,038 | $ 0.25 | $ 80.12 | $158,672,375 | $0 | $0 | $158,672,375 |
| 2 | I-B | 150.9 | $ 500 | $ 4,099 | $ 14,606 | $ 4,433 | $ - | $ 3,642 | $ - | $ - | $ 1,434 | $ 392 | $ 13,229 | $ 9,841 | $ 29,769 | $ 22,406 | $ 52,175 | $ 0.95 | $ 308.74 | $418,388,366 | $190,172,406 | $141,467,348 | $750,028,120 |
| | II-B | 156.5 | $ 501 | $ 3,999 | $ - | $ - | $ - | $ 3,642 | $ - | $ - | $ 1,434 | $ 379 | $ 13,229 | $ 9,841 | $ 15,164 | $ 17,861 | $ 33,025 | $ 0.58 | $ 188.39 | $143,096,359 | $190,172,406 | $141,467,348 | $474,736,112 |
| 3 | I-C | 116.2 | $ 492 | $ 2,913 | $ 14,193 | $ 4,398 | $ - | $ 5,906 | $ - | $ - | $ 1,434 | $ 390 | $ - | $ - | $ 16,118 | $ 13,607 | $ 29,725 | $ 0.70 | $ 228.35 | $427,304,963 | $0 | $0 | $427,304,963 |
| | II-C | 123.0 | $ 493 | $ 2,815 | $ - | $ - | $ - | $ 5,906 | $ - | $ - | $ 1,434 | $ 390 | $ - | $ - | $ 1,926 | $ 9,112 | $ 11,038 | $ 0.25 | $ 80.12 | $158,672,375 | $0 | $0 | $158,672,375 |
| 4 | I-D | 150.9 | $ 500 | $ 4,099 | $ 14,606 | $ 4,433 | $ - | $ 3,642 | $ - | $ - | $ 1,434 | $ 392 | $ 13,229 | $ 9,841 | $ 29,769 | $ 22,406 | $ 52,175 | $ 0.95 | $ 308.74 | $418,388,366 | $190,172,406 | $141,467,348 | $750,028,120 |
| | II-D | 156.5 | $ 501 | $ 3,999 | $ - | $ - | $ - | $ 3,642 | $ - | $ - | $ 1,434 | $ 379 | $ 13,229 | $ 9,841 | $ 15,164 | $ 17,861 | $ 33,025 | $ 0.58 | $ 188.39 | $143,096,359 | $190,172,406 | $141,467,348 | $474,736,112 |
| 5 | III-A | 130.0 | $ - | $ - | $ - | $ - | $ - | $ 5,906 | $ 2,641 | $ 5,379 | $ 1,458 | $ 471 | $ - | $ - | $ 4,100 | $ 11,757 | $ 15,856 | $ 0.33 | $ 108.91 | $227,939,018 | $0 | $0 | $227,939,018 |
| | IV-A | 115.1 | $ 61 | $ - | $ 18,319 | $ 3,345 | $ - | $ 5,539 | $ 2,641 | $ 5,832 | $ 1,457 | $ 467 | $ - | $ - | $ 22,478 | $ 15,184 | $ 37,662 | $ 0.90 | $ 292.06 | $541,393,206 | $0 | $0 | $541,393,206 |
| 6 | III-B | 156.2 | $ - | $ - | $ - | $ - | $ - | $ 5,906 | $ 2,641 | $ 5,379 | $ 1,458 | $ 474 | $ 8,196 | $ 5,976 | $ 12,296 | $ 17,736 | $ 30,032 | $ 0.53 | $ 171.69 | $227,988,044 | $117,816,443 | $85,905,633 | $431,710,119 |
| | IV-B | 149.9 | $ 61 | $ - | $ 17,740 | $ 3,185 | $ - | $ 5,537 | $ 2,641 | $ 5,830 | $ 1,457 | $ 483 | $ 8,196 | $ 5,976 | $ 30,096 | $ 21,011 | $ 51,106 | $ 0.93 | $ 304.39 | $530,942,414 | $117,816,443 | $85,905,633 | $734,664,490 |
| 7 | III-C | 130.0 | $ - | $ - | $ - | $ - | $ - | $ 5,906 | $ 2,641 | $ 5,379 | $ 1,458 | $ 471 | $ - | $ - | $ 4,100 | $ 11,757 | $ 15,856 | $ 0.33 | $ 108.91 | $227,939,018 | $0 | $0 | $227,939,018 |
| | IV-C | 115.1 | $ 61 | $ - | $ 18,319 | $ 3,345 | $ - | $ 5,539 | $ 2,641 | $ 5,832 | $ 1,457 | $ 467 | $ - | $ - | $ 22,478 | $ 15,184 | $ 37,662 | $ 0.90 | $ 292.06 | $541,393,206 | $0 | $0 | $541,393,206 |
| 8 | III-D | 156.2 | $ - | $ - | $ - | $ - | $ - | $ 5,906 | $ 2,641 | $ 5,379 | $ 1,458 | $ 474 | $ 8,196 | $ 5,976 | $ 12,296 | $ 17,736 | $ 30,032 | $ 0.53 | $ 171.69 | $227,988,044 | $117,816,443 | $85,905,633 | $431,710,119 |
| | IV-D | 149.9 | $ 61 | $ - | $ 17,740 | $ 3,185 | $ - | $ 5,537 | $ 2,641 | $ 5,830 | $ 1,457 | $ 483 | $ 8,196 | $ 5,976 | $ 30,096 | $ 21,011 | $ 51,106 | $ 0.93 | $ 304.39 | $530,942,414 | $117,816,443 | $85,905,633 | $734,664,490 |
| 9 | III-E | 154.6 | $ - | $ - | $ - | $ - | $ - | $ 5,206 | $ 2,641 | $ 6,134 | $ 1,458 | $ 472 | $ 13,514 | $ 10,739 | $ 17,614 | $ 22,551 | $ 40,165 | $ 0.71 | $ 231.88 | $228,737,311 | $194,267,938 | $154,380,416 | $577,385,665 |
| | IV-E | 153.1 | $ 61 | $ - | $ 17,537 | $ 3,305 | $ - | $ 5,047 | $ 2,641 | $ 6,585 | $ 1,458 | $ 471 | $ 13,514 | $ 10,739 | $ 35,212 | $ 26,147 | $ 61,359 | $ 1.10 | $ 357.90 | $533,399,637 | $194,267,938 | $154,380,416 | $882,047,990 |
| 10 | III-F | 154.6 | $ - | $ - | $ - | $ - | $ - | $ 5,206 | $ 2,641 | $ 6,134 | $ 1,458 | $ 472 | $ 13,514 | $ 10,739 | $ 17,614 | $ 22,551 | $ 40,165 | $ 0.71 | $ 231.88 | $228,737,311 | $194,267,938 | $154,380,416 | $577,385,665 |
| | IV-F | 153.1 | $ 61 | $ - | $ 17,537 | $ 3,305 | $ - | $ 5,047 | $ 2,641 | $ 6,585 | $ 1,458 | $ 471 | $ 13,514 | $ 10,739 | $ 35,212 | $ 26,147 | $ 61,359 | $ 1.10 | $ 357.90 | $533,399,637 | $194,267,938 | $154,380,416 | $882,047,990 |
| 11 | I-E | 154.6 | $ 498 | $ 3,702 | $ 15,146 | $ 4,422 | $ - | $ 5,054 | $ - | $ - | $ 1,436 | $ 377 | $ 13,229 | $ 9,841 | $ 30,309 | $ 23,396 | $ 53,706 | $ 0.95 | $ 310.05 | $440,388,505 | $190,172,406 | $141,467,348 | $772,028,259 |
| | II-E | 154.6 | $ 499 | $ 3,605 | $ - | $ - | $ - | $ 4,831 | $ - | $ - | $ 1,434 | $ 374 | $ 13,229 | $ 9,841 | $ 15,162 | $ 18,651 | $ 33,813 | $ 0.60 | $ 195.21 | $154,429,985 | $190,172,406 | $141,467,348 | $486,069,738 |
| 12 | I-F | 154.6 | $ 498 | $ 3,702 | $ 15,146 | $ 4,422 | $ - | $ 5,054 | $ - | $ - | $ 1,436 | $ 377 | $ 13,229 | $ 9,841 | $ 30,309 | $ 23,396 | $ 53,706 | $ 0.95 | $ 310.05 | $440,388,505 | $190,172,406 | $141,467,348 | $772,028,259 |
| | II-F | 154.6 | $ 499 | $ 3,605 | $ - | $ - | $ - | $ 4,831 | $ - | $ - | $ 1,434 | $ 374 | $ 13,229 | $ 9,841 | $ 15,162 | $ 18,651 | $ 33,813 | $ 0.60 | $ 195.21 | $154,429,985 | $190,172,406 | $141,467,348 | $486,069,738 |
| 13 | I-G | 154.6 | $ 492 | $ 2,910 | $ 12,639 | $ 3,573 | $ - | $ 5,906 | $ - | $ - | $ 1,434 | $ 402 | $ 13,152 | $ 10,782 | $ 27,717 | $ 23,573 | $ 51,290 | $ 0.91 | $ 296.13 | $393,237,265 | $189,068,807 | $154,992,158 | $737,298,229 |
| | II-G | 154.6 | $ 493 | $ 2,815 | $ - | $ - | $ - | $ 5,906 | $ - | $ - | $ 1,434 | $ 396 | $ 13,152 | $ 10,782 | $ 15,079 | $ 19,899 | $ 34,978 | $ 0.62 | $ 202.00 | $158,760,511 | $189,068,807 | $154,992,158 | $502,821,476 |
| 14 | I-H | 154.6 | $ 492 | $ 2,910 | $ 12,639 | $ 3,573 | $ - | $ 5,906 | $ - | $ - | $ 1,434 | $ 402 | $ 13,152 | $ 10,782 | $ 27,717 | $ 23,573 | $ 51,290 | $ 0.91 | $ 296.13 | $393,237,265 | $189,068,807 | $154,992,158 | $737,298,229 |
| | II-H | 154.6 | $ 493 | $ 2,815 | $ - | $ - | $ - | $ 5,906 | $ - | $ - | $ 1,434 | $ 396 | $ 13,152 | $ 10,782 | $ 15,079 | $ 19,899 | $ 34,978 | $ 0.62 | $ 202.00 | $158,760,511 | $189,068,807 | $154,992,158 | $502,821,476 |

***Highlighted boxes contain flows that are in addition to those flows that appear on each of the Clearwater Cost Model output sheets. Added flows were derived from the use of effluent credits to pump additional ground water or from direct use of enhanced treated effluent**

**EhT: Enhanced Treatment; CAP: Central Arizona Project water**

| Abbreviation | Explanation | Abbreviation | Explanation |
|---|---|---|---|
| EFF credits | Recovered effluent long-term storage credits | TARP | Tucson Airport Remediation Project |
| EFF Recovery | Annual recovery of recharged effluent | PIMA MINE RD | Recovery of Colorado River water stored at the Pima Mine Road Recharge Project |
| SAVSARP Storage | Recovered Colorado River water long-term storage credits | CAP Bypass | Direct-treated Colorado River water from the Hayden-Udall Treatment Plant |
| RO Filt EFF | Highly treated effluent | CAP Permeate | Direct- and enhanced-treated Colorado River water from the Hayden-Udall Treatment Plant |
| Phase 1 | The first phase of wells shut-down in the Central Well Field | THREE POINTS | Three Points Well Field |
| Phase 2 | Second phase of above | AVS | South portion of the Avra Valley Well Field |
| Phase 3 | Third phase of above | SAVSARP | Southern Avra Valley Storage and Recovery Project |
| Central | Remaining wells in the Central Well Field | AVN | North portion of the Avra Valley Well Field |
| E&G | Wells located in the E&G water service areas | CAVSARP | Central Avra Valley Storage and Recovery Project |
| SANTA CRUZ | Santa Cruz Well Field | ISOLATED | Wells located in the isolated water systems |
| SOUTHSIDE | Southside Well Field | | |

**Table F-2:** Water-Supply Abbreviations Shown on Supply Graphs for Pathways.

# CLEARWATER COST MODEL OUTPUT

Add Run to Database

Show Input Form

**Pathway 1**
**Combined Future I-A**

| | | |
|---|---|---|
| ALTERNATIVE NAME | Future I-A | |
| RUN NAME | Run 1 | |
| DATE | 9/13/2004 | |

Final TDS Target from Resource Planning Tool: 450 (mg/L)

| *Input Values* | | |
|---|---|---|
| Power Cost for HUWTP | $0.08 | ($/kWh) |
| Labor Rate | $26 | ($/hr) |
| Annual Discount Rate | 0.050 | (per year as decimal) |
| ENR 20 Cities Average Cost Construction Index | 7188 | |
| Target Year | 2030 | (Year) |
| Planning Horizon | 26 | (Years) |
| Spencer Interconnect | TRUE | |
| SAVSARP Deep Wells | 15 | |
| Three-Points Wellfield | 2012 | |

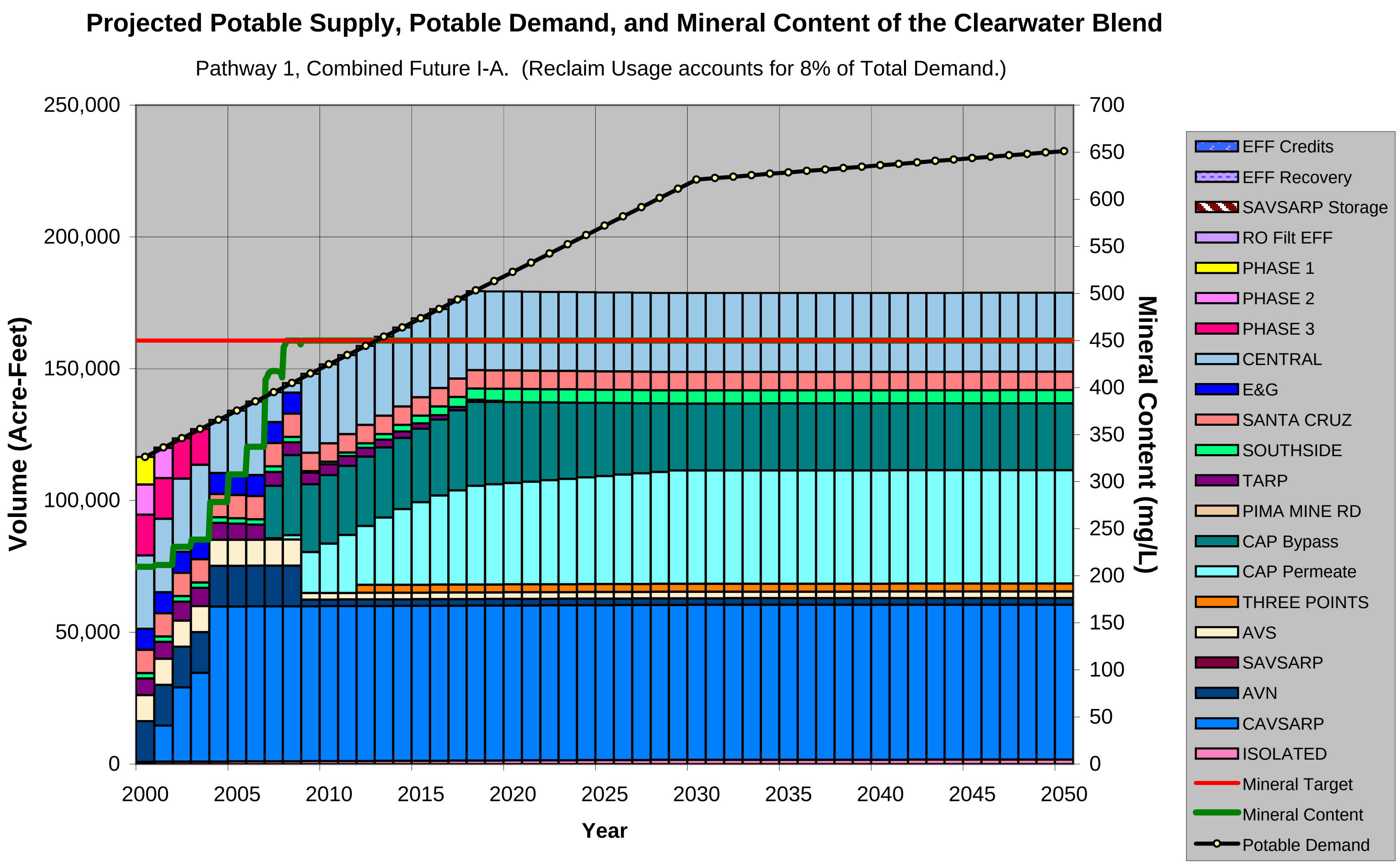
| *Overall Output Values* *($millions except where noted)* | |
|---|---|
| Present Worth Capital Cost | $ 231.7 |
| Average Annual O&M Cost | $ 15.6 |
| Present Worth of O&M Costs | $ 195.6 |
| **Total Present Worth** | $ 427.3 |
| Annualized Capital Cost | $ 16.1 |
| Uniform Annualized O&M Cost | $ 13.6 |
| **Total Equivalent Annual Cost** | $ 29.7 |
| **Equivalent Unit Cost** (based on Target Year flows): | |
| $/1,000 gallons | $ 0.70 |
| $/acre-foot | $ 228 |

## *Project Cost Breakdown*

| Project ($1,000s except where noted) | Design Flow (MGD) *[based on max. flow over planning period]* | Average Flow in Target Year (MGD) | Present Worth Capital Cost ($k) | Average Annual O&M Cost ($k/yr) | Present Worth O&M Costs ($k) | **Total Present Worth ($k)** | Annualized Capital Cost ($k/yr) | Uniform Annualized O&M Cost ($k/yr) | **Total Equivalent Annual Cost ($k/yr)** | Equivalent Unit Production Cost (based on Target Year flows) $/1,000 gal | $/acre-ft |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hayden-Udall WTP: | | | | | | | | | | | |
| General Rehabilitation | | | $ 4,480 | | | $ 4,480 | $ 312 | | $ 312 | | |
| Primary Disinfection Options | | | | | | | | | | | |
| UV Disinfection | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Giardia & Cryptosporidium) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Taste & Odor) | 102.1 | 67.8 | $ 2,162 | $ 499 | $ 5,887 | $ 8,048 | $ 150 | $ 409 | $ 560 | $ 0 | $ 7 |
| Chlorination* | 102.1 | 67.8 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Existing Direct Filtration | 102.1 | 67.8 | | $ 2,860 | $ 33,261 | $ 33,261 | | $ 2,314 | $ 2,314 | $ 0 | $ 30 |
| TDS Removal of CAP Water | | | | | | | | | | | |
| NF/RO (with Existing Direct Filtration) | 60.5 | 45.2 | $ 54,263 | $ 4,319 | $ 47,462 | $ 101,725 | $ 3,775 | $ 3,302 | $ 7,076 | $ 0 | $ 140 |
| NF/RO (with MF/UF Pre-treatment) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 9.1 | 6.8 | $ 149,766 | $ 1,434 | $ 15,754 | $ 165,520 | $ 10,418 | $ 1,096 | $ 11,514 | $ 5 | $ 1,517 |
| TDS Removal of Recovered Water | | | | | | | | | | | |
| NF/RO for Recovered Water | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection | | | | | | | | | | | |
| Chlorine | 93.9 | 61.0 | $ 424 | $ 234 | $ 2,728 | $ 3,151 | $ 29 | $ 190 | $ 219 | $ 0 | $ 3 |
| Chloramines | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Sub-total (Hayden-Udall WTP) | 93.9 | 61.0 | $ 211,095 | $ 9,344 | $ 105,090 | $ 316,185 | $ 14,685 | $ 7,311 | $ 21,995 | $ 0.99 | $ 322 |
| CAVSARP | 61.2 | 52.5 | | $ 5,696 | $ 84,906 | $ 84,906 | | $ 5,906 | $ 5,906 | $ 0.31 | $ 100 |
| SAVSARP | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection- Recovered Water | 61.2 | 52.5 | $ 143 | $ 92 | $ 1,319 | $ 1,462 | $ 10 | $ 92 | $ 102 | $ 0.01 | $ 2 |
| Three Points Wellfield | 3.1 | 2.7 | $ 5,249 | $ 221 | $ 2,400 | $ 7,649 | $ 365 | $ 167 | $ 532 | $ 0.54 | $ 177 |
| Secondary Disinfection- Three Points Wellfield | 3.1 | 2.7 | $ 86 | $ 5 | $ 60 | $ 145 | $ 6 | $ 4 | $ 10 | $ 0.01 | $ 3 |
| Total Clearwater Production (MGD) | 158.2 | 116.2 | | | | | | | | | |
| Spencer Interconnect | | | $ 15,130 | $ 192 | $ 1,827 | $ 16,957 | $ 1,052 | $ 127 | $ 1,180 | | |
| TOTAL COSTS** | | | $ 231,702 | $ 15,551 | $ 195,603 | $ 427,305 | $ 16,118 | $ 13,607 | $ 29,725 | $ 0.70 | $ 228 |

* All primary disinfection chlorine costs are included in the secondary disinfection costs when chlorine is the primary disinfectant.

** Equivalent unit production costs in the Total Costs row include Spencer Interconnect costs.






RunDate: 9/13/2004

# CLEARWATER COST MODEL OUTPUT

Add Run to Database | Show Input Form

| | |
|---|---|
| ALTERNATIVE NAME | Future II-A |
| RUN NAME | Run 1 |
| DATE | 9/13/2004 |

**Pathway 1**
**Combined Future II-A**

Final TDS Target from Resource Planning Tool: 650 (mg/L)

## *Input Values*

| | | |
|---|---|---|
| Power Cost for HUWTP | $0.08 | ($/kWh) |
| Labor Rate | $26 | ($/hr) |
| Annual Discount Rate | 0.050 | (per year as decimal) |
| ENR 20 Cities Average Cost Construction Index | 7188 | |
| Target Year | 2030 | (Year) |
| Planning Horizon | 26 | (Years) |
| Spencer Interconnect | TRUE | |
| SAVSARP Deep Wells | 15 | |
| Three-Points Wellfield | 2012 | |

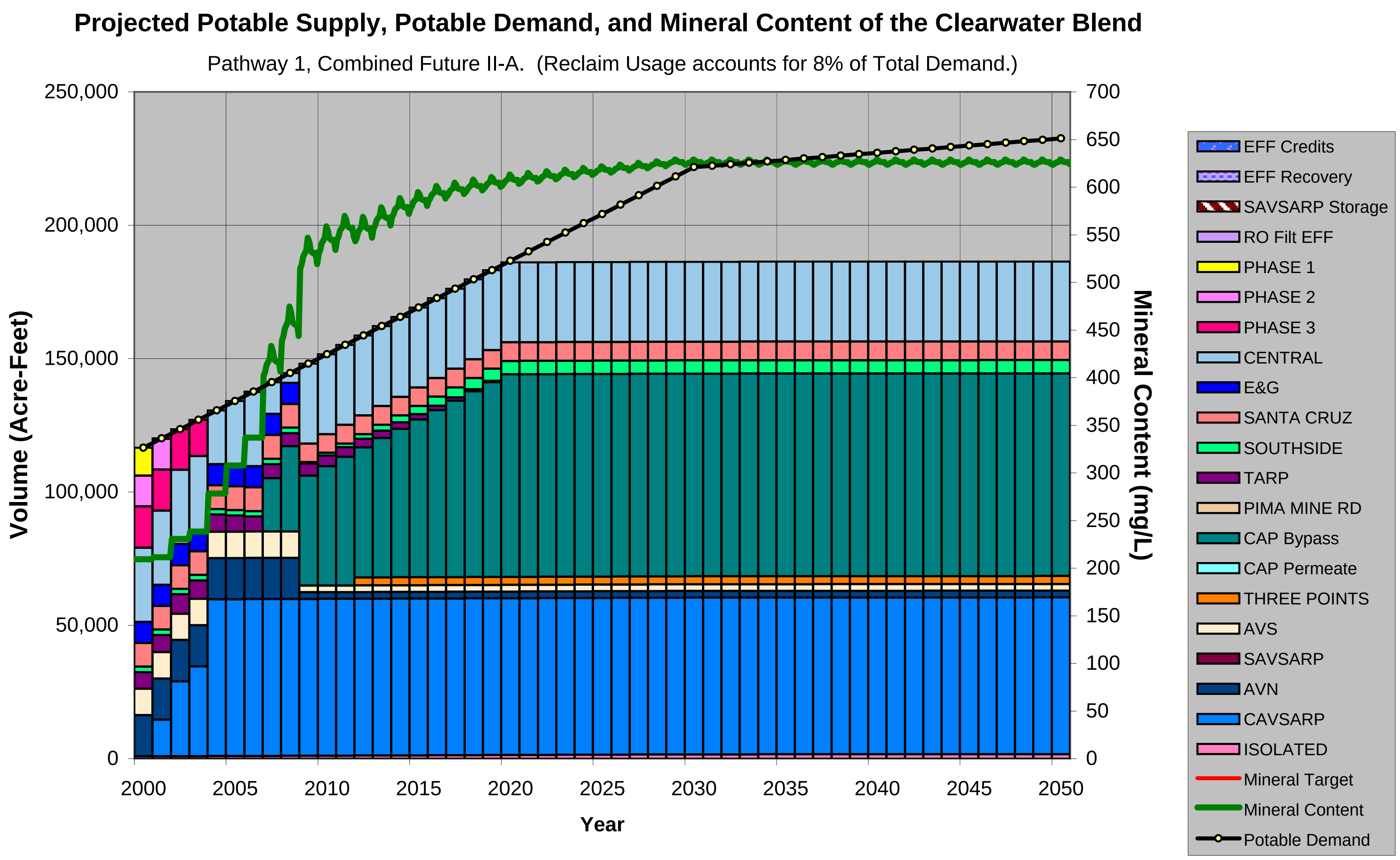
## *Overall Output Values* *($millions except where noted)*

| | |
|---|---|
| Present Worth Capital Cost | $ 27.7 |
| Average Annual O&M Cost | $ 9.7 |
| Present Worth of O&M Costs | $ 131.0 |
| **Total Present Worth** | $ 158.7 |
| Annualized Capital Cost | $ 1.9 |
| Uniform Annualized O&M Cost | $ 9.1 |
| **Total Equivalent Annual Cost** | $ 11.0 |
| **Equivalent Unit Cost** (based on Target Year flows): | |
| $/1,000 gallons | $ 0.25 |
| $/acre-foot | $ 80 |

## *Project Cost Breakdown*

| Project ($1,000s except where noted) | Design Flow (MGD) *[based on max. flow over planning period]* | Average Flow in Target Year (MGD) | Present Worth Capital Cost ($k) | Average Annual O&M Cost ($k/yr) | Present Worth O&M Costs ($k) | **Total Present Worth ($k)** | Annualized Capital Cost ($k/yr) | Uniform Annualized O&M Cost ($k/yr) | **Total Equivalent Annual Cost ($k/yr)** | Equivalent Unit Production Cost (based on Target Year flows) $/1,000 gal | $/acre-ft |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hayden-Udall WTP: | | | | | | | | | | | |
| General Rehabilitation | | | $ 4,480 | | | $ 4,480 | $ 312 | | $ 312 | | |
| Primary Disinfection Options | | | | | | | | | | | |
| UV Disinfection | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Giardia & Cryptosporidium) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Taste & Odor) | 101.4 | 67.8 | $ 2,162 | $ 485 | $ 5,687 | $ 7,848 | $ 150 | $ 396 | $ 546 | $ 0 | $ 7 |
| Chlorination* | 101.4 | 67.8 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Existing Direct Filtration | 101.4 | 67.8 | | $ 2,769 | $ 31,936 | $ 31,936 | | $ 2,222 | $ 2,222 | $ 0 | $ 29 |
| TDS Removal of CAP Water | | | | | | | | | | | |
| NF/RO (with Existing Direct Filtration) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| NF/RO (with MF/UF Pre-treatment) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| TDS Removal of Recovered Water | | | | | | | | | | | |
| NF/RO for Recovered Water | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection | | | | | | | | | | | |
| Chlorine | 101.4 | 67.8 | $ 442 | $ 247 | $ 2,845 | $ 3,288 | $ 31 | $ 198 | $ 229 | $ 0 | $ 3 |
| Chloramines | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Sub-total (Hayden-Udall WTP) | 101.4 | 67.8 | $ 7,084 | $ 3,502 | $ 40,468 | $ 47,553 | $ 493 | $ 2,815 | $ 3,308 | $ 0.13 | $ 44 |
| CAVSARP | 61.2 | 52.5 | | $ 5,696 | $ 84,906 | $ 84,906 | | $ 5,906 | $ 5,906 | $ 0.31 | $ 100 |
| SAVSARP | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection- Recovered Water | 61.2 | 52.5 | $ 143 | $ 92 | $ 1,319 | $ 1,462 | $ 10 | $ 92 | $ 102 | $ 0.01 | $ 2 |
| Three Points Wellfield | 3.1 | 2.7 | $ 5,249 | $ 221 | $ 2,400 | $ 7,649 | $ 365 | $ 167 | $ 532 | $ 0.54 | $ 177 |
| Secondary Disinfection- Three Points Wellfield | 3.1 | 2.7 | $ 86 | $ 5 | $ 60 | $ 145 | $ 6 | $ 4 | $ 10 | $ 0.01 | $ 3 |
| Total Clearwater Production (MGD) | 165.7 | 123.0 | | | | | | | | | |
| Spencer Interconnect | | | $ 15,130 | $ 192 | $ 1,827 | $ 16,957 | $ 1,052 | $ 127 | $ 1,180 | | |
| TOTAL COSTS** | | | $ 27,692 | $ 9,708 | $ 130,981 | $ 158,672 | $ 1,926 | $ 9,112 | $ 11,038 | $ 0.25 | $ 80 |

* All primary disinfection chlorine costs are included in the secondary disinfection costs when chlorine is the primary disinfectant.
** Equivalent unit production costs in the Total Costs row include Spencer Interconnect costs.






RunDate: 9/13/2004

# CLEARWATER COST MODEL OUTPUT

Add Run to Database | Show Input Form

**Pathway 2**
**Combined Future I-B**

| | | |
|---|---|---|
| ALTERNATIVE NAME | Future I-B | |
| RUN NAME | Run 1 | |
| DATE | 9/13/2004 | |

Final TDS Target from Resource Planning Tool: 450 (mg/L)

## *Input Values*

| | | |
|---|---|---|
| Power Cost for HUWTP | $0.08 | ($/kWh) |
| Labor Rate | $26 | ($/hr) |
| Annual Discount Rate | 0.050 | (per year as decimal) |
| ENR 20 Cities Average Cost Construction Index | 7188 | |
| Target Year | 2030 | (Year) |
| Planning Horizon | 26 | (Years) |
| Spencer Interconnect | TRUE | |
| SAVSARP Deep Wells | 15 | |
| Three-Points Wellfield | 2012 | |

## *Overall Output Values* *($millions except where noted)*

| | |
|---|---|
| Present Worth Capital Cost | $ 237.8 |
| Average Annual O&M Cost | $ 14.5 |
| Present Worth of O&M Costs | $ 180.6 |
| **Total Present Worth** | $ 418.4 |
| Annualized Capital Cost | $ 16.5 |
| Uniform Annualized O&M Cost | $ 12.6 |
| **Total Equivalent Annual Cost** | $ 29.1 |
| **Equivalent Unit Cost** (based on Target Year flows): | |
| $/1,000 gallons | $ 0.67 |
| $/acre-foot | $ 217 |

## *Project Cost Breakdown*

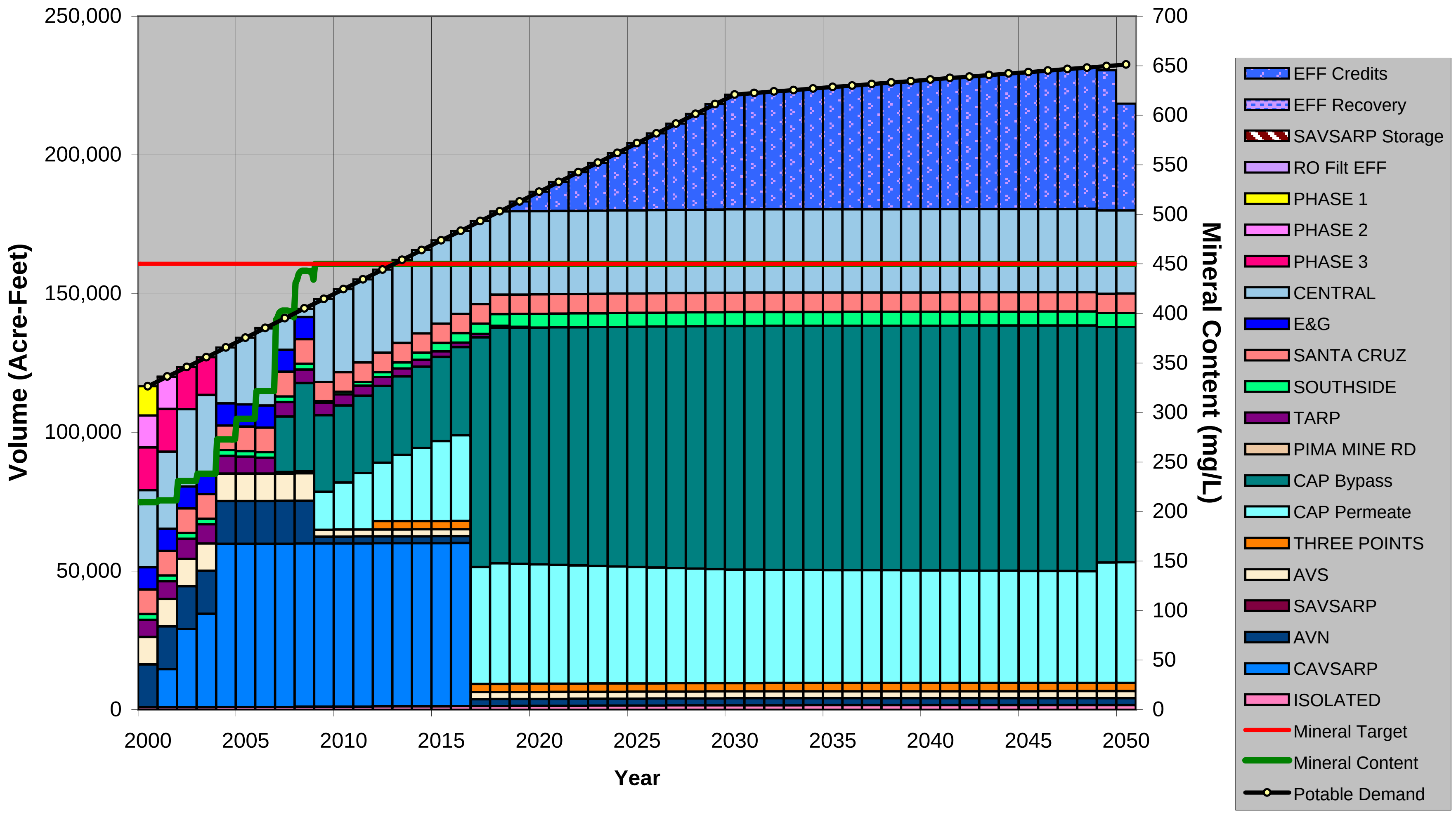
| Project ($1,000s except where noted) | Design Flow (MGD) *[based on max. flow over planning period]* | Average Flow in Target Year (MGD) | Present Worth Capital Cost ($k) | Average Annual O&M Cost ($k/yr) | Present Worth O&M Costs ($k) | **Total Present Worth ($k)** | Annualized Capital Cost ($k/yr) | Uniform Annualized O&M Cost ($k/yr) | **Total Equivalent Annual Cost ($k/yr)** | Equivalent Unit Production Cost (based on Target Year flows) $/1,000 gal | $/acre-ft |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hayden-Udall WTP: | | | | | | | | | | | |
| General Rehabilitation | | | $ 4,480 | | | $ 4,480 | $ 312 | | $ 312 | | |
| Primary Disinfection Options | | | | | | | | | | | |
| UV Disinfection | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Giardia & Cryptosporidium) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Taste & Odor) | 164.7 | 121.4 | $ 2,162 | $ 702 | $ 7,805 | $ 9,967 | $ 150 | $ 543 | $ 693 | $ 0 | $ 5 |
| Chlorination* | 164.7 | 121.4 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Existing Direct Filtration | 164.7 | 121.4 | | $ 4,328 | $ 47,116 | $ 47,116 | | $ 3,278 | $ 3,278 | $ 0 | $ 24 |
| TDS Removal of CAP Water | | | | | | | | | | | |
| NF/RO (with Existing Direct Filtration) | 62.3 | 42.9 | $ 55,725 | $ 4,381 | $ 47,842 | $ 103,567 | $ 3,876 | $ 3,328 | $ 7,205 | $ 0 | $ 150 |
| NF/RO (with MF/UF Pre-treatment) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 9.3 | 6.4 | $ 154,238 | $ 1,454 | $ 15,880 | $ 170,118 | $ 10,729 | $ 1,105 | $ 11,834 | $ 5 | $ 1,641 |
| TDS Removal of Recovered Water | | | | | | | | | | | |
| NF/RO for Recovered Water | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection | | | | | | | | | | | |
| Chlorine | 155.8 | 114.9 | $ 545 | $ 369 | $ 4,002 | $ 4,547 | $ 38 | $ 278 | $ 316 | $ 0 | $ 2 |
| Chloramines | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Sub-total (Hayden-Udall WTP) | 155.8 | 114.9 | $ 217,150 | $ 11,235 | $ 122,646 | $ 339,796 | $ 15,106 | $ 8,532 | $ 23,638 | $ 0.56 | $ 184 |
| | | | | | | | | | | | |
| CAVSARP | 61.2 | 0.0 | | $ 2,742 | $ 52,350 | $ 52,350 | | $ 3,642 | $ 3,642 | $ - | $ - |
| SAVSARP | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection- Recovered Water | 61.2 | 0.0 | $ 143 | $ 44 | $ 813 | $ 956 | $ 10 | $ 57 | $ 66 | $ - | $ - |
| | | | | | | | | | | | |
| Three Points Wellfield | 5.7 | 4.9 | $ 5,249 | $ 285 | $ 2,919 | $ 8,169 | $ 365 | $ 203 | $ 568 | $ 0.32 | $ 103 |
| Secondary Disinfection- Three Points Wellfield | 5.7 | 4.9 | $ 92 | $ 7 | $ 68 | $ 160 | $ 6 | $ 5 | $ 11 | $ 0.01 | $ 2 |
| Total Clearwater Production (MGD) | 222.7 | 119.9 | | | | | | | | | |
| | | | | | | | | | | | |
| Spencer Interconnect | | | $ 15,130 | $ 192 | $ 1,827 | $ 16,957 | $ 1,052 | $ 127 | $ 1,180 | | |
| | | | | | | | | | | | |
| TOTAL COSTS** | | | $ 237,764 | $ 14,505 | $ 180,625 | $ 418,388 | $ 16,540 | $ 12,565 | $ 29,105 | $ 0.67 | $ 217 |

* All primary disinfection chlorine costs are included in the secondary disinfection costs when chlorine is the primary disinfectant.

** Equivalent unit production costs in the Total Costs row include Spencer Interconnect costs.

## Projected Potable Supply, Potable Demand, and Mineral Content of the Clearwater Blend

Pathway 2, Combined Future I-B. (Reclaim Usage accounts for 8% of Total Demand.)






RunDate: 9/13/2004

# CLEARWATER COST MODEL OUTPUT

Add Run to Database

Show Input Form

## Pathway 2
## Combined Future II-B

| | |
|---|---|
| ALTERNATIVE NAME | Future II-B |
| RUN NAME | Run 1 |
| DATE | 9/13/2004 |

Final TDS Target from Resource Planning Tool: 650 (mg/L)

### *Input Values*

| | | |
|---|---|---|
| Power Cost for HUWTP | $0.08 | ($/kWh) |
| Labor Rate | $26 | ($/hr) |
| Annual Discount Rate | 0.050 | (per year as decimal) |
| ENR 20 Cities Average Cost Construction Index | 7188 | |
| Target Year | 2030 | (Year) |
| Planning Horizon | 26 | (Years) |
| Spencer Interconnect | TRUE | |
| SAVSARP Deep Wells | 15 | |
| Three-Points Wellfield | 2012 | |

### *Overall Output Values* *($millions except where noted)*

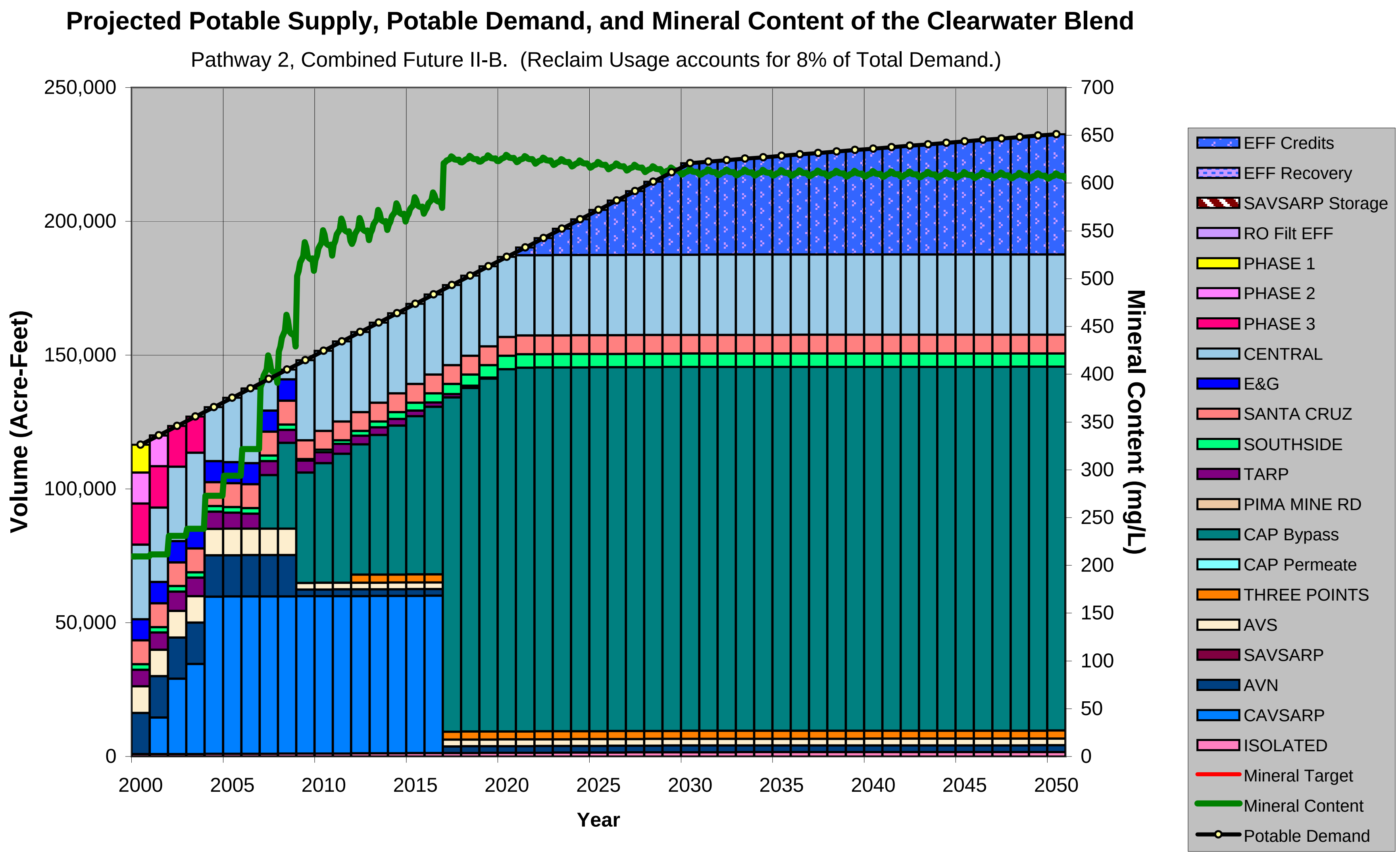
| | |
|---|---|
| Present Worth Capital Cost | $ 27.8 |
| Average Annual O&M Cost | $ 8.6 |
| Present Worth of O&M Costs | $ 115.3 |
| **Total Present Worth** | $ 143.1 |
| Annualized Capital Cost | $ 1.9 |
| Uniform Annualized O&M Cost | $ 8.0 |
| **Total Equivalent Annual Cost** | $ 10.0 |
| **Equivalent Unit Cost** (based on Target Year flows): | |
| $/1,000 gallons | $ 0.22 |
| $/acre-foot | $ 71 |

### *Project Cost Breakdown*

| Project ($1,000s except where noted) | Design Flow (MGD) *[based on max. flow over planning period]* | Average Flow in Target Year (MGD) | Present Worth Capital Cost ($k) | Average Annual O&M Cost ($k/yr) | Present Worth O&M Costs ($k) | **Total Present Worth ($k)** | Annualized Capital Cost ($k/yr) | Uniform Annualized O&M Cost ($k/yr) | **Total Equivalent Annual Cost ($k/yr)** | Equivalent Unit Production Cost (based on Target Year flows) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hayden-Udall WTP: | | | | | | | | | | $/1,000 gal | $/acre-ft |
| General Rehabilitation | | | $ 4,480 | | | $ 4,480 | $ 312 | | $ 312 | | |
| Primary Disinfection Options | | | | | | | | | | | |
| UV Disinfection | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Giardia & Cryptosporidium) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Taste & Odor) | 164.1 | 121.4 | $ 2,162 | $ 688 | $ 7,600 | $ 9,762 | $ 150 | $ 529 | $ 679 | $ 0 | $ 5 |
| Chlorination* | 164.1 | 121.4 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Existing Direct Filtration | 164.1 | 121.4 | | $ 4,235 | $ 45,771 | $ 45,771 | | $ 3,184 | $ 3,184 | $ 0 | $ 23 |
| TDS Removal of CAP Water | | | | | | | | | | | |
| NF/RO (with Existing Direct Filtration) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| NF/RO (with MF/UF Pre-treatment) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| TDS Removal of Recovered Water | | | | | | | | | | | |
| NF/RO for Recovered Water | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection | | | | | | | | | | | |
| Chlorine | 164.1 | 121.4 | $ 556 | $ 382 | $ 4,119 | $ 4,675 | $ 39 | $ 287 | $ 325 | $ 0 | $ 2 |
| Chloramines | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Sub-total (Hayden-Udall WTP) | 164.1 | 121.4 | $ 7,198 | $ 5,306 | $ 57,490 | $ 64,688 | $ 501 | $ 3,999 | $ 4,500 | $ 0.10 | $ 33 |
| CAVSARP | 61.2 | 0.0 | | $ 2,742 | $ 52,350 | $ 52,350 | | $ 3,642 | $ 3,642 | $ - | $ - |
| SAVSARP | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection- Recovered Water | 61.2 | 0.0 | $ 143 | $ 44 | $ 813 | $ 956 | $ 10 | $ 57 | $ 66 | $ - | $ - |
| Three Points Wellfield | 5.1 | 4.5 | $ 5,249 | $ 264 | $ 2,740 | $ 7,989 | $ 365 | $ 191 | $ 556 | $ 0.34 | $ 110 |
| Secondary Disinfection- Three Points Wellfield | 5.1 | 4.5 | $ 90 | $ 6 | $ 65 | $ 156 | $ 6 | $ 5 | $ 11 | $ 0.01 | $ 2 |
| Total Clearwater Production (MGD) | 230.4 | 125.9 | | | | | | | | | |
| Spencer Interconnect | | | $ 15,130 | $ 192 | $ 1,827 | $ 16,957 | $ 1,052 | $ 127 | $ 1,180 | | |
| TOTAL COSTS** | | | $ 27,810 | $ 8,555 | $ 115,286 | $ 143,096 | $ 1,935 | $ 8,020 | $ 9,954 | $ 0.22 | $ 71 |

* All primary disinfection chlorine costs are included in the secondary disinfection costs when chlorine is the primary disinfectant.

** Equivalent unit production costs in the Total Costs row include Spencer Interconnect costs.






RunDate: 9/13/2004

# CLEARWATER COST MODEL OUTPUT

Add Run to Database

Show Input Form

## Pathway 3
## Combined Future I-C

| | | |
|---|---|---|
| ALTERNATIVE NAME | Future I-C | |
| RUN NAME | Run 1 | |
| DATE | 9/13/2004 | |

| | | |
|---|---|---|
| Final TDS Target from Resource Planning Tool | 450 | (mg/L) |

### *Input Values*

| | | |
|---|---|---|
| Power Cost for HUWTP | $0.08 | ($/kWh) |
| Labor Rate | $26 | ($/hr) |
| Annual Discount Rate | 0.050 | (per year as decimal) |
| ENR 20 Cities Average Cost Construction Index | 7188 | |
| Target Year | 2030 | (Year) |
| Planning Horizon | 26 | (Years) |
| Spencer Interconnect | TRUE | |
| SAVSARP Deep Wells | 15 | |
| Three-Points Wellfield | 2012 | |

### *Overall Output Values* *($millions except where noted)*

| | |
|---|---|
| Present Worth Capital Cost | $ 231.7 |
| Average Annual O&M Cost | $ 15.6 |
| Present Worth of O&M Costs | $ 195.6 |
| **Total Present Worth** | $ 427.3 |
| Annualized Capital Cost | $ 16.1 |
| Uniform Annualized O&M Cost | $ 13.6 |
| **Total Equivalent Annual Cost** | $ 29.7 |
| **Equivalent Unit Cost** (based on Target Year flows): | |
| $/1,000 gallons | $ 0.70 |
| $/acre-foot | $ 228 |

### *Project Cost Breakdown*

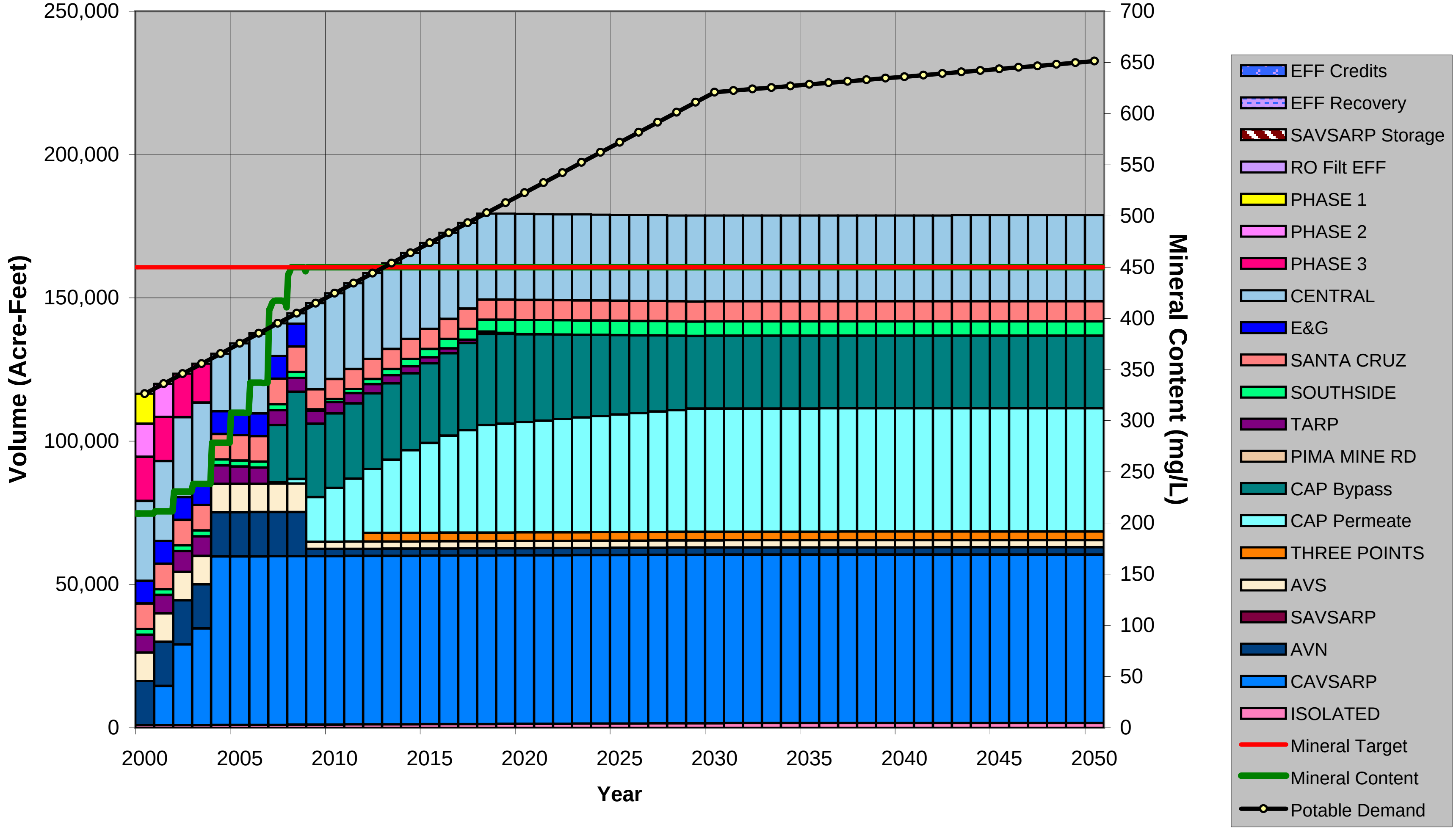
| Project ($1,000s except where noted) | Design Flow (MGD) *[based on max. flow over planning period]* | Average Flow in Target Year (MGD) | Present Worth Capital Cost ($k) | Average Annual O&M Cost ($k/yr) | Present Worth O&M Costs ($k) | **Total Present Worth ($k)** | Annualized Capital Cost ($k/yr) | Uniform Annualized O&M Cost ($k/yr) | **Total Equivalent Annual Cost ($k/yr)** | Equivalent Unit Production Cost (based on Target Year flows) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hayden-Udall WTP: | | | | | | | | | | $/1,000 gal | $/acre-ft |
| General Rehabilitation | | | $ 4,480 | | | $ 4,480 | $ 312 | | $ 312 | | |
| Primary Disinfection Options | | | | | | | | | | | |
| UV Disinfection | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Giardia & Cryptosporidium) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Taste & Odor) | 102.1 | 67.8 | $ 2,162 | $ 499 | $ 5,887 | $ 8,048 | $ 150 | $ 409 | $ 560 | $ 0 | $ 7 |
| Chlorination* | 102.1 | 67.8 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Existing Direct Filtration | 102.1 | 67.8 | | $ 2,860 | $ 33,261 | $ 33,261 | | $ 2,314 | $ 2,314 | $ 0 | $ 30 |
| TDS Removal of CAP Water | | | | | | | | | | | |
| NF/RO (with Existing Direct Filtration) | 60.5 | 45.2 | $ 54,263 | $ 4,319 | $ 47,462 | $ 101,725 | $ 3,775 | $ 3,302 | $ 7,076 | $ 0 | $ 140 |
| NF/RO (with MF/UF Pre-treatment) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 9.1 | 6.8 | $ 149,766 | $ 1,434 | $ 15,754 | $ 165,520 | $ 10,418 | $ 1,096 | $ 11,514 | $ 5 | $ 1,517 |
| TDS Removal of Recovered Water | | | | | | | | | | | |
| NF/RO for Recovered Water | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection | | | | | | | | | | | |
| Chlorine | 93.9 | 61.0 | $ 424 | $ 234 | $ 2,728 | $ 3,151 | $ 29 | $ 190 | $ 219 | $ 0 | $ 3 |
| Chloramines | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Sub-total (Hayden-Udall WTP) | 93.9 | 61.0 | $ 211,095 | $ 9,344 | $ 105,090 | $ 316,185 | $ 14,685 | $ 7,311 | $ 21,995 | $ 0.99 | $ 322 |
| CAVSARP | 61.2 | 52.5 | | $ 5,696 | $ 84,906 | $ 84,906 | | $ 5,906 | $ 5,906 | $ 0.31 | $ 100 |
| SAVSARP | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection- Recovered Water | 61.2 | 52.5 | $ 143 | $ 92 | $ 1,319 | $ 1,462 | $ 10 | $ 92 | $ 102 | $ 0.01 | $ 2 |
| Three Points Wellfield | 3.1 | 2.7 | $ 5,249 | $ 221 | $ 2,400 | $ 7,649 | $ 365 | $ 167 | $ 532 | $ 0.54 | $ 177 |
| Secondary Disinfection- Three Points Wellfield | 3.1 | 2.7 | $ 86 | $ 5 | $ 60 | $ 145 | $ 6 | $ 4 | $ 10 | $ 0.01 | $ 3 |
| Total Clearwater Production (MGD) | 158.2 | 116.2 | | | | | | | | | |
| Spencer Interconnect | | | $ 15,130 | $ 192 | $ 1,827 | $ 16,957 | $ 1,052 | $ 127 | $ 1,180 | | |
| TOTAL COSTS** | | | $ 231,702 | $ 15,551 | $ 195,603 | $ 427,305 | $ 16,118 | $ 13,607 | $ 29,725 | $ 0.70 | $ 228 |

* All primary disinfection chlorine costs are included in the secondary disinfection costs when chlorine is the primary disinfectant.

** Equivalent unit production costs in the Total Costs row include Spencer Interconnect costs.

**Projected Potable Supply, Potable Demand, and Mineral Content of the Clearwater Blend**

Pathway 3, Combined Future I-C. (Reclaim Usage accounts for 8% of Total Demand.)






RunDate: 9/13/2004

# CLEARWATER COST MODEL OUTPUT

Add Run to Database

Show Input Form

**Pathway 3**
**Combined Future II-C**

| | | |
|---|---|---|
| ALTERNATIVE NAME | Future II-C | |
| RUN NAME | Run 1 | |
| DATE | 9/13/2004 | |

Final TDS Target from Resource Planning Tool: 650 (mg/L)

## *Input Values*

| | | |
|---|---|---|
| Power Cost for HUWTP | $0.08 | ($/kWh) |
| Labor Rate | $26 | ($/hr) |
| Annual Discount Rate | 0.050 | (per year as decimal) |
| ENR 20 Cities Average Cost Construction Index | 7188 | |
| Target Year | 2030 | (Year) |
| Planning Horizon | 26 | (Years) |
| Spencer Interconnect | TRUE | |
| SAVSARP Deep Wells | 15 | |
| Three-Points Wellfield | 2012 | |

## *Overall Output Values* *($millions except where noted)*

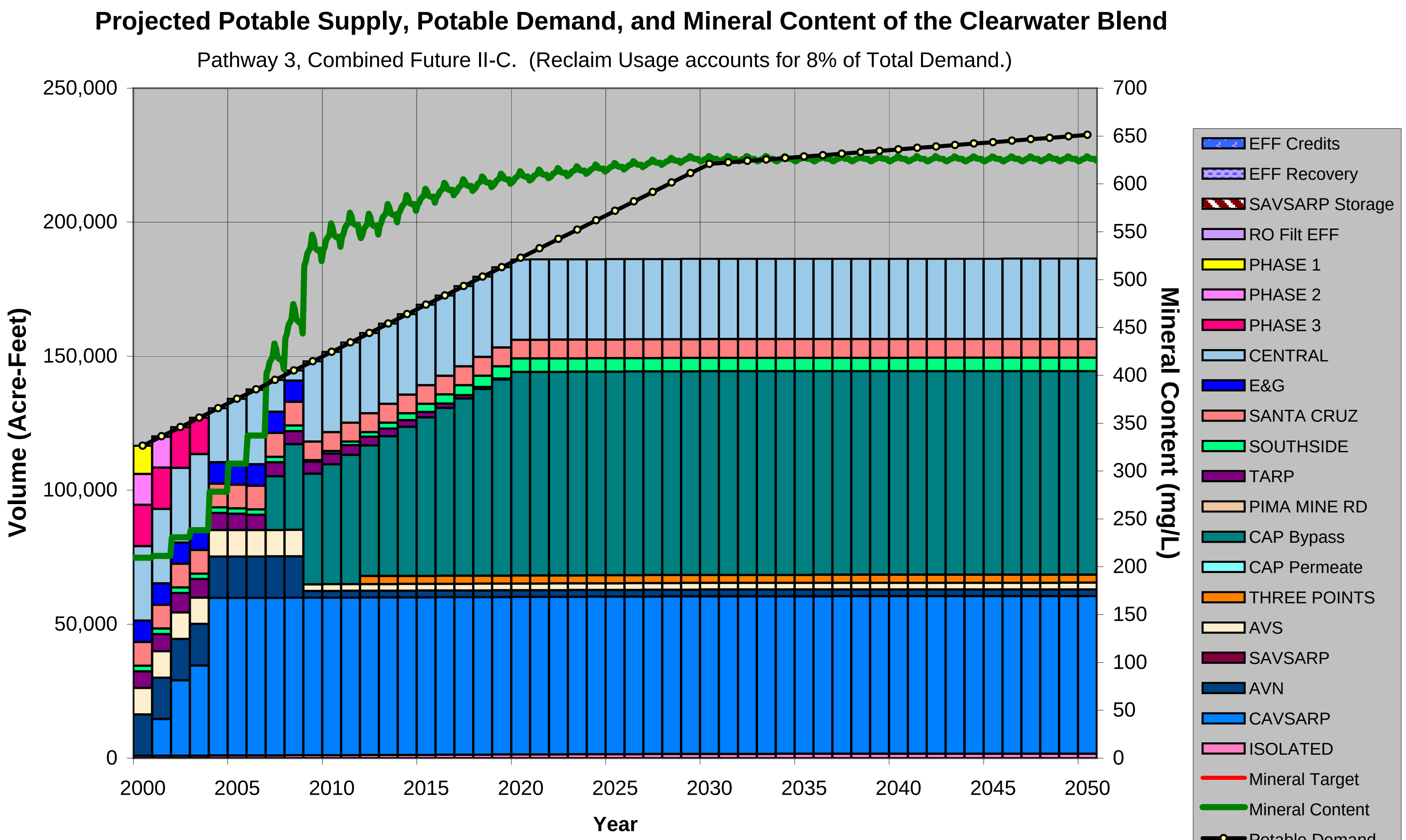
| | |
|---|---|
| Present Worth Capital Cost | $ 27.7 |
| Average Annual O&M Cost | $ 9.7 |
| Present Worth of O&M Costs | $ 131.0 |
| **Total Present Worth** | $ 158.7 |
| Annualized Capital Cost | $ 1.9 |
| Uniform Annualized O&M Cost | $ 9.1 |
| **Total Equivalent Annual Cost** | $ 11.0 |
| **Equivalent Unit Cost** (based on Target Year flows): | |
| $/1,000 gallons | $ 0.25 |
| $/acre-foot | $ 80 |

## *Project Cost Breakdown*

| Project ($1,000s except where noted) | Design Flow (MGD) *[based on max. flow over planning period]* | Average Flow in Target Year (MGD) | Present Worth Capital Cost ($k) | Average Annual O&M Cost ($k/yr) | Present Worth O&M Costs ($k) | **Total Present Worth ($k)** | Annualized Capital Cost ($k/yr) | Uniform Annualized O&M Cost ($k/yr) | **Total Equivalent Annual Cost ($k/yr)** | Equivalent Unit Production Cost (based on Target Year flows) $/1,000 gal | $/acre-ft |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hayden-Udall WTP: | | | | | | | | | | | |
| General Rehabilitation | | | $ 4,480 | | | $ 4,480 | $ 312 | | $ 312 | | |
| Primary Disinfection Options | | | | | | | | | | | |
| UV Disinfection | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Giardia & Cryptosporidium) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Taste & Odor) | 101.4 | 67.8 | $ 2,162 | $ 485 | $ 5,687 | $ 7,848 | $ 150 | $ 396 | $ 546 | $ 0 | $ 7 |
| Chlorination* | 101.4 | 67.8 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Existing Direct Filtration | 101.4 | 67.8 | | $ 2,769 | $ 31,936 | $ 31,936 | | $ 2,222 | $ 2,222 | $ 0 | $ 29 |
| TDS Removal of CAP Water | | | | | | | | | | | |
| NF/RO (with Existing Direct Filtration) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| NF/RO (with MF/UF Pre-treatment) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| TDS Removal of Recovered Water | | | | | | | | | | | |
| NF/RO for Recovered Water | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection | | | | | | | | | | | |
| Chlorine | 101.4 | 67.8 | $ 442 | $ 247 | $ 2,845 | $ 3,288 | $ 31 | $ 198 | $ 229 | $ 0 | $ 3 |
| Chloramines | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Sub-total (Hayden-Udall WTP) | 101.4 | 67.8 | $ 7,084 | $ 3,502 | $ 40,468 | $ 47,553 | $ 493 | $ 2,815 | $ 3,308 | $ 0.13 | $ 44 |
| CAVSARP | 61.2 | 52.5 | | $ 5,696 | $ 84,906 | $ 84,906 | | $ 5,906 | $ 5,906 | $ 0.31 | $ 100 |
| SAVSARP | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection- Recovered Water | 61.2 | 52.5 | $ 143 | $ 92 | $ 1,319 | $ 1,462 | $ 10 | $ 92 | $ 102 | $ 0.01 | $ 2 |
| Three Points Wellfield | 3.1 | 2.7 | $ 5,249 | $ 221 | $ 2,400 | $ 7,649 | $ 365 | $ 167 | $ 532 | $ 0.54 | $ 177 |
| Secondary Disinfection- Three Points Wellfield | 3.1 | 2.7 | $ 86 | $ 5 | $ 60 | $ 145 | $ 6 | $ 4 | $ 10 | $ 0.01 | $ 3 |
| Total Clearwater Production (MGD) | 165.7 | 123.0 | | | | | | | | | |
| Spencer Interconnect | | | $ 15,130 | $ 192 | $ 1,827 | $ 16,957 | $ 1,052 | $ 127 | $ 1,180 | | |
| TOTAL COSTS** | | | $ 27,692 | $ 9,708 | $ 130,981 | $ 158,672 | $ 1,926 | $ 9,112 | $ 11,038 | $ 0.25 | $ 80 |

* All primary disinfection chlorine costs are included in the secondary disinfection costs when chlorine is the primary disinfectant.

** Equivalent unit production costs in the Total Costs row include Spencer Interconnect costs.






RunDate: 9/13/2004

# CLEARWATER COST MODEL OUTPUT

Add Run to Database

Show Input Form

**Pathway 4**
**Combined Future I-D**

| | | |
|---|---|---|
| ALTERNATIVE NAME | Future I-D | |
| RUN NAME | Run 1 | |
| DATE | 9/13/2004 | |

Final TDS Target from Resource Planning Tool: 450 (mg/L)

## Input Values

| | | |
|---|---|---|
| Power Cost for HUWTP | $0.08 | ($/kWh) |
| Labor Rate | $26 | ($/hr) |
| Annual Discount Rate | 0.050 | (per year as decimal) |
| ENR 20 Cities Average Cost Construction Index | 7188 | |
| Target Year | 2030 | (Year) |
| Planning Horizon | 26 | (Years) |
| Spencer Interconnect | TRUE | |
| SAVSARP Deep Wells | 15 | |
| Three-Points Wellfield | 2012 | |

## Overall Output Values *($millions except where noted)*

| | |
|---|---|
| Present Worth Capital Cost | $ 237.8 |
| Average Annual O&M Cost | $ 14.5 |
| Present Worth of O&M Costs | $ 180.6 |
| **Total Present Worth** | $ 418.4 |
| Annualized Capital Cost | $ 16.5 |
| Uniform Annualized O&M Cost | $ 12.6 |
| **Total Equivalent Annual Cost** | $ 29.1 |
| **Equivalent Unit Cost** (based on Target Year flows): | |
| $/1,000 gallons | $ 0.67 |
| $/acre-foot | $ 217 |

## Project Cost Breakdown

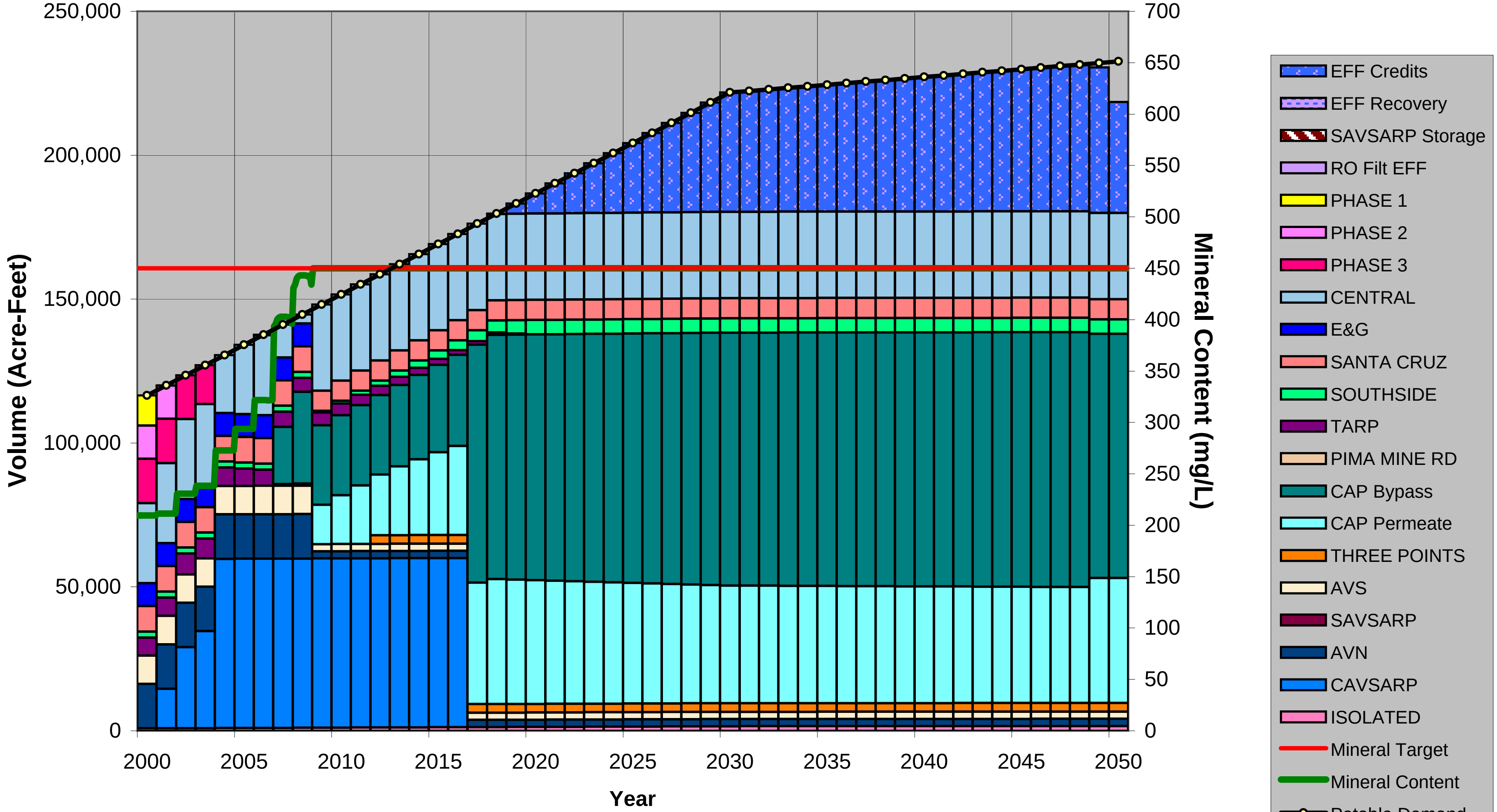
| Project ($1,000s except where noted) | Design Flow (MGD) *[based on max. flow over planning period]* | Average Flow in Target Year (MGD) | Present Worth Capital Cost ($k) | Average Annual O&M Cost ($k/yr) | Present Worth O&M Costs ($k) | **Total Present Worth ($k)** | Annualized Capital Cost ($k/yr) | Uniform Annualized O&M Cost ($k/yr) | **Total Equivalent Annual Cost ($k/yr)** | Equivalent Unit Production Cost (based on Target Year flows) $/1,000 gal | $/acre-ft |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hayden-Udall WTP: | | | | | | | | | | | |
| General Rehabilitation | | | $ 4,480 | | | $ 4,480 | $ 312 | | $ 312 | | |
| Primary Disinfection Options | | | | | | | | | | | |
| UV Disinfection | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Giardia & Cryptosporidium) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Taste & Odor) | 164.7 | 121.4 | $ 2,162 | $ 702 | $ 7,805 | $ 9,967 | $ 150 | $ 543 | $ 693 | $ 0 | $ 5 |
| Chlorination* | 164.7 | 121.4 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Existing Direct Filtration | 164.7 | 121.4 | | $ 4,328 | $ 47,116 | $ 47,116 | | $ 3,278 | $ 3,278 | $ 0 | $ 24 |
| TDS Removal of CAP Water | | | | | | | | | | | |
| NF/RO (with Existing Direct Filtration) | 62.3 | 42.9 | $ 55,725 | $ 4,381 | $ 47,842 | $ 103,567 | $ 3,876 | $ 3,328 | $ 7,205 | $ 0 | $ 150 |
| NF/RO (with MF/UF Pre-treatment) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 9.3 | 6.4 | $ 154,238 | $ 1,454 | $ 15,880 | $ 170,118 | $ 10,729 | $ 1,105 | $ 11,834 | $ 5 | $ 1,641 |
| TDS Removal of Recovered Water | | | | | | | | | | | |
| NF/RO for Recovered Water | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection | | | | | | | | | | | |
| Chlorine | 155.8 | 114.9 | $ 545 | $ 369 | $ 4,002 | $ 4,547 | $ 38 | $ 278 | $ 316 | $ 0 | $ 2 |
| Chloramines | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Sub-total (Hayden-Udall WTP) | 155.8 | 114.9 | $ 217,150 | $ 11,235 | $ 122,646 | $ 339,796 | $ 15,106 | $ 8,532 | $ 23,638 | $ 0.56 | $ 184 |
| CAVSARP | 61.2 | 0.0 | | $ 2,742 | $ 52,350 | $ 52,350 | | $ 3,642 | $ 3,642 | $ - | $ - |
| SAVSARP | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection- Recovered Water | 61.2 | 0.0 | $ 143 | $ 44 | $ 813 | $ 956 | $ 10 | $ 57 | $ 66 | $ - | $ - |
| Three Points Wellfield | 5.7 | 4.9 | $ 5,249 | $ 285 | $ 2,919 | $ 8,169 | $ 365 | $ 203 | $ 568 | $ 0.32 | $ 103 |
| Secondary Disinfection- Three Points Wellfield | 5.7 | 4.9 | $ 92 | $ 7 | $ 68 | $ 160 | $ 6 | $ 5 | $ 11 | $ 0.01 | $ 2 |
| Total Clearwater Production (MGD) | 222.7 | 119.9 | | | | | | | | | |
| Spencer Interconnect | | | $ 15,130 | $ 192 | $ 1,827 | $ 16,957 | $ 1,052 | $ 127 | $ 1,180 | | |
| TOTAL COSTS** | | | $ 237,764 | $ 14,505 | $ 180,625 | $ 418,388 | $ 16,540 | $ 12,565 | $ 29,105 | $ 0.67 | $ 217 |

* All primary disinfection chlorine costs are included in the secondary disinfection costs when chlorine is the primary disinfectant.

** Equivalent unit production costs in the Total Costs row include Spencer Interconnect costs.

# Projected Potable Supply, Potable Demand, and Mineral Content of the Clearwater Blend

Pathway 4, Combined Future I-D. (Reclaim Usage accounts for 8% of Total Demand.)






RunDate: 9/13/2004

# CLEARWATER COST MODEL OUTPUT

Add Run to Database

Show Input Form

**Pathway 4**
**Combined Future II-D**

| | | |
|---|---|---|
| ALTERNATIVE NAME | Future II-D | |
| RUN NAME | Run 1 | |
| DATE | 9/13/2004 | |

Final TDS Target from Resource Planning Tool: 650 (mg/L)

## *Input Values*

| | | |
|---|---|---|
| Power Cost for HUWTP | $0.08 | ($/kWh) |
| Labor Rate | $26 | ($/hr) |
| Annual Discount Rate | 0.050 | (per year as decimal) |
| ENR 20 Cities Average Cost Construction Index | 7188 | |
| Target Year | 2030 | (Year) |
| Planning Horizon | 26 | (Years) |
| Spencer Interconnect | TRUE | |
| SAVSARP Deep Wells | 15 | |
| Three-Points Wellfield | 2012 | |

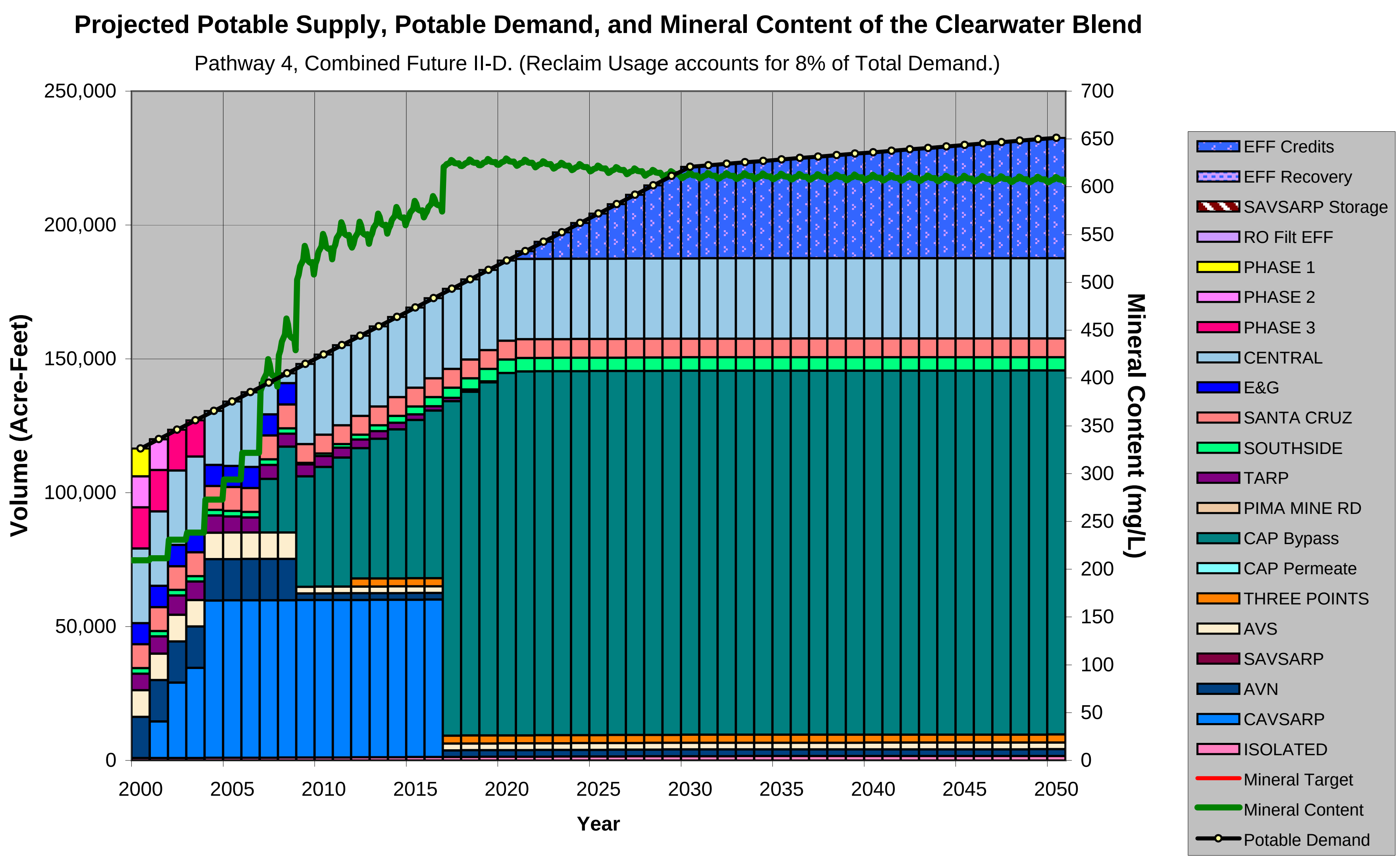
## *Overall Output Values* *($millions except where noted)*

| | |
|---|---|
| Present Worth Capital Cost | $ 27.8 |
| Average Annual O&M Cost | $ 8.6 |
| Present Worth of O&M Costs | $ 115.3 |
| **Total Present Worth** | $ 143.1 |
| Annualized Capital Cost | $ 1.9 |
| Uniform Annualized O&M Cost | $ 8.0 |
| **Total Equivalent Annual Cost** | $ 10.0 |
| **Equivalent Unit Cost** (based on Target Year flows): | |
| $/1,000 gallons | $ 0.22 |
| $/acre-foot | $ 71 |

## *Project Cost Breakdown*

| Project ($1,000s except where noted) | Design Flow (MGD) *[based on max. flow over planning period]* | Average Flow in Target Year (MGD) | Present Worth Capital Cost ($k) | Average Annual O&M Cost ($k/yr) | Present Worth O&M Costs ($k) | **Total Present Worth ($k)** | Annualized Capital Cost ($k/yr) | Uniform Annualized O&M Cost ($k/yr) | **Total Equivalent Annual Cost ($k/yr)** | Equivalent Unit Production Cost (based on Target Year flows) $/1,000 gal | $/acre-ft |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hayden-Udall WTP: | | | | | | | | | | | |
| General Rehabilitation | | | $ 4,480 | | | $ 4,480 | $ 312 | | $ 312 | | |
| Primary Disinfection Options | | | | | | | | | | | |
| UV Disinfection | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Giardia & Cryptosporidium) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Taste & Odor) | 164.1 | 121.4 | $ 2,162 | $ 688 | $ 7,600 | $ 9,762 | $ 150 | $ 529 | $ 679 | $ 0 | $ 5 |
| Chlorination* | 164.1 | 121.4 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Existing Direct Filtration | 164.1 | 121.4 | | $ 4,235 | $ 45,771 | $ 45,771 | | $ 3,184 | $ 3,184 | $ 0 | $ 23 |
| TDS Removal of CAP Water | | | | | | | | | | | |
| NF/RO (with Existing Direct Filtration) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| NF/RO (with MF/UF Pre-treatment) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| TDS Removal of Recovered Water | | | | | | | | | | | |
| NF/RO for Recovered Water | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection | | | | | | | | | | | |
| Chlorine | 164.1 | 121.4 | $ 556 | $ 382 | $ 4,119 | $ 4,675 | $ 39 | $ 287 | $ 325 | $ 0 | $ 2 |
| Chloramines | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Sub-total (Hayden-Udall WTP) | 164.1 | 121.4 | $ 7,198 | $ 5,306 | $ 57,490 | $ 64,688 | $ 501 | $ 3,999 | $ 4,500 | $ 0.10 | $ 33 |
| CAVSARP | 61.2 | 0.0 | | $ 2,742 | $ 52,350 | $ 52,350 | | $ 3,642 | $ 3,642 | $ - | $ - |
| SAVSARP | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection- Recovered Water | 61.2 | 0.0 | $ 143 | $ 44 | $ 813 | $ 956 | $ 10 | $ 57 | $ 66 | $ - | $ - |
| Three Points Wellfield | 5.1 | 4.5 | $ 5,249 | $ 264 | $ 2,740 | $ 7,989 | $ 365 | $ 191 | $ 556 | $ 0.34 | $ 110 |
| Secondary Disinfection- Three Points Wellfield | 5.1 | 4.5 | $ 90 | $ 6 | $ 65 | $ 156 | $ 6 | $ 5 | $ 11 | $ 0.01 | $ 2 |
| Total Clearwater Production (MGD) | 230.4 | 125.9 | | | | | | | | | |
| Spencer Interconnect | | | $ 15,130 | $ 192 | $ 1,827 | $ 16,957 | $ 1,052 | $ 127 | $ 1,180 | | |
| TOTAL COSTS** | | | $ 27,810 | $ 8,555 | $ 115,286 | $ 143,096 | $ 1,935 | $ 8,020 | $ 9,954 | $ 0.22 | $ 71 |

* All primary disinfection chlorine costs are included in the secondary disinfection costs when chlorine is the primary disinfectant.
** Equivalent unit production costs in the Total Costs row include Spencer Interconnect costs.






RunDate: 9/13/2004

# CLEARWATER COST MODEL OUTPUT

Add Run to Database | Show Input Form

**Pathway 5**
**Combined Future III-A**

| | | |
|---|---|---|
| ALTERNATIVE NAME | Future III-A | |
| RUN NAME | Run 1 | |
| DATE | 9/10/2004 | |

Final TDS Target from Resource Planning Tool: 650 (mg/L)

### *Input Values*

| | | |
|---|---|---|
| Power Cost for HUWTP | $0.08 | ($/kWh) |
| Labor Rate | $26 | ($/hr) |
| Annual Discount Rate | 0.050 | (per year as decimal) |
| ENR 20 Cities Average Cost Construction Index | 7188 | |
| Target Year | 2030 | (Year) |
| Planning Horizon | 26 | (Years) |
| Spencer Interconnect | TRUE | |
| SAVSARP Deep Wells | 15 | |
| Three-Points Wellfield | 2012 | |

### *Overall Output Values* *($millions except where noted)*

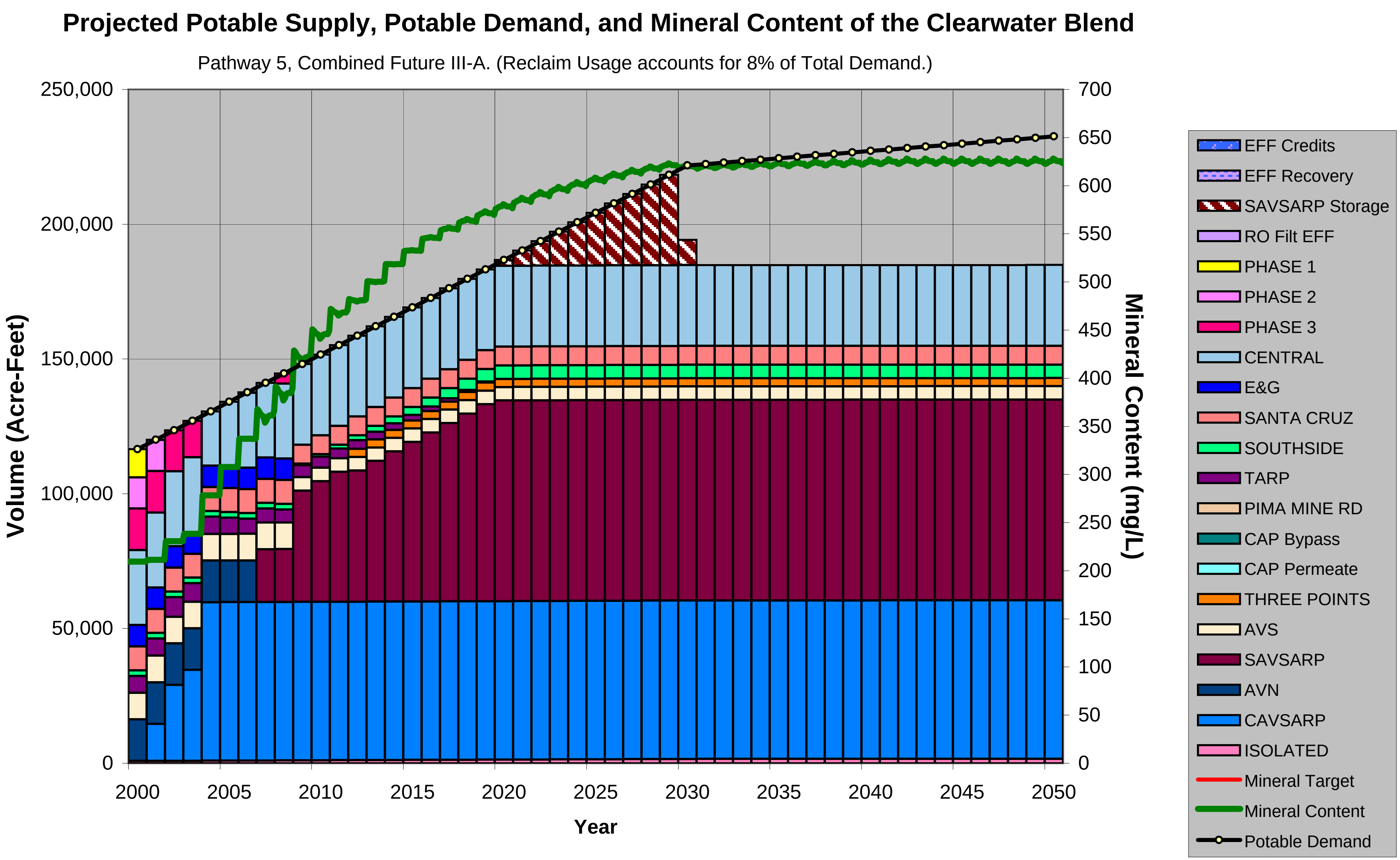
| | |
|---|---|
| Present Worth Capital Cost | $ 58.9 |
| Average Annual O&M Cost | $ 13.1 |
| Present Worth of O&M Costs | $ 169.0 |
| **Total Present Worth** | $ 227.9 |
| Annualized Capital Cost | $ 4.1 |
| Uniform Annualized O&M Cost | $ 11.8 |
| **Total Equivalent Annual Cost** | $ 15.9 |
| **Equivalent Unit Cost** (based on Target Year flows): | |
| $/1,000 gallons | $ 0.33 |
| $/acre-foot | $ 109 |

### *Project Cost Breakdown*

| Project ($1,000s except where noted) | Design Flow (MGD) *[based on max. flow over planning period]* | Average Flow in Target Year (MGD) | Present Worth Capital Cost ($k) | Average Annual O&M Cost ($k/yr) | Present Worth O&M Costs ($k) | **Total Present Worth ($k)** | Annualized Capital Cost ($k/yr) | Uniform Annualized O&M Cost ($k/yr) | **Total Equivalent Annual Cost ($k/yr)** | Equivalent Unit Production Cost (based on Target Year flows): $/1,000 gal | $/acre-ft |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hayden-Udall WTP: | | | | | | | | | | | |
| General Rehabilitation | | | $ - | | | $ - | $ - | | $ - | | |
| Primary Disinfection Options | | | | | | | | | | | |
| UV Disinfection | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Giardia & Cryptosporidium) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Taste & Odor) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Chlorination* | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Existing Direct Filtration | 0.0 | 0.0 | | $ - | $ - | $ - | | $ - | $ - | $ - | $ - |
| TDS Removal of CAP Water | | | | | | | | | | | |
| NF/RO (with Existing Direct Filtration) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| NF/RO (with MF/UF Pre-treatment) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| TDS Removal of Recovered Water | | | | | | | | | | | |
| NF/RO for Recovered Water | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection | | | | | | | | | | | |
| Chlorine | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Chloramines | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Sub-total (Hayden-Udall WTP) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAVSARP | 61.2 | 52.5 | | $ 5,696 | $ 84,906 | $ 84,906 | | $ 5,906 | $ 5,906 | $ 0.31 | $ 100 |
| SAVSARP | 139.9 | 74.8 | $ 37,972 | $ 6,978 | $ 77,330 | $ 115,302 | $ 2,641 | $ 5,379 | $ 8,021 | $ 0.29 | $ 96 |
| Secondary Disinfection- Recovered Water | 201.1 | 127.3 | $ 495 | $ 185 | $ 2,484 | $ 2,979 | $ 34 | $ 173 | $ 207 | $ 0.00 | $ 1 |
| Three Points Wellfield | 3.1 | 2.7 | $ 5,249 | $ - | $ 2,400 | $ 7,649 | $ 365 | $ 167 | $ 532 | $ 0.54 | $ 177 |
| Secondary Disinfection- Three Points Wellfield | 3.1 | 2.7 | $ 86 | $ - | $ 60 | $ 145 | $ 6 | $ 4 | $ 10 | $ 0.01 | $ 3 |
| Total Clearwater Production (MGD) | 204.2 | 130.0 | | | | | | | | | |
| Spencer Interconnect | | | $ 15,130 | $ 192 | $ 1,827 | $ 16,957 | $ 1,052 | $ 127 | $ 1,180 | | |
| TOTAL COSTS** | | | $ 58,931 | $ 13,051 | $ 169,008 | $ 227,939 | $ 4,100 | $ 11,757 | $ 15,856 | $ 0.33 | $ 109 |

* All primary disinfection chlorine costs are included in the secondary disinfection costs when chlorine is the primary disinfectant.

** Equivalent unit production costs in the Total Costs row include Spencer Interconnect costs.






RunDate: 9/10/2004

# CLEARWATER COST MODEL OUTPUT

Add Run to Database | Show Input Form

**Pathway 5**
**Combined Future IV-A**

| | | |
|---|---|---|
| ALTERNATIVE NAME | Pathway IV-A | |
| RUN NAME | Run 1 | |
| DATE | 9/10/2004 | |

Final TDS Target from Resource Planning Tool: 450 (mg/L)

## *Input Values*

| | | |
|---|---|---|
| Power Cost for HUWTP | $0.08 | ($/kWh) |
| Labor Rate | $26 | ($/hr) |
| Annual Discount Rate | 0.050 | (per year as decimal) |
| ENR 20 Cities Average Cost Construction Index | 7188 | |
| Target Year | 2030 | (Year) |
| Planning Horizon | 26 | (Years) |
| Spencer Interconnect | TRUE | |
| SAVSARP Deep Wells | 15 | |
| Three-Points Wellfield | 2012 | |

## *Overall Output Values* *($millions except where noted)*

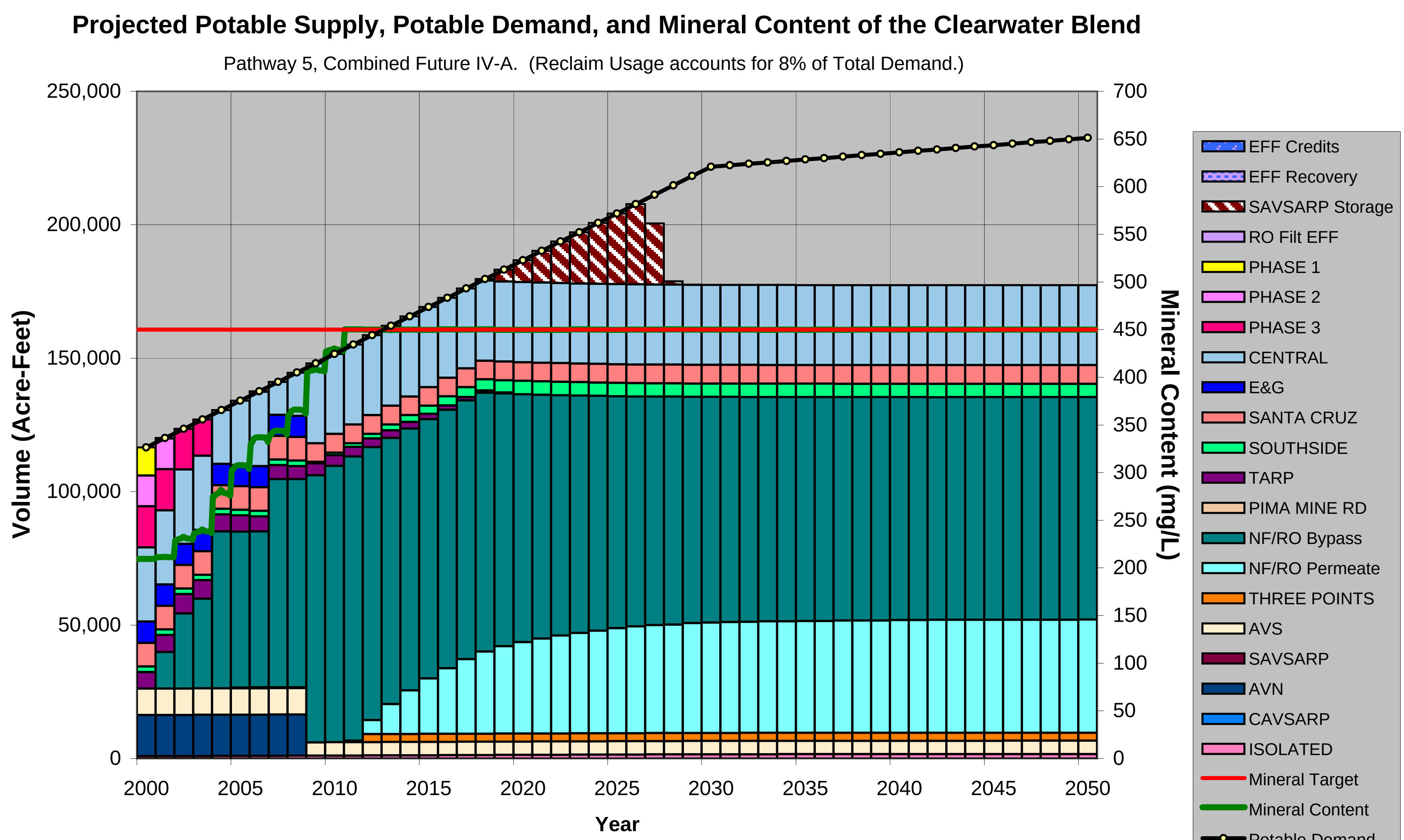
| | |
|---|---|
| Present Worth Capital Cost | $ 323.1 |
| Average Annual O&M Cost | $ 17.6 |
| Present Worth of O&M Costs | $ 218.3 |
| **Total Present Worth** | $ 541.4 |
| Annualized Capital Cost | $ 22.5 |
| Uniform Annualized O&M Cost | $ 15.2 |
| **Total Equivalent Annual Cost** | $ 37.7 |
| **Equivalent Unit Cost** (based on Target Year flows): | |
| $/1,000 gallons | $ 0.90 |
| $/acre-foot | $ 292 |

## *Project Cost Breakdown*

| Project ($1,000s except where noted) | Design Flow (MGD) *[based on max. flow over planning period]* | Average Flow in Target Year (MGD) | Present Worth Capital Cost ($k) | Average Annual O&M Cost ($k/yr) | Present Worth O&M Costs ($k) | **Total Present Worth ($k)** | Annualized Capital Cost ($k/yr) | Uniform Annualized O&M Cost ($k/yr) | **Total Equivalent Annual Cost ($k/yr)** | Equivalent Unit Production Cost (based on Target Year flows) $/1,000 gal | $/acre-ft |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hayden-Udall WTP: | | | | | | | | | | | |
| General Rehabilitation | | | $ 879 | | | $ 879 | $ 61 | | $ 61 | | |
| Primary Disinfection Options | | | | | | | | | | | |
| UV Disinfection | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Giardia & Cryptosporidium) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Taste & Odor) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Chlorination* | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Existing Direct Filtration | 0.0 | 0.0 | | $ - | $ - | $ - | | $ - | $ - | $ - | $ - |
| TDS Removal of CAP Water | | | | | | | | | | | |
| NF/RO (with Existing Direct Filtration) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| NF/RO (with MF/UF Pre-treatment) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| TDS Removal of Recovered Water | | | | | | | | | | | |
| NF/RO for Recovered Water | 71.1 | 43.4 | $ 69,262 | $ 3,373 | $ 36,107 | $ 105,369 | $ 4,818 | $ 2,512 | $ 7,330 | $ 0 | $ 151 |
| Evaporation Ponds | 10.7 | 6.5 | $ 194,072 | $ 1,119 | $ 11,982 | $ 206,054 | $ 13,501 | $ 834 | $ 14,334 | $ 6 | $ 1,964 |
| Secondary Disinfection | | | | | | | | | | | |
| Chlorine | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Chloramines | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Sub-total (Hayden-Udall WTP) | 0.0 | 0.0 | $ 264,213 | $ 4,492 | $ 48,088 | $ 312,302 | $ 18,380 | $ 3,345 | $ 21,725 | $ - | $ - |
| | | | | | | | | | | | |
| CAVSARP | 72.8 | 52.5 | | $ 5,423 | $ 79,631 | $ 79,631 | | $ 5,539 | $ 5,539 | $ 0.29 | $ 94 |
| SAVSARP | 128.3 | 66.5 | $ 37,972 | $ 7,301 | $ 83,830 | $ 121,802 | $ 2,641 | $ 5,832 | $ 8,473 | $ 0.35 | $ 114 |
| Secondary Disinfection- Recovered Water | 188.5 | 112.4 | $ 475 | $ 179 | $ 2,432 | $ 2,907 | $ 33 | $ 169 | $ 202 | $ 0.00 | $ 2 |
| | | | | | | | | | | | |
| Three Points Wellfield | 3.1 | 2.7 | $ 5,249 | $ - | $ 2,400 | $ 7,649 | $ 365 | $ 167 | $ 532 | $ 0.54 | $ 177 |
| Secondary Disinfection- Three Points Wellfield | 3.1 | 2.7 | $ 86 | $ - | $ 60 | $ 145 | $ 6 | $ 4 | $ 10 | $ 0.01 | $ 3 |
| Total Clearwater Production (MGD) | 191.7 | 115.1 | | | | | | | | | |
| | | | | | | | | | | | |
| Spencer Interconnect | | | $ 15,130 | $ 192 | $ 1,827 | $ 16,957 | $ 1,052 | $ 127 | $ 1,180 | | |
| | | | | | | | | | | | |
| TOTAL COSTS** | | | $ 323,125 | $ 17,587 | $ 218,268 | $ 541,393 | $ 22,478 | $ 15,184 | $ 37,662 | $ 0.90 | $ 292 |

* All primary disinfection chlorine costs are included in the secondary disinfection costs when chlorine is the primary disinfectant.

** Equivalent unit production costs in the Total Costs row include Spencer Interconnect costs.






RunDate: 9/10/2004

# CLEARWATER COST MODEL OUTPUT

Add Run to Database | Show Input Form

**Pathway 6**
**Combined Future III-B**

| | | |
|---|---|---|
| ALTERNATIVE NAME | Future III-B | |
| RUN NAME | Run 1 | |
| DATE | 9/13/2004 | |

Final TDS Target from Resource Planning Tool: 650 (mg/L)

## *Input Values*

| | | |
|---|---|---|
| Power Cost for HUWTP | $0.08 | ($/kWh) |
| Labor Rate | $26 | ($/hr) |
| Annual Discount Rate | 0.050 | (per year as decimal) |
| ENR 20 Cities Average Cost Construction Index | 7188 | |
| Target Year | 2030 | (Year) |
| Planning Horizon | 26 | (Years) |
| Spencer Interconnect | TRUE | |
| SAVSARP Deep Wells | 15 | |
| Three-Points Wellfield | 2012 | |

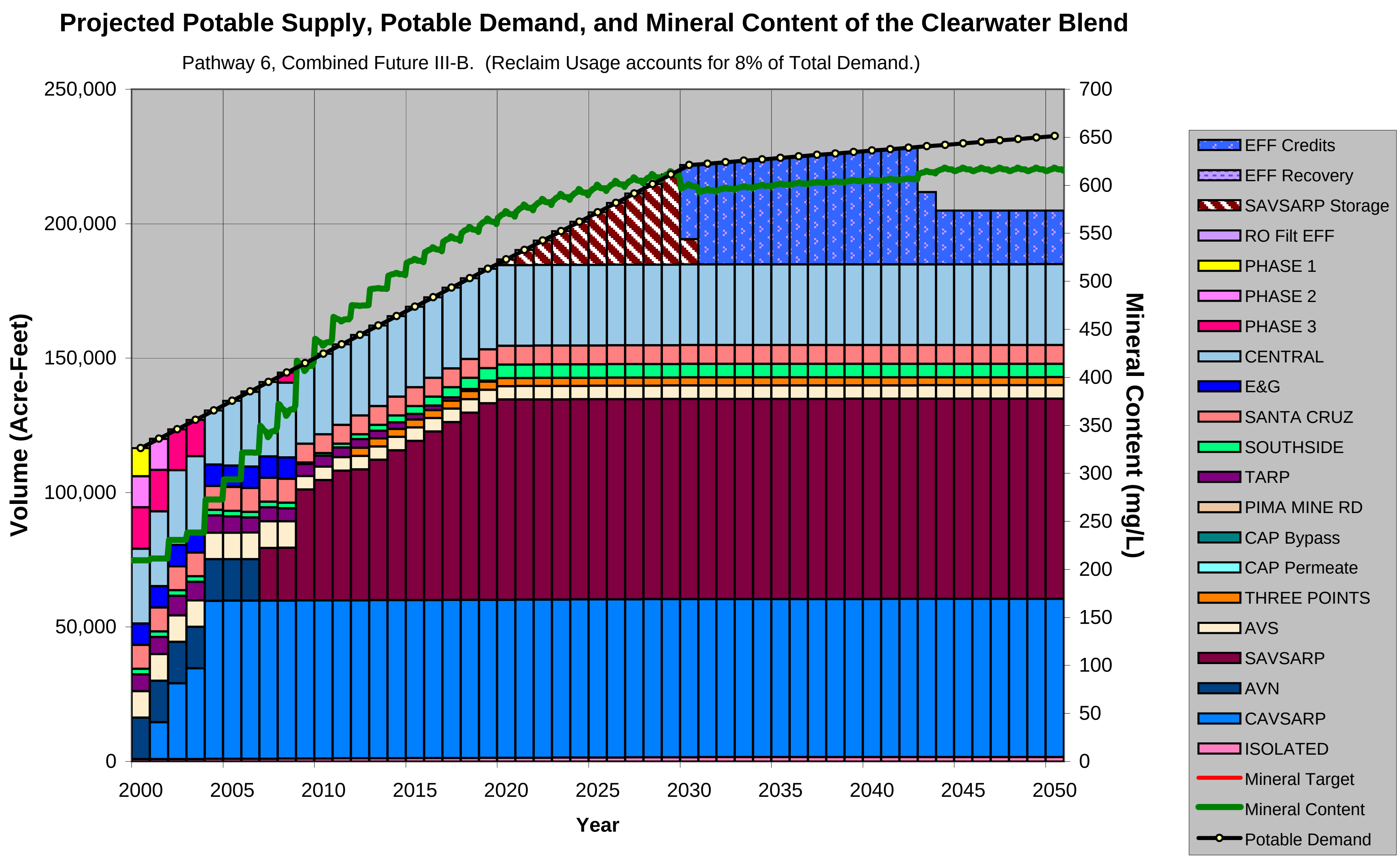
## *Overall Output Values* *($millions except where noted)*

| | |
|---|---|
| Present Worth Capital Cost | $ 58.9 |
| Average Annual O&M Cost | $ 13.1 |
| Present Worth of O&M Costs | $ 169.1 |
| **Total Present Worth** | $ 228.0 |
| Annualized Capital Cost | $ 4.1 |
| Uniform Annualized O&M Cost | $ 11.8 |
| **Total Equivalent Annual Cost** | $ 15.9 |
| **Equivalent Unit Cost** (based on Target Year flows): | |
| $/1,000 gallons | $ 0.33 |
| $/acre-foot | $ 108 |

## *Project Cost Breakdown*

| Project ($1,000s except where noted) | Design Flow (MGD) *[based on max. flow over planning period]* | Average Flow in Target Year (MGD) | Present Worth Capital Cost ($k) | Average Annual O&M Cost ($k/yr) | Present Worth O&M Costs ($k) | **Total Present Worth ($k)** | Annualized Capital Cost ($k/yr) | Uniform Annualized O&M Cost ($k/yr) | **Total Equivalent Annual Cost ($k/yr)** | Equivalent Unit Production Cost (based on Target Year flows) $/1,000 gal | $/acre-ft |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hayden-Udall WTP: | | | | | | | | | | | |
| General Rehabilitation | | | $ - | | | $ - | $ - | | $ - | | |
| Primary Disinfection Options | | | | | | | | | | | |
| UV Disinfection | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Giardia & Cryptosporidium) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Taste & Odor) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Chlorination* | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Existing Direct Filtration | 0.0 | 0.0 | | $ - | $ - | $ - | | $ - | $ - | $ - | $ - |
| TDS Removal of CAP Water | | | | | | | | | | | |
| NF/RO (with Existing Direct Filtration) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| NF/RO (with MF/UF Pre-treatment) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| TDS Removal of Recovered Water | | | | | | | | | | | |
| NF/RO for Recovered Water | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection | | | | | | | | | | | |
| Chlorine | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Chloramines | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Sub-total (Hayden-Udall WTP) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| | | | | | | | | | | | |
| CAVSARP | 61.2 | 52.5 | | $ 5,696 | $ 84,906 | $ 84,906 | | $ 5,906 | $ 5,906 | $ 0.31 | $ 100 |
| SAVSARP | 139.9 | 74.8 | $ 37,972 | $ 6,978 | $ 77,330 | $ 115,302 | $ 2,641 | $ 5,379 | $ 8,021 | $ 0.29 | $ 96 |
| Secondary Disinfection- Recovered Water | 201.1 | 127.3 | $ 495 | $ 185 | $ 2,484 | $ 2,979 | $ 34 | $ 173 | $ 207 | $ 0.00 | $ 1 |
| | | | | | | | | | | | |
| Three Points Wellfield | 5.1 | 4.2 | $ 5,249 | $ - | $ 2,444 | $ 7,693 | $ 365 | $ 170 | $ 535 | $ 0.35 | $ 115 |
| Secondary Disinfection- Three Points Wellfield | 5.1 | 4.2 | $ 90 | $ - | $ 60 | $ 151 | $ 6 | $ 4 | $ 10 | $ 0.01 | $ 2 |
| Total Clearwater Production (MGD) | 206.2 | 131.5 | | | | | | | | | |
| | | | | | | | | | | | |
| Spencer Interconnect | | | $ 15,130 | $ 192 | $ 1,827 | $ 16,957 | $ 1,052 | $ 127 | $ 1,180 | | |
| | | | | | | | | | | | |
| TOTAL COSTS** | | | $ 58,936 | $ 13,051 | $ 169,052 | $ 227,988 | $ 4,100 | $ 11,760 | $ 15,860 | $ 0.33 | $ 108 |

* All primary disinfection chlorine costs are included in the secondary disinfection costs when chlorine is the primary disinfectant.
** Equivalent unit production costs in the Total Costs row include Spencer Interconnect costs.






RunDate: 9/13/2004

# CLEARWATER COST MODEL OUTPUT

Add Run to Database

Show Input Form

**Pathway 6**
**Combined Future IV-B**

| | | |
|---|---|---|
| ALTERNATIVE NAME | Future IV-B | |
| RUN NAME | Run 1 | |
| DATE | 9/13/2004 | |

Final TDS Target from Resource Planning Tool: 450 (mg/L)

| ***Input Values*** | | |
|---|---|---|
| Power Cost for HUWTP | $0.08 | ($/kWh) |
| Labor Rate | $26 | ($/hr) |
| Annual Discount Rate | 0.050 | (per year as decimal) |
| ENR 20 Cities Average Cost Construction Index | 7188 | |
| Target Year | 2030 | (Year) |
| Planning Horizon | 26 | (Years) |
| Spencer Interconnect | TRUE | |
| SAVSARP Deep Wells | 15 | |
| Three-Points Wellfield | 2012 | |

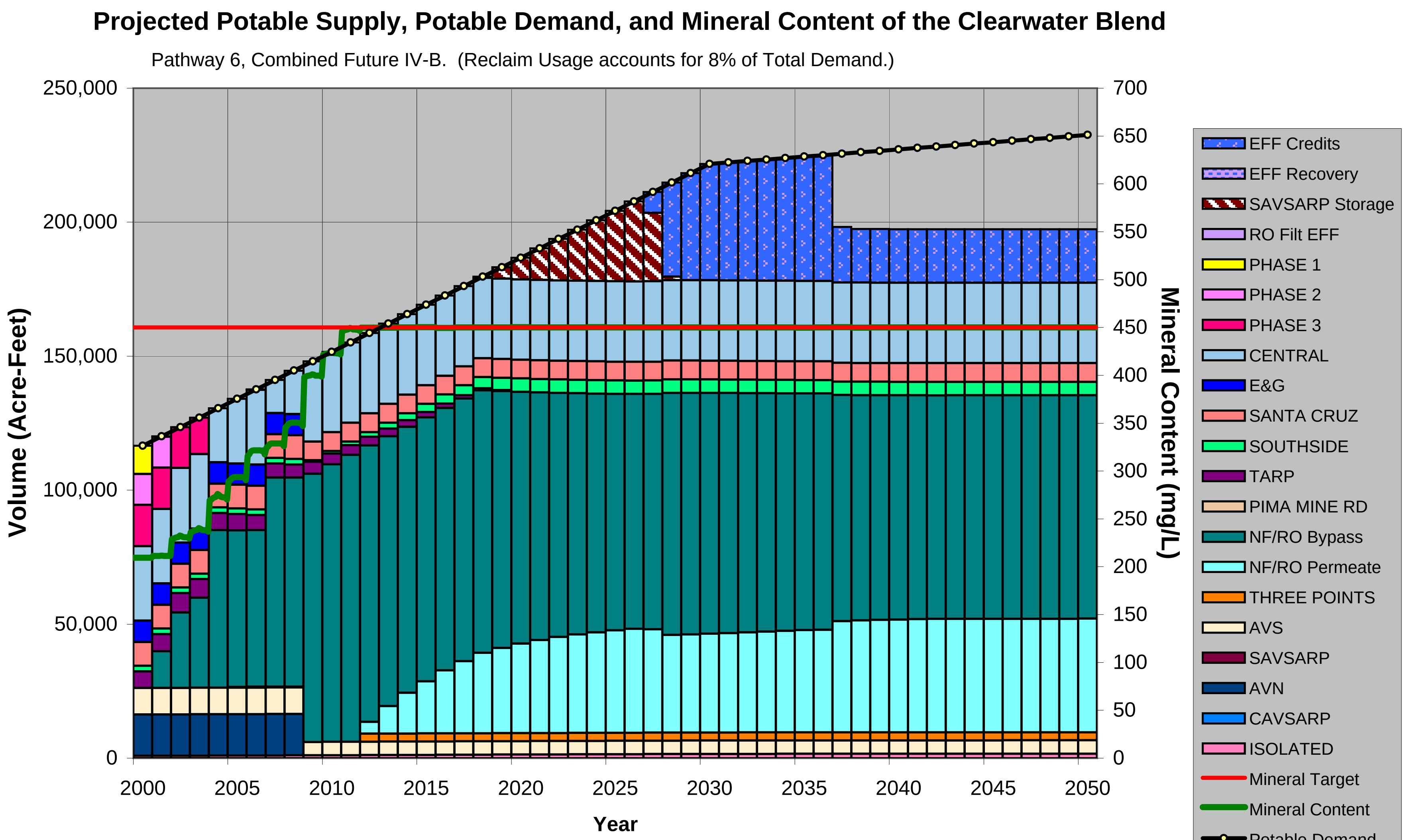
| ***Overall Output Values*** *($millions except where noted)* | |
|---|---|
| Present Worth Capital Cost | $ 314.8 |
| Average Annual O&M Cost | $ 17.4 |
| Present Worth of O&M Costs | $ 216.1 |
| **Total Present Worth** | $ 530.9 |
| Annualized Capital Cost | $ 21.9 |
| Uniform Annualized O&M Cost | $ 15.0 |
| **Total Equivalent Annual Cost** | $ 36.9 |
| **Equivalent Unit Cost** (based on Target Year flows): | |
| $/1,000 gallons | $ 0.86 |
| $/acre-foot | $ 279 |

## *Project Cost Breakdown*

| Project ($1,000s except where noted) | Design Flow (MGD) *[based on max. flow over planning period]* | Average Flow in Target Year (MGD) | Present Worth Capital Cost ($k) | Average Annual O&M Cost ($k/yr) | Present Worth O&M Costs ($k) | **Total Present Worth ($k)** | Annualized Capital Cost ($k/yr) | Uniform Annualized O&M Cost ($k/yr) | **Total Equivalent Annual Cost ($k/yr)** | Equivalent Unit Production Cost (based on Target Year flows): $/1,000 gal | $/acre-ft |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hayden-Udall WTP: | | | | | | | | | | | |
| General Rehabilitation | | | $ 879 | | | $ 879 | $ 61 | | $ 61 | | |
| Primary Disinfection Options | | | | | | | | | | | |
| UV Disinfection | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Giardia & Cryptosporidium) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Taste & Odor) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Chlorination* | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Existing Direct Filtration | 0.0 | 0.0 | | $ - | $ - | $ - | | $ - | $ - | $ - | $ - |
| TDS Removal of CAP Water | | | | | | | | | | | |
| NF/RO (with Existing Direct Filtration) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| NF/RO (with MF/UF Pre-treatment) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| TDS Removal of Recovered Water | | | | | | | | | | | |
| NF/RO for Recovered Water | 68.8 | 38.7 | $ 67,254 | $ 3,206 | $ 34,374 | $ 101,627 | $ 4,678 | $ 2,391 | $ 7,070 | $ 1 | $ 163 |
| Evaporation Ponds | 10.3 | 5.8 | $ 187,763 | $ 1,064 | $ 11,407 | $ 199,170 | $ 13,062 | $ 794 | $ 13,855 | $ 7 | $ 2,131 |
| Secondary Disinfection | | | | | | | | | | | |
| Chlorine | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Chloramines | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Sub-total (Hayden-Udall WTP) | 0.0 | 0.0 | $ 255,896 | $ 4,270 | $ 45,781 | $ 301,676 | $ 17,801 | $ 3,185 | $ 20,986 | $ - | $ - |
| | | | | | | | | | | | |
| CAVSARP | 72.8 | 52.5 | | $ 5,421 | $ 79,598 | $ 79,598 | | $ 5,537 | $ 5,537 | $ 0.29 | $ 94 |
| SAVSARP | 127.9 | 66.5 | $ 37,972 | $ 7,303 | $ 83,813 | $ 121,785 | $ 2,641 | $ 5,830 | $ 8,472 | $ 0.35 | $ 114 |
| Secondary Disinfection- Recovered Water | 188.5 | 113.2 | $ 475 | $ 179 | $ 2,434 | $ 2,909 | $ 33 | $ 169 | $ 202 | $ 0.00 | $ 2 |
| | | | | | | | | | | | |
| Three Points Wellfield | 5.9 | 5.0 | $ 5,249 | $ - | $ 2,612 | $ 7,861 | $ 365 | $ 182 | $ 547 | $ 0.30 | $ 97 |
| Secondary Disinfection- Three Points Wellfield | 5.9 | 5.0 | $ 92 | $ - | $ 63 | $ 155 | $ 6 | $ 4 | $ 11 | $ 0.01 | $ 2 |
| Total Clearwater Production (MGD) | 194.4 | 118.2 | | | | | | | | | |
| | | | | | | | | | | | |
| Spencer Interconnect | | | $ 15,130 | $ 192 | $ 1,827 | $ 16,957 | $ 1,052 | $ 127 | $ 1,180 | | |
| | | | | | | | | | | | |
| TOTAL COSTS** | | | $ 314,814 | $ 17,366 | $ 216,128 | $ 530,942 | $ 21,900 | $ 15,035 | $ 36,935 | $ 0.86 | $ 279 |

* All primary disinfection chlorine costs are included in the secondary disinfection costs when chlorine is the primary disinfectant.

** Equivalent unit production costs in the Total Costs row include Spencer Interconnect costs.






RunDate: 9/13/2004

# CLEARWATER COST MODEL OUTPUT

Add Run to Database | Show Input Form

**Pathway 7**
**Combined Future III-C**

| | | |
|---|---|---|
| ALTERNATIVE NAME | Future III-C | |
| RUN NAME | Run 1 | |
| DATE | 9/10/2004 | |

Final TDS Target from Resource Planning Tool: 650 (mg/L)

## *Input Values*

| | | |
|---|---|---|
| Power Cost for HUWTP | $0.08 | ($/kWh) |
| Labor Rate | $26 | ($/hr) |
| Annual Discount Rate | 0.050 | (per year as decimal) |
| ENR 20 Cities Average Cost Construction Index | 7188 | |
| Target Year | 2030 | (Year) |
| Planning Horizon | 26 | (Years) |
| Spencer Interconnect | TRUE | |
| SAVSARP Deep Wells | 15 | |
| Three-Points Wellfield | 2012 | |

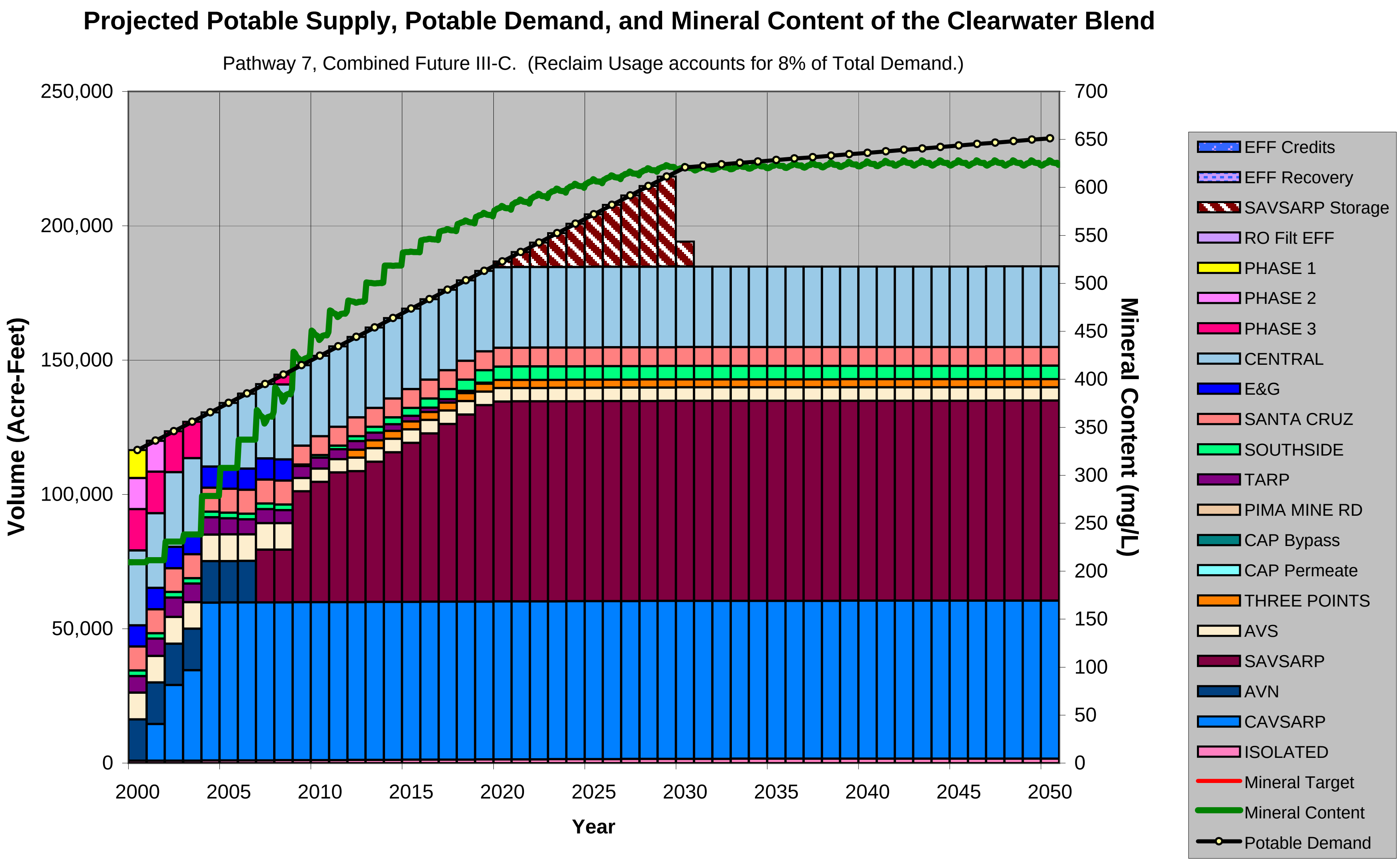
## *Overall Output Values* *($millions except where noted)*

| | |
|---|---|
| Present Worth Capital Cost | $ 58.9 |
| Average Annual O&M Cost | $ 13.1 |
| Present Worth of O&M Costs | $ 169.0 |
| **Total Present Worth** | $ 227.9 |
| Annualized Capital Cost | $ 4.1 |
| Uniform Annualized O&M Cost | $ 11.8 |
| **Total Equivalent Annual Cost** | $ 15.9 |
| **Equivalent Unit Cost** (based on Target Year flows): | |
| $/1,000 gallons | $ 0.33 |
| $/acre-foot | $ 109 |

## *Project Cost Breakdown*

| Project ($1,000s except where noted) | Design Flow (MGD) *[based on max. flow over planning period]* | Average Flow in Target Year (MGD) | Present Worth Capital Cost ($k) | Average Annual O&M Cost ($k/yr) | Present Worth O&M Costs ($k) | **Total Present Worth ($k)** | Annualized Capital Cost ($k/yr) | Uniform Annualized O&M Cost ($k/yr) | **Total Equivalent Annual Cost ($k/yr)** | Equivalent Unit Production Cost (based on Target Year flows) $/1,000 gal | $/acre-ft |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hayden-Udall WTP: | | | | | | | | | | | |
| General Rehabilitation | | | $ - | | | $ - | $ - | | $ - | | |
| Primary Disinfection Options | | | | | | | | | | | |
| UV Disinfection | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Giardia & Cryptosporidium) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Taste & Odor) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Chlorination* | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Existing Direct Filtration | 0.0 | 0.0 | | $ - | $ - | $ - | | $ - | $ - | $ - | $ - |
| TDS Removal of CAP Water | | | | | | | | | | | |
| NF/RO (with Existing Direct Filtration) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| NF/RO (with MF/UF Pre-treatment) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| TDS Removal of Recovered Water | | | | | | | | | | | |
| NF/RO for Recovered Water | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection | | | | | | | | | | | |
| Chlorine | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Chloramines | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Sub-total (Hayden-Udall WTP) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAVSARP | 61.2 | 52.5 | | $ 5,696 | $ 84,906 | $ 84,906 | | $ 5,906 | $ 5,906 | $ 0.31 | $ 100 |
| SAVSARP | 139.9 | 74.8 | $ 37,972 | $ 6,978 | $ 77,330 | $ 115,302 | $ 2,641 | $ 5,379 | $ 8,021 | $ 0.29 | $ 96 |
| Secondary Disinfection- Recovered Water | 201.1 | 127.3 | $ 495 | $ 185 | $ 2,484 | $ 2,979 | $ 34 | $ 173 | $ 207 | $ 0.00 | $ 1 |
| Three Points Wellfield | 3.1 | 2.7 | $ 5,249 | $ - | $ 2,400 | $ 7,649 | $ 365 | $ 167 | $ 532 | $ 0.54 | $ 177 |
| Secondary Disinfection- Three Points Wellfield | 3.1 | 2.7 | $ 86 | $ - | $ 60 | $ 145 | $ 6 | $ 4 | $ 10 | $ 0.01 | $ 3 |
| Total Clearwater Production (MGD) | 204.2 | 130.0 | | | | | | | | | |
| Spencer Interconnect | | | $ 15,130 | $ 192 | $ 1,827 | $ 16,957 | $ 1,052 | $ 127 | $ 1,180 | | |
| TOTAL COSTS** | | | $ 58,931 | $ 13,051 | $ 169,008 | $ 227,939 | $ 4,100 | $ 11,757 | $ 15,856 | $ 0.33 | $ 109 |

* All primary disinfection chlorine costs are included in the secondary disinfection costs when chlorine is the primary disinfectant.
** Equivalent unit production costs in the Total Costs row include Spencer Interconnect costs.






RunDate: 9/10/2004

# CLEARWATER COST MODEL OUTPUT

Add Run to Database

Show Input Form

**Pathway 7**
**Combined Future IV-C**

| | |
|---|---|
| ALTERNATIVE NAME | Future IV-C |
| RUN NAME | Run 1 |
| DATE | 9/10/2004 |

Final TDS Target from Resource Planning Tool: 450 (mg/L)

## *Input Values*

| | | |
|---|---|---|
| Power Cost for HUWTP | $0.08 | ($/kWh) |
| Labor Rate | $26 | ($/hr) |
| Annual Discount Rate | 0.050 | (per year as decimal) |
| ENR 20 Cities Average Cost Construction Index | 7188 | |
| Target Year | 2030 | (Year) |
| Planning Horizon | 26 | (Years) |
| Spencer Interconnect | TRUE | |
| SAVSARP Deep Wells | 15 | |
| Three-Points Wellfield | 2012 | |

## *Overall Output Values* *($millions except where noted)*

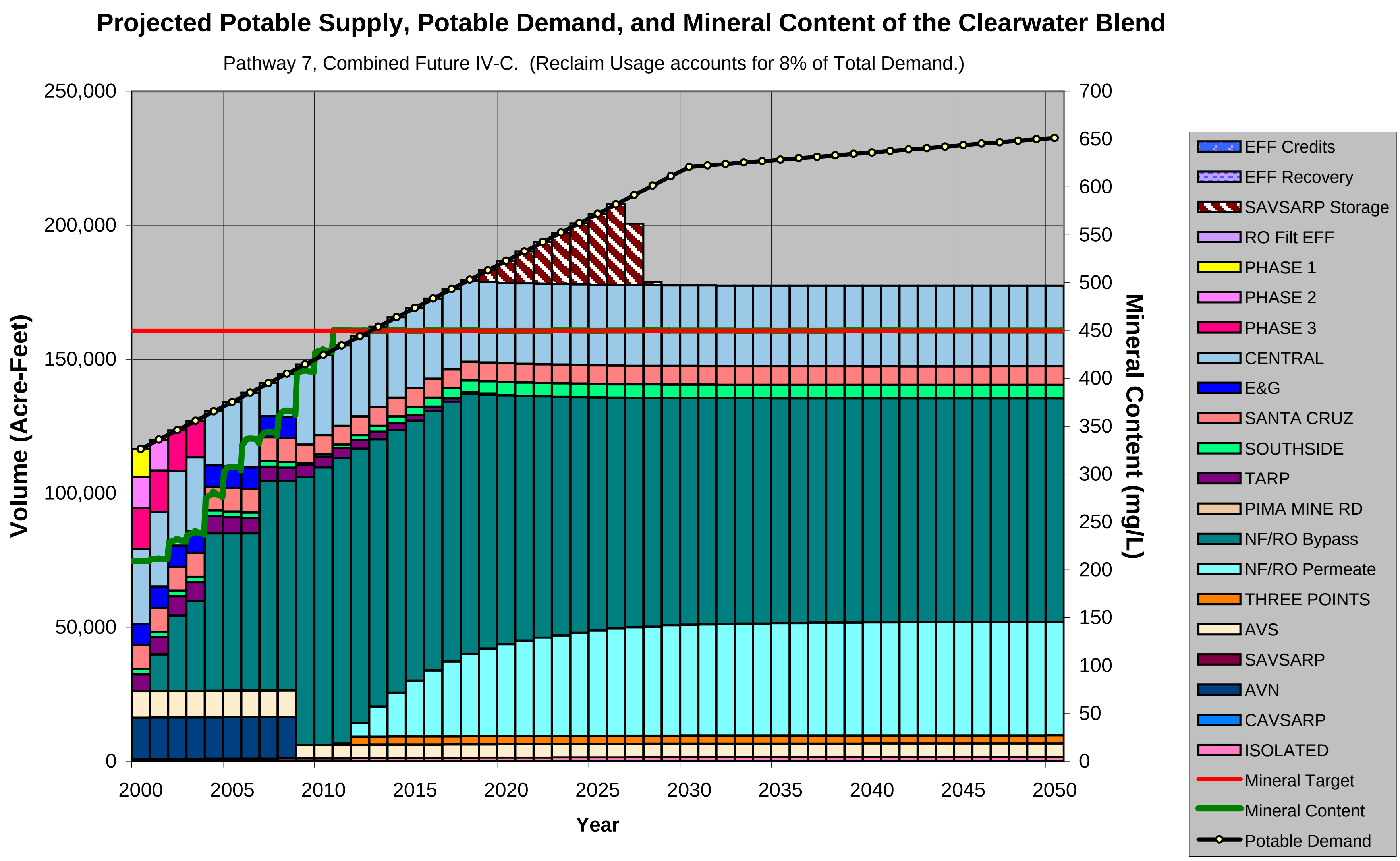
| | |
|---|---|
| Present Worth Capital Cost | $ 323.1 |
| Average Annual O&M Cost | $ 17.6 |
| Present Worth of O&M Costs | $ 218.3 |
| **Total Present Worth** | $ 541.4 |
| Annualized Capital Cost | $ 22.5 |
| Uniform Annualized O&M Cost | $ 15.2 |
| **Total Equivalent Annual Cost** | $ 37.7 |
| **Equivalent Unit Cost** (based on Target Year flows): | |
| $/1,000 gallons | $ 0.90 |
| $/acre-foot | $ 292 |

## *Project Cost Breakdown*

| Project ($1,000s except where noted) | Design Flow (MGD) *[based on max. flow over planning period]* | Average Flow in Target Year (MGD) | Present Worth Capital Cost ($k) | Average Annual O&M Cost ($k/yr) | Present Worth O&M Costs ($k) | **Total Present Worth ($k)** | Annualized Capital Cost ($k/yr) | Uniform Annualized O&M Cost ($k/yr) | **Total Equivalent Annual Cost ($k/yr)** | Equivalent Unit Production Cost (based on Target Year flows) $/1,000 gal | $/acre-ft |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hayden-Udall WTP: | | | | | | | | | | | |
| General Rehabilitation | | | $ 879 | | | $ 879 | $ 61 | | $ 61 | | |
| Primary Disinfection Options | | | | | | | | | | | |
| UV Disinfection | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Giardia & Cryptosporidium) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Taste & Odor) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Chlorination* | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Existing Direct Filtration | 0.0 | 0.0 | | $ - | $ - | $ - | | $ - | $ - | $ - | $ - |
| TDS Removal of CAP Water | | | | | | | | | | | |
| NF/RO (with Existing Direct Filtration) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| NF/RO (with MF/UF Pre-treatment) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| TDS Removal of Recovered Water | | | | | | | | | | | |
| NF/RO for Recovered Water | 71.1 | 43.4 | $ 69,262 | $ 3,373 | $ 36,107 | $ 105,369 | $ 4,818 | $ 2,512 | $ 7,330 | $ 0 | $ 151 |
| Evaporation Ponds | 10.7 | 6.5 | $ 194,072 | $ 1,119 | $ 11,982 | $ 206,054 | $ 13,501 | $ 834 | $ 14,334 | $ 6 | $ 1,964 |
| Secondary Disinfection | | | | | | | | | | | |
| Chlorine | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Chloramines | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Sub-total (Hayden-Udall WTP) | 0.0 | 0.0 | $ 264,213 | $ 4,492 | $ 48,088 | $ 312,302 | $ 18,380 | $ 3,345 | $ 21,725 | $ - | $ - |
| CAVSARP | 72.8 | 52.5 | | $ 5,423 | $ 79,631 | $ 79,631 | | $ 5,539 | $ 5,539 | $ 0.29 | $ 94 |
| SAVSARP | 128.3 | 66.5 | $ 37,972 | $ 7,301 | $ 83,830 | $ 121,802 | $ 2,641 | $ 5,832 | $ 8,473 | $ 0.35 | $ 114 |
| Secondary Disinfection- Recovered Water | 188.5 | 112.4 | $ 475 | $ 179 | $ 2,432 | $ 2,907 | $ 33 | $ 169 | $ 202 | $ 0.00 | $ 2 |
| Three Points Wellfield | 3.1 | 2.7 | $ 5,249 | $ - | $ 2,400 | $ 7,649 | $ 365 | $ 167 | $ 532 | $ 0.54 | $ 177 |
| Secondary Disinfection- Three Points Wellfield | 3.1 | 2.7 | $ 86 | $ - | $ 60 | $ 145 | $ 6 | $ 4 | $ 10 | $ 0.01 | $ 3 |
| Total Clearwater Production (MGD) | 191.7 | 115.1 | | | | | | | | | |
| Spencer Interconnect | | | $ 15,130 | $ 192 | $ 1,827 | $ 16,957 | $ 1,052 | $ 127 | $ 1,180 | | |
| TOTAL COSTS** | | | $ 323,125 | $ 17,587 | $ 218,268 | $ 541,393 | $ 22,478 | $ 15,184 | $ 37,662 | $ 0.90 | $ 292 |

* All primary disinfection chlorine costs are included in the secondary disinfection costs when chlorine is the primary disinfectant.

** Equivalent unit production costs in the Total Costs row include Spencer Interconnect costs.






RunDate: 9/13/2004

# CLEARWATER COST MODEL OUTPUT

Add Run to Database | Show Input Form

**Pathway 8**
**Combined Future III-D**

| | | |
|---|---|---|
| ALTERNATIVE NAME | Future III-D | |
| RUN NAME | Run 1 | |
| DATE | 9/10/2004 | |

Final TDS Target from Resource Planning Tool: 650 (mg/L)

## *Input Values*

| | | |
|---|---|---|
| Power Cost for HUWTP | $0.08 | ($/kWh) |
| Labor Rate | $26 | ($/hr) |
| Annual Discount Rate | 0.050 | (per year as decimal) |
| ENR 20 Cities Average Cost Construction Index | 7188 | |
| Target Year | 2030 | (Year) |
| Planning Horizon | 26 | (Years) |
| Spencer Interconnect | TRUE | |
| SAVSARP Deep Wells | 15 | |
| Three-Points Wellfield | 2012 | |

## *Overall Output Values* *($millions except where noted)*

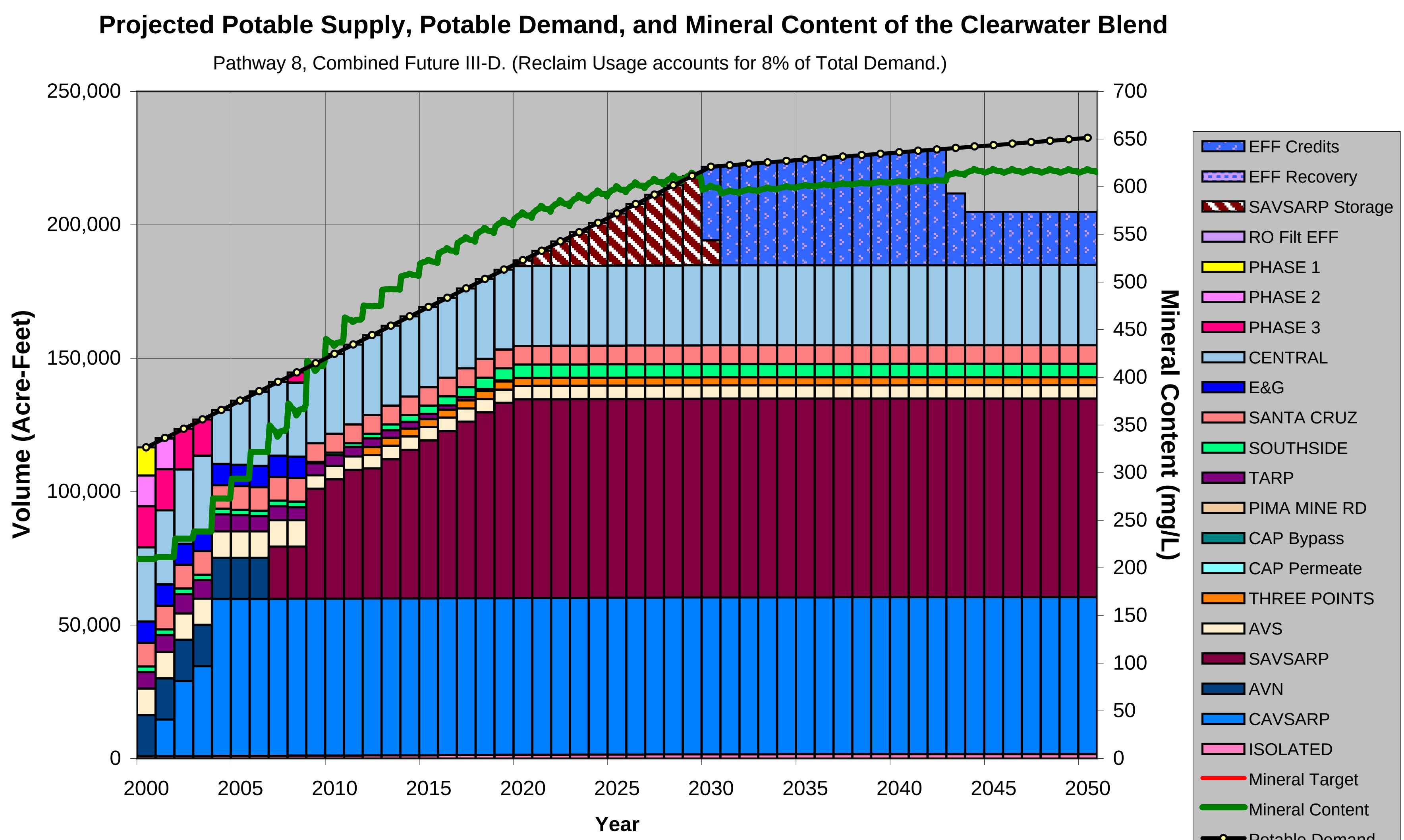
| | |
|---|---|
| Present Worth Capital Cost | $ 58.9 |
| Average Annual O&M Cost | $ 13.1 |
| Present Worth of O&M Costs | $ 169.1 |
| **Total Present Worth** | $ 228.0 |
| Annualized Capital Cost | $ 4.1 |
| Uniform Annualized O&M Cost | $ 11.8 |
| **Total Equivalent Annual Cost** | $ 15.9 |
| **Equivalent Unit Cost** (based on Target Year flows): | |
| $/1,000 gallons | $ 0.33 |
| $/acre-foot | $ 108 |

## *Project Cost Breakdown*

| Project ($1,000s except where noted) | Design Flow (MGD) *[based on max. flow over planning period]* | Average Flow in Target Year (MGD) | Present Worth Capital Cost ($k) | Average Annual O&M Cost ($k/yr) | Present Worth O&M Costs ($k) | **Total Present Worth ($k)** | Annualized Capital Cost ($k/yr) | Uniform Annualized O&M Cost ($k/yr) | **Total Equivalent Annual Cost ($k/yr)** | Equivalent Unit Production Cost (based on Target Year flows) $/1,000 gal | $/acre-ft |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hayden-Udall WTP: | | | | | | | | | | | |
| General Rehabilitation | | | $ - | | | $ - | $ - | | $ - | | |
| Primary Disinfection Options | | | | | | | | | | | |
| UV Disinfection | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Giardia & Cryptosporidium) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Taste & Odor) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Chlorination* | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Existing Direct Filtration | 0.0 | 0.0 | | $ - | $ - | $ - | | $ - | $ - | $ - | $ - |
| TDS Removal of CAP Water | | | | | | | | | | | |
| NF/RO (with Existing Direct Filtration) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| NF/RO (with MF/UF Pre-treatment) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| TDS Removal of Recovered Water | | | | | | | | | | | |
| NF/RO for Recovered Water | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection | | | | | | | | | | | |
| Chlorine | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Chloramines | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Sub-total (Hayden-Udall WTP) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| | | | | | | | | | | | |
| CAVSARP | 61.2 | 52.5 | | $ 5,696 | $ 84,906 | $ 84,906 | | $ 5,906 | $ 5,906 | $ 0.31 | $ 100 |
| SAVSARP | 139.9 | 74.8 | $ 37,972 | $ 6,978 | $ 77,330 | $ 115,302 | $ 2,641 | $ 5,379 | $ 8,021 | $ 0.29 | $ 96 |
| Secondary Disinfection- Recovered Water | 201.1 | 127.3 | $ 495 | $ 185 | $ 2,484 | $ 2,979 | $ 34 | $ 173 | $ 207 | $ 0.00 | $ 1 |
| | | | | | | | | | | | |
| Three Points Wellfield | 5.1 | 4.2 | $ 5,249 | $ - | $ 2,444 | $ 7,693 | $ 365 | $ 170 | $ 535 | $ 0.35 | $ 115 |
| Secondary Disinfection- Three Points Wellfield | 5.1 | 4.2 | $ 90 | $ - | $ 60 | $ 151 | $ 6 | $ 4 | $ 10 | $ 0.01 | $ 2 |
| Total Clearwater Production (MGD) | 206.2 | 131.5 | | | | | | | | | |
| | | | | | | | | | | | |
| Spencer Interconnect | | | $ 15,130 | $ 192 | $ 1,827 | $ 16,957 | $ 1,052 | $ 127 | $ 1,180 | | |
| | | | | | | | | | | | |
| TOTAL COSTS** | | | $ 58,936 | $ 13,051 | $ 169,052 | $ 227,988 | $ 4,100 | $ 11,760 | $ 15,860 | $ 0.33 | $ 108 |

* All primary disinfection chlorine costs are included in the secondary disinfection costs when chlorine is the primary disinfectant.

** Equivalent unit production costs in the Total Costs row include Spencer Interconnect costs.






RunDate: 9/10/2004

# CLEARWATER COST MODEL OUTPUT

Add Run to Database | Show Input Form

**Pathway 8**
**Combined Future IV-D**

| | | |
|---|---|---|
| ALTERNATIVE NAME | Future IV-D | |
| RUN NAME | Run 1 | |
| DATE | 9/10/2004 | |

Final TDS Target from Resource Planning Tool: 450 (mg/L)

## *Input Values*

| | | |
|---|---|---|
| Power Cost for HUWTP | $0.08 | ($/kWh) |
| Labor Rate | $26 | ($/hr) |
| Annual Discount Rate | 0.050 | (per year as decimal) |
| ENR 20 Cities Average Cost Construction Index | 7188 | |
| Target Year | 2030 | (Year) |
| Planning Horizon | 26 | (Years) |
| Spencer Interconnect | TRUE | |
| SAVSARP Deep Wells | 15 | |
| Three-Points Wellfield | 2012 | |

## *Overall Output Values* *($millions except where noted)*

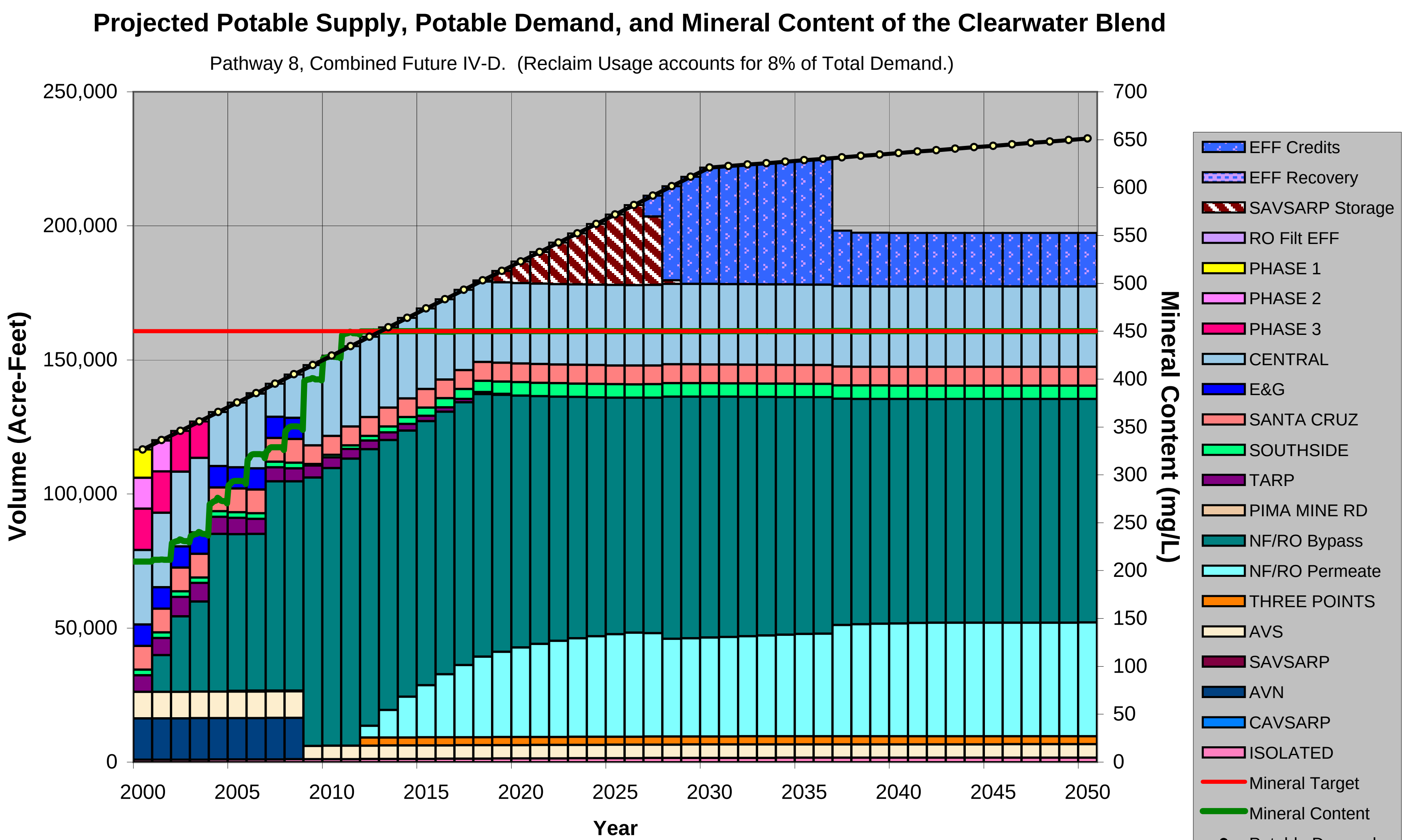
| | |
|---|---|
| Present Worth Capital Cost | $ 314.8 |
| Average Annual O&M Cost | $ 17.4 |
| Present Worth of O&M Costs | $ 216.1 |
| **Total Present Worth** | $ 530.9 |
| Annualized Capital Cost | $ 21.9 |
| Uniform Annualized O&M Cost | $ 15.0 |
| **Total Equivalent Annual Cost** | $ 36.9 |
| **Equivalent Unit Cost** (based on Target Year flows): | |
| $/1,000 gallons | $ 0.86 |
| $/acre-foot | $ 279 |

## *Project Cost Breakdown*

| Project ($1,000s except where noted) | Design Flow (MGD) *[based on max. flow over planning period]* | Average Flow in Target Year (MGD) | Present Worth Capital Cost ($k) | Average Annual O&M Cost ($k/yr) | Present Worth O&M Costs ($k) | **Total Present Worth ($k)** | Annualized Capital Cost ($k/yr) | Uniform Annualized O&M Cost ($k/yr) | **Total Equivalent Annual Cost ($k/yr)** | Equivalent Unit Production Cost (based on Target Year flows) $/1,000 gal | $/acre-ft |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hayden-Udall WTP: | | | | | | | | | | | |
| General Rehabilitation | | | $ 879 | | | $ 879 | $ 61 | | $ 61 | | |
| Primary Disinfection Options | | | | | | | | | | | |
| UV Disinfection | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Giardia & Cryptosporidium) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Taste & Odor) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Chlorination* | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Existing Direct Filtration | 0.0 | 0.0 | | $ - | $ - | $ - | | $ - | $ - | $ - | $ - |
| TDS Removal of CAP Water | | | | | | | | | | | |
| NF/RO (with Existing Direct Filtration) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| NF/RO (with MF/UF Pre-treatment) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| TDS Removal of Recovered Water | | | | | | | | | | | |
| NF/RO for Recovered Water | 68.8 | 38.7 | $ 67,254 | $ 3,206 | $ 34,374 | $ 101,627 | $ 4,678 | $ 2,391 | $ 7,070 | $ 1 | $ 163 |
| Evaporation Ponds | 10.3 | 5.8 | $ 187,763 | $ 1,064 | $ 11,407 | $ 199,170 | $ 13,062 | $ 794 | $ 13,855 | $ 7 | $ 2,131 |
| Secondary Disinfection | | | | | | | | | | | |
| Chlorine | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Chloramines | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Sub-total (Hayden-Udall WTP) | 0.0 | 0.0 | $ 255,896 | $ 4,270 | $ 45,781 | $ 301,676 | $ 17,801 | $ 3,185 | $ 20,986 | $ - | $ - |
| | | | | | | | | | | | |
| CAVSARP | 72.8 | 52.5 | | $ 5,421 | $ 79,598 | $ 79,598 | | $ 5,537 | $ 5,537 | $ 0.29 | $ 94 |
| SAVSARP | 127.9 | 66.5 | $ 37,972 | $ 7,303 | $ 83,813 | $ 121,785 | $ 2,641 | $ 5,830 | $ 8,472 | $ 0.35 | $ 114 |
| Secondary Disinfection- Recovered Water | 188.5 | 113.2 | $ 475 | $ 179 | $ 2,434 | $ 2,909 | $ 33 | $ 169 | $ 202 | $ 0.00 | $ 2 |
| | | | | | | | | | | | |
| Three Points Wellfield | 5.9 | 5.0 | $ 5,249 | $ - | $ 2,612 | $ 7,861 | $ 365 | $ 182 | $ 547 | $ 0.30 | $ 97 |
| Secondary Disinfection- Three Points Wellfield | 5.9 | 5.0 | $ 92 | $ - | $ 63 | $ 155 | $ 6 | $ 4 | $ 11 | $ 0.01 | $ 2 |
| Total Clearwater Production (MGD) | 194.4 | 118.2 | | | | | | | | | |
| | | | | | | | | | | | |
| Spencer Interconnect | | | $ 15,130 | $ 192 | $ 1,827 | $ 16,957 | $ 1,052 | $ 127 | $ 1,180 | | |
| | | | | | | | | | | | |
| TOTAL COSTS** | | | $ 314,814 | $ 17,366 | $ 216,128 | $ 530,942 | $ 21,900 | $ 15,035 | $ 36,935 | $ 0.86 | $ 279 |

* All primary disinfection chlorine costs are included in the secondary disinfection costs when chlorine is the primary disinfectant.

** Equivalent unit production costs in the Total Costs row include Spencer Interconnect costs.






RunDate: 9/13/2004

# CLEARWATER COST MODEL OUTPUT

Add Run to Database | Show Input Form

**Pathway 9**
**Combined Future III-E**

| | | |
|---|---|---|
| ALTERNATIVE NAME | Future III-E | |
| RUN NAME | Run 1 | |
| DATE | 9/10/2004 | |

Final TDS Target from Resource Planning Tool: 650 (mg/L)

## *Input Values*

| | | |
|---|---|---|
| Power Cost for HUWTP | $0.08 | ($/kWh) |
| Labor Rate | $26 | ($/hr) |
| Annual Discount Rate | 0.050 | (per year as decimal) |
| ENR 20 Cities Average Cost Construction Index | 7188 | |
| Target Year | 2030 | (Year) |
| Planning Horizon | 26 | (Years) |
| Spencer Interconnect | TRUE | |
| SAVSARP Deep Wells | 15 | |
| Three-Points Wellfield | 2012 | |

## *Overall Output Values* *($millions except where noted)*

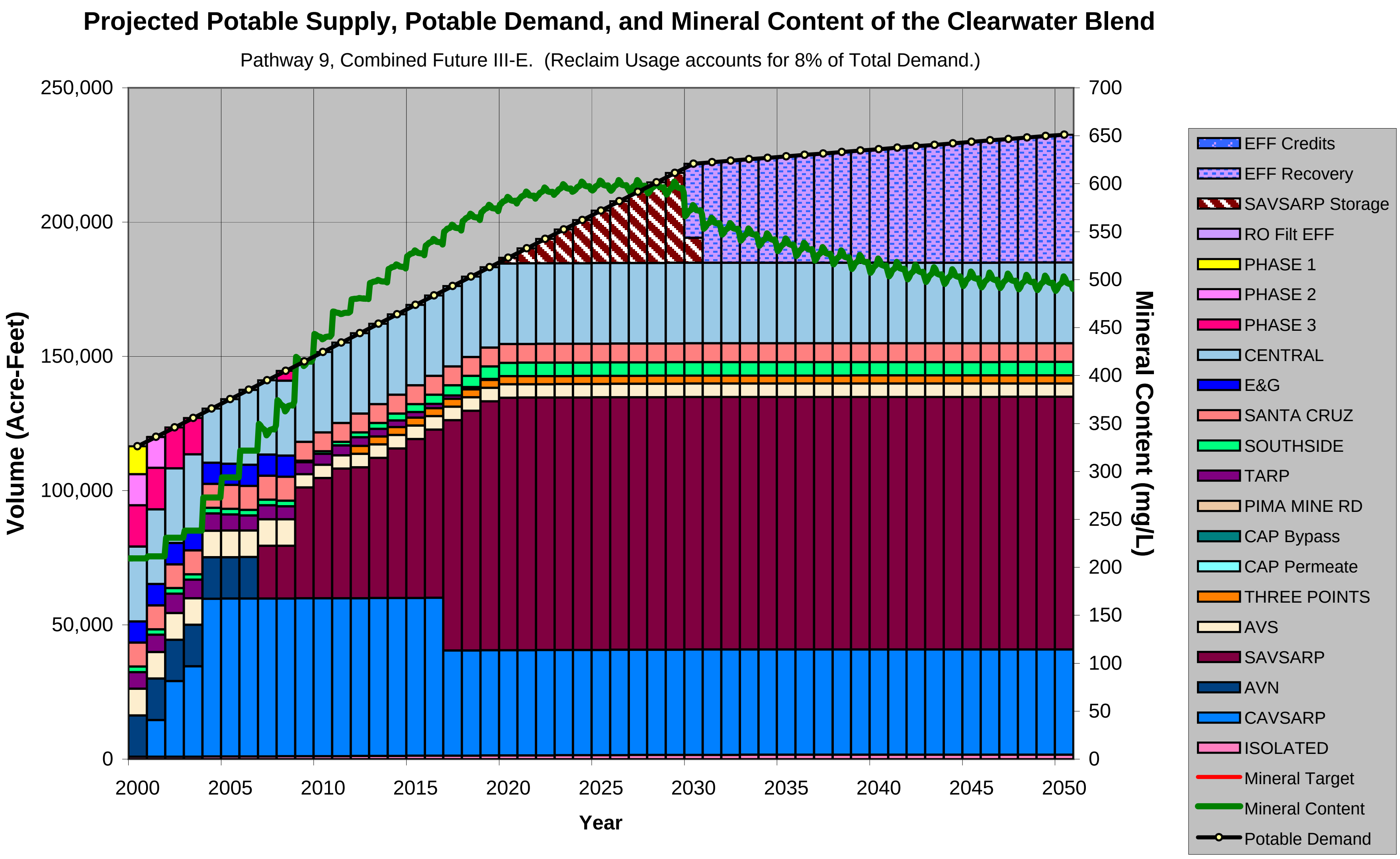
| | |
|---|---|
| Present Worth Capital Cost | $ 58.9 |
| Average Annual O&M Cost | $ 13.3 |
| Present Worth of O&M Costs | $ 169.8 |
| **Total Present Worth** | $ 228.7 |
| Annualized Capital Cost | $ 4.1 |
| Uniform Annualized O&M Cost | $ 11.8 |
| **Total Equivalent Annual Cost** | $ 15.9 |
| **Equivalent Unit Cost** (based on Target Year flows): | |
| $/1,000 gallons | $ 0.28 |
| $/acre-foot | $ 92 |

## *Project Cost Breakdown*

| Project ($1,000s except where noted) | Design Flow (MGD) *[based on max. flow over planning period]* | Average Flow in Target Year (MGD) | Present Worth Capital Cost ($k) | Average Annual O&M Cost ($k/yr) | Present Worth O&M Costs ($k) | **Total Present Worth ($k)** | Annualized Capital Cost ($k/yr) | Uniform Annualized O&M Cost ($k/yr) | **Total Equivalent Annual Cost ($k/yr)** | Equivalent Unit Production Cost (based on Target Year flows) $/1,000 gal | $/acre-ft |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hayden-Udall WTP: | | | | | | | | | | | |
| General Rehabilitation | | | $ - | | | $ - | $ - | | $ - | | |
| Primary Disinfection Options | | | | | | | | | | | |
| UV Disinfection | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Giardia & Cryptosporidium) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Taste & Odor) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Chlorination* | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Existing Direct Filtration | 0.0 | 0.0 | | $ - | $ - | $ - | | $ - | $ - | $ - | $ - |
| TDS Removal of CAP Water | | | | | | | | | | | |
| NF/RO (with Existing Direct Filtration) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| NF/RO (with MF/UF Pre-treatment) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| TDS Removal of Recovered Water | | | | | | | | | | | |
| NF/RO for Recovered Water | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection | | | | | | | | | | | |
| Chlorine | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Chloramines | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Sub-total (Hayden-Udall WTP) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAVSARP | 75.5 | 59.7 | | $ 4,810 | $ 74,835 | $ 74,835 | | $ 5,206 | $ 5,206 | $ 0.24 | $ 78 |
| SAVSARP | 160.3 | 92.3 | $ 37,972 | $ 8,126 | $ 88,182 | $ 126,154 | $ 2,641 | $ 6,134 | $ 8,776 | $ 0.26 | $ 85 |
| Secondary Disinfection- Recovered Water | 205.3 | 152.0 | $ 501 | $ 187 | $ 2,495 | $ 2,997 | $ 35 | $ 174 | $ 208 | $ 0.00 | $ 1 |
| Three Points Wellfield | 3.1 | 2.7 | $ 5,249 | $ - | $ 2,400 | $ 7,649 | $ 365 | $ 167 | $ 532 | $ 0.54 | $ 177 |
| Secondary Disinfection- Three Points Wellfield | 3.1 | 2.7 | $ 86 | $ - | $ 60 | $ 145 | $ 6 | $ 4 | $ 10 | $ 0.01 | $ 3 |
| Total Clearwater Production (MGD) | 208.4 | 154.6 | | | | | | | | | |
| Spencer Interconnect | | | $ 15,130 | $ 192 | $ 1,827 | $ 16,957 | $ 1,052 | $ 127 | $ 1,180 | | |
| TOTAL COSTS** | | | $ 58,937 | $ 13,316 | $ 169,800 | $ 228,737 | $ 4,100 | $ 11,812 | $ 15,912 | $ 0.28 | $ 92 |

* All primary disinfection chlorine costs are included in the secondary disinfection costs when chlorine is the primary disinfectant.

** Equivalent unit production costs in the Total Costs row include Spencer Interconnect costs.






RunDate: 9/10/2004

# CLEARWATER COST MODEL OUTPUT

Add Run to Database

Show Input Form

**Pathway 9**
**Combined Future IV-E**

| | |
|---|---|
| ALTERNATIVE NAME | Future IV-E |
| RUN NAME | Run 1 |
| DATE | 9/10/2004 |

Final TDS Target from Resource Planning Tool: 450 (mg/L)

## *Input Values*

| | | |
|---|---|---|
| Power Cost for HUWTP | $0.08 | ($/kWh) |
| Labor Rate | $26 | ($/hr) |
| Annual Discount Rate | 0.050 | (per year as decimal) |
| ENR 20 Cities Average Cost Construction Index | 7188 | |
| Target Year | 2030 | (Year) |
| Planning Horizon | 26 | (Years) |
| Spencer Interconnect | TRUE | |
| SAVSARP Deep Wells | 15 | |
| Three-Points Wellfield | 2012 | |

## *Overall Output Values* *($millions except where noted)*

| | |
|---|---|
| Present Worth Capital Cost | $ 311.9 |
| Average Annual O&M Cost | $ 18.1 |
| Present Worth of O&M Costs | $ 221.5 |
| **Total Present Worth** | $ 533.4 |
| Annualized Capital Cost | $ 21.7 |
| Uniform Annualized O&M Cost | $ 15.4 |
| **Total Equivalent Annual Cost** | $ 37.1 |
| **Equivalent Unit Cost** (based on Target Year flows): | |
| $/1,000 gallons | $ 0.66 |
| $/acre-foot | $ 216 |

## *Project Cost Breakdown*

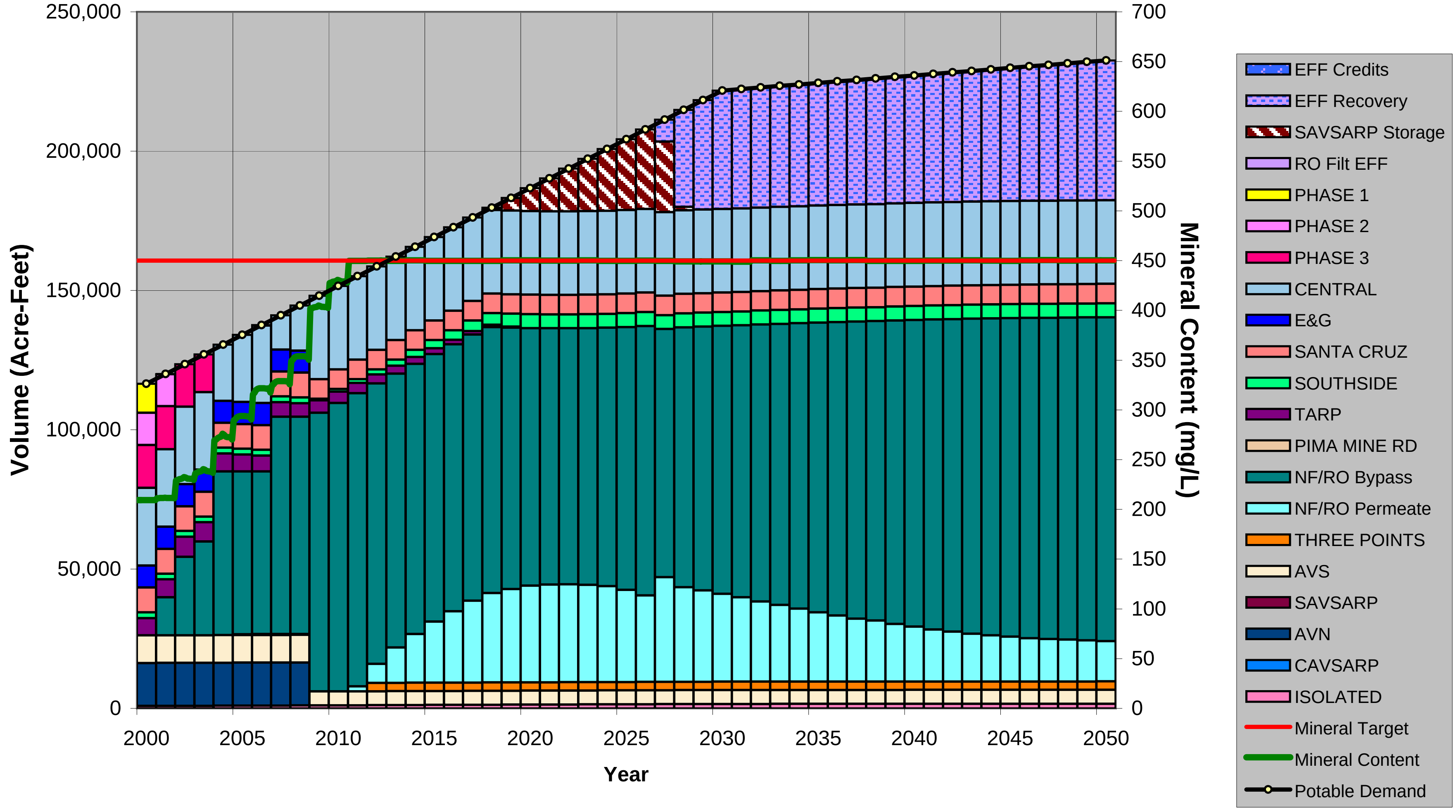
| Project ($1,000s except where noted) | Design Flow (MGD) *[based on max. flow over planning period]* | Average Flow in Target Year (MGD) | Present Worth Capital Cost ($k) | Average Annual O&M Cost ($k/yr) | Present Worth O&M Costs ($k) | **Total Present Worth ($k)** | Annualized Capital Cost ($k/yr) | Uniform Annualized O&M Cost ($k/yr) | **Total Equivalent Annual Cost ($k/yr)** | Equivalent Unit Production Cost (based on Target Year flows) $/1,000 gal | $/acre-ft |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hayden-Udall WTP: | | | | | | | | | | | |
| General Rehabilitation | | | $ 879 | | | $ 879 | $ 61 | | $ 61 | | |
| Primary Disinfection Options | | | | | | | | | | | |
| UV Disinfection | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Giardia & Cryptosporidium) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Taste & Odor) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Chlorination* | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Existing Direct Filtration | 0.0 | 0.0 | | $ - | $ - | $ - | | $ - | $ - | $ - | $ - |
| TDS Removal of CAP Water | | | | | | | | | | | |
| NF/RO (with Existing Direct Filtration) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| NF/RO (with MF/UF Pre-treatment) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| TDS Removal of Recovered Water | | | | | | | | | | | |
| NF/RO for Recovered Water | 67.9 | 43.6 | $ 66,544 | $ 3,292 | $ 35,674 | $ 102,219 | $ 4,629 | $ 2,482 | $ 7,111 | $ 0 | $ 145 |
| Evaporation Ponds | 10.2 | 6.5 | $ 185,547 | $ 1,093 | $ 11,839 | $ 197,386 | $ 12,907 | $ 824 | $ 13,731 | $ 6 | $ 1,873 |
| Secondary Disinfection | | | | | | | | | | | |
| Chlorine | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Chloramines | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Sub-total (Hayden-Udall WTP) | 0.0 | 0.0 | $ 252,970 | $ 4,385 | $ 47,513 | $ 300,483 | $ 17,598 | $ 3,305 | $ 20,903 | $ - | $ - |
| CAVSARP | 100.9 | 73.0 | | $ 4,888 | $ 72,550 | $ 72,550 | | $ 5,047 | $ 5,047 | $ 0.19 | $ 62 |
| SAVSARP | 149.5 | 84.0 | $ 37,972 | $ 8,445 | $ 94,654 | $ 132,626 | $ 2,641 | $ 6,585 | $ 9,226 | $ 0.30 | $ 98 |
| Secondary Disinfection- Recovered Water | 205.3 | 150.4 | $ 501 | $ 186 | $ 2,489 | $ 2,990 | $ 35 | $ 173 | $ 208 | $ 0.00 | $ 1 |
| Three Points Wellfield | 3.1 | 2.7 | $ 5,249 | $ - | $ 2,400 | $ 7,649 | $ 365 | $ 167 | $ 532 | $ 0.54 | $ 177 |
| Secondary Disinfection- Three Points Wellfield | 3.1 | 2.7 | $ 86 | $ - | $ 60 | $ 145 | $ 6 | $ 4 | $ 10 | $ 0.01 | $ 3 |
| Total Clearwater Production (MGD) | 208.4 | 153.1 | | | | | | | | | |
| Spencer Interconnect | | | $ 15,130 | $ 192 | $ 1,827 | $ 16,957 | $ 1,052 | $ 127 | $ 1,180 | | |
| TOTAL COSTS** | | | $ 311,908 | $ 18,097 | $ 221,492 | $ 533,400 | $ 21,698 | $ 15,408 | $ 37,106 | $ 0.66 | $ 216 |

* All primary disinfection chlorine costs are included in the secondary disinfection costs when chlorine is the primary disinfectant.

** Equivalent unit production costs in the Total Costs row include Spencer Interconnect costs.

## Projected Potable Supply, Potable Demand, and Mineral Content of the Clearwater Blend

Pathway 9, Combined Future IV-E. (Reclaim Usage accounts for 8% of Total Demand.)






RunDate: 9/13/2004

# CLEARWATER COST MODEL OUTPUT

Add Run to Database

Show Input Form

## Pathway 10
## Combined Future III-F

| | | |
|---|---|---|
| ALTERNATIVE NAME | Future III-F | |
| RUN NAME | Run 1 | |
| DATE | 9/10/2004 | |

Final TDS Target from Resource Planning Tool: 650 (mg/L)

### *Input Values*

| | | |
|---|---|---|
| Power Cost for HUWTP | $0.08 | ($/kWh) |
| Labor Rate | $26 | ($/hr) |
| Annual Discount Rate | 0.050 | (per year as decimal) |
| ENR 20 Cities Average Cost Construction Index | 7188 | |
| Target Year | 2030 | (Year) |
| Planning Horizon | 26 | (Years) |
| Spencer Interconnect | TRUE | |
| SAVSARP Deep Wells | 15 | |
| Three-Points Wellfield | 2012 | |

### *Overall Output Values* *($millions except where noted)*

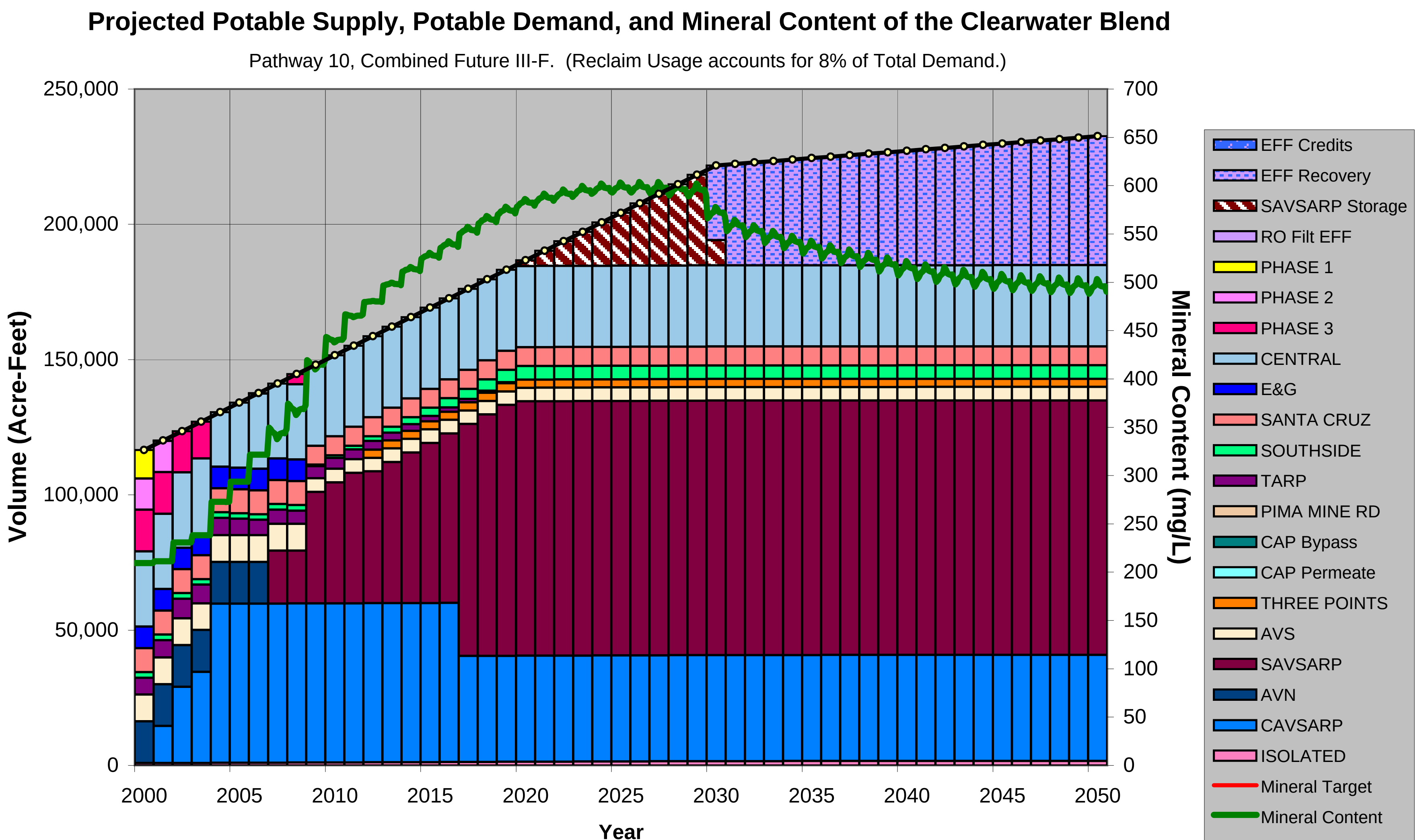
| | |
|---|---|
| Present Worth Capital Cost | $ 58.9 |
| Average Annual O&M Cost | $ 13.3 |
| Present Worth of O&M Costs | $ 169.8 |
| **Total Present Worth** | $ 228.7 |
| Annualized Capital Cost | $ 4.1 |
| Uniform Annualized O&M Cost | $ 11.8 |
| **Total Equivalent Annual Cost** | $ 15.9 |
| **Equivalent Unit Cost** (based on Target Year flows): | |
| $/1,000 gallons | $ 0.28 |
| $/acre-foot | $ 92 |

### *Project Cost Breakdown*

| Project ($1,000s except where noted) | Design Flow (MGD) *[based on max. flow over planning period]* | Average Flow in Target Year (MGD) | Present Worth Capital Cost ($k) | Average Annual O&M Cost ($k/yr) | Present Worth O&M Costs ($k) | **Total Present Worth ($k)** | Annualized Capital Cost ($k/yr) | Uniform Annualized O&M Cost ($k/yr) | **Total Equivalent Annual Cost ($k/yr)** | Equivalent Unit Production Cost (based on Target Year flows) $/1,000 gal | $/acre-ft |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hayden-Udall WTP: | | | | | | | | | | | |
| General Rehabilitation | | | $ - | | | $ - | $ - | | $ - | | |
| Primary Disinfection Options | | | | | | | | | | | |
| UV Disinfection | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Giardia & Cryptosporidium) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Taste & Odor) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Chlorination* | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Existing Direct Filtration | 0.0 | 0.0 | | $ - | $ - | $ - | | $ - | $ - | $ - | $ - |
| TDS Removal of CAP Water | | | | | | | | | | | |
| NF/RO (with Existing Direct Filtration) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| NF/RO (with MF/UF Pre-treatment) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| TDS Removal of Recovered Water | | | | | | | | | | | |
| NF/RO for Recovered Water | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection | | | | | | | | | | | |
| Chlorine | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Chloramines | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Sub-total (Hayden-Udall WTP) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| | | | | | | | | | | | |
| CAVSARP | 75.5 | 59.7 | | $ 4,810 | $ 74,835 | $ 74,835 | | $ 5,206 | $ 5,206 | $ 0.24 | $ 78 |
| SAVSARP | 160.3 | 92.3 | $ 37,972 | $ 8,126 | $ 88,182 | $ 126,154 | $ 2,641 | $ 6,134 | $ 8,776 | $ 0.26 | $ 85 |
| Secondary Disinfection- Recovered Water | 205.3 | 152.0 | $ 501 | $ 187 | $ 2,495 | $ 2,997 | $ 35 | $ 174 | $ 208 | $ 0.00 | $ 1 |
| | | | | | | | | | | | |
| Three Points Wellfield | 3.1 | 2.7 | $ 5,249 | $ - | $ 2,400 | $ 7,649 | $ 365 | $ 167 | $ 532 | $ 0.54 | $ 177 |
| Secondary Disinfection- Three Points Wellfield | 3.1 | 2.7 | $ 86 | $ - | $ 60 | $ 145 | $ 6 | $ 4 | $ 10 | $ 0.01 | $ 3 |
| Total Clearwater Production (MGD) | 208.4 | 154.6 | | | | | | | | | |
| | | | | | | | | | | | |
| Spencer Interconnect | | | $ 15,130 | $ 192 | $ 1,827 | $ 16,957 | $ 1,052 | $ 127 | $ 1,180 | | |
| | | | | | | | | | | | |
| TOTAL COSTS** | | | $ 58,937 | $ 13,316 | $ 169,800 | $ 228,737 | $ 4,100 | $ 11,812 | $ 15,912 | $ 0.28 | $ 92 |

* All primary disinfection chlorine costs are included in the secondary disinfection costs when chlorine is the primary disinfectant.

** Equivalent unit production costs in the Total Costs row include Spencer Interconnect costs.






RunDate: 9/10/2004

# CLEARWATER COST MODEL OUTPUT

Add Run to Database | Show Input Form

**Pathway 10**
**Combined Future IV-F**

| | |
|---|---|
| ALTERNATIVE NAME | Future IV-F |
| RUN NAME | Run 1 |
| DATE | 9/10/2004 |

Final TDS Target from Resource Planning Tool: 450 (mg/L)

## *Input Values*

| | | |
|---|---|---|
| Power Cost for HUWTP | $0.08 | ($/kWh) |
| Labor Rate | $26 | ($/hr) |
| Annual Discount Rate | 0.050 | (per year as decimal) |
| ENR 20 Cities Average Cost Construction Index | 7188 | |
| Target Year | 2030 | (Year) |
| Planning Horizon | 26 | (Years) |
| Spencer Interconnect | TRUE | |
| SAVSARP Deep Wells | 15 | |
| Three-Points Wellfield | 2012 | |

## *Overall Output Values* *($millions except where noted)*

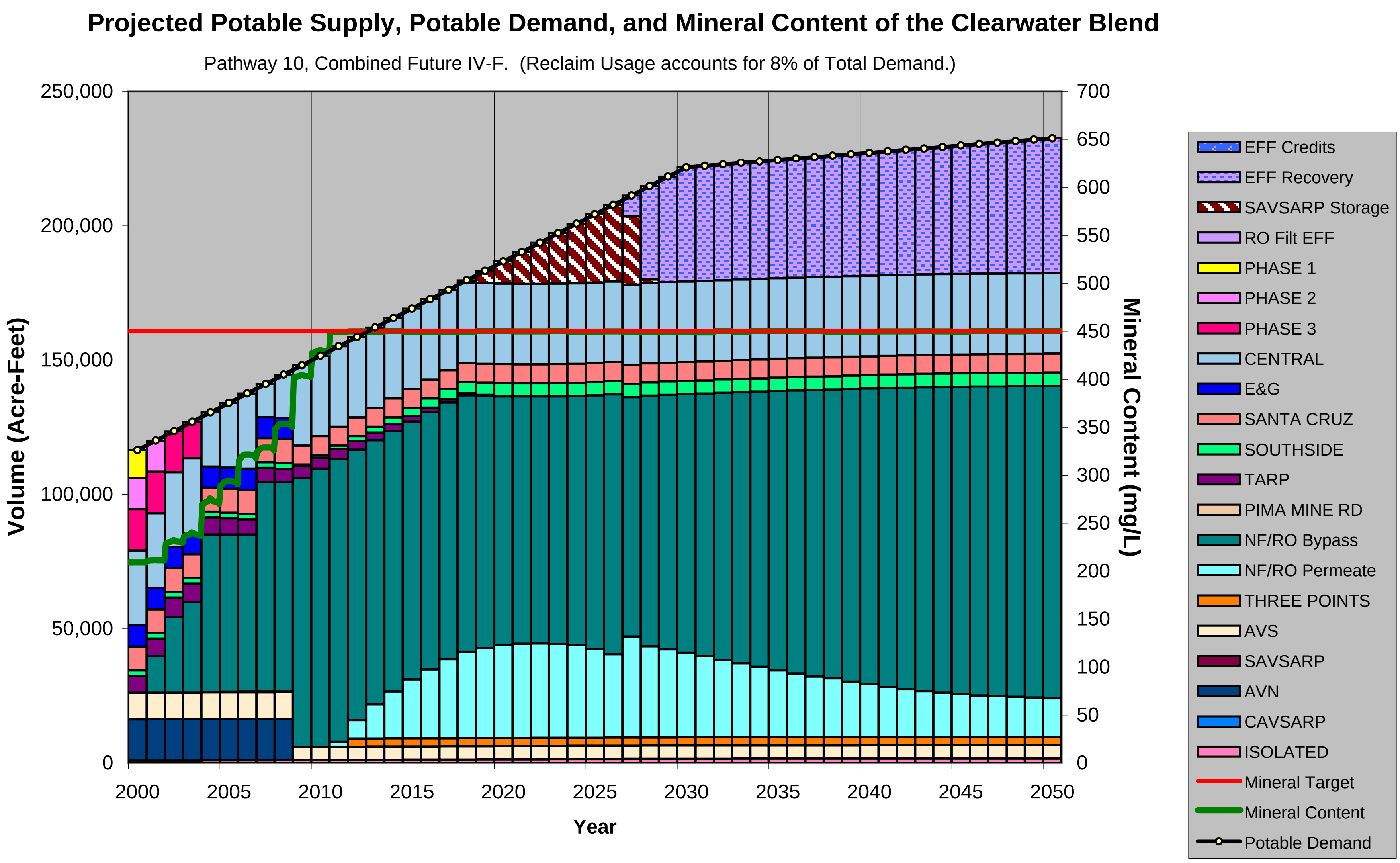
| | |
|---|---|
| Present Worth Capital Cost | $ 311.9 |
| Average Annual O&M Cost | $ 18.1 |
| Present Worth of O&M Costs | $ 221.5 |
| **Total Present Worth** | $ 533.4 |
| Annualized Capital Cost | $ 21.7 |
| Uniform Annualized O&M Cost | $ 15.4 |
| **Total Equivalent Annual Cost** | $ 37.1 |
| **Equivalent Unit Cost** (based on Target Year flows): | |
| $/1,000 gallons | $ 0.66 |
| $/acre-foot | $ 216 |

## *Project Cost Breakdown*

| Project ($1,000s except where noted) | Design Flow (MGD) *[based on max. flow over planning period]* | Average Flow in Target Year (MGD) | Present Worth Capital Cost ($k) | Average Annual O&M Cost ($k/yr) | Present Worth O&M Costs ($k) | **Total Present Worth ($k)** | Annualized Capital Cost ($k/yr) | Uniform Annualized O&M Cost ($k/yr) | **Total Equivalent Annual Cost ($k/yr)** | Equivalent Unit Production Cost (based on Target Year flows) $/1,000 gal | $/acre-ft |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hayden-Udall WTP: | | | | | | | | | | | |
| General Rehabilitation | | | $ 879 | | | $ 879 | $ 61 | | $ 61 | | |
| Primary Disinfection Options | | | | | | | | | | | |
| UV Disinfection | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Giardia & Cryptosporidium) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Taste & Odor) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Chlorination* | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Existing Direct Filtration | 0.0 | 0.0 | | $ - | $ - | $ - | | $ - | $ - | $ - | $ - |
| TDS Removal of CAP Water | | | | | | | | | | | |
| NF/RO (with Existing Direct Filtration) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| NF/RO (with MF/UF Pre-treatment) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| TDS Removal of Recovered Water | | | | | | | | | | | |
| NF/RO for Recovered Water | 67.9 | 43.6 | $ 66,544 | $ 3,292 | $ 35,674 | $ 102,219 | $ 4,629 | $ 2,482 | $ 7,111 | $ 0 | $ 145 |
| Evaporation Ponds | 10.2 | 6.5 | $ 185,547 | $ 1,093 | $ 11,839 | $ 197,386 | $ 12,907 | $ 824 | $ 13,731 | $ 6 | $ 1,873 |
| Secondary Disinfection | | | | | | | | | | | |
| Chlorine | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Chloramines | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Sub-total (Hayden-Udall WTP) | 0.0 | 0.0 | $ 252,970 | $ 4,385 | $ 47,513 | $ 300,483 | $ 17,598 | $ 3,305 | $ 20,903 | $ - | $ - |
| | | | | | | | | | | | |
| CAVSARP | 100.9 | 73.0 | | $ 4,888 | $ 72,550 | $ 72,550 | | $ 5,047 | $ 5,047 | $ 0.19 | $ 62 |
| SAVSARP | 149.5 | 84.0 | $ 37,972 | $ 8,445 | $ 94,654 | $ 132,626 | $ 2,641 | $ 6,585 | $ 9,226 | $ 0.30 | $ 98 |
| Secondary Disinfection- Recovered Water | 205.3 | 150.4 | $ 501 | $ 186 | $ 2,489 | $ 2,990 | $ 35 | $ 173 | $ 208 | $ 0.00 | $ 1 |
| | | | | | | | | | | | |
| Three Points Wellfield | 3.1 | 2.7 | $ 5,249 | $ - | $ 2,400 | $ 7,649 | $ 365 | $ 167 | $ 532 | $ 0.54 | $ 177 |
| Secondary Disinfection- Three Points Wellfield | 3.1 | 2.7 | $ 86 | $ - | $ 60 | $ 145 | $ 6 | $ 4 | $ 10 | $ 0.01 | $ 3 |
| Total Clearwater Production (MGD) | 208.4 | 153.1 | | | | | | | | | |
| | | | | | | | | | | | |
| Spencer Interconnect | | | $ 15,130 | $ 192 | $ 1,827 | $ 16,957 | $ 1,052 | $ 127 | $ 1,180 | | |
| | | | | | | | | | | | |
| TOTAL COSTS** | | | $ 311,908 | $ 18,097 | $ 221,492 | $ 533,400 | $ 21,698 | $ 15,408 | $ 37,106 | $ 0.66 | $ 216 |

* All primary disinfection chlorine costs are included in the secondary disinfection costs when chlorine is the primary disinfectant.

** Equivalent unit production costs in the Total Costs row include Spencer Interconnect costs.






RunDate: 9/13/2004

# CLEARWATER COST MODEL OUTPUT

Add Run to Database | Show Input Form

## Pathway 11
## Combined Future I-E

| | |
|---|---|
| ALTERNATIVE NAME | Future I-E |
| RUN NAME | Run 1 |
| DATE | 9/13/2004 |

Final TDS Target from Resource Planning Tool: 450 (mg/L)

### *Input Values*

| | | |
|---|---|---|
| Power Cost for HUWTP | $0.08 | ($/kWh) |
| Labor Rate | $26 | ($/hr) |
| Annual Discount Rate | 0.050 | (per year as decimal) |
| ENR 20 Cities Average Cost Construction Index | 7188 | |
| Target Year | 2030 | (Year) |
| Planning Horizon | 26 | (Years) |
| Spencer Interconnect | TRUE | |
| SAVSARP Deep Wells | 15 | |
| Three-Points Wellfield | 2012 | |

### *Overall Output Values* *($millions except where noted)*

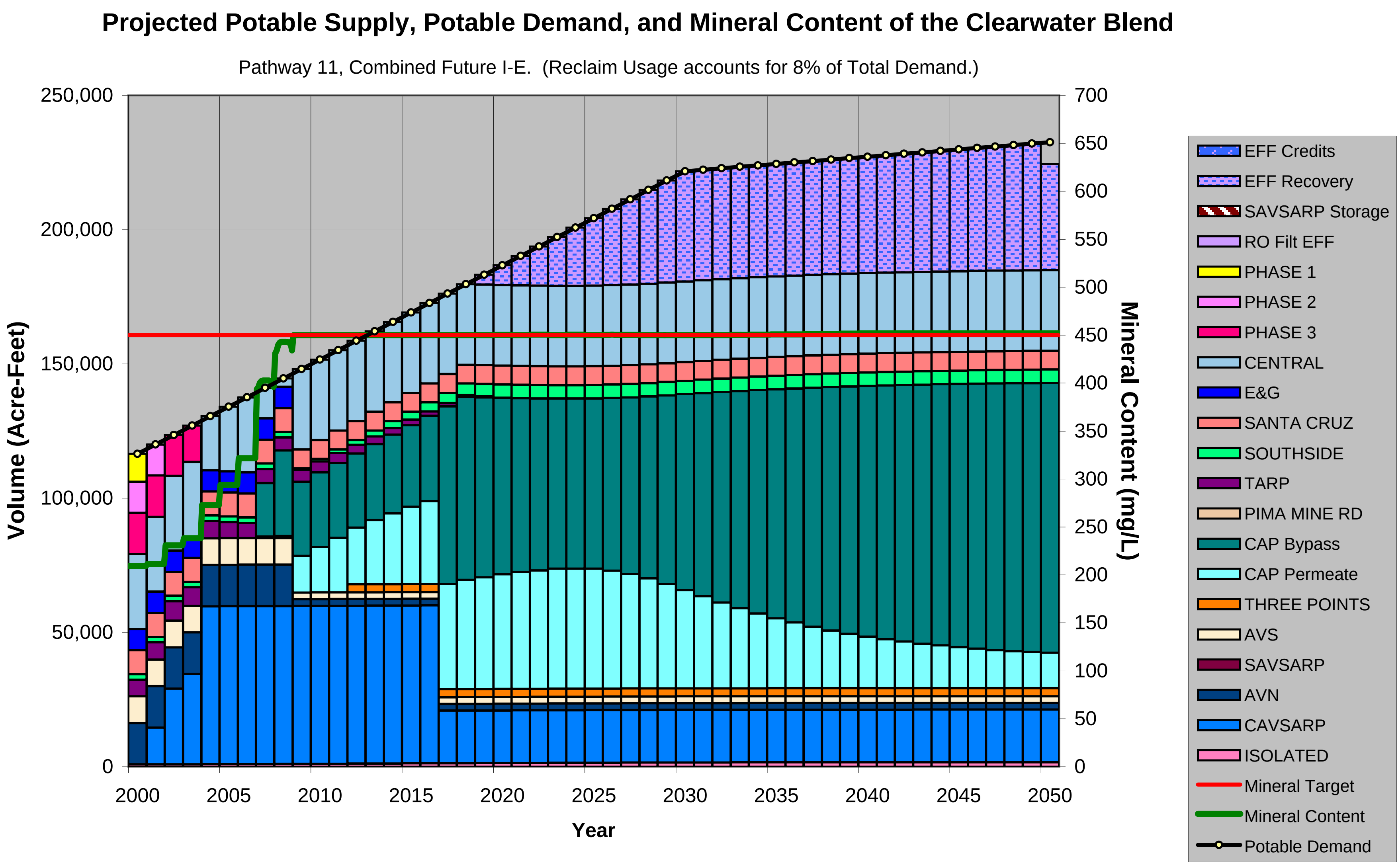
| | |
|---|---|
| Present Worth Capital Cost | $ 245.5 |
| Average Annual O&M Cost | $ 15.8 |
| Present Worth of O&M Costs | $ 194.9 |
| **Total Present Worth** | $ 440.4 |
| Annualized Capital Cost | $ 17.1 |
| Uniform Annualized O&M Cost | $ 13.6 |
| **Total Equivalent Annual Cost** | $ 30.6 |
| **Equivalent Unit Cost** (based on Target Year flows): | |
| $/1,000 gallons | $ 0.54 |
| $/acre-foot | $ 177 |

### *Project Cost Breakdown*

| Project ($1,000s except where noted) | Design Flow (MGD) *[based on max. flow over planning period]* | Average Flow in Target Year (MGD) | Present Worth Capital Cost ($k) | Average Annual O&M Cost ($k/yr) | Present Worth O&M Costs ($k) | **Total Present Worth ($k)** | Annualized Capital Cost ($k/yr) | Uniform Annualized O&M Cost ($k/yr) | **Total Equivalent Annual Cost ($k/yr)** | Equivalent Unit Production Cost (based on Target Year flows): $/1,000 gal | $/acre-ft |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hayden-Udall WTP: | | | | | | | | | | | |
| General Rehabilitation | | | $ 4,480 | | | $ 4,480 | $ 312 | | $ 312 | | |
| Primary Disinfection Options | | | | | | | | | | | |
| UV Disinfection | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Giardia & Cryptosporidium) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Taste & Odor) | 143.5 | 103.5 | $ 2,162 | $ 633 | $ 7,154 | $ 9,316 | $ 150 | $ 498 | $ 648 | $ 0 | $ 6 |
| Chlorination* | 143.5 | 103.5 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Existing Direct Filtration | 143.5 | 103.5 | | $ 3,838 | $ 42,487 | $ 42,487 | | $ 2,956 | $ 2,956 | $ 0 | $ 25 |
| TDS Removal of CAP Water | | | | | | | | | | | |
| NF/RO (with Existing Direct Filtration) | 64.6 | 38.4 | $ 57,629 | $ 4,376 | $ 47,730 | $ 105,360 | $ 4,009 | $ 3,320 | $ 7,329 | $ 1 | $ 170 |
| NF/RO (with MF/UF Pre-treatment) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 9.7 | 5.8 | $ 160,104 | $ 1,452 | $ 15,843 | $ 175,947 | $ 11,138 | $ 1,102 | $ 12,240 | $ 6 | $ 1,896 |
| TDS Removal of Recovered Water | | | | | | | | | | | |
| NF/RO for Recovered Water | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection | | | | | | | | | | | |
| Chlorine | 134.7 | 97.8 | $ 512 | $ 324 | $ 3,576 | $ 4,087 | $ 36 | $ 249 | $ 284 | $ 0 | $ 3 |
| Chloramines | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Sub-total (Hayden-Udall WTP) | 134.7 | 97.8 | $ 224,887 | $ 10,623 | $ 116,789 | $ 341,676 | $ 15,644 | $ 8,124 | $ 23,768 | $ 0.67 | $ 217 |
| CAVSARP | 71.0 | 54.2 | | $ 4,716 | $ 72,650 | $ 72,650 | | $ 5,054 | $ 5,054 | $ 0.26 | $ 83 |
| SAVSARP | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection- Recovered Water | 71.0 | 54.2 | $ 177 | $ 76 | $ 1,134 | $ 1,310 | $ 12 | $ 79 | $ 91 | $ 0.00 | $ 2 |
| Three Points Wellfield | 3.1 | 2.7 | $ 5,249 | $ 221 | $ 2,400 | $ 7,649 | $ 365 | $ 167 | $ 532 | $ 0.54 | $ 177 |
| Secondary Disinfection- Three Points Wellfield | 3.1 | 2.7 | $ 86 | $ 5 | $ 60 | $ 145 | $ 6 | $ 4 | $ 10 | $ 0.01 | $ 3 |
| Total Clearwater Production (MGD) | 208.7 | 154.6 | | | | | | | | | |
| Spencer Interconnect | | | $ 15,130 | $ 192 | $ 1,827 | $ 16,957 | $ 1,052 | $ 127 | $ 1,180 | | |
| TOTAL COSTS** | | | $ 245,528 | $ 15,835 | $ 194,860 | $ 440,389 | $ 17,080 | $ 13,555 | $ 30,635 | $ 0.54 | $ 177 |

* All primary disinfection chlorine costs are included in the secondary disinfection costs when chlorine is the primary disinfectant.

** Equivalent unit production costs in the Total Costs row include Spencer Interconnect costs.






RunDate: 9/13/2004

# CLEARWATER COST MODEL OUTPUT

Add Run to Database

Show Input Form

**Pathway 11**
**Combined Future II-E**

| | | |
|---|---|---|
| ALTERNATIVE NAME | Future II-E | |
| RUN NAME | Run 1 | |
| DATE | 9/13/2004 | |

Final TDS Target from Resource Planning Tool: 650 (mg/L)

***Input Values***

| | | |
|---|---|---|
| Power Cost for HUWTP | $0.08 | ($/kWh) |
| Labor Rate | $26 | ($/hr) |
| Annual Discount Rate | 0.050 | (per year as decimal) |
| ENR 20 Cities Average Cost Construction Index | 7188 | |
| Target Year | 2030 | (Year) |
| Planning Horizon | 26 | (Years) |
| Spencer Interconnect | TRUE | |
| SAVSARP Deep Wells | 15 | |
| Three-Points Wellfield | 2012 | |

***Overall Output Values*** *($millions except where noted)*

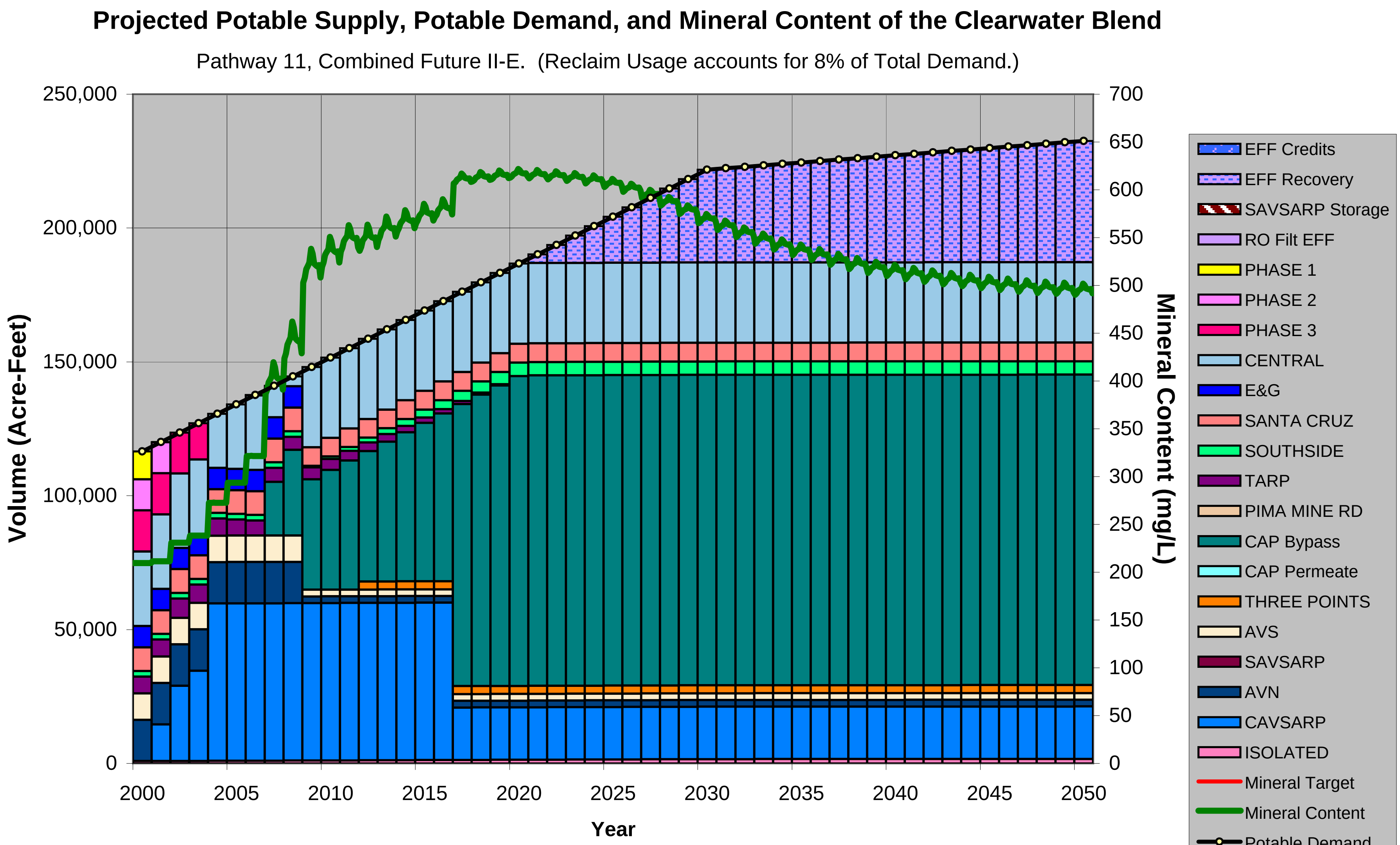
| | |
|---|---|
| Present Worth Capital Cost | $ 27.8 |
| Average Annual O&M Cost | $ 9.6 |
| Present Worth of O&M Costs | $ 126.6 |
| **Total Present Worth** | $ 154.4 |
| Annualized Capital Cost | $ 1.9 |
| Uniform Annualized O&M Cost | $ 8.8 |
| **Total Equivalent Annual Cost** | $ 10.7 |
| **Equivalent Unit Cost** (based on Target Year flows): | |
| $/1,000 gallons | $ 0.19 |
| $/acre-foot | $ 62 |

***Project Cost Breakdown***

| Project ($1,000s except where noted) | Design Flow (MGD) *[based on max. flow over planning period]* | Average Flow in Target Year (MGD) | Present Worth Capital Cost ($k) | Average Annual O&M Cost ($k/yr) | Present Worth O&M Costs ($k) | **Total Present Worth ($k)** | Annualized Capital Cost ($k/yr) | Uniform Annualized O&M Cost ($k/yr) | **Total Equivalent Annual Cost ($k/yr)** | Equivalent Unit Production Cost (based on Target Year flows) $/1,000 gal | $/acre-ft |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hayden-Udall WTP: | | | | | | | | | | | |
| General Rehabilitation | | | $ 4,480 | | | $ 4,480 | $ 312 | | $ 312 | | |
| Primary Disinfection Options | | | | | | | | | | | |
| UV Disinfection | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Giardia & Cryptosporidium) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Taste & Odor) | 143.1 | 103.5 | $ 2,162 | $ 620 | $ 6,955 | $ 9,116 | $ 150 | $ 484 | $ 634 | $ 0 | $ 5 |
| Chlorination* | 143.1 | 103.5 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Existing Direct Filtration | 143.1 | 103.5 | | $ 3,748 | $ 41,176 | $ 41,176 | | $ 2,864 | $ 2,864 | $ 0 | $ 25 |
| TDS Removal of CAP Water | | | | | | | | | | | |
| NF/RO (with Existing Direct Filtration) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| NF/RO (with MF/UF Pre-treatment) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| TDS Removal of Recovered Water | | | | | | | | | | | |
| NF/RO for Recovered Water | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection | | | | | | | | | | | |
| Chlorine | 143.1 | 103.5 | $ 526 | $ 337 | $ 3,696 | $ 4,222 | $ 37 | $ 257 | $ 294 | $ 0 | $ 3 |
| Chloramines | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Sub-total (Hayden-Udall WTP) | 143.1 | 103.5 | $ 7,168 | $ 4,705 | $ 51,826 | $ 58,995 | $ 499 | $ 3,605 | $ 4,104 | $ 0.11 | $ 35 |
| CAVSARP | 62.9 | 48.4 | | $ 4,408 | $ 69,450 | $ 69,450 | | $ 4,831 | $ 4,831 | $ 0.27 | $ 89 |
| SAVSARP | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection- Recovered Water | 62.9 | 48.4 | $ 149 | $ 72 | $ 1,085 | $ 1,234 | $ 10 | $ 75 | $ 86 | $ 0.00 | $ 2 |
| Three Points Wellfield | 3.1 | 2.7 | $ 5,249 | $ 221 | $ 2,400 | $ 7,649 | $ 365 | $ 167 | $ 532 | $ 0.54 | $ 177 |
| Secondary Disinfection- Three Points Wellfield | 3.1 | 2.7 | $ 86 | $ 5 | $ 60 | $ 145 | $ 6 | $ 4 | $ 10 | $ 0.01 | $ 3 |
| Total Clearwater Production (MGD) | 209.2 | 154.6 | | | | | | | | | |
| Spencer Interconnect | | | $ 15,130 | $ 192 | $ 1,827 | $ 16,957 | $ 1,052 | $ 127 | $ 1,180 | | |
| TOTAL COSTS** | | | $ 27,781 | $ 9,603 | $ 126,649 | $ 154,430 | $ 1,933 | $ 8,810 | $ 10,743 | $ 0.19 | $ 62 |

* All primary disinfection chlorine costs are included in the secondary disinfection costs when chlorine is the primary disinfectant.

** Equivalent unit production costs in the Total Costs row include Spencer Interconnect costs.






RunDate: 9/13/2004

# CLEARWATER COST MODEL OUTPUT

Add Run to Database | Show Input Form

**Pathway 12**
**Combined Future I-F**

| | |
|---|---|
| ALTERNATIVE NAME | Future I-F |
| RUN NAME | Run 1 |
| DATE | 9/13/2004 |

Final TDS Target from Resource Planning Tool: 450 (mg/L)

### *Input Values*

| | | |
|---|---|---|
| Power Cost for HUWTP | $0.08 | ($/kWh) |
| Labor Rate | $26 | ($/hr) |
| Annual Discount Rate | 0.050 | (per year as decimal) |
| ENR 20 Cities Average Cost Construction Index | 7188 | |
| Target Year | 2030 | (Year) |
| Planning Horizon | 26 | (Years) |
| Spencer Interconnect | TRUE | |
| SAVSARP Deep Wells | 15 | |
| Three-Points Wellfield | 2012 | |

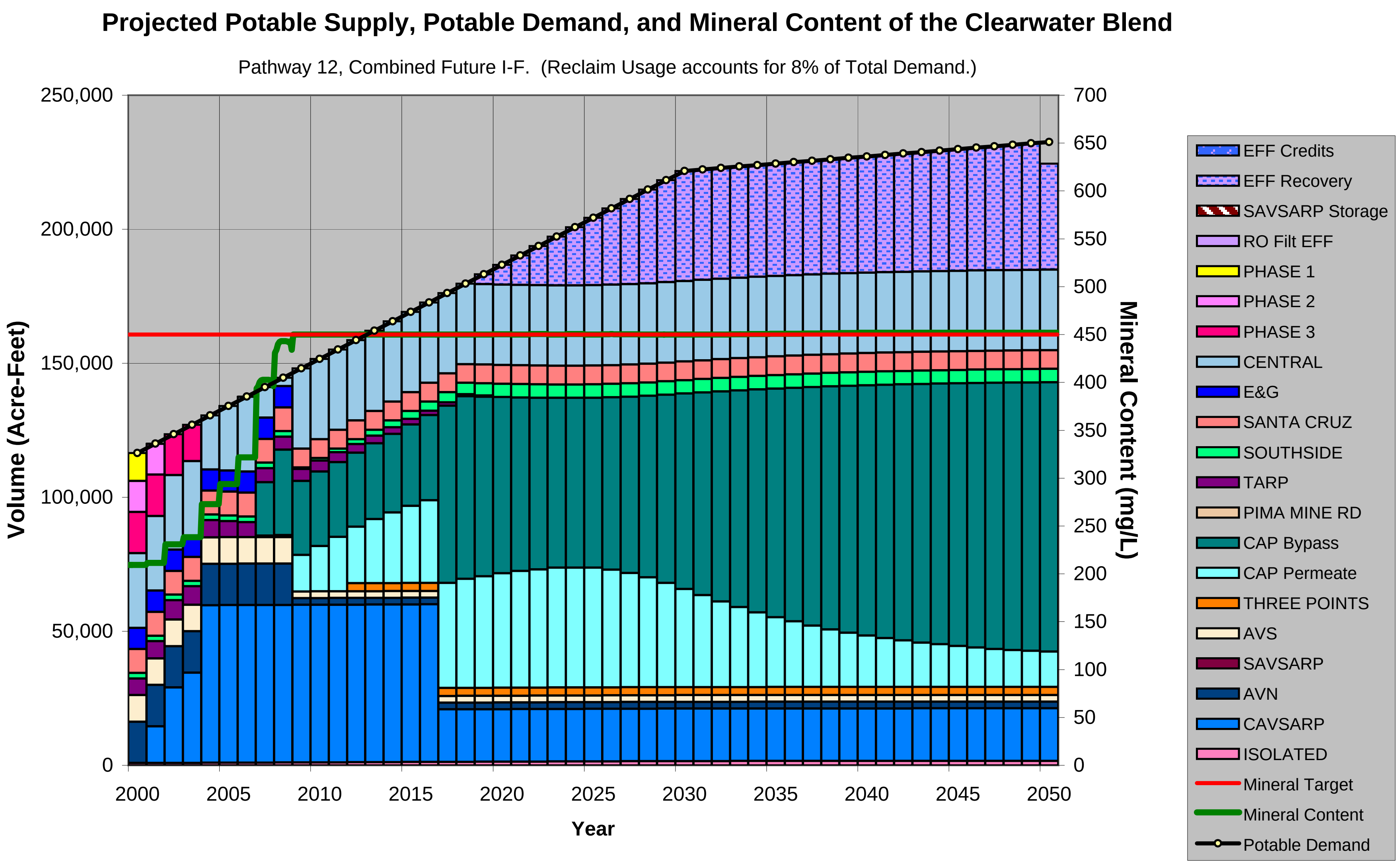
### *Overall Output Values* *($millions except where noted)*

| | |
|---|---|
| Present Worth Capital Cost | $ 245.5 |
| Average Annual O&M Cost | $ 15.8 |
| Present Worth of O&M Costs | $ 194.9 |
| **Total Present Worth** | $ 440.4 |
| Annualized Capital Cost | $ 17.1 |
| Uniform Annualized O&M Cost | $ 13.6 |
| **Total Equivalent Annual Cost** | $ 30.6 |
| **Equivalent Unit Cost** (based on Target Year flows): | |
| $/1,000 gallons | $ 0.54 |
| $/acre-foot | $ 177 |

### *Project Cost Breakdown*

| Project ($1,000s except where noted) | Design Flow (MGD) *[based on max. flow over planning period]* | Average Flow in Target Year (MGD) | Present Worth Capital Cost ($k) | Average Annual O&M Cost ($k/yr) | Present Worth O&M Costs ($k) | **Total Present Worth ($k)** | Annualized Capital Cost ($k/yr) | Uniform Annualized O&M Cost ($k/yr) | **Total Equivalent Annual Cost ($k/yr)** | Equivalent Unit Production Cost (based on Target Year flows) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hayden-Udall WTP: | | | | | | | | | | $/1,000 gal | $/acre-ft |
| General Rehabilitation | | | $ 4,480 | | | $ 4,480 | $ 312 | | $ 312 | | |
| Primary Disinfection Options | | | | | | | | | | | |
| UV Disinfection | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Giardia & Cryptosporidium) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Taste & Odor) | 143.5 | 103.5 | $ 2,162 | $ 633 | $ 7,154 | $ 9,316 | $ 150 | $ 498 | $ 648 | $ 0 | $ 6 |
| Chlorination* | 143.5 | 103.5 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Existing Direct Filtration | 143.5 | 103.5 | | $ 3,838 | $ 42,487 | $ 42,487 | | $ 2,956 | $ 2,956 | $ 0 | $ 25 |
| TDS Removal of CAP Water | | | | | | | | | | | |
| NF/RO (with Existing Direct Filtration) | 64.6 | 38.4 | $ 57,629 | $ 4,376 | $ 47,730 | $ 105,360 | $ 4,009 | $ 3,320 | $ 7,329 | $ 1 | $ 170 |
| NF/RO (with MF/UF Pre-treatment) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 9.7 | 5.8 | $ 160,104 | $ 1,452 | $ 15,843 | $ 175,947 | $ 11,138 | $ 1,102 | $ 12,240 | $ 6 | $ 1,896 |
| TDS Removal of Recovered Water | | | | | | | | | | | |
| NF/RO for Recovered Water | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection | | | | | | | | | | | |
| Chlorine | 134.7 | 97.8 | $ 512 | $ 324 | $ 3,576 | $ 4,087 | $ 36 | $ 249 | $ 284 | $ 0 | $ 3 |
| Chloramines | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Sub-total (Hayden-Udall WTP) | 134.7 | 97.8 | $ 224,887 | $ 10,623 | $ 116,789 | $ 341,676 | $ 15,644 | $ 8,124 | $ 23,768 | $ 0.67 | $ 217 |
| | | | | | | | | | | | |
| CAVSARP | 71.0 | 54.2 | | $ 4,716 | $ 72,650 | $ 72,650 | | $ 5,054 | $ 5,054 | $ 0.26 | $ 83 |
| SAVSARP | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection- Recovered Water | 71.0 | 54.2 | $ 177 | $ 76 | $ 1,134 | $ 1,310 | $ 12 | $ 79 | $ 91 | $ 0.00 | $ 2 |
| | | | | | | | | | | | |
| Three Points Wellfield | 3.1 | 2.7 | $ 5,249 | $ 221 | $ 2,400 | $ 7,649 | $ 365 | $ 167 | $ 532 | $ 0.54 | $ 177 |
| Secondary Disinfection- Three Points Wellfield | 3.1 | 2.7 | $ 86 | $ 5 | $ 60 | $ 145 | $ 6 | $ 4 | $ 10 | $ 0.01 | $ 3 |
| Total Clearwater Production (MGD) | 208.7 | 154.6 | | | | | | | | | |
| | | | | | | | | | | | |
| Spencer Interconnect | | | $ 15,130 | $ 192 | $ 1,827 | $ 16,957 | $ 1,052 | $ 127 | $ 1,180 | | |
| | | | | | | | | | | | |
| TOTAL COSTS** | | | $ 245,528 | $ 15,835 | $ 194,860 | $ 440,389 | $ 17,080 | $ 13,555 | $ 30,635 | $ 0.54 | $ 177 |

* All primary disinfection chlorine costs are included in the secondary disinfection costs when chlorine is the primary disinfectant.
** Equivalent unit production costs in the Total Costs row include Spencer Interconnect costs.






RunDate: 9/13/2004

# CLEARWATER COST MODEL OUTPUT

Add Run to Database | Show Input Form

**Pathway 12**
**Combined Future II-F**

| | | |
|---|---|---|
| ALTERNATIVE NAME | Future II-F | |
| RUN NAME | Run 1 | |
| DATE | 9/13/2004 | |

Final TDS Target from Resource Planning Tool: 650 (mg/L)

## *Input Values*

| | | |
|---|---|---|
| Power Cost for HUWTP | $0.08 | ($/kWh) |
| Labor Rate | $26 | ($/hr) |
| Annual Discount Rate | 0.050 | (per year as decimal) |
| ENR 20 Cities Average Cost Construction Index | 7188 | |
| Target Year | 2030 | (Year) |
| Planning Horizon | 26 | (Years) |
| Spencer Interconnect | TRUE | |
| SAVSARP Deep Wells | 15 | |
| Three-Points Wellfield | 2012 | |

## *Overall Output Values* *($millions except where noted)*

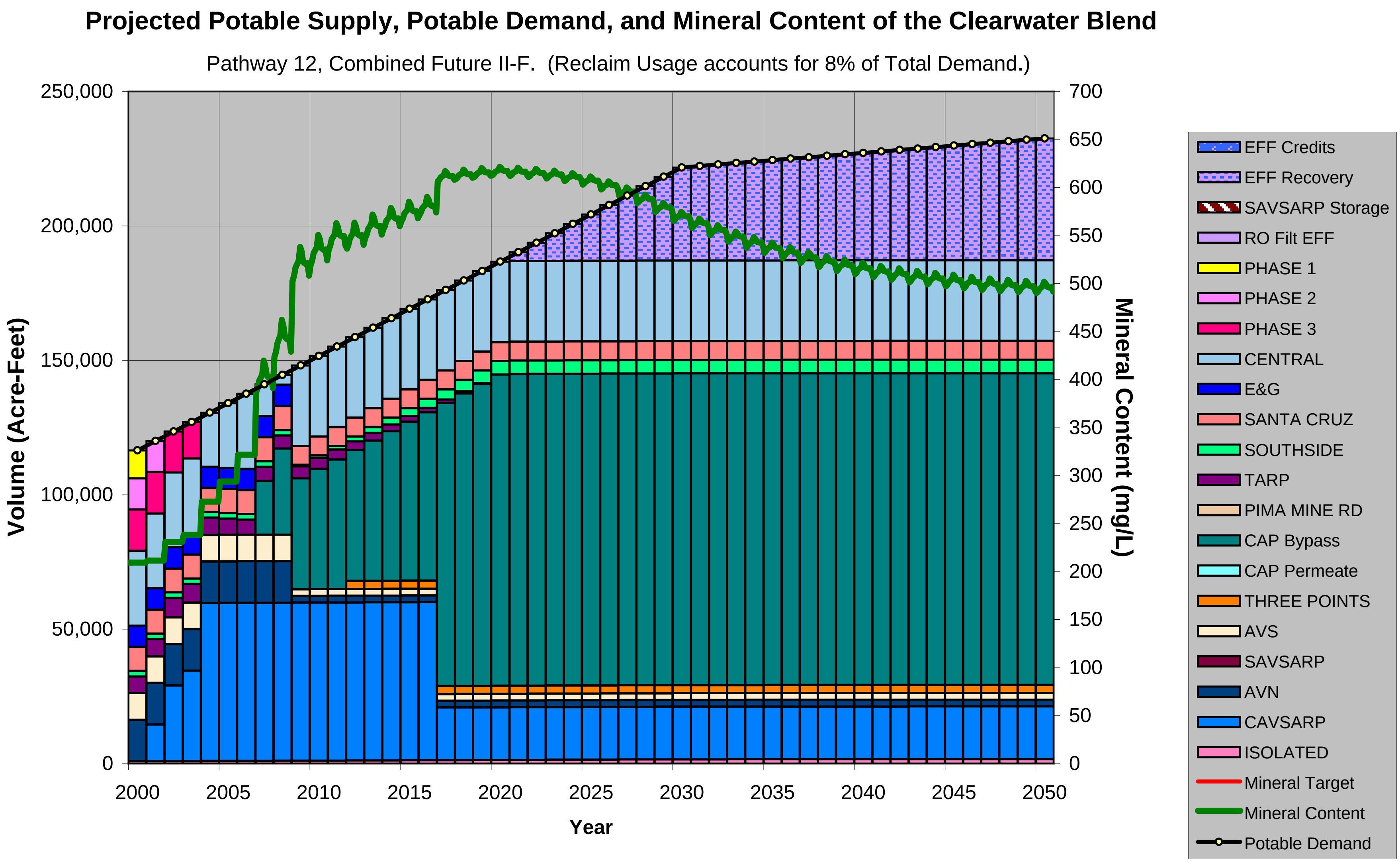
| | |
|---|---|
| Present Worth Capital Cost | $ 27.8 |
| Average Annual O&M Cost | $ 9.6 |
| Present Worth of O&M Costs | $ 126.6 |
| **Total Present Worth** | $ 154.4 |
| Annualized Capital Cost | $ 1.9 |
| Uniform Annualized O&M Cost | $ 8.8 |
| **Total Equivalent Annual Cost** | $ 10.7 |
| **Equivalent Unit Cost** (based on Target Year flows): | |
| $/1,000 gallons | $ 0.19 |
| $/acre-foot | $ 62 |

## *Project Cost Breakdown*

| Project ($1,000s except where noted) | Design Flow (MGD) *[based on max. flow over planning period]* | Average Flow in Target Year (MGD) | Present Worth Capital Cost ($k) | Average Annual O&M Cost ($k/yr) | Present Worth O&M Costs ($k) | **Total Present Worth ($k)** | Annualized Capital Cost ($k/yr) | Uniform Annualized O&M Cost ($k/yr) | **Total Equivalent Annual Cost ($k/yr)** | Equivalent Unit Production Cost (based on Target Year flows) $/1,000 gal | $/acre-ft |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hayden-Udall WTP: | | | | | | | | | | | |
| General Rehabilitation | | | $ 4,480 | | | $ 4,480 | $ 312 | | $ 312 | | |
| Primary Disinfection Options | | | | | | | | | | | |
| UV Disinfection | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Giardia & Cryptosporidium) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Taste & Odor) | 143.1 | 103.5 | $ 2,162 | $ 620 | $ 6,955 | $ 9,116 | $ 150 | $ 484 | $ 634 | $ 0 | $ 5 |
| Chlorination* | 143.1 | 103.5 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Existing Direct Filtration | 143.1 | 103.5 | | $ 3,748 | $ 41,176 | $ 41,176 | | $ 2,864 | $ 2,864 | $ 0 | $ 25 |
| TDS Removal of CAP Water | | | | | | | | | | | |
| NF/RO (with Existing Direct Filtration) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| NF/RO (with MF/UF Pre-treatment) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| TDS Removal of Recovered Water | | | | | | | | | | | |
| NF/RO for Recovered Water | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection | | | | | | | | | | | |
| Chlorine | 143.1 | 103.5 | $ 526 | $ 337 | $ 3,696 | $ 4,222 | $ 37 | $ 257 | $ 294 | $ 0 | $ 3 |
| Chloramines | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Sub-total (Hayden-Udall WTP) | 143.1 | 103.5 | $ 7,168 | $ 4,705 | $ 51,826 | $ 58,995 | $ 499 | $ 3,605 | $ 4,104 | $ 0.11 | $ 35 |
| CAVSARP | 62.9 | 48.4 | | $ 4,408 | $ 69,450 | $ 69,450 | | $ 4,831 | $ 4,831 | $ 0.27 | $ 89 |
| SAVSARP | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection- Recovered Water | 62.9 | 48.4 | $ 149 | $ 72 | $ 1,085 | $ 1,234 | $ 10 | $ 75 | $ 86 | $ 0.00 | $ 2 |
| Three Points Wellfield | 3.1 | 2.7 | $ 5,249 | $ 221 | $ 2,400 | $ 7,649 | $ 365 | $ 167 | $ 532 | $ 0.54 | $ 177 |
| Secondary Disinfection- Three Points Wellfield | 3.1 | 2.7 | $ 86 | $ 5 | $ 60 | $ 145 | $ 6 | $ 4 | $ 10 | $ 0.01 | $ 3 |
| Total Clearwater Production (MGD) | 209.2 | 154.6 | | | | | | | | | |
| Spencer Interconnect | | | $ 15,130 | $ 192 | $ 1,827 | $ 16,957 | $ 1,052 | $ 127 | $ 1,180 | | |
| TOTAL COSTS** | | | $ 27,781 | $ 9,603 | $ 126,649 | $ 154,430 | $ 1,933 | $ 8,810 | $ 10,743 | $ 0.19 | $ 62 |

* All primary disinfection chlorine costs are included in the secondary disinfection costs when chlorine is the primary disinfectant.

** Equivalent unit production costs in the Total Costs row include Spencer Interconnect costs.






RunDate: 9/13/2004

# CLEARWATER COST MODEL OUTPUT

Add Run to Database | Show Input Form

**Pathway 13**
**Combined Future I-G**

| | | |
|---|---|---|
| ALTERNATIVE NAME | Future I-G | |
| RUN NAME | Run 1 | |
| DATE | 9/13/2004 | |

Final TDS Target from Resource Planning Tool: 450 (mg/L)

## *Input Values*

| | | |
|---|---|---|
| Power Cost for HUWTP | $0.08 | ($/kWh) |
| Labor Rate | $26 | ($/hr) |
| Annual Discount Rate | 0.050 | (per year as decimal) |
| ENR 20 Cities Average Cost Construction Index | 7188 | |
| Target Year | 2030 | (Year) |
| Planning Horizon | 26 | (Years) |
| Spencer Interconnect | TRUE | |
| SAVSARP Deep Wells | 15 | |
| Three-Points Wellfield | 2012 | |

## *Overall Output Values* *($millions except where noted)*

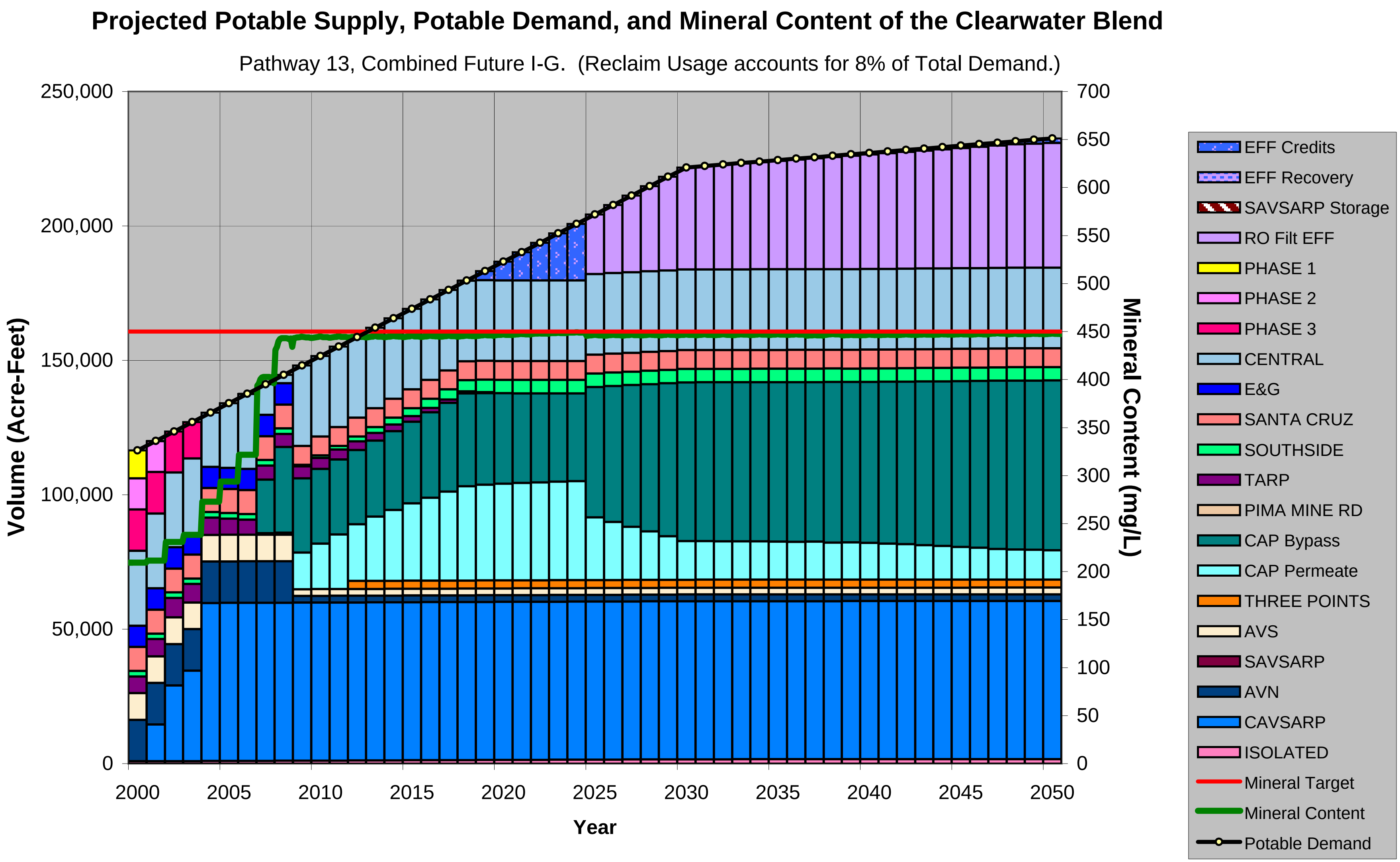
| | |
|---|---|
| Present Worth Capital Cost | $ 209.4 |
| Average Annual O&M Cost | $ 14.2 |
| Present Worth of O&M Costs | $ 183.9 |
| **Total Present Worth** | $ 393.2 |
| Annualized Capital Cost | $ 14.6 |
| Uniform Annualized O&M Cost | $ 12.8 |
| **Total Equivalent Annual Cost** | $ 27.4 |
| **Equivalent Unit Cost** (based on Target Year flows): | |
| $/1,000 gallons | $ 0.62 |
| $/acre-foot | $ 202 |

## *Project Cost Breakdown*

| Project ($1,000s except where noted) | Design Flow (MGD) *[based on max. flow over planning period]* | Average Flow in Target Year (MGD) | Present Worth Capital Cost ($k) | Average Annual O&M Cost ($k/yr) | Present Worth O&M Costs ($k) | **Total Present Worth ($k)** | Annualized Capital Cost ($k/yr) | Uniform Annualized O&M Cost ($k/yr) | **Total Equivalent Annual Cost ($k/yr)** | Equivalent Unit Production Cost (based on Target Year flows) $/1,000 gal | $/acre-ft |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hayden-Udall WTP: | | | | | | | | | | | |
| General Rehabilitation | | | $ 4,480 | | | $ 4,480 | $ 312 | | $ 312 | | |
| Primary Disinfection Options | | | | | | | | | | | |
| UV Disinfection | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Giardia & Cryptosporidium) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Taste & Odor) | 102.0 | 67.8 | $ 2,162 | $ 498 | $ 5,876 | $ 8,038 | $ 150 | $ 409 | $ 559 | $ 0 | $ 7 |
| Chlorination* | 102.0 | 67.8 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Existing Direct Filtration | 102.0 | 67.8 | | $ 2,854 | $ 33,184 | $ 33,184 | | $ 2,308 | $ 2,308 | $ 0 | $ 30 |
| TDS Removal of CAP Water | | | | | | | | | | | |
| NF/RO (with Existing Direct Filtration) | 53.7 | 15.1 | $ 48,696 | $ 3,300 | $ 38,562 | $ 87,257 | $ 3,387 | $ 2,683 | $ 6,070 | $ 1 | $ 359 |
| NF/RO (with MF/UF Pre-treatment) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 8.1 | 2.3 | $ 132,990 | $ 1,095 | $ 12,798 | $ 145,788 | $ 9,251 | $ 890 | $ 10,142 | $ 12 | $ 3,995 |
| TDS Removal of Recovered Water | | | | | | | | | | | |
| NF/RO for Recovered Water | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection | | | | | | | | | | | |
| Chlorine | 95.5 | 65.6 | $ 428 | $ 238 | $ 2,765 | $ 3,193 | $ 30 | $ 192 | $ 222 | $ 0 | $ 3 |
| Chloramines | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Sub-total (Hayden-Udall WTP) | 95.5 | 65.6 | $ 188,756 | $ 7,986 | $ 93,185 | $ 281,941 | $ 13,131 | $ 6,482 | $ 19,613 | $ 0.82 | $ 267 |
| | | | | | | | | | | | |
| CAVSARP | 61.2 | 52.5 | | $ 5,696 | $ 84,906 | $ 84,906 | | $ 5,906 | $ 5,906 | $ 0.31 | $ 100 |
| SAVSARP | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection- Recovered Water | 61.2 | 52.5 | $ 143 | $ 92 | $ 1,319 | $ 1,462 | $ 10 | $ 92 | $ 102 | $ 0.01 | $ 2 |
| | | | | | | | | | | | |
| Three Points Wellfield | 4.5 | 2.7 | $ 5,249 | $ 239 | $ 2,570 | $ 7,820 | $ 365 | $ 179 | $ 544 | $ 0.56 | $ 181 |
| Secondary Disinfection- Three Points Wellfield | 4.5 | 2.7 | $ 89 | $ 6 | $ 62 | $ 151 | $ 6 | $ 4 | $ 11 | $ 0.01 | $ 4 |
| Total Clearwater Production (MGD) | 161.2 | 120.7 | | | | | | | | | |
| | | | | | | | | | | | |
| Spencer Interconnect | | | $ 15,130 | $ 192 | $ 1,827 | $ 16,957 | $ 1,052 | $ 127 | $ 1,180 | | |
| | | | | | | | | | | | |
| TOTAL COSTS** | | | $ 209,366 | $ 14,210 | $ 183,871 | $ 393,237 | $ 14,564 | $ 12,791 | $ 27,355 | $ 0.62 | $ 202 |

* All primary disinfection chlorine costs are included in the secondary disinfection costs when chlorine is the primary disinfectant.

** Equivalent unit production costs in the Total Costs row include Spencer Interconnect costs.






RunDate: 9/13/2004

# CLEARWATER COST MODEL OUTPUT

Add Run to Database

Show Input Form

## Pathway 13
## Combined Future II-G

| | | |
|---|---|---|
| ALTERNATIVE NAME | Future II-G | |
| RUN NAME | Run 1 | |
| DATE | 9/13/2004 | |

Final TDS Target from Resource Planning Tool: 650 (mg/L)

### *Input Values*

| | | |
|---|---|---|
| Power Cost for HUWTP | $0.08 | ($/kWh) |
| Labor Rate | $26 | ($/hr) |
| Annual Discount Rate | 0.050 | (per year as decimal) |
| ENR 20 Cities Average Cost Construction Index | 7188 | |
| Target Year | 2030 | (Year) |
| Planning Horizon | 26 | (Years) |
| Spencer Interconnect | TRUE | |
| SAVSARP Deep Wells | 15 | |
| Three-Points Wellfield | 2012 | |

### *Overall Output Values* *($millions except where noted)*

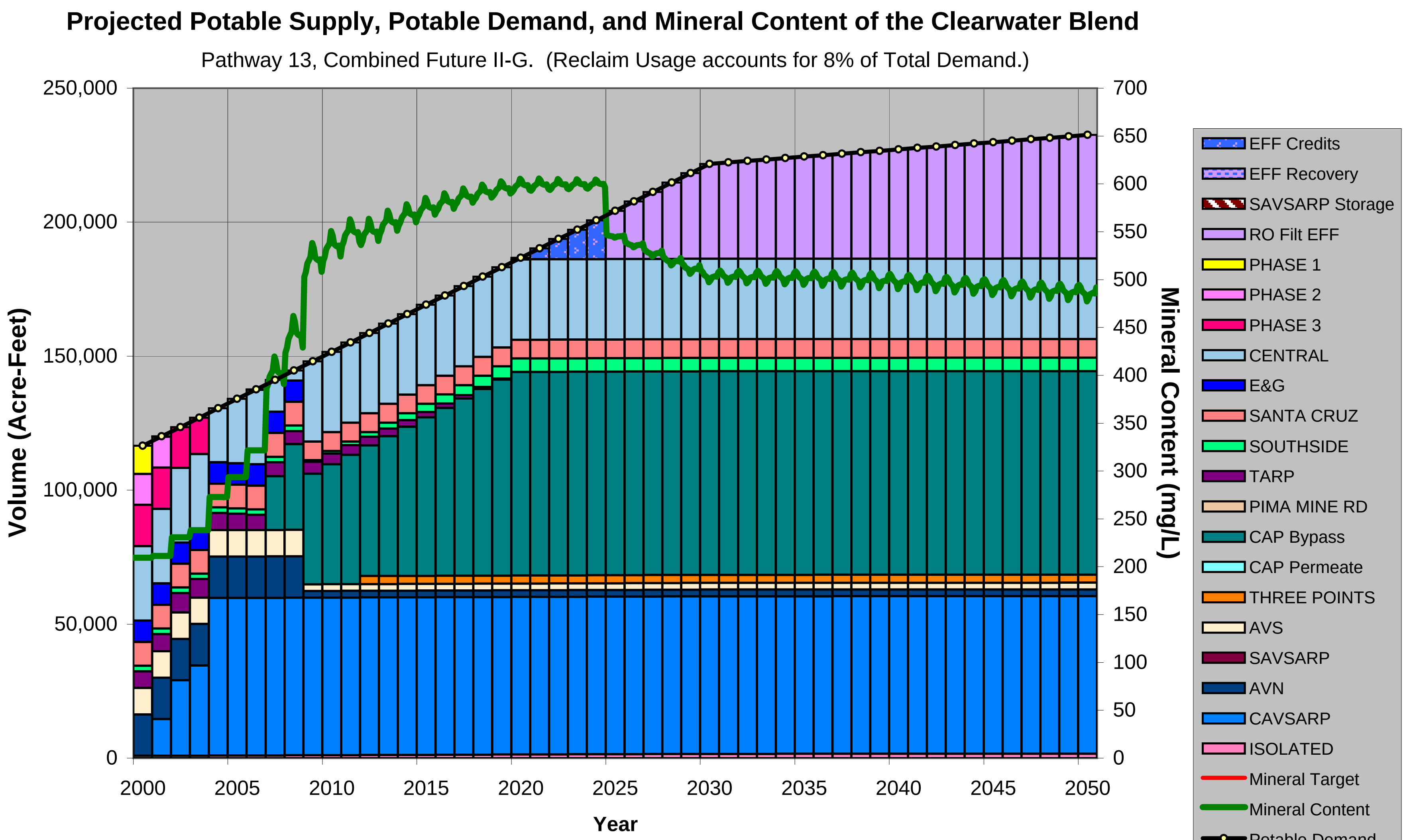
| | |
|---|---|
| Present Worth Capital Cost | $ 27.7 |
| Average Annual O&M Cost | $ 9.7 |
| Present Worth of O&M Costs | $ 131.1 |
| **Total Present Worth** | $ 158.8 |
| Annualized Capital Cost | $ 1.9 |
| Uniform Annualized O&M Cost | $ 9.1 |
| **Total Equivalent Annual Cost** | $ 11.0 |
| **Equivalent Unit Cost** (based on Target Year flows): | |
| $/1,000 gallons | $ 0.25 |
| $/acre-foot | $ 80 |

### *Project Cost Breakdown*

| Project ($1,000s except where noted) | Design Flow (MGD) *[based on max. flow over planning period]* | Average Flow in Target Year (MGD) | Present Worth Capital Cost ($k) | Average Annual O&M Cost ($k/yr) | Present Worth O&M Costs ($k) | **Total Present Worth ($k)** | Annualized Capital Cost ($k/yr) | Uniform Annualized O&M Cost ($k/yr) | **Total Equivalent Annual Cost ($k/yr)** | Equivalent Unit Production Cost (based on Target Year flows) $/1,000 gal | $/acre-ft |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hayden-Udall WTP: | | | | | | | | | | | |
| General Rehabilitation | | | $ 4,480 | | | $ 4,480 | $ 312 | | $ 312 | | |
| Primary Disinfection Options | | | | | | | | | | | |
| UV Disinfection | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Giardia & Cryptosporidium) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Taste & Odor) | 101.4 | 67.8 | $ 2,162 | $ 485 | $ 5,687 | $ 7,848 | $ 150 | $ 396 | $ 546 | $ 0 | $ 7 |
| Chlorination* | 101.4 | 67.8 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Existing Direct Filtration | 101.4 | 67.8 | | $ 2,769 | $ 31,936 | $ 31,936 | | $ 2,222 | $ 2,222 | $ 0 | $ 29 |
| TDS Removal of CAP Water | | | | | | | | | | | |
| NF/RO (with Existing Direct Filtration) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| NF/RO (with MF/UF Pre-treatment) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| TDS Removal of Recovered Water | | | | | | | | | | | |
| NF/RO for Recovered Water | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection | | | | | | | | | | | |
| Chlorine | 101.4 | 67.8 | $ 442 | $ 247 | $ 2,845 | $ 3,288 | $ 31 | $ 198 | $ 229 | $ 0 | $ 3 |
| Chloramines | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Sub-total (Hayden-Udall WTP) | 101.4 | 67.8 | $ 7,084 | $ 3,502 | $ 40,468 | $ 47,553 | $ 493 | $ 2,815 | $ 3,308 | $ 0.13 | $ 44 |
| | | | | | | | | | | | |
| CAVSARP | 61.2 | 52.5 | | $ 5,696 | $ 84,906 | $ 84,906 | | $ 5,906 | $ 5,906 | $ 0.31 | $ 100 |
| SAVSARP | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection- Recovered Water | 61.2 | 52.5 | $ 143 | $ 92 | $ 1,319 | $ 1,462 | $ 10 | $ 92 | $ 102 | $ 0.01 | $ 2 |
| | | | | | | | | | | | |
| Three Points Wellfield | 4.1 | 2.7 | $ 5,249 | $ 230 | $ 2,484 | $ 7,734 | $ 365 | $ 173 | $ 538 | $ 0.55 | $ 179 |
| Secondary Disinfection- Three Points Wellfield | 4.1 | 2.7 | $ 88 | $ 6 | $ 61 | $ 149 | $ 6 | $ 4 | $ 10 | $ 0.01 | $ 3 |
| Total Clearwater Production (MGD) | 166.7 | 123.0 | | | | | | | | | |
| | | | | | | | | | | | |
| Spencer Interconnect | | | $ 15,130 | $ 192 | $ 1,827 | $ 16,957 | $ 1,052 | $ 127 | $ 1,180 | | |
| | | | | | | | | | | | |
| TOTAL COSTS** | | | $ 27,694 | $ 9,717 | $ 131,066 | $ 158,761 | $ 1,927 | $ 9,118 | $ 11,044 | $ 0.25 | $ 80 |

* All primary disinfection chlorine costs are included in the secondary disinfection costs when chlorine is the primary disinfectant.

** Equivalent unit production costs in the Total Costs row include Spencer Interconnect costs.






RunDate: 9/13/2004

# CLEARWATER COST MODEL OUTPUT

Add Run to Database

Show Input Form

## Pathway 14
## Combined Future I-H

| | | |
|---|---|---|
| ALTERNATIVE NAME | Future I-H | |
| RUN NAME | Run 1 | |
| DATE | 9/13/2004 | |

Final TDS Target from Resource Planning Tool | 450 | (mg/L)

### *Input Values*

| | | |
|---|---|---|
| Power Cost for HUWTP | $0.08 | ($/kWh) |
| Labor Rate | $26 | ($/hr) |
| Annual Discount Rate | 0.050 | (per year as decimal) |
| ENR 20 Cities Average Cost Construction Index | 7188 | |
| Target Year | 2030 | (Year) |
| Planning Horizon | 26 | (Years) |
| Spencer Interconnect | TRUE | |
| SAVSARP Deep Wells | 15 | |
| Three-Points Wellfield | 2012 | |

### *Overall Output Values* *($millions except where noted)*

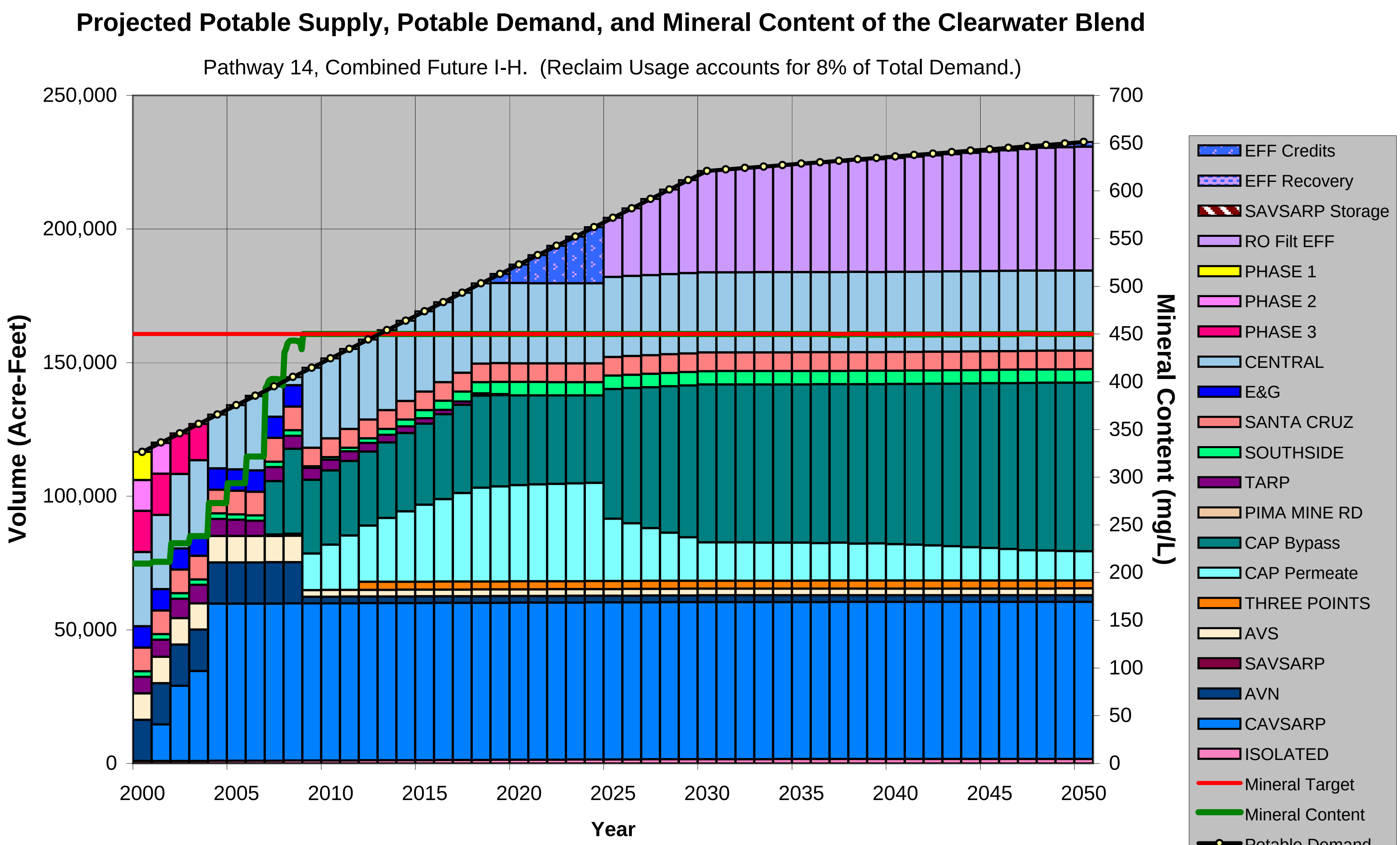
| | |
|---|---|
| Present Worth Capital Cost | $ 209.4 |
| Average Annual O&M Cost | $ 14.2 |
| Present Worth of O&M Costs | $ 183.9 |
| **Total Present Worth** | $ 393.2 |
| Annualized Capital Cost | $ 14.6 |
| Uniform Annualized O&M Cost | $ 12.8 |
| **Total Equivalent Annual Cost** | $ 27.4 |
| **Equivalent Unit Cost** (based on Target Year flows): | |
| $/1,000 gallons | $ 0.62 |
| $/acre-foot | $ 202 |

### *Project Cost Breakdown*

| Project ($1,000s except where noted) | Design Flow (MGD) *[based on max. flow over planning period]* | Average Flow in Target Year (MGD) | Present Worth Capital Cost ($k) | Average Annual O&M Cost ($k/yr) | Present Worth O&M Costs ($k) | **Total Present Worth ($k)** | Annualized Capital Cost ($k/yr) | Uniform Annualized O&M Cost ($k/yr) | **Total Equivalent Annual Cost ($k/yr)** | Equivalent Unit Production Cost (based on Target Year flows) $/1,000 gal | $/acre-ft |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hayden-Udall WTP: | | | | | | | | | | | |
| General Rehabilitation | | | $ 4,480 | | | $ 4,480 | $ 312 | | $ 312 | | |
| Primary Disinfection Options | | | | | | | | | | | |
| UV Disinfection | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Giardia & Cryptosporidium) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Taste & Odor) | 102.0 | 67.8 | $ 2,162 | $ 498 | $ 5,876 | $ 8,038 | $ 150 | $ 409 | $ 559 | $ 0 | $ 7 |
| Chlorination* | 102.0 | 67.8 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Existing Direct Filtration | 102.0 | 67.8 | | $ 2,854 | $ 33,184 | $ 33,184 | | $ 2,308 | $ 2,308 | $ 0 | $ 30 |
| TDS Removal of CAP Water | | | | | | | | | | | |
| NF/RO (with Existing Direct Filtration) | 53.7 | 15.1 | $ 48,696 | $ 3,300 | $ 38,562 | $ 87,257 | $ 3,387 | $ 2,683 | $ 6,070 | $ 1 | $ 359 |
| NF/RO (with MF/UF Pre-treatment) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 8.1 | 2.3 | $ 132,990 | $ 1,095 | $ 12,798 | $ 145,788 | $ 9,251 | $ 890 | $ 10,142 | $ 12 | $ 3,995 |
| TDS Removal of Recovered Water | | | | | | | | | | | |
| NF/RO for Recovered Water | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection | | | | | | | | | | | |
| Chlorine | 95.5 | 65.6 | $ 428 | $ 238 | $ 2,765 | $ 3,193 | $ 30 | $ 192 | $ 222 | $ 0 | $ 3 |
| Chloramines | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Sub-total (Hayden-Udall WTP) | 95.5 | 65.6 | $ 188,756 | $ 7,986 | $ 93,185 | $ 281,941 | $ 13,131 | $ 6,482 | $ 19,613 | $ 0.82 | $ 267 |
| CAVSARP | 61.2 | 52.5 | | $ 5,696 | $ 84,906 | $ 84,906 | | $ 5,906 | $ 5,906 | $ 0.31 | $ 100 |
| SAVSARP | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection- Recovered Water | 61.2 | 52.5 | $ 143 | $ 92 | $ 1,319 | $ 1,462 | $ 10 | $ 92 | $ 102 | $ 0.01 | $ 2 |
| Three Points Wellfield | 4.5 | 2.7 | $ 5,249 | $ 239 | $ 2,570 | $ 7,820 | $ 365 | $ 179 | $ 544 | $ 0.56 | $ 181 |
| Secondary Disinfection- Three Points Wellfield | 4.5 | 2.7 | $ 89 | $ 6 | $ 62 | $ 151 | $ 6 | $ 4 | $ 11 | $ 0.01 | $ 4 |
| Total Clearwater Production (MGD) | 161.2 | 120.7 | | | | | | | | | |
| Spencer Interconnect | | | $ 15,130 | $ 192 | $ 1,827 | $ 16,957 | $ 1,052 | $ 127 | $ 1,180 | | |
| TOTAL COSTS** | | | $ 209,366 | $ 14,210 | $ 183,871 | $ 393,237 | $ 14,564 | $ 12,791 | $ 27,355 | $ 0.62 | $ 202 |

* All primary disinfection chlorine costs are included in the secondary disinfection costs when chlorine is the primary disinfectant.

** Equivalent unit production costs in the Total Costs row include Spencer Interconnect costs.






RunDate: 9/13/2004

# CLEARWATER COST MODEL OUTPUT

Add Run to Database | Show Input Form

**Pathway 14**
**Combined Future II-H**

| | |
|---|---|
| ALTERNATIVE NAME | Future II-H |
| RUN NAME | Run 1 |
| DATE | 9/13/2004 |

Final TDS Target from Resource Planning Tool: 650 (mg/L)

### Input Values

| | | |
|---|---|---|
| Power Cost for HUWTP | $0.08 | ($/kWh) |
| Labor Rate | $26 | ($/hr) |
| Annual Discount Rate | 0.050 | (per year as decimal) |
| ENR 20 Cities Average Cost Construction Index | 7188 | |
| Target Year | 2030 | (Year) |
| Planning Horizon | 26 | (Years) |
| Spencer Interconnect | TRUE | |
| SAVSARP Deep Wells | 15 | |
| Three-Points Wellfield | 2012 | |

### Overall Output Values ($millions except where noted)

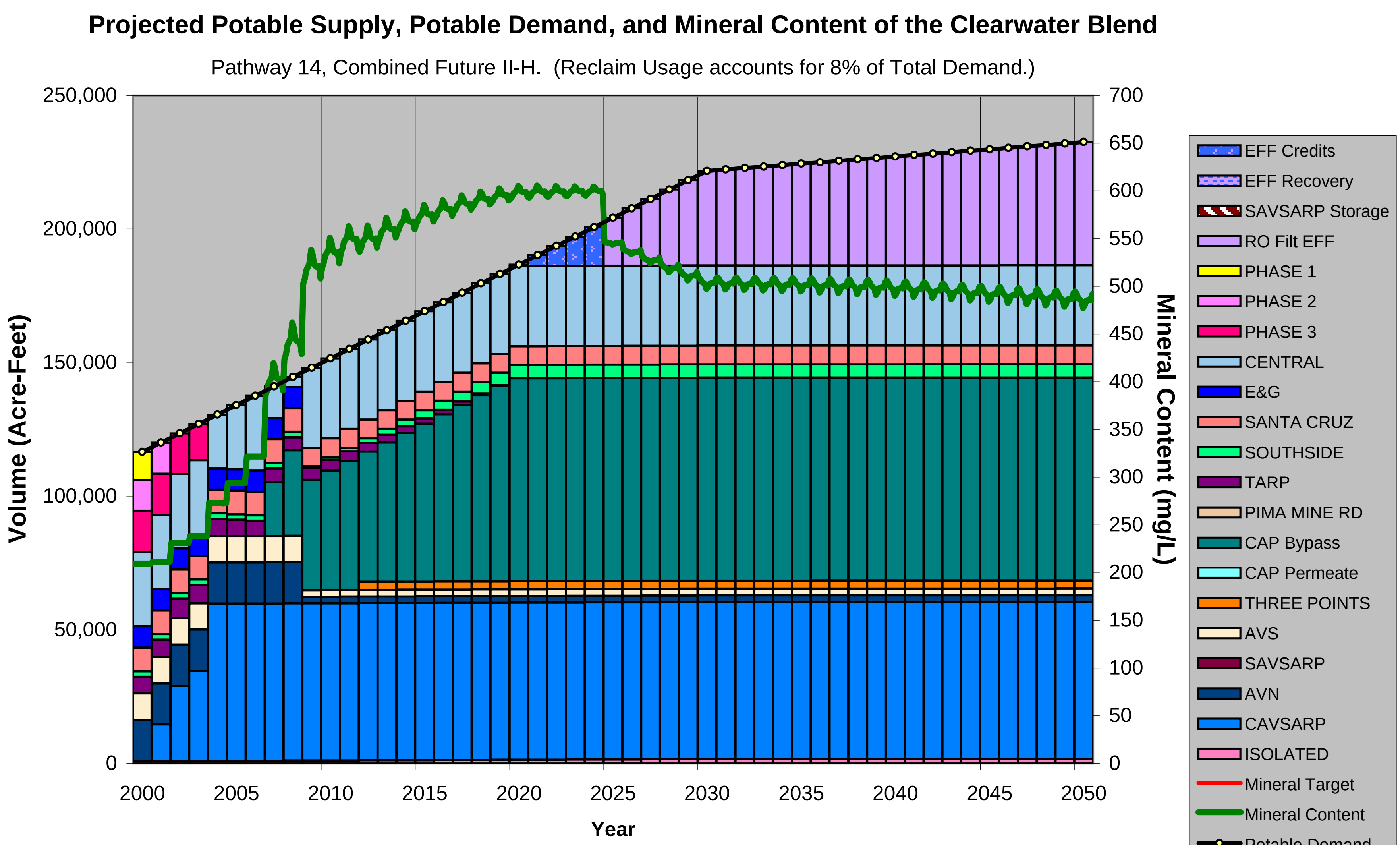
| | |
|---|---|
| Present Worth Capital Cost | $ 27.7 |
| Average Annual O&M Cost | $ 9.7 |
| Present Worth of O&M Costs | $ 131.1 |
| **Total Present Worth** | $ 158.8 |
| Annualized Capital Cost | $ 1.9 |
| Uniform Annualized O&M Cost | $ 9.1 |
| **Total Equivalent Annual Cost** | $ 11.0 |
| **Equivalent Unit Cost** (based on Target Year flows): | |
| $/1,000 gallons | $ 0.25 |
| $/acre-foot | $ 80 |

### Project Cost Breakdown

| Project ($1,000s except where noted) | Design Flow (MGD) *[based on max. flow over planning period]* | Average Flow in Target Year (MGD) | Present Worth Capital Cost ($k) | Average Annual O&M Cost ($k/yr) | Present Worth O&M Costs ($k) | **Total Present Worth ($k)** | Annualized Capital Cost ($k/yr) | Uniform Annualized O&M Cost ($k/yr) | **Total Equivalent Annual Cost ($k/yr)** | Equivalent Unit Production Cost (based on Target Year flows) $/1,000 gal | $/acre-ft |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hayden-Udall WTP: | | | | | | | | | | | |
| General Rehabilitation | | | $ 4,480 | | | $ 4,480 | $ 312 | | $ 312 | | |
| Primary Disinfection Options | | | | | | | | | | | |
| UV Disinfection | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Giardia & Cryptosporidium) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Ozonation (Taste & Odor) | 101.4 | 67.8 | $ 2,162 | $ 485 | $ 5,687 | $ 7,848 | $ 150 | $ 396 | $ 546 | $ 0 | $ 7 |
| Chlorination* | 101.4 | 67.8 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Existing Direct Filtration | 101.4 | 67.8 | | $ 2,769 | $ 31,936 | $ 31,936 | | $ 2,222 | $ 2,222 | $ 0 | $ 29 |
| TDS Removal of CAP Water | | | | | | | | | | | |
| NF/RO (with Existing Direct Filtration) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| NF/RO (with MF/UF Pre-treatment) | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| TDS Removal of Recovered Water | | | | | | | | | | | |
| NF/RO for Recovered Water | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Evaporation Ponds | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection | | | | | | | | | | | |
| Chlorine | 101.4 | 67.8 | $ 442 | $ 247 | $ 2,845 | $ 3,288 | $ 31 | $ 198 | $ 229 | $ 0 | $ 3 |
| Chloramines | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Sub-total (Hayden-Udall WTP) | 101.4 | 67.8 | $ 7,084 | $ 3,502 | $ 40,468 | $ 47,553 | $ 493 | $ 2,815 | $ 3,308 | $ 0.13 | $ 44 |
| CAVSARP | 61.2 | 52.5 | | $ 5,696 | $ 84,906 | $ 84,906 | | $ 5,906 | $ 5,906 | $ 0.31 | $ 100 |
| SAVSARP | 0.0 | 0.0 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Secondary Disinfection- Recovered Water | 61.2 | 52.5 | $ 143 | $ 92 | $ 1,319 | $ 1,462 | $ 10 | $ 92 | $ 102 | $ 0.01 | $ 2 |
| Three Points Wellfield | 4.1 | 2.7 | $ 5,249 | $ 230 | $ 2,484 | $ 7,734 | $ 365 | $ 173 | $ 538 | $ 0.55 | $ 179 |
| Secondary Disinfection- Three Points Wellfield | 4.1 | 2.7 | $ 88 | $ 6 | $ 61 | $ 149 | $ 6 | $ 4 | $ 10 | $ 0.01 | $ 3 |
| Total Clearwater Production (MGD) | 166.7 | 123.0 | | | | | | | | | |
| Spencer Interconnect | | | $ 15,130 | $ 192 | $ 1,827 | $ 16,957 | $ 1,052 | $ 127 | $ 1,180 | | |
| TOTAL COSTS** | | | $ 27,694 | $ 9,717 | $ 131,066 | $ 158,761 | $ 1,927 | $ 9,118 | $ 11,044 | $ 0.25 | $ 80 |

* All primary disinfection chlorine costs are included in the secondary disinfection costs when chlorine is the primary disinfectant.

** Equivalent unit production costs in the Total Costs row include Spencer Interconnect costs.






RunDate: 9/13/2004

The costs of using effluent to augment potable supply are presented in this section. Table F-3 presents an overview of the costs of each effluent project that might be included along each planning pathway.

| Effluent Costs | Total Present Worth Capital | Total Present Worth O&M | Annualized Capital | Annualized O&M |
|---|---|---|---|---|
| Avra Valley Pipeline (54 in Dia) | $34,232,773 | $6,389,672 | $2,381,380 | $444,493 |
| Tucson Basin Pipeline (42 in Dia.) | $33,129,174 | $19,914,482 | $2,304,609 | $1,385,337 |
| CAVSARP Recovery Expansion (42 in. Dia.) | $4,095,532 | $12,913,068 | $284,903 | $898,289 |
| Sweetwater EhT Plant (41 MGD) | $147,188,800 | $126,973,312 | $10,239,089 | $8,832,812 |
| Sweetwater EhT Plant (18 MGD) | $75,936,436 | $57,886,787 | $5,282,467 | $4,026,855 |
| Ina-Roger Interconnect (42 in Dia.) | $8,750,833 | $8,104,364 | $608,746 | $563,775 |

**Table F-3**: Effluent Utilization Costs

Detailed costs for each treatment technology employed at the Sweetwater Enhanced Treatment Plant are presented on the following two pages. The treatment train presented in this report is only for cost estimating purposes and is shown on Figure F-1.

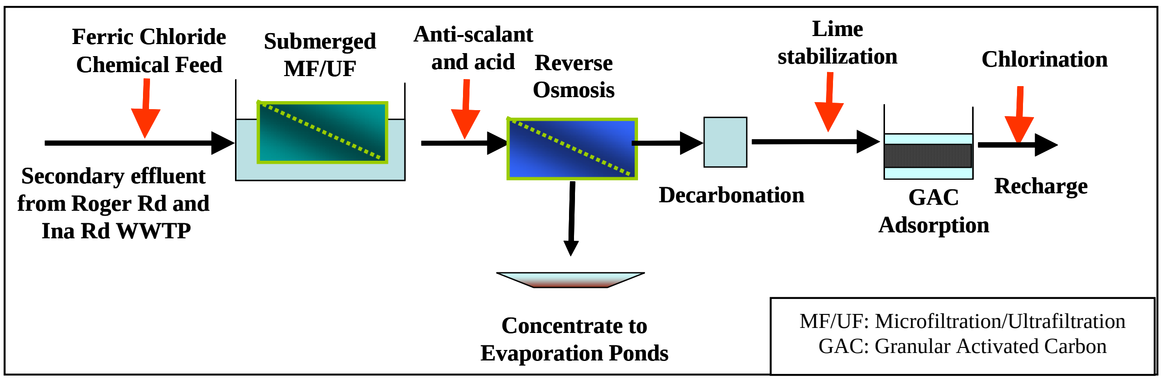



**Figure F-1:** Preliminary Effluent Treatment Train for Cost Estimates

It is highly likely that the eventual treatment processes will differ from that presented here based on the emergence of new and better technologies and the desired treatment goals. Costs are presented for two different treatment plant sizes (small and large) with average daily treatment capacities of 18 MGD and 41 MGD, respectively.

# Effluent Enhanced Treatment

**Small Plant (18 MGD)**

**Treatment Technology**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Labor | $ 26.00 | Power | | $ 0.08 | | |
| Ferric Chloride Feed | | Qdes. | 22 | Qavg | | 18 | | |
| Total Capital Cost | ($) | | $285,320 | | | | | |
| Annual O&M | Labor (hours) | | | | 71 | $1,846 | | |
| | Power (kWh) | | | | 12746 | $1,020 | | |
| | Other ($) | | | | | $235,277 | | |
| | | | | Sum | | $238,143 | | |
| Submerged Membrane | | | | | | | | |
| Total Capital Cost | ($) | | $32,694,970 | | | | | |
| Annual O&M | Labor (hours) | | | | 4576 | $118,976 | | |
| | Power (kWh) | | | | 2734570 | $218,766 | | |
| | Other ($) | | | | | $583,542 | | |
| | | | | Sum | | $921,283 | | |
| Reverse Osmosis | | | | | | | | |
| Total Capital Cost | ($) | | $29,887,691 | | | | | |
| Annual O&M | Labor (hours) | | | | 4576 | $118,976 | | |
| | Power (kWh) | | | | 15601746 | $1,248,140 | | |
| | Other ($) | | | | | $1,297,365 | | |
| | | | | Sum | | $2,664,480 | | |
| Decarbonation | | | | | | | | |
| Total Capital Cost | ($) | | $800,280 | | | | | |
| Annual O&M | Labor (hours) | | | | 180 | $4,670 | | |
| | Power (kWh) | | | | 101426 | $8,114 | | |
| | Other ($) | | | | | $2,982 | | |
| | | | | Sum | | $15,767 | | |
| Lime Addition | | | | | | | | |
| Total Capital Cost | ($) | | $809,533 | | | | | |
| Annual O&M | Labor (hours) | | | | 551 | $14,337 | | |
| | Power (kWh) | | | | 4211 | $337 | | |
| | Other ($) | | | | | $22,821 | | |
| | | | | Sum | | $37,495 | | |
| GAC Adsorption | | | | | | | | |
| Total Capital Cost | ($) | | $17,127,560 | | | | | |
| Annual O&M | Labor (hours) | | | | 3024 | $78,629 | | |
| | Power (kWh) | | | | 41138 | $3,291 | | |
| | Other ($) | | | | | $992,577 | | |
| | | | | Sum | | $1,074,497 | | |
| Chlorine Feed | | | | | | | | |
| Total Capital Cost | ($) | | $445,220 | | | | | |
| Annual O&M | Labor (hours) | | | | 117 | $3,039 | | |
| | Power (kWh) | | | | 7891 | $631 | | |
| | Other ($) | | | | | $125,255 | | |
| | | | | Sum | | $128,925 | | |
| Evaporation Ponds | | | | | | | | |
| Total Capital Cost | ($) | | $61,138,902 | | | | | |
| Annual O&M | Labor (hours) | | | | 2377 | $61,793 | | |
| | Power (kWh) | | | | 0 | $0 | | |
| | Other ($) | | | | | $705,570 | Years | 13 |
| | | | | Sum | | $767,363 | | |
| | | **Total Capital** | **$143,189,476** | **Total Annual O&M** | | **$5,847,953** | **Total O&M** | **$76,023,383** |

# Effluent Enhanced Treatment

## Large Plant (41 MGD)

**Treatment Technology**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Labor | $ 26.00 | Power | | $ 0.08 | |
| Ferric Chloride Feed | | Qdes. | 46 | Qavg | | 41 | |
| Total Capital Cost | ($) | | $563,192 | | | | |
| Annual O&M | Labor (hours) | | | | 75 | $1,940 | |
| | Power (kWh) | | | | 17592 | $1,407 | |
| | Other ($) | | | | | $541,677 | |
| | | | | Sum | | $545,025 | |
| Submerged Membrane | | | | | | | |
| Total Capital Cost | ($) | | $65,450,482 | | | | |
| Annual O&M | Labor (hours) | | | | 4576 | $118,976 | |
| | Power (kWh) | | | | 6157497 | $492,600 | |
| | Other ($) | | | | | $1,294,987 | |
| | | | | Sum | | $1,906,563 | |
| Reverse Osmosis | | | | | | | |
| Total Capital Cost | ($) | | $59,518,307 | | | | |
| Annual O&M | Labor (hours) | | | | 4576 | $118,976 | |
| | Power (kWh) | | | | 35826210 | $2,866,097 | |
| | Other ($) | | | | | $2,818,545 | |
| | | | | Sum | | $5,803,618 | |
| Decarbonation | | | | | | | |
| Total Capital Cost | ($) | | $1,203,048 | | | | |
| Annual O&M | Labor (hours) | | | | 250 | $6,488 | |
| | Power (kWh) | | | | 232905 | $18,632 | |
| | Other ($) | | | | | $5,334 | |
| | | | | Sum | | $30,454 | |
| Lime Addition | | | | | | | |
| Total Capital Cost | ($) | | $958,198 | | | | |
| Annual O&M | Labor (hours) | | | | 1136 | $29,548 | |
| | Power (kWh) | | | | 5140 | $411 | |
| | Other ($) | | | | | $51,806 | |
| | | | | Sum | | $81,765 | |
| GAC Adsorption | | | | | | | |
| Total Capital Cost | ($) | | $21,354,896 | | | | |
| Annual O&M | Labor (hours) | | | | 4845 | $125,978 | |
| | Power (kWh) | | | | 91757 | $7,341 | |
| | Other ($) | | | | | $2,272,357 | |
| | | | | Sum | | $2,405,675 | |
| Chlorine Feed | | | | | | | |
| Total Capital Cost | ($) | | $662,428 | | | | |
| Annual O&M | Labor (hours) | | | | 155 | $4,024 | |
| | Power (kWh) | | | | 12160 | $973 | |
| | Other ($) | | | | | $287,158 | |
| | | | | Sum | | $292,155 | |
| Evaporation Ponds | | | | | | | |
| Total Capital Cost | ($) | | $127,835,886 | | | | |
| Annual O&M | Labor (hours) | | | | 5458 | $141,895 | |
| | Power (kWh) | | | | 0 | $0 | |
| | Other ($) | | | | | $1,620,197 | Years 13 |
| | | | | Sum | | $1,762,092 | |
| | | **Total Capital** | **$277,546,437** | **Total Annual O&M** | | **$12,827,348** | **Total O&M $166,755,521** |

CITY OF TUCSON

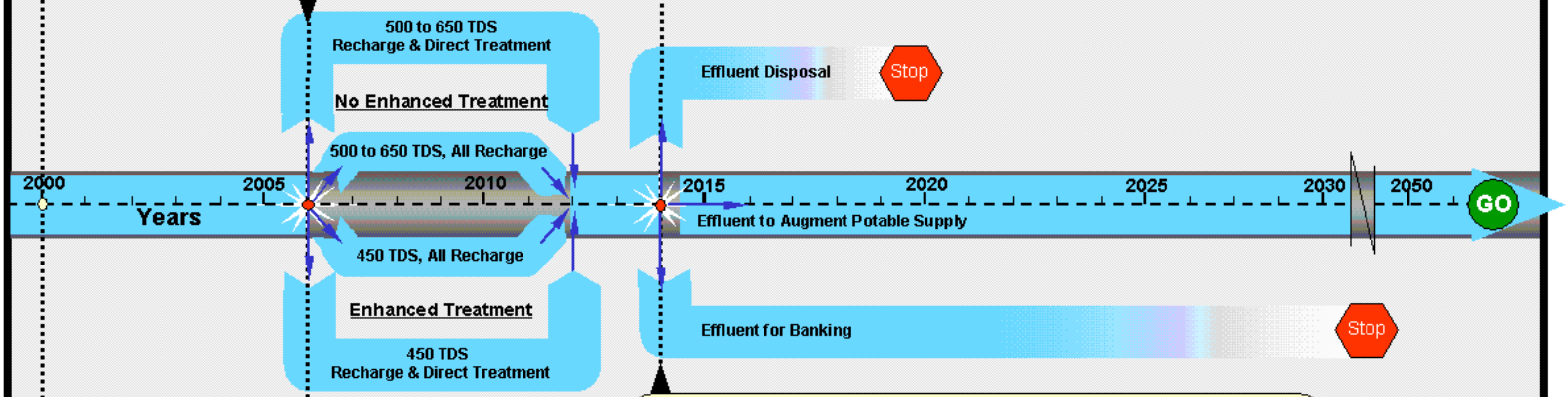
TUCSON WATER

# PLATE 1
# Recommended Plan Summary

## Decision Point: 2006

**Decision #1** - What is an acceptable long-term mineral content target for the Clearwater blended water program?

**Decision #2** - Should Tucson Water expand the Clearwater recharge program by building SAVSARP to maximum capacity or rehabilitate the Hayden-Udall Treatment Plant to perform direct treatment?




## Decision Point: 2014

**Decision #3** - Should current effluent disposal practices continue or should Tucson Water maximize the use of effluent as a water supply?

**Decision #4** - If the use of effluent is to be maximized, should it be stored in long-term banking facilities or should it be used to augment the potable water supply?

## Initiate Common Elements: 2000 to 2006

*Programs*
- Acquire Additional Supplies
- Develop a Salinity Management Program
- Encourage Sewer Connections
- Evaluate the Effectiveness of Additional Conservation Programming
- Evaluate Emerging Contaminants
- Expand Public Outreach
- Provide Water-Resource Information to Planning Entities
- Pursue Regional Cooperation
- Reduce Lost and Unaccounted for Water

*Projects*
- Conduct SAVSARP Feasibility Assessment
- Construct Spencer Interconnect Pipeline
- Design SAVSARP Facilities
- Expand Recharge Capacity of CAVSARP
- Study Secondary Disinfectants
- Upgrade the Distribution System

## Initiate Common Elements: 2006 to 2014

*Programs*
- Achieve Full Colorado River Water Utilization
- Achieve Sustainable Ground-Water Pumping
- Evaluate Effluent Exchanges

*Projects*
- Augment Avra Valley Main
- Construct New Reclaimed Supply Sources
- Construct & Operate SAVSARP Phase I

## Common Elements (Decision - Dependent): 2006 to 2014

DECISION #1

**Maintain Blended Water Mineral Content between 500 and 650 mg/L**
- No Further Action Required

-or-

**Maintain Blended Water Mineral Content at 450 mg/L**
- Implement Enhanced Treatment
- Implement Residuals Management
- Implement Three-Points Well Field

DECISION #2

**Expand Clearwater Recharge Program**
- Design, Construct, and Operate SAVSARP Phase II

-or-

**Implement Direct Treatment**
- Rehabilitate Hayden-Udall Treatment Plant
- Study Primary Disinfectants

## Common Elements (Decision - Dependent): 2014 to 2025

DECISION #3

**Use Effluent Resource**
- Augment Recharge Program
- Construct Effluent Pipeline
- Construct Ina Road Interconnect
- Construct Sweetwater Enhanced Treatment Plant
- Develop Treatment Technology
- Involve the Community

-or-

**Continue Effluent Disposal with no Wet-Water End Use**
- No Further Action Required
- Shortfall Before 2020 (Stop)

DECISION #4

**Effluent to Augment Potable Supply**
- Initiate Effluent Enhanced Treatment
- Initiate Effluent Residuals Management
- Supply Beyond 2050 (GO)

-or-

**Preserve Effluent for Long-Term Banking**
- No Further Action Required
- Shortfall Before 2040 (Stop)

2000 2005 2010 2015 2020 2025 2030 2050

Years