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Meeting future challenges of water and energy demand using watershed management strategies in the Inland Empire

Abigail Zepeda Gomez

MEETING FUTURE CHALLENGES OF WATER AND ENERGY DEMAND USING WATERSHED MANAGEMENT STRATEGIES IN THE INLAND EMPIRE

A Project

Presented to the

Faculty of

California State University,

San Bernardino

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

in

Environmental Sciences

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by

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ABSTRACT

Water shortages and drought conditions have increased the cost for treatment of potable water and imported water universally. As the population and potable water demand increases over the next 20 years, the availability of recycled water is also projected to grow. The population in the City of Fontana is expected to grow by 42% by the year 2025 from 159,000 to 226,000 people. The potable water rates for the Fontana Water Company (FWC) are projected to increase water rates in its service area over the next three years by approximately 32%. This increase would bring the cost of potable water near to $1,000 per ac-ft. The indicator used to divide Fontana into north and south was the 210 freeway. Everything north of the 210 freeway was labeled as north Fontana and everything south of the 210 freeway was called south Fontana. The objective of this project is to provide a cost analysis and possibility of utilizing recycled water to the north area of Fontana and if it was even possible. The results of the analysis show that implementing recycled water to the north Fontana area is feasible and would ultimately benefit the present and future residents in the Inland Empire by conserving potable water and utilizing recycled water that

would otherwise be discharged to the ocean. The total savings for parks using recycled water instead of potable water from FWC or Cucamonga Valley Water District (CVWD) was $3,509.12 and $2,382.99 correspondingly. The monthly saving for schools using FWC and CVWD was $982.94 and $667.50. The total savings, with no surcharges, from FWC or CVWD was $4,492.06 and $3,050.98 respectively. When current CVWD surcharges are considered the savings was minimal for both the parks and schools. The CVWD price difference for potable water and recycled water is approximately $51 per ac-ft. The monthly savings for parks and school was $256.40 and $71.82 respectively. The total savings per month was $328.22.

ACKNOWLEDGMENTS

I would like to express my appreciation to the members of my graduate committee, Dr. James Noblet and Dr. Brett Stanley, for their guidance and patience throughout this entire process. I would like to express my gratitude to Ms. Parivash Dezham, for her inspiration both as a woman and as an environmental compliance manager. I would also like to acknowledge the funding provided for my masters program by the Inland Empire Utilities Agency.

Thank you to both my parents, brothers, sisters and friends who have offered their encouragement and support throughout this incredibly stressful process.

In particular, I owe a special thank you to my husband Javier Gomez for always supporting me and guiding me in my weakest of moments. Thank you for all of the unconditional love you have given me throughout the years. For all you have done for me I will be forever grateful to you my love.

DEDICATION

For my parents Eva and Antonio Zepeda, Thank you for all you have done for us. I love you both more than anything in this world.

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INTRODUCTION AND BACKGROUND

Purpose of the Project

Water shortages and drought conditions have increased the cost for treatment of potable water and imported water universally. This has brought much attention to recycled water far and wide. As the population and potable water demand increases over the next 20 years, the availability of recycled water is also projected to grow. In 2007, California experienced its driest year *(1)*. As a result, there has been a larger demand on State Water Project (SWP) water. The drought conditions, coupled with the recent environmental court decisions affecting the operation of the SWP have significantly reduced the availability of imported water. Typically, Southern California receives its water from northern California via the SWP, or the Colorado River through aqueducts, channels or pipes. "On February 27, 2009, California's governor declared a state of emergency for California due to drought conditions and statewide shortages with the reservoir storage reaching exceptionally low levels. Of this years allotment the snow pack water content was 39% below average, and the SWP allocation was set at 15%. These dry conditions were intensified by depletion of surface and groundwater storage caused by very dry conditions in 2007 and 2008 *(2)*". California's water is managed by a variety of state and federal court decisions geared towards protecting surface water quality, fish and wildlife. These decisions limit the supply of water deliveries agriculture and future development in California. The continuing disagreement between protecting and restoring the San Joaquin River Delta (SJRD) and establishing a reliable water supply for California is the root problem in California's water crisis *(2)*.

On May 14, 2009, the State Water Resource Control Board (State Water Board) approved Resolution No. 77-1, California's Recycled Water Policy. The mission of the State Water Board is to preserve, enhance and restore the quality of California's water resources to the benefit of present and future generations *(3)*. In the policy, the State Water Board encourages regional agencies to move toward clean water, enhance water recycling, and conservation. It recommends that the water agencies declare independence from relying on annual precipitation.

It encourages them to movė towards sustainable management of surface waters and groundwater.

Adopting the following goals for California: increase the use of recycled water over 2002 levels at least one million acre-feet per year (acre-ft/yr), and by the year 2020 increase recycled water to two million acre-ft/yr, and increasing the use of storm water in 2007 by at least 500,000 acre-ft/yr by 2020. Also, recycled water use should be up at least one million acre feet per feet by 2030. Included in these goals is the substitution of as much recycled water for potable water as possible by 2030 *(3)*.

The Inland Empire Utilities Agency (IEUA) was established in June 1950 as a municipal water district. IEUA distributes imported water and provides municipal/industrial wastewater collection and treatment to its residents, community, and industries. It services more than 800,000 people within a 244-square mile area in the western portion of San Bernardino County. IEUA is a public agency that chemically treats approximately 40,000 ac-ft/y of waste water. The cities in its service area include: Chino, Chino Hills, Ontario, Upland, Rancho Cucamonga, Montclair and Fontana. The court decisions and continuing disagreements over the SJRD have created an impact on the water and economy of the cities and water agencies served by the IEUA *(4)*.

IEUA owns and operates a Non-Reclaimable Waste Water System (NRWS) that consists of a North and South system. These systems export high salinity and industrial wastewater produced in IEUA service areas to the Pacific Ocean. The North system, which serves approximately 45 industries, conveys wastewater to adjacent interceptor sewer lines owned and operated by the County Sanitation Districts of Los Angeles County (CSDLAC). From there, the water is conveyed to CSDLAC's treatment facility in Carson, where it is treated and discharged to the ocean. The south system, which serves approximately 15 industries, conveys wastewater to the Santa Ana Regional Interceptor (SARI) pipeline, owned by the Santa Ana Watershed Project Authority (SAWPA), and from there it is carried to the Orange County Sanitation Districts (OCSD) facility in Fountain Valley for treatment and ocean discharge *(5)*.

Removing the high salinity form the IEUA service area enhances the quality and protects the recycled water for local use and helps ensure that IEUA fulfills the final effluent total dissolved solids (TDS) and total nitrogen limits listed in the National Pollutant Discharge Elimination System (NPDES) permits *(5)*. Meeting these regulations sequentially helps IEUA fulfill the major points in the Chino Basin Watermaster's Optimum Basin Management Plan (OBMP). The reduction or elimination of salts from residential water softeners and diverting the brine from groundwater desalter facilities additionally reduces the TDS level. These types of practices will reduce the TDS levels in the recycled water by approximately 430 mg/l. It is estimated that diverting most of the existing industrial users with TDS concentrations above 550 mg/l to the NRWS could lower the TDS level of the recycled water by another 8 to 11 mg/l *(5)*.

The population in the City of Fontana is expected to grow as much as 42% by 2025 from 159,000 to 226,000 people *(5)*. The purpose of this project is to explore the option of implementing recycled water from the IEUA's regional facilities to irrigate the parks and school grounds in the North Fontana area.

Background

Some studies have shown traces of sanitation practices dating as far back as 10,000 BC. Environmental engineering methods were used by the Romans and by the Minoan Culture to help prevent disease. The Greeks even imposed a user charge to cover the cost of waste disposal. Later on, events in Europe and England led to environmental regulations and the invention of various treatment processes to satisfy them *(6)*. In the mid to late 19th century large cities began to realize that they had to decrease the amount of contaminants they were discharging into receiving waters and minimizing their impact on the environment *(6)*. An awareness of the impact of pollutants on wildlife, spearheaded by Rachel Carson's book "Silent Spring," led to the environmental movement in the late 19th century. Along with this movement came the awareness of many other problems we as a society face today.

California

California is the nation's most populated state. In 2008, the population was an estimated 36,756,666 residents *(7)*. As a consequence, great deals of resources have been used resulting in a negative impact on the environment. California has overcome many problems such as: fires, earthquakes, landslides, and floods. Unfortunately, California is now experiencing one of the most dangerous of them all. That problem is a severe drought that will change life in California as we know it.

Several agencies are drought proofing their service areas in hopes that their residents will not be affected. This has led to improved water management and administrative responsibility when it comes to water practices. Some believe that simply implementing responsible water practices and reducing water use will decrease the effects of the drought. Responsible water practices and reducing water will help mitigate the problem, but will not solve it. Such practices are only the beginning step in addressing the overall problem. In order to guarantee that California has a sufficient sustainable water supply, recycled water use will need to be implemented immediately.

> According to the Department of Water Resources (DWR), Water year 2009 is the third consecutive dry year for the state. Water year 2007-08 resulted in 63% of average annual precipitation across the state, and water year 2008-09 resulted in 72% of average annual precipitation, and the statewide precipitation average at the end of August 2009 was 78% *(8)*.

Still, California has not found a reliable and sustainable source of water.

Fortunately, California could reduce the impacts of the drought by utilizing existing supplies of recycled water that are currently being released to streams and the ocean every day.

> In the U.S. in 1995 about 44,400 wastewater-treatment plants sent about 44,600 million gallons per day of treated water back into the groundwater. About 983 million gallons per day were reclaimed and used after treatment, mainly as irrigation water *(9)*.

In May 2009, there was a series of heavy rain storms. These storms brought much needed rainfall to California, the SWP and Central Valley Project (CVP) remain near historical lows *(10)*. The SWP and CVP are two of the world's largest water storage and transport systems. Unfortunately, the long term effects of the drought have diminished the utility of the system.

The conservation of water is a very important practice for the simple fact that the water conserved by one person could be used to fill the needs of another. Reducing the amount of water used for irrigation is also an essential component for mitigating the water shortage in California.

The recent drought in California will affect all of its residents. This water shortage can potentially lead to a catastrophic downfall of the agriculture community in California as we know it.

> On September 28, 2009, a team of UC Davis researchers led by Dr. Richard Howitt revised their forecasts of 2009 water shortage and the employment impacts. They now estimate that this year's water shortages have led to 21,000 total jobs lost in the San Joaquin Valley (SJV), of which 16,000 are due to the drought alone, and 5,000 are due to environmental pumping restrictions. The 2009 water shortages in the SJV are projected to result in $703 million in

> lost agricultural gross revenue, expressed in 2008 dollars *(8)*.

California's water supplies could best be described as variable because of the variety in its sources of water. However, "The Sacramento-San Joaquin River Delta is the hub of California's water system and also an imperiled habitat for fish and other wildlife" *(11)*. Unfortunately, California's water sources are what are presenting a threat to the water structure of California. Projected changes in climate of the Northern Hemisphere may result in the Eastern and Northern mountains in the United States do not always getting consistent seasonal rain or snow *(12)*. This inconsistency reduces the mountain precipitation as a reliable source of water from the mountains for Southern California.

> California's temperature has risen one degree Fahrenheit, mostly at night and during the winter, with higher elevations experiencing the greatest increase. Average early spring snow pack in the Sierra Nevada has decreased by about 10%, a reduction of 1.5 million acre-foot (ac-ft) of water in storage. One ac-ft of water is enough to supply two families for one year *(13)*.

On average, in California each year about 2 million acre-feet more groundwater is used than naturally recharged.

Groundwater is the source of about 37% of the water that county and city water departments supply to households and businesses. It provides drinking water for more than 90% of the rural population who do not get their water delivered to them from a county/city water department or private water company. About 42% of the water used for irrigation comes from groundwater and withdrawals of groundwater are expected to rise as the population increases and available sites for surface reservoirs become more limited *(9)*.

Approximately 120 million acre-feet of precipitation in an average year either evaporates, is used by native vegetation, provides rainfall for agriculture and wetlands, or flows out of the state or to salt sinks *(13)*. California needs to develop a solution to better use the water that is here. The most obvious way to resolve this problem would be to implement more recycled water programs in California and promote the use of recycled water for landscape irrigation. Executing such practices would give California a reliable source of water and increase the amount of potable water available for California's residents.

Inland Empire Utilities Agency

The IEUA was established in June 1950 as a municipal water district. IEUA distributes imported water and provides municipal/industrial wastewater collection and treatment to its residents, community, and industries. It serves more than 800,000 people within a 244-square mile area in the western portion of San Bernardino County.

IEUA is governed by a five member Board of Directors, each of which is elected publicly and serves a four year term by their respective divisions. The divisions are separated as follows: Division 1 Upland/Montclair, Division 2 Ontario, Division 3 Chino/Chino Hills, Division 4 Fontana, and Division 5 Rancho Cucamonga.

The mission of IEUA is to supply imported and recycled water; collect, treat, and dispose of wastewater; and provide other utility-related services to the communities it serves. IEUA is a public agency that chemically treats roughly 40,000 acre-ft/yr of waste water. The cities in its service area include: Chino, Chino Hills, Ontario, Upland, Rancho Cucamonga, Montclair and Fontana.

In 2002 through the development of its new Administrative Headquarters in Chino, California IEUA has moved one step closer to attaining its mission and goals in energy efficiency. The design and construction of this project has earned the agency recognition through the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) program. The LEED program has a possible rating of 69 credit points. The agency achieved 52 credit points and earned the platinum level rating. In recent years, IEUA has implemented many projects that will earn all of the sixty-nine credit points in the near future.

Water Supply

Groundwater is the primary water supply in IEUA's service area. It accounts for 60-70% of the water supply. Recycled water accounts for approximately 5-10% and imported water accounts for approximately 30-40% *(1)*.

In the last couple of years IEUA has invested more than $350 million in improvements for their regional facilities in: groundwater recharge, desalination, recycled water, and conservation programs. Implementing such practices will enable IEUA to meet about 85% of their water needs for their service area and 100% compliance in the Regional Urban Water Management Program by 2030. Recycled water sales could also lower water and sewer rates by 20-30% with full implementation of the Regional Recycled Water System *(1)*. IEUA has looked into water shortages and catastrophic interruptions and has developed mutual aid programs, infrastructure connections, regional coordination and local ordinances that would inhibit the interruption of their water supplies. Organization and planning like this is why the agency is amongst the leaders in water management.

Renewable Energy

IEUA has taken a ground-breaking approach in water quality management. The first year that IEUA began to receive SWP water was 1988 *(1)*. IEUA has also become a provider of recycled water, biosolid/compost, and has built energy/production facilities for renewable energy through methane gas and solar generation.

Currently, the Agency generates 43% of its energy use and 64% of the gas it uses to produce power saving the agency approximately 1.2 million dollars a year *(14)*. This was increased in 2009 when IEUA adopted the use of solar panels that produce 10% of the electrical energy needed at Headquarters and wastewater treatment plant sites. The seven acre solar power project produces approximately 3.5 megawatts. It was designed to make up 9% of IEUA's 13 megawatt load *(14)*. All of the solar panels combined from headquarters and all of the wastewater treatment plants produce enough energy to power 0.4% of the agency's facilities. This would be equivalent to providing electricity to 2,800 homes *(14)*.

Recycled Water

When it comes to recycled water IEUA stands out above any other agency. Becoming a supplier of recycled water required IEUA to meet the water quality-based effluent limits that are established in their NPDES permit that applies at the discharge point, generally referred to as the end of the pipe *(15)*.

Following treatment:

> A portion of the recycled water is used for: industrial cooling towers, industrial process water, irrigation of unrestricted access golf courses, irrigation of freeway landscaping, irrigation of pasture for animals, groundwater

recharge, cleaning roads, sidewalks and outdoor work areas, dust control on roads and streets, soil compaction, mixing concrete, recreational impoundments, decorative fountains, commercial laundries, commercial car washes, flushing toilets and urinals, irrigation of residential landscaping, irrigation of parks and playgrounds, school yards, and, irrigation of food crops, recharging of basins, and water table *(14)*.

At this time, IEUA distributes recycled water to the Cities of Chino, Chino Hills, and Ontario. Due to cost of construction the majority of the recycled water that the agency distributes is located in the southern region of its service area with Reliant Energy located in Fontana being the exception *(14)*. IEUA also offers the following incentives to encourage the use of recycled water: a discount for Non-Reclaimable Wastewater System (NRW) service users in order to promote removal of salts from the groundwater basin; shared costs for service connections, water meters, and signage; loans to help finance local (non-regional) infrastructure and retrofit projects that contribute to use of recycled water; technical assistance with engineering, regulatory and institutional issues and with preparation of funding applications; and guarantee of recycled water supply reliability, especially during droughts *(1)*.

In 2002, IEUA completed a feasibility study and in 2005 completed an Implementation Plan to assess the potential customers for recycled water within the Inland Empire. It showed that 2,300 potential customers were within IEUA's service area that could use recycled water programs.

> This information was used to determine pipeline locations that would eventually distribute to over 1,900 of the largest customers an overall supply of 44,000 acre-ft/yr, of which 35,000 acre-ft/yr will be used to recharge the Chino Basin Groundwater *(1)*.

Implementing recycled water at this level is ideally what IEUA strives for.

Table 1. Inland Empire Utilities Agency Annual Recycled Water Added Capacity Summary *(1)*.

Type	Existing	2007/ 2008	2008/ 2009	2009/ 2010	2010/ 2011	Subtotal (AFY)
Direct Use	10,969	8,250	44,397	5,160	6,850	35,600
Groundwater Recharge	2,989	1,500	9,700	2,400	1,00	17,500
Total	13,958	9,700	14,00	7,600	7,800	53,100

Table 1, shows the total groundwater recharge in 2010 would be at 17,500 acre-ft/yr and direct use would add 35,600 acre-ft/yr to the groundwater water capacity in the Inland Empire. Table 2, shows the service area's water demands in 2005 were increased by 31% in the Inland Empire and 74% in Ontario which is also in IEUA's service area. Unquestionably, the demand for water is not going to slow down any time soon and water conservation can only help so much. What California needs to focus on is finding a reliable water source. Table 3, shows the potential amount of water each water agency can recycle. It shows the IEUA has less recycled water potential capacity than Los Angles because of the available land. It also shows that IEUA discharges approximately 26,830 acre-feet/year more water to the Santa Ana River than it is required to. The 26,830 ac-ft per year could be used to recharge groundwater or irrigate landscaping in the Inland Empire.

Table 2. Comparison of Four Southern California Agencies *(1)*.

Agency	**IEUA**	**Ontario**	**San Diego**	**Los Angeles**
Description	Formed in 1950; provide wastewater treatment, recycled water & biosolids	Founded as "model colony" in 1882, incorporated as city in 1891.	Founded in 1769, incorporated as city in 1850.	Founded in 1781, incorporated in 1850.
Service Area	242 sq. miles	50 sq. miles	371 sq. miles	464 sq. miles
Location	Southwest San Bernardino County, Santa Ana River	35 miles east of Los Angeles	Southwest coast of California to inland buttes	Southern California
Elevation	500′ to 2,000′	925′	Average 72′ (0 to 1586′)	City Hall @ 233′
Average Temperatures	January 67°F To July 95°F	83°F	July 70°F To December 57°F	15°/year
Avg. Precipitation	15″/year	16.1″/year	10.2″/year	15″/year
Population, Current & Projected	2007: 700,000 (incl. Ontario) 2025: 1.1 million (57% increase)	2007: 172,000 2025: 274,500 (60% increase)	2005: 227,456 2030: 275,925 (21% increase)	2005: 661,000 2030: 776,000 (17% increase)
Water Demand (AFY)	2005: 235,600 2025: 308,000 (31% increase)	2005: 45,041 2025: 78,167 (74% increase)	2005: 227,456 2030: 275,925 (21% increase)	2005: 661,000 2030: 776,000 (17% increase)
Primary Water Supplies	1 – Recycled (3%) 2 – Chino Desalter Groundwater (65%) 3 – Local Strem Flows (7%)	1 – Chino Desalter Groundwater 2 – Recycled 3 – SWP via IEUA and MWD 4 – Local Groundwater Wells (63-89%)	1 – Local Surface Water (8-23%) 2 – Recycled (2%) 3 – Imports via SDCWA (75-90%)	1 – Los Angeles Aqueduct (50%) 2 – Groundwater (15%) 3 – Imports via MWD (35%)

Table 3. Recycled Water Opportunity Profiles of Four Southern California Water Agencies *(1)*.

	IEUA	Ontario	San Diego	Los Angles
Recycled Water, Maximum Potential (2005)	Capacity: 86,600 afy Flows: 68,080 afy	Depends on IEUA's ability to provide	Capacity: 42,000 afy Flows: 36,400 afy	Capacity: 151,200 afy Flows: 85,100 afy
Additional Tertiary Recycled Water Available Now	43,705 afy	n/a	23,512 afy	24,650 afy
Recylced Water, Projections at 2020	Capacity: 133,600 afy Flows: 107,400 afy Use: 86,000 afy	Use: 11,761 afy	Use: 15,000 afy	Use: 50,450 afy

Implementing recycled water will ensure a more dependable local water supply for future years to come *(1)*. More over, it will reduce the possibility of water rationing during droughts. It will also enhance the safe yield and water quality in the Inland Empire. In March of 2008, California's Recycled Water Task Force reported that approximately 10% of municipal wastewater in California is being recycled, but as much as 23% of the municipal wastewater flow could be recycled *(3)*. Implementation of such programs would alleviate stress from the groundwater and, the SWP, and help ensure that California would never experience such a severe water shortage again. This is another reason implementing recycled water programs are imperative. It is an important source of water supply that grows in tandem with urban water demands. Implementing recycled water lessens the demand on our groundwater and drinking water supplies.

However, if California does not implement recycled water programs the state will enter a severe water shortage for a series of years that will radically diminish the water supplies in California. Longer droughts can create numerous problems, including extreme fire danger, economic harm to urban and rural communities, loss of crops, and the potential for species collapse and degraded water quality in some regions *(13)*. The only solution for California is to use water efficiently, protect the quality of our water supplies, and expand water management responsibilities.

Water Quality

The quality and quantity of California's water supplies is deteriorating each year *(14)*. In order to establish limits an assessment of four steps is performed to determine the Water Quality Based Effluent Limits (WQBELs) for wastewater treatment plants: Step one is identifying applicable water quality standards, Step 2 is characterizing the effluent and receiving water, Step 3 is determining the need for parameter specific WQBELs, and step 4 is calculating parameter specific WQBELs *(14)*.

Recharge Basin

Imported water supplies from northern California are the most expensive source of water for the Chino Basin and are increasingly unreliable, especially during droughts. Additional reliable, local water supplies are needed in the Chino Basin to meet the future needs of our rapidly growing cities and to avoid future drought shortages. Figure 1 provides a detailed map of the Basin involved in the Chino Basin Recycled Water Groundwater Recharge Program.

> Groundwater provides more than 40 % of California's drinking water. To protect this vital resource, the State of California created the Groundwater Ambient Monitoring and Assessment (GAMA) Program. Under GAMA, the USGS is working with the State Water Resources Control Board to monitor and assess water quality in groundwater basins that are used for public supply *(12)*.

Fortunately, with the help of GAMA watching the supply and quality of California's groundwater it will be protected and available for our future generations.

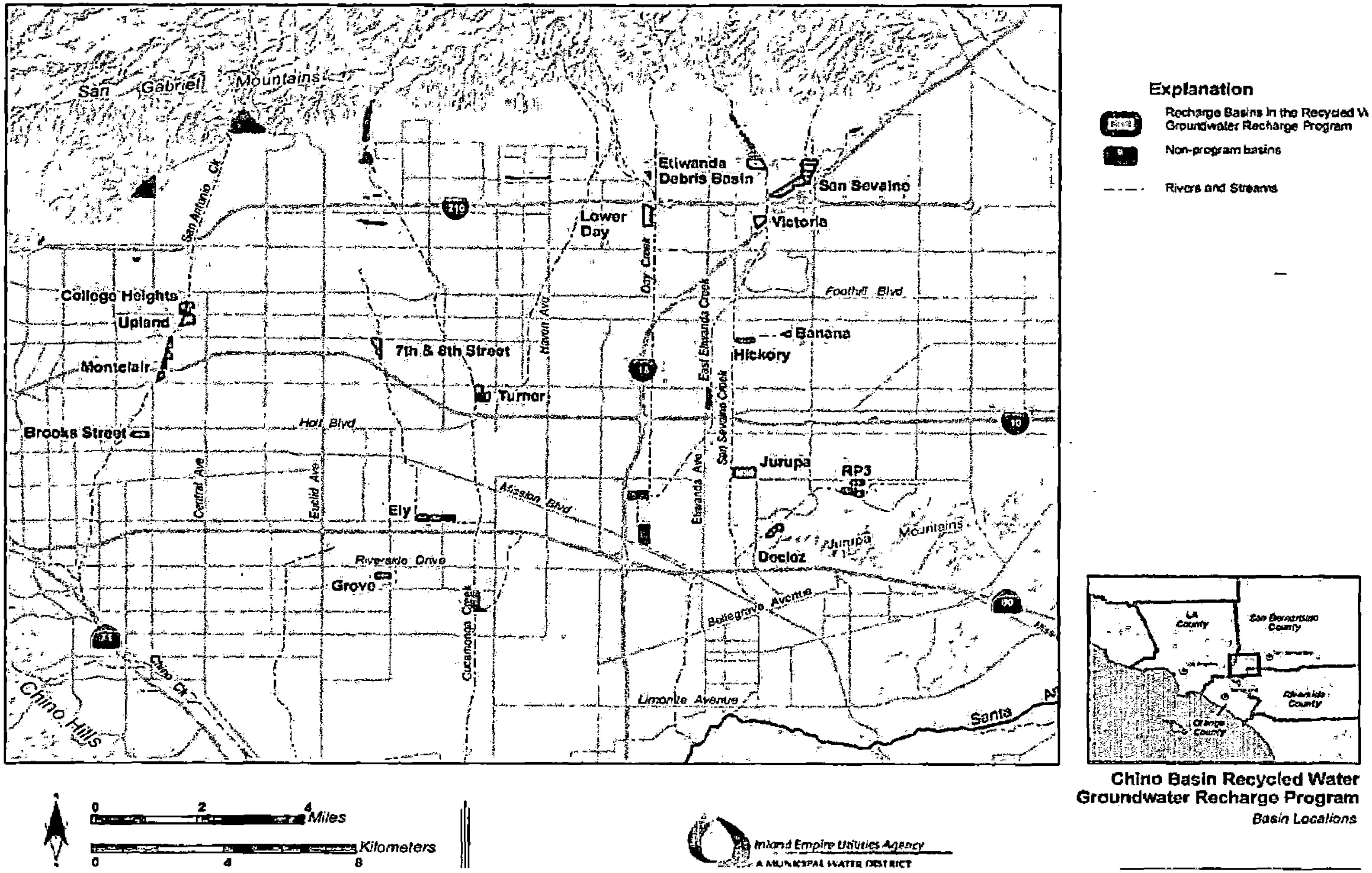

Figure 1. Chino Basin Recycled Water Groundwater Recharge Program *(15)*.

Groundwater recharge projects replenish groundwater with recycled water that can be utilized when the water levels drop. There are two methods of recharge: through percolation ponds (spreading basins) and by injection through wells. IEUA has 17 recharge basins in its service area. Currently, IEUA uses a mixture of recycled water, storm water and imported water from the SWP to recharge the groundwater basin in order to meet the requirements with: the Chino Basin Water Master's Optimum Basin Management Plan, the Santa Ana Regional Water Quality Control Board's Basin Plan and the State of California Department of Health Services. Increasing the amount of groundwater will secure and improve the water quality of a resource for the Inland Empire that can be tapped during dry years. By 2025, total urban groundwater production is expected to provide about 68% of the area's water during normal years, and 72% during dry years *(1)*.

Chino Basin Watermaster

The Chino Basin Watermaster (CBW) was established on February 19, 1998. According to the California Water Code (AB 3030) the State of California is not allowed to manage groundwater. Therefore, the amount of water that can be extracted has been defined by a court in some basins. In these basins, the groundwater may be managed by agencies that obtain their authority from the Water Code. The CBW is managed by the Chino Basin Watermaster Board of Directors (Watermaster). The Watermaster was established under a judgment entered in the Superior Court of the State of California for the court of San Bernardino, Chino Basin Municipal Water District v. City of Chino *et al (16)*.

The adjudication stated that a safe yield of the Chino Basin was 140,000 acre-ft/yr *(16)*. Of this amount, three pools were to be allocated with the first being an overlying agricultural pool of 82,800 acre-ft/yr, the second an overlying non-agricultural pool of 7,366 acre-ft/yr, and the third an appropriative pool of 49,834 acre-ft/yr *(16)*. The premise was to allow all of the Chino Basin users to pump sufficient water from the basin to meet their needs. It also required that an Optimum Basin Management Program (OBMP) be prepared to address ongoing quantity and quality issues in the basin. One of the issues was land subsidence and related ground fissuring that apparently occurred as a result of groundwater production and intense overdrafting of groundwater levels. The OBMP had to include future plans to address the subsidence while cooperating with the basin storage and recovery programs. The purpose of the OBMP is to develop a groundwater management program that enhances the safe yield and the water quality of the Basin, enabling all groundwater users to produce water from the basin in a cost-effective manner *(17)*. The OBMP summarizes the water supplies and demands over the next twenty years and a detailed summary of the water conservation and water management activities that are planned and addresses the topics of reliability, water quality and opportunities to maximize local water sources, including conservation, groundwater and recycled water, and to minimize the need for additional imported water supplies within IEUA's service area *(14)*. The implementation of such a plan has maximized the development and use of the local water supplies. Additionally, it has reduced the amount of imported water IEUA receives annually and reduces the demand there is on the SWP water.

IEUA is not the only agency involved in the management of the Chino Basin in the Santa Ana River Watershed. It works with several agencies to ensure that each of the agencies reaches water supply reliability, optimum water quality, and attains their watershed management goals. In the last ten years all of the cities and water agencies in the area have invested almost $500 million in order to increase the availability of local water supplies through water recycling, conservation, recharge improvements, and the Metropolitan Water District (MWD) groundwater storage and recovery project *(15)*. For that reason, in 1988 the Local Resource Program (LRP) was established to promote the implementation of recycled water and groundwater recovery programs. The LRP replaced the Local Projects Program (LPP) and the Groundwater Recovery Program (GRP). It encourages agencies to construct recycled water and establish groundwater recovery projects *(17)*.

There are several benefits to meeting the water needs of the service area. For example, in 1988 the MWD established a program called the Conservation Credits Program. This program pays member agencies approximately $154 per acre-foot of water recycling that both alleviates the demand on the MWD and helps the agency become less reliant on imported water. An additional monetary program is, the Request for Proposal (RFP) process. This program also rewards agencies that treat contaminated groundwater and produce clean water $250 an acre-foot.

Figure 2 shows the storage and recovery of the Chino Basin. It shows the basic facilities that are involved in recharging the Chino Basin and how a Desalter pumps out the lower quality groundwater and leaving the high quality groundwater for municipalities to treat and recycled the water.

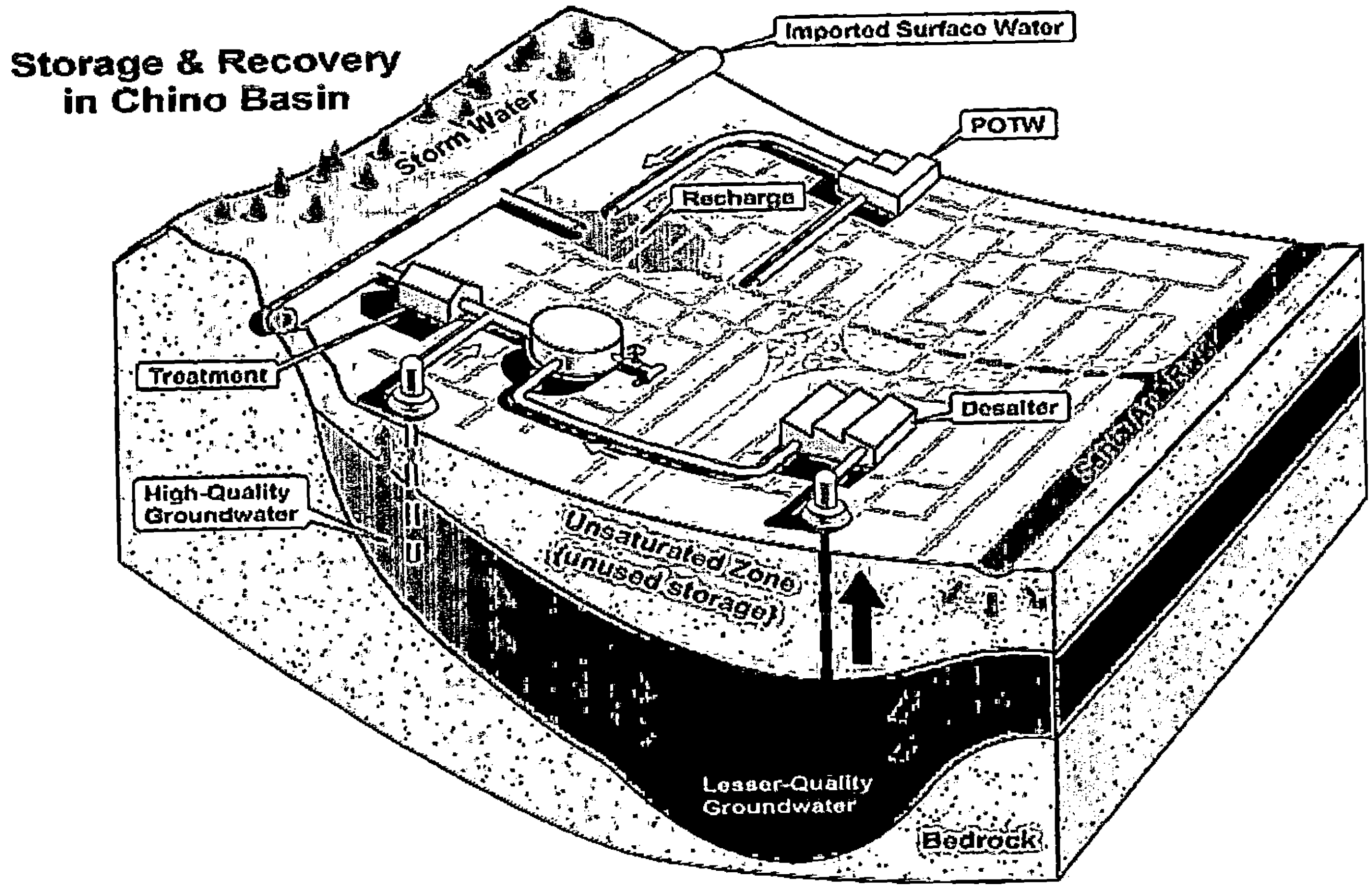

Figure 2. The Chino Basin: Storage and Recovery *(14)*.

Water Softener Removal Rebate Program

> In 2000, the United States used about 62 billion gallons per day of saline water, which was about 15% of all water used. But saline water can only be used for certain purposes. The main use was for thermoelectric power-plant cooling. As for the other uses, about 8% of water was used for industrial purposes, and about 43% of all water was used for mining purposes. Saline water can be desalinated for use as drinking water by putting it through a process to remove the salt from the water. However, the process is very costly and isn't used very much *(9)*.

Fortunately, in the Inland Empire IEUA is constantly making an effort to reduce the salt in the Santa Ana Watershed. In 2008 IEUA launched a water softener rebate program for the residents in its service area. Residents with an active water softener are eligible to receive up to $2000 as a rebate for removing their water softeners. The program also offers free removal by a pre-qualified licensed plumber and disposal of the unit. The water softeners that use rock salt and potassium chloride produce waste full of salt that is introduced to our sewage system and treatment facilities. The two types of water softeners are automatic and exchange tanks. Automatic water softeners use ion exchange to eliminate hard water (calcium and magnesium) in the water. Each tank has resin that is negatively charged inside of it and a separate brine tank has either sodium chloride (salt) or potassium chloride that is used to regenerate the water softener. When the calcium and magnesium ions enter the tank and replace the sodium or potassium ions in the resin. This is what makes the water "soft" because the calcium and magnesium in the water were replaced by the sodium and potassium. However, the sodium or potassium left on the resin will begin to reduce everyday making the softener to regenerate itself. The regeneration process is when the brine tank sends high levels of salt water to the mineral tank usually in the middle of the night. This process forces the calcium and magnesium off of the resin and replaces it with either sodium or potassium. Once the regeneration process is complete the brine solution is sent to the sewer and eventually to IEUA's treatment facilities that recycle the water. This hinders the hard work of the agency in its recycled water efforts. These water softeners are the source of the TDS problem the Chino Basin is experiencing.

Removing the softeners will reduce the cost of treatment incurred by the agency and the residents within its service area. Removing the high saline water from IEUA service areas enhances the quality and protects the recycled water for local use and helps ensure that IEUA fulfills the final effluent total dissolved solids (TDS) and total nitrogen limits listed in the National Pollutant Discharge Elimination System (NPDES) permits *(4)*. Meeting these regulations sequentially helps IEUA fulfill the major points in the Chino Basin Watermaster's Optimum Basin Management Plan (OBMP). The reduction or elimination of salts from residential water softeners and diverting the brine from groundwater desalter facilities additionally reduces the TDS level. Those types of practices will reduce the TDS levels in the recycled water by approximately 430 mg/l. It is estimated that diverting most of the existing industrial users with TDS concentrations above 550 mg/l to the NRWS could lower the TDS level of the recycled water by another 8 to 11 mg/l *(4)*.

Population Growth / Land Use of Chino Basin

In the last ten years IEUA's service area has experienced rapid growth in population. The population in

1995 was approximately 635,000 people. By 2000, the area had grown to a population of about 708,200 and by 2005 to 814,168. This means that in 10 years the population has grown at an annual rate of 2.8 % *(4)*.

Table 4. 2000-2025 Projected Population by Communities Within Inland Empire Utilities Agencies Service Area *(1)*.

City	2000	2005	2010	2015	2020	2025
Chino	71,688	78,715	91,090	114,978	124,476	126,646
Chino Hills	66,787	77, 819	80,126	80,916	83,636	85,284
Montclair	46, 049	54,930	59,600	66,750	71,250	76,000
Ontario	158,394	172,408	203,811	225,385	248,424	273,047
Fontana	148,928	174,968	179,426	195,373	211,105	226,186
Rancho Cucamonga	142,743	178,855	203,870	220,180	233,400	242,700
San Antonio	3,238	3,238	3,281	4,290	4,413	4,586
Upland	70,393	73,235	73,600	73,700	73,800	73,900
Total	708,200	814,168	894,804	982,572	1,050,504	1,108,349

As a consequence, the population growth has also had an effect on the land use in Chino. IEUA's first purchase of imported water was 12,000 acre-feet in 1988, and has been increasing ever since. In 1995, approximately 26,000 acre-feet were purchased and roughly 40,000 acre-feet in 2005. This brought the delivery purchases to a 28,000 acre-feet increase every year *(1)*. According to the 2005 Urban Management Plan, in 2010 IEUA will be receiving approximately 190,000 acre feet per year of imported water.

California Public Utilities Commission

In 2005, the California Public Utilities Commission adopted five measures that would help agencies achieve their water conservation targets: Best management practices, appliance efficiency standards, landscape water conservation, irrigation efficiency, and analytical tools *(4)*. Proudly, IEUA has taken the initiative and has implemented all five of the practices and continues to promote conservation and strive towards excellence in water management and enhancing the quality of life in the Inland Empire. The overall goals of the IEUA Recycled Water Program is to encourage maximum use of the recycled water resource for beneficial purposes, thereby conserving imported water within the Chino Basin and reducing the dependency on imported water *(1)*.

Inland Empire Utilities Agency
Waste Water Treatment Plants

IEUA operates and maintains one reverse osmosis desalination plant, a completely enclosed composting facility, a recycled water program, a composting program, four water reclamation facilities, and a biosolids treatment facility that discharges into a non-reclaimable waste line and ultimately discharges into the ocean. The following are the water reclamation facilities: Regional Plant 1(RP-1, Regional Plant 4 (RP-4), Regional Plant 5 (RP-5) and Carbon Canyon Water Reclamation facility (CCWRF). Of the four reclamation facilities one includes a biosolids treatment facility *(1)*.

All four of the facilities have the capability or reclaiming wastewater received from the cities in IEUA's service area. This brings the maximum amount of water that can be treated by the reclamation facilities to 84 million gallons per day (mgd). Presently, the combined production of the wastewater treatment plants is approximately 60 mgd. By 2020, the plants are expected to produce 95.5 mgd *(12)*. Needless to say, each reclamation facility's effluent is used in very distinct ways.

Regional Plant One (RP-1)

RP-1 was constructed in 1948 and was purchased by IEUA in January 1973 through a joint powers agreement between the cities of Ontario and Upland. RP-1 has a treatment capacity of 44 mgd and a biosolids treatment capacity comparable to a wastewater flow rate of 60 mgd. The biosolids treatment at RP-1 the solids includes a gravity thickening process and a dissolved air flotation thickening process. The solids are processed through anaerobic decomposition and as a byproduct release carbon dioxide, hydrogen sulfide, and usable methane gas that is used to fuel engine generators. The effluent from RP-1 is used in a number of different ways. A portion of the effluent is used to irrigate the Whispering Lakes Golf Course, El Prado Golf Course, and Westwind Park. The recycled water is used to recharge the Chino Basin through The Ely Basin Number 3. Another portion of the effluent from RP-1 is released to the Prado Regional Park Lake and the rest of the effluent is released into the Cucamonga Creek Flood Control channel and eventually reaches the Santa Ana River *(1)*.

Carbon Canyon Water Reclamation Facility

Carbon Canyon Water Reclamation Facility is a state-of-the art facility that works in collaboration with RP-2.

The forty-six million dollar facility services the cities of Chino, Chino Hills, Montclair and Upland. It receives approximately 11.4 mgd and is monitored through a Supervisory Control and Data Acquisition (SCADA) System *(15)*. CCWRF distributes water through a 21,400 foot pipe, to the cities of Chino and Chino Hills *(15)*. Both cities have a large range of customers that receive recycled water. Nonetheless, the customers in Chino Hills use larger amounts of water primarily around the cities greenbelt areas *(15)*.

Regional Plant Four (RP-4)

RP-4 was established in 1997 and is currently being expanded from its 7 mgd to 14 mgd. RP-4 receives approximately 11 mgd and works in tandem with RP-1 in order to distribute recycled water to IEUA's customers. RP-4 is estimated to be expanded in order to meet future population demands in the areas of CVWD, the City of Fontana and unincorporated areas of San Bernardino County *(15)*.

The Chino Desalter Authority (CDA)

Well water is an accumulation of rain water that has percolated through the Earth's surface and accumulated underground. As the water percolates through the Earth's surface it is naturally cleaned and purified. However, groundwater is prone to contamination.

In order to meet the drinking water needs of the residents of the Inland Empire the CDA was established in 2002. The CDA has also helped in cleaning the groundwater supply of the Inland Empire.

> The CDA has the capacity to treat 14 mgd of drinking water to 35,000 families. It receives water through fourteen wells that pump groundwater, it produces 51,800 acre-ft/yr of potable water; and extracts an estimate 54,000 tons of salt from the Chino Basin annually *(3)*.

The CDA uses a reverse osmosis and ion exchange on all of the water it treats and produces the highest quality of drinking water.

The Inland Empire Regional Composting Facility

The Inland Empire Regional Composting Facility (IERCF) is the nation's largest indoor composting facility. The facility is approximately 453,900 square feet and is constructed on 24 acres. IERCF takes bio-solids and turns it into wood-based nutrient rich compost that is used in horticultural, landscape, agricultural and erosion control uses *(15)*.

Scope of the Project

Recycled water is California's most valuable resource. IEUA has recognized the advantages of using recycled water and reducing California's reliance on imported water. IEUA has embraced it and currently generates approximately 60 mgd of recycled water. In order to reduce the demand on potable water and decrease the drought in California the State has adopted a statewide goal of 1 million acre-feet of reuse of water by 2010 and 1.7 million acre-feet by 2020 yielding a 20 % reduction per person in water use *(18)*.

It is important to make clear that both water and energy are linked together. Reducing our water use instantly reduces our energy use regardless of how small the amounts may be. This makes conserving water imperative. Doing so will help in reducing our dependency on imported water.

Many everyday tasks do not require water to be potable. Nevertheless, in the United States we customarily pour drinking water on our lawns, landscaped industrial parks, cooling towers, and use it to drive industrial processes. The transportation and treatment of the water requires considerable quantities of energy sequentially creating a larger carbon foot print.

Limitations of the Project

Nevertheless, there are still some customers that refuse to take advantage of recycled water. Consequently, in May 2002 Ordinance No. 75 was adopted establishing incentives and mandating the use of recycled water. It is consistent with the California Water Code (Sec 13550) and the State Water Resources Control Board guidelines, and it stipulates that potential recycled water customers who do not use recycled water when it is available are subject to a 50 % surcharge on their potable water rate *(1)*

Another limitation to this project is the public misconceptions of recycled water. Educating the public that recycled water is both filtered and disinfected so that it is free of bacteria and other pathogens will promote the use or recycled water. Promoting the use of recycled water for only non-drinking purposes will be the key point in the success of implementing recycled water for landscape irrigation and groundwater recharge.

CHAPTER TWO

METHODOLOGY

Introduction

The projected impacts of using recycled water in the north Fontana area were estimated using a feasibility study to serve recycled water in the city of Fontana *(5)*. Also, CVWD water rates were used in the cost analysis. The purpose of this project is to explore the option of implementing recycled water from the IEUA's regional facilities to irrigate the parks and school grounds in the North Fontana area.

This research, however, is based on data obtained from public documents. Many assumptions were made through estimated water calculations, estimated population growth, and estimated pipeline construction. Many case studies and feasibility studies were reviewed and incorporated into this research.

FWC is the one of the primary entities that provides potable water to the city of Fontana's residents and others. However, it was excluded from the cost analysis because the FWC does not sell recycled water. Estimating the actual rates for recycled water for FWC was therefore not possible, and there was no estimate made because of the potential surcharges imposed on the recycled. Thus the use of recycled water without surcharges, and the water rates currently used by CVWD were used to estimate the feasibility of using recycled water for irrigating open areas in the City of Fontana.

Water Rates

The potable water rates for CVWD are $1.49 per hundred cubic feet for non residential customers and $1.12 per hundred cubic feet for recycled water customers.

> It should be noted that court hearings are currently being conducted to consider a petition by the FWC to increase water rates in its service area over the next three years by approximately 32 percent. This increase would bring the cost of water close to $1,000 per ac-ft *(5)*.

Table 5. Potable Water Rates for Fontana Water Company and Cucamonga Valley Water District *(5)*.

Fontana Water Company		Cucamonga Valley Water District	
Total Cost per ac-ft	$763.44	Total Cost per ac-ft	$529.30

North Fontana Area

The marker used to divide Fontana into north and south was the 210 freeway. Everything north of the 210 freeway was labeled as north Fontana and everything south of the 210 freeway was label south Fontana. The locations that were primarily focused on were schools and public parks. Table 6, lists the locations for parks: Rosena Park Common Area, Rosena Park East, Rosena Park West, Fontana Park, Westgate Park, Patricia Marrujo Park, Ralph M. Lewis Memorial Sports Complex, Summit at Rosena Parks, Summit at Rosena Green Garden, Hunter's Ridge Park, San Sevaine Park, Sierra Lakes Golf Course, Hunter's Ridge, Ventana Point, Summit Heights, and Sierra Lakes. Table 6 also lists the locations for schools: Summit High School, Sierra Lakes Elementary School, Fontana AB Miller High School, Wayne Ruble Elementary School, Wayne Ruble Middle School, Summit at Rosena Middle School, and The Arboretum at Fontana North

Elementary School *(5)*. Island and street beautification projects were not considered as well as residential homes. In total there are 17 parks and 7 schools. The total landscaped area for parks and schools was 14,127,534 square feet and 3,729,250 square feet respectively *(5)*. The total consumption of water for the parks and schools is 1,835 acre feet per year and 514 acre feet per year respectively. The total consumption is 2,349 acre feet per year. Ultimately, the bulk of the recycled water would be utilized in the parks of north Fontana.

Table 6. Locations, Landscape Areas, and Consumption of North Fontana Area *(5)*.

Location	**Landscaped Area (ft2)**	**Consumption (acre-ft/yr)**
Rosena Park Common Area	167,454	23
Rosena Park East	457,835	63
Rosena Park West	136,677	19
Fontana Park	1,524,600	210
Westgate Park	614,196	85
Patricia Marrujo Park	219,576	30
Ralph M. Lewis Memorial Sports Complex	830,036	114
Summit at Rosena Parks	680,000	94
Summit at Rosena Green Garden	1,575,000	72
Hunter's Ridge Park	205,125	28
San Sevaine Park	248	34
Private Users		
Sierra Lakes Golf Course (Irrigation)	6,523,981	899
Other		
Hunter's Ridge	774,050	107
Ventana Point	22,995	3
Summit Heights	203,726	28
Sierra Lakes	192,035	26
Total (Parks)	**14,127,534**	**1,835**
Schools		
Summit High School	969,614	134
Sierra Lakes Elem School	225,113	31
Fontana AB Miller High School	1,101,157	152
Wayne Ruble Elementary School	539,708	74
Wayne Ruble Middle School	311,484	43
Summit at Rosena Middle School	292,500	40
The Arboretum at Fontana North Elementary School	289,674	40
Total (Schools)	3,729,250	514
GRAND TOTAL	**17,856,784**	**2,349**

Construction Estimate

It was estimated that the construction of recycled water pipes, pump stations, etc. to the areas of north Fontana would cost approximately $15,438,600 *(5)*. Approximately, 15 pipelines ranging from 36 inches in diameter to 8 inches in diameter would have to be installed in lengths of 6,300 feet to 750 feet. The sizes of the pipelines were calculated to meet the future demands for the areas of north Fontana for the next 20 years. The population in the City of Fontana is expected to grow by 42 percent by the year 2025 from 159,000 to 226,000 people *(5)*. Table 7 is an engineer's estimate of the construction for recycled water pipelines to the north Fontana area *(5)*.

Table 7. Engineers Estimate *(5)*.

Description of Job	Type	Lth (ft)	Diam. (in)	Flow (MGD)	Unit Cost	Total
High pressure pump 210 to Beech	Pump Station		1000		$2,000	**$2,000,000**
Hydro Tank					LS	**$400,000**
Summit From POC to Lytle Creek	Pipeline	6,300	36	33.03	$540	**$3,402,000**
Jacking under 15 Freeway	Bore and Jack		36	33.03	LS	**$200,000**
Lytle Creek from Summit to HS	Pipeline	750	10	1.08	$120	**$90,000**
Lytle Creek from HS to Curtis	Pipeline	1,850	8	0.6	$96	**$177,600**
Rosena Park	Pipeline	3,740	6	0.28	$72	**$269,280**
Summit to Fontana Park	Pipeline	1,000	10	1.08	$120	**$120,000**
Summit From Lytle to Citrus	Pipeline	4,000	30	20.31	$450	**$1,800,000**
Citrus from Lytle to P Marrujo Park	Pipeline	1,250	24	11.2	$360	**$450,000**
Citrus from PM Park to Ralph L Park	Pipeline	2,000	20	6.89	$240	**$480,000**
Sierra Lakes Golf Course	Pipeline	3,250	20	6.89	$240	**$780,000**
Jacking under 215 Freeway	Bore and Jack LS		10	1.08	LS	**$100,000**
Wayne Rubble & AB Miller Schools	Pipeline	3,250	10	1.08	$120	**$390,000**
Summit at Rosena	Pipeline	1,500	16	3.8	$192	**$288,000**
The Arboretum	Pipeline	3,750	16	3.8	$192	**$720,000**
Cherry from PS to D Long Elementary	Pipeline	2,500	10	1.08	$120	**$300,000**
Cherry from Long Elem to H.R. Park	Pipeline	1,750	8	0.6	$96	**$168,000**
Bridlepath	Pipeline	3,000	6	0.28	$72	**$216,000**
Subtotal						**$12,350,880**

Subtotal	$ 12,350,880
Contingency (25%)	$ 3,087,720
Total Cost	**$ 15,438,600**

Ultimately, the cost of recycled water was increased due to the added construction fees. The initial cost per acre feet of recycled water from IEUA was $63. With the addition of construction fees the total cost per acre feet is $438. The cost per acre foot was calculated by taking the total cost of the project, $15,438,600 and dividing it by the total consumption of acre feet and dividing it by twenty. It was divided by twenty because that was the estimated payback time in years. The pumping and O&M pumping cost were calculated by taking the energy cost and dividing it by the total acre feet. The total cost per acre foot was then determined by adding the total acre feet per year, the cost per acre feet, the pumping and O&M cost per acre feet, and the nominal cost per acre feet. The total added up to $438.

Table 8. Cost Per Acre Foot of Recycled Water *(5)*.

Total acre-ft/yr	2,349
Cost per ac-ft	$ 329
Pumping Cost per ac-ft	$ 24
O&M Cost per ac-ft	$ 20
Cost per ac-ft from IEUA	$ 65
Total cost per ac-ft	$ 438

Maximum Flow

The Manning formula was used to calculate the maximum flow of water through the pipelines as seen in equation 1 below.

$$Q = (1.49/n)*(A)*(R^{2/3})*(S^{1/2}) \quad (1)$$

Where n is Manning's Roughness Coefficient. It was assumed that it is 0.012, for a VCP pipe, A = Area of the pipe, R is the Hydraulic Radius (this is defined as cross sectional area of flow divided by the wetted perimeter). Since the pipe is flowing full, we will take the area, $7.07 ft^2$ and divide it by the perimeter of the pipe. S is the slope of the pipe, which is 0.005 *(20)*.

CHAPTER THREE

RESULTS

Introduction

The results of the cost analysis for implementing recycled water to the north Fontana area can be seen in the following tables. The cost analysis was a comparison of the rates that the city of Fontana currently pays for potable water to the FWC and CVWD versus the rates they could be paying using recycled water from IEUA without surcharges. The actual rates for CVWD were also calculated in this project. Presently, FWC does not sell recycled water so there were no actual rates available.

State Revolving Fund

The State Revolving Fund (SRF) loan programs provide low-interest loans to communities for projects that improve wastewater and drinking water infrastructure.

> The program's mission is to provide eligible entities with the lowest interest rates possible on the financing of such projects while protecting public health and the environment. SRF

also funds non-point source projects that are tied to a wastewater loan *(19)*.

It should be noted that each entity inserts surcharges that ultimately increase the final cost of the recycled water. Whereas, IEUA rates are not geared towards producing a profit, instead the agencies' rates reflect the cost to construct the pipes and treatment. Often, the money recovered does not cover the total cost of the project. Fortunately, IEUA receives a rebate from the MWD for utilizing recycled water. The rebate is offered thorough the Conservation Credits Program. This program pays member agencies approximately $154 per acre-foot of water recycling that both reduces the demand on the MWD and helps the agency become less reliant on imported water. The LRP also encourages agencies to construct recycled water and establish groundwater recovery projects *(17)*. However, the rebate combined with the $65 rate usually does not add up to the total amount of the SRF loan. Unfortunately, the cost difference is absorbed by IEUA and not the water companies.

California Energy Commission

The California Energy Commission (CEC) has reported that water supply and conveyance of water from northern to southern California consumes and estimated 3.2 megawatt hours per acre-foot (MWh/AF). In contrast, the estimated cost to recycle water is approximately 0.7 MWh/AF *(11)*. This would produce a possible energy savings of 2.5 MWh/AF for southern California communities that import water *(1)*.

In 2003 the Pacific Institute for Studies in Development, developed a model that calculated the savings of what the reduction of 10,000 acre-ft/yr of imported water would save, 16.8 million kilowatt hours annually. To put things in perspective, 16.8 million kilowatt hours are enough to meet the energy needs of about 1,650 average single family homes for one year *(10)*. Consequently, reducing energy demands also reduces air pollution. For example, for each 10,000 ac-ft of imported water that IEUA reduces the area will see a decrease in carbon dioxide, carbon monoxide, nitrogen oxide, sulfur oxide, total organic gases, and total particulates. This will reduce carbon dioxide emissions by 7.9 billion grams per year; carbon monoxide emissions by 3.5 million grams per year; nitrogen oxide emissions by 1.7 million grams per year;

sulfur oxide emissions by 165,000 grams per year; total organic gases by 1 million grams per year; and total particulates by 362,000 grams per year *(1)*.

In hopes to draw more customers towards purchasing recycled water contracting agencies reduce recycled water rates. The prior rate was at 80% of the cost of imported water. Currently, IEUA's rates are $65 an acre-foot *(19)*.

Implementing recycled water to the areas of north Fontana area would increase the levels of groundwater by approximately 5,200 acre-ft/yr (*1*).

> IEUA's Implementation Plan identified over 2,000 potential recycled water customers within IEUA's service area and estimated an ultimate recycled water demand of approximately 93,000 acre-ft/yr. Of this amount, approximately 27,000 ac-ft of recycled water are anticipated to be used for groundwater recharge purposes at 17 spreading basins located throughout the Chino Groundwater Basin. The plan also estimated 38,400 acre-ft/yr of recycled water was identified for irrigation purposes, 5,800 acre-ft/yr for industrial use, and approximately 7,000 acre-ft/yr for agricultural use (30).

Table 9. Potable Water Rate Comparison for Schools and Parks in North Fontana Using Fontana Water Company, Cucamonga Valley Water District, and Inland Empire Utilities Agency.

Loc.	FWC ($763 ac-ft)	CVWD ($539 ac-ft)	IEUA ($65 ac-ft)	FWC savings using R.W.	CVWD savings using R.W.
Parks	$3,835.90	$2,709.77	$326.78	$3,509.12	$2,382.99
Schools	$1,074.47	$759.03	$91.53	$982.94	$667.50
Total	$4,910.38	$3,468.80	$418.32	$4,492.06	$3,050.48

Table 9 is a water rate comparison of potable water for the schools and parks in the north Fontana area. It shows that applying recycled water, without the added surcharges, would also provide a monetary savings in the city of Fontana's water bill.

The savings were calculating by taking IEUA's recycled water rate per ac-ft and subtracting from what each water entity is currently billing. According to Table 9 the total savings for parks using recycled water instead of potable water from FWC or CVWD was $3,509.12 and $2,382.99 per month correspondingly. Figure 3 shows a breakdown of the monthly saving for schools using FWC and CVWD was $982.94 and $667.50. The total savings was $4,492.06 and $3,050.98 respectively. The saving for schools was less because of the smaller size of the fields.

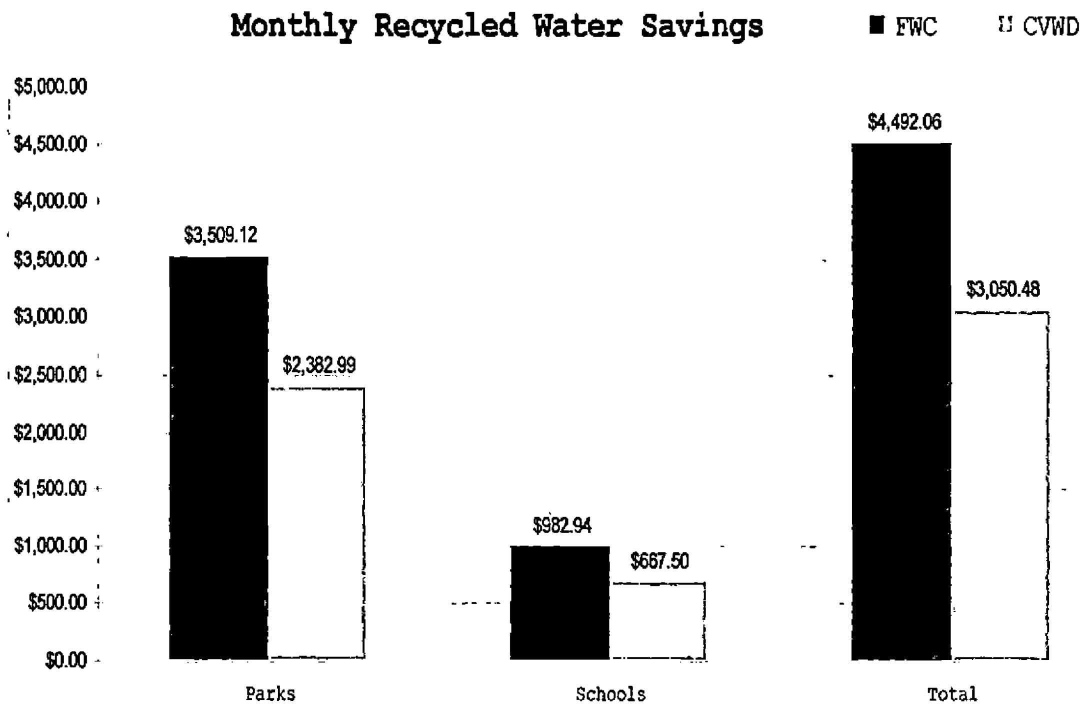

Figure 3. Graph of Water Rate Comparison for Schools and Parks in North Fontana Using Fontana Water Company, Cucamonga Valley Water District, and Inland Empire Utilities Agency Without Surcharges From Entities.

Cucamonga Valley Water District
Current Rates

The current rates for CVWD were approximately $488 ac-foot for recycled water. Unfortunately, there was no estimate for the FWC because it does not currently sell recycled water. The difference in price is between potable water and recycled water is approximately $51 per ac-ft.

Figure 4 is a comparison of potable water rates versus the recycled water rates. The difference in savings was minimal. The monthly savings for parks and school was $256.40 and $71.82 respectively. The total savings per month was $328.22.

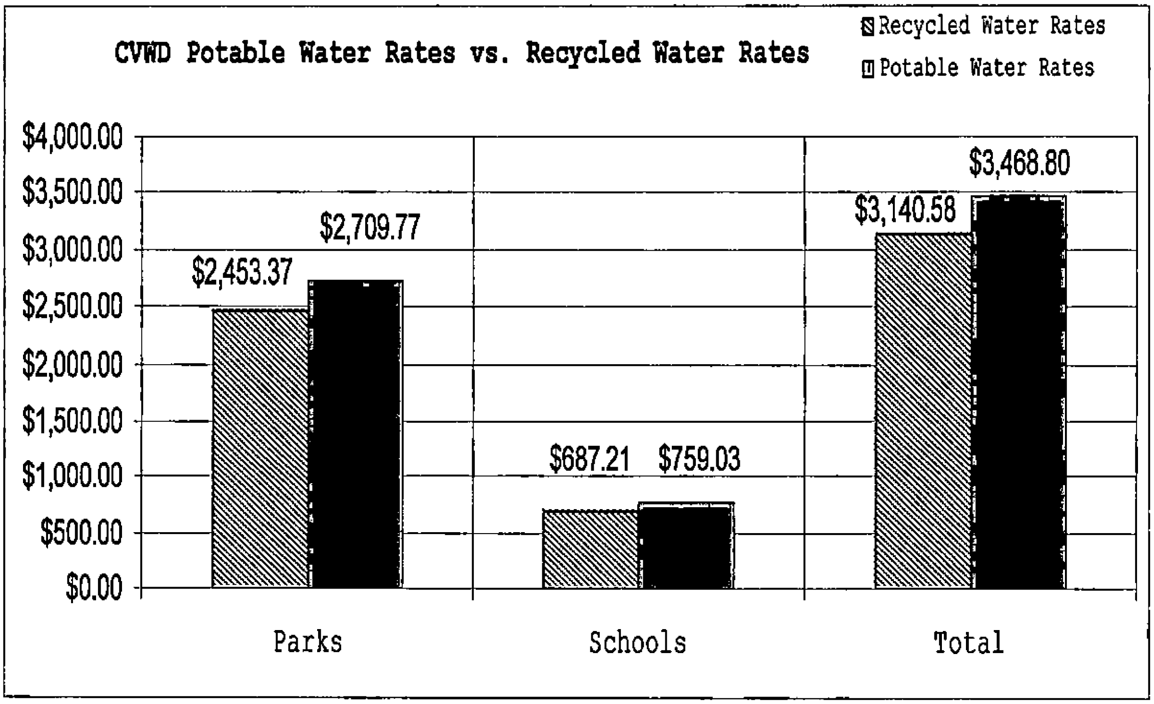

Figure 4. Comparison of Cucamonga Valley Water District Potable Water Rates Versus Cucamonga Valley Water District Recycled Water Rates.

While the savings may not seem worth constructing pipelines to north Fontana to some, the future savings in groundwater and finally having a reliable source of water for the Inland Empire is priceless. Future new developments played an essential role in deciphering where to implement recycled water. It was concluded that the largest future consumers would be the Arboretum and Rosena Ranch in north Fontana. These future large developments are expected to use a large amount of recycled water for their landscaping areas.

CHAPTER FOUR

CONCLUSION

Introduction

About 75% of Earth is covered by water, with only 1% of that as potable water. Unfortunately, that 1% of potable water has to meet the drinking water needs of the entire world. In addition, drought and pollution are adversely affecting the 1%. The population in the world is persistently increasing, sequentially increasing the demand for water. In California, more than 66% of our water supply is imported. In the next 15 years California has to reduce its imported water supply by 1 million acre-feet *(19)*.

In order to assure that California has enough water to meet future and present water demands, recycled water practices must be implemented uses need to be expanded. Making recycled water available for landscape and industrial uses will preserve the drinking water supply for other needs. Irrigating with recycled water will help avoid water shortages in the future. Aside from increasing groundwater levels, implementing recycled water will ultimately reduce our dependence on expensive imported water and finally enable us to utilize our resources here in the Inland Empire.

The findings in this research suggest that using recycled water in the north Fontana area will not save the city of Fontana as much money as hoped for. However, the benefits in for the environment outweigh the monetary costs. The total savings for parks using recycled water instead of potable water from FWC or CVWD was $3,509.12 and $2,382.99 per month correspondingly. The monthly saving for schools using FWC and CVWD was $982.94 and $667.50. The total savings, with no surcharges, from FWC or CVWD was $4,492.06 and $3,050.98 respectively. The actual cost savings for parks and schools using CVWD was actually calculated because of the fact that CVWD currently sells recycled water. This was not possible for FWC because they do not currently sell recycled water. However, it is estimated that the FWC will do so in the next couple of years. Regrettably, the savings was small for both the parks and schools. The CVWD price difference for potable water and recycled water is approximately $51 and ac-ft. The monthly savings for parks and school was $256.40 and

$71.82 respectively. The total savings per month was $328.22. With savings this small the cities would not be able to cover the cost the pipelines. While the savings may not seem worth constructing pipelines to north Fontana to some, the future savings in groundwater and finally having a reliable source of water for the Inland Empire is priceless. This project evaluated the possibility of utilizing recycled water form an entity comparable to FWC because to the fact that FWC does not have established recycled water rates as of yet. It is important to note that this project is one of many scenarios that could take place. The ultimate purpose of this project was to provide a cost analysis of what it would cost to utilize recycled water to the north area of Fontana and if it was even possible. Fortunately, it was discovered that implementing recycled water to the north Fontana area is possible and would ultimately benefit the present and future residents in the Inland Empire by conserving potable water and utilizing recycled water that would otherwise be discharged to the Santa Ana River and or ultimately to the ocean.

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