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Water conservation in the Las Vegas Valley

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ABSTRACT

This thesis deals primarily with residential use of water in the Las Vegas Valley, an arid climate located in the Mojave Desert, and whether the education of people living here has any bearing on whether or not they conserve water. Many of the residents of the Las Vegas Valley have moved from other areas of the country, and perhaps are not aware of the fact that there is a limited supply of water available to the Valley. I believe that people are not necessarily wasteful, and that they would want to conserve water, if they were aware that conservation and the efficient use of water are a concern.

Although conservation has been used in past to pull communities through short-term crises, such as drought-induced shortages, I agree with the literature I have reviewed that looks at conservation as a method to meet long-range water needs.

I believe that we need to educate the residents of the area as to the climate and what plants and grasses will grow with less water. Cost is not the only factor that determines water use. Education is extremely important. People need to know how much water we have available to us, and how best to conserve what is available so we may enable others to benefit from it as well.

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I am grateful to my professors both present and past, whose teachings guided me along the path to completing my degree. I thank Dr. James Deacon of the Environmental Studies Department for his support of continuing my mentorship program with the local school district.

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INTRODUCTION

The principle of resource conservation is that most resources are limited and should not be wasted; there are not always more, and these additional resources are not all for us (Miller, 1996). This paper will look at water conservation in the Las Vegas Valley, an arid region in the Western United States with a growing population of approximately 1.2 million people. Population centers have shifted to western areas where supplies of water are limited and often already being maximized. Many new residents to the Valley are coming from regions where water supplies are abundant and continue their historical use patterns even though the climate of their new residence may be arid and water supplies are scarce (Waddington, 1995).

Pressure to conserve water is increasing. As population growth swells dramatically, water scarcity has become a critical environmental issue due to increases in the amount of personal water consumption, the increased demand for industrial, commercial, and agricultural use, and natural causes such as drought. It will take a considerable effort to keep up with the population's need for fresh water (Switzer, 1994). Water is a fixed-sum resource: you cannot make more of it and you cannot destroy it. It therefore follows that as human numbers increase, water availability per person must decrease (Clarke, 1993).

Water resource management has traditionally been synonymous with the construction of treatment facilities and the development of dams and reservoirs. Increased water efficiency is now emerging as a viable alternative to developing new water supplies and expanding treatment facilities. In order to keep up with the accelerated growth and development in Southern Nevada, meeting increased water-related services with limited quantities of water has become a necessity. In some parts of the country, water consumers have been forced to adopt conservation measures

during droughts because the existing supply could not meet the demand in their area (Clark County Conservation District, 1995).

Las Vegas currently acquires its water from the Colorado River. In 1992, Congress approved the Colorado River Compact, which divided the Colorado River's resources between the three lower basin states of California, Arizona, and Nevada, and the four upper basin states of Wyoming, Colorado, New Mexico, and Utah. Congress authorized the building of Hoover Dam in 1928, giving the U.S. total control over the Colorado River (Switzer, 1994). Of the seven states that draw from the Colorado River water supply, Nevada is in the most precarious position. It has a 300,000 acre-foot* annual allocation compared, for example, with Arizona's 2.8 million acre-feet and California's 4.4 million acre-feet.

The challenges of water conservation in the Las Vegas Valley are compounded by its increasing population and arid climate. Many residents currently resist water conservation; therefore, getting people to conserve is difficult, and the ability to save water is low. If conservation efforts were successful, we could use the water conserved as an additional or extended resource for future demands.

Why should we conserve water? Growth and development in this region will continue to be dictated to a large extent by the availability of adequate water supplies. As a result, increasing pressure is being placed on water users to become more efficient in all aspects of water use. If urban communities, such as Southern Nevada, wish to become better stewards of water resources, practices should be developed to protect and conserve water (Clark County

* An acre-foot is the volume of water required to cover one acre of land (43,560 square feet) to a depth of one foot and is a common unit of measure for water, particularly in the West. One acre-foot meets the needs of an average household for one year (Greene, 1997).

Conservation District, 1995). The increased demand on the available supply of water and our flagrant abuse of one of our most precious and limited resources is, or should be, a concern for the many people who live in this arid region (Austin, 1995). Conservation of water is being seen as a tool for long-term water resource planning, as the source of an additional water supply to meet future water demands. The western United States has experienced significant droughts during the past fifteen years, making the implementation of water conservation activities necessary in many communities (Darilek, 1995; Cuthbert and Lemoine, 1995). Conservation can have an impact if there is a definite decrease in the amount of water used, but it requires education of the public and a change in mindset regarding the need for water (Austin, 1995).

For decades, the communities in Southern Nevada have blatantly abused our water resources. Despite being relatively isolated on the outskirts of the Mojave desert, Southern Nevada has thrived to become one of the nation's most desirable places to live and conduct business (SNWA, 1995).

Water is the key ingredient to our region's economic prosperity. Water is necessary for drinking, irrigation, and for life (SNWA, 1995). We need to take a proactive approach in managing our water resources in Southern Nevada by applying water efficient practices. Accomplishing more with less, which is essentially what water conservation is all about, requires a foundation of knowledge about the effectiveness of resource preservation. We must work together to foster the efficient and sustainable use of our most precious natural resource, water (Clark County Conservation District, 1995).

The Southern Nevada Water Authority (SNWA) is the agency charged with managing this precious resource. The SNWA meets daily challenges to plan for present and future water

needs of a widely-diverse area that is home to more than one million residents, a booming business environment and some of the most popular tourist attractions in the world (SNWA, 1995). Water consumption in the United States is higher than anywhere else in the world (Darrell, 1986). Water resources are not inexhaustible. The basic issue is not a technical one. It is, according to Professor Malin Falkenmark, Stockholm Natural Science Research Council, "… in reality a problem of incentives, social controls, and the ability to handle complexity as well as social pressures and conflicts". What matters most is not whether a country has enough water to satisfy its theoretical needs; what matters is how people can best adapt their use of water to provide the greatest benefits from what is available (Clarke, 1993). Water management in the United States has traditionally focused on manipulating the country's abundant supplies of fresh water to meet the needs of users. The era of building large dams and conveyance systems is quickly ending, and as we approach the 21st century, we must manage a relatively fixed water supply more effectively to meet increasing demands. The "new" supplies of the future are more likely to be the result of conservation and water-use efficiency efforts rather than from development projects (Hadley et al., 1995). Marc Reisner, author of "*Cadillac Desert*", the landmark book on Western water, was quoted in a recent article as saying that "We have managed to get by on a piece of the water pie that is exactly the same size as it was 40 years ago. As millions of people continue to settle in Nevada, Arizona and California, the old ways of stretching a finite resource will increasingly fail" (McKinnon, 1998).

Las Vegas uses 325 gallons per capita per day, a figure believed to be greater than any city in the world. Although water prices have been raised sharply, they are still among the lowest in the West (Cauchon, 1997). Predictions have been made which suggest that Las Vegas will run short of water in the year 2007. Local water authorities predict that the Valley's two sources of

water, the Colorado River and groundwater, will not be able to supply water to new residents in ten years. The Southern Nevada Water Authority has launched an aggressive effort to locate more water for Las Vegas, but so far has been unsuccessful.

In the November 11, 1997 issue of *USA Today*, Dennis Cauchon wrote about water thirsty Las Vegas: "This desert city is draining its water supply. But for residents who use water freely, conservation and a change in landscaping habits have been difficult to accept" (6A). He notes the aquatic wonderland of waterfalls, swimming pools and green lawns, and the imitation volcano. "We import water-guzzling English oak trees to reconstruct a desert version of Robin Hood's Sherwood Forest. I call Las Vegas an artificial desert rain forest. You have to pour ten feet of water on a lawn every year here to keep it green," says University of Nevada horticulturist, Robert Morris, in an interview with *USA Today* (Cauchon, 1997).

While many Las Vegas homeowners have converted their indoor water fixtures to low water use equipment, by installing faucet aerators, water-efficient shower heads and devices to reduce the water used in the toilet, most of the SNWA's water-saving efforts have centered on outdoor usage. During the winter, according to David Riggleman, SNWA conservation manager, two-thirds of the water used by the average homeowner is used outside to water plants and trees. In the summer, up to 90 percent of the water consumed is for outdoor use. Water is often wasted because of mis-aimed sprinklers, broken sprinkler heads and overwatering (White, 1997). Of the available supply, residential use of water in Southern Nevada during calendar year 1996 accounted for the highest amount used at 65 percent (SNWA, 1997). Would education of the people and increased costs of water improve conservation efforts? In an effort to reduce outdoor watering, several communities in Southern Nevada have implemented lawn-watering ordinances

that limit the hours of the day that lawns and outdoor plants can be watered. These ordinances help eliminate costly water evaporation and reduce water demand during peak times of the day (Figure 1).

In 1995, the SNWA member agencies entered into a Memorandum of Understanding (MOU) regarding a regional water conservation plan. The MOU identifies specific management practices, timelines and criteria that member agencies agree to follow in order to implement water conservation and efficiency measures. These practices include a water measurement and accounting system, incentive pricing and billing, water conservation and efficiency coordination, and information and education programs, including customer audits and incentives, and landscape programs. Through programs such as these, the efficient use of water is promoted throughout the year (SNWA, 1995).

Residential homeowners in the Las Vegas Valley consume 65 percent of the available water supply, with two-thirds of that going to landscaping and lush green expanses of lawn. In 1976, the city of Tucson, Arizona raised their water rates more than 500 percent for some users in an effort to save depleted supplies of groundwater. A valuable lesson was learned. When residential bills went from $7 per month to $60 per month, Tucson Mayor George Miller converted much of his lawn to desert landscaping (6A). “Things got brown in a hurry after water prices went up,” stated Mayor Miller (6A). Today Tucson uses 165 gallons per capita per day. Only cemeteries, playgrounds and golf courses are covered with grass. John Begeman, horticulturist at the University of Arizona, noted that “people in Tucson want to live in the desert, rather than change it” (Cauchon, 1997).

There are two basic solutions to the water scarcity and management problem: conservation and technology. We must convince users to use less. Technological solutions include conservation efforts such as consumption ordinances, water-saving showerheads and low-flow toilets. Although it is obvious to most that water conservation is the most obvious choice among these strategies, it is also one of the most difficult to implement as long as residents are used to simply turning on the tap. It is especially difficult to convince residents of Las Vegas of this need, when they have previously been encouraged to use water so the Valley wouldn't lose rights to the water from the Colorado River (Cauchon, 1997).

Conservation can have an impact if there is a definite decrease in the amount of water used. It requires education of the public and a change in mindset regarding the need for water or for high water-using plants and activities (Waddington, 1995). In the past, the construction of dams and reservoirs was considered a primary water conservation measure, to help insure that adequate water supplies would be available in times of drought. Now attention has shifted to the other side of the picture, the water user. Increasing water use efficiency and reducing water demands in the municipal, industrial, and agricultural water-use sectors is the prime goal of most water conservation programs.

For municipal water suppliers, conservation can help preserve area water supplies and ensure a more readily available supply for future needs. Water conservation usually provides the least costly alternative for obtaining a new municipal water supply (Darilek, 1995).

The focus of this thesis, then, is to discuss water conservation practices in the Las Vegas Valley. First, the current use of water for residential landscaping in the Las Vegas Valley will be discussed. I believe the volume of water for residential landscaping in the Las Vegas could be

reduced by increasing the cost of water and by educating residents. Second, the influences of increasing water cost to residents in Las Vegas to promote water conservation will be examined. Finally, the effectiveness of water conservation education of Las Vegas Valley residents will be addressed.

I believe raising the price of water will not necessarily lead to water conservation. However, I do believe the more educated a resident is on water issues, the more he or she will be concerned about water availability and conservation in the Las Vegas Valley. Therefore, this thesis will examine water conservation and how residents may react to educational efforts and an increased cost in water.

CASE STUDY

What is conservation? Since the historic Conference of Governors in 1908 in Washington, DC, the term “conservation” has yielded to many interpretations. Gifford Pinchot, considered by many to be the father of the conservation movement in this country, stated that, “Conservation is the use of natural resources for the greatest good of the greatest number for the longest time” (Pinchot, 1947).

But what is a resource? To some, a resource is the physical substance itself; to others, it is its market value; and to yet others, its beauty. It depends on your perspective, whether it’s from an economic, ecological, aesthetic, or moral standpoint.

HISTORY OF WATER IN THE LAS VEGAS VALLEY

The history of water in Southern Nevada dates back centuries, when Native Americans first inhabited the fertile valley. Archaeological evidence indicates that the Big, Middle, and Little Springs (the abundant water supply that originally attracted settlers to Las Vegas) provided water to many groups of people including Native American tribes dating as far back as 10,000 BC. These springs provided water to travelers of the Old Spanish Trail, also known as the Mormon Trail, which linked Salt Lake City, Utah to Southern California. The City of Las Vegas relied on these springs as the primary source of water for many years. Water drainage flows west to east to escape the valley via the Las Vegas Wash. A deep groundwater aquifer lies within the north-central zone of the Valley, fed by runoff from the Spring Mountains and seasonal rains.

With the development of the Union Pacific Railroad, Las Vegas became a boomtown for commerce and trade, housing workers and their families attracted by the railroad. In May 1905,

with the birth of a thriving community, the Las Vegas Land and Water Company was formed to ensure an adequate water supply to the railroad industry and to new homes on the horizon (SNWA, 1995).

By 1930, early in the Great Depression years, Nevada's population stood at 91,058 persons. This was only the beginning of an unbroken growth trend for the southern Nevada economy. Over the next fifty years, the population of Las Vegas (Clark County) would virtually double every ten years, equating to an annual average rate of growth of over eight percent per year (Horton, 1995).

Much of the population of the southwestern United States living along the Colorado River's lower reaches had continually lived under the threat of its periodic unruly and destructive nature. Stretching 1,430 miles from its source of Lake Granby near Long's Peak, Colorado, to its outlet in the Gulf of California in Baja, Mexico, the Colorado River provided life-sustaining, and sometimes life-threatening, waters to much of the southwestern portion of the United States.

The Colorado River drains some of the most barren and arid lands in the United States, lands frequently susceptible to violent storms, flash floods, and extensive erosion. Its strength and destructiveness are based primarily on the rapid changes in its rates of flow and the volume of sediment it carries. A number of dams were built along it to regulate its flow, harness its vast potential as a power source, and provide a stable source of irrigation water to farms in Arizona and California.

Lake Mead was formed as a result of the building of Hoover Dam on the Lower Colorado River, and covers 157,000 acres, or 247 square miles. The lake extends approximately 110 miles upstream toward the Grand Canyon, and 35 miles up the Virgin River. It holds 28,537,000 acre-feet of water, or some 9.3 trillion gallons, equivalent to almost two years of normal Colorado River flows.

An agreement would have to be formulated among the states that shared the waters along this vast and virtually untamed river system. The Colorado River Compact, providing for the general allocation of the waters of the Colorado River, was entered into on November 24, 1922 and subsequently ratified by the legislatures of the seven states within the Colorado River Basin—Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming. The compact divided the entire Colorado River Basin into an Upper Basin and a Lower Basin, with the division point established at Lees Ferry, a point in the mainstream of the Colorado River located approximately 30 river miles south of the Utah-Arizona border.

The Upper Colorado River Basin was defined to include those parts of the States of Arizona, Colorado, New Mexico, Utah, and Wyoming within and from which waters naturally drain into the Colorado River system above Lees Ferry, and all parts of these states that are not part of the river's drainage system but may benefit from water diverted from the system above Lees Ferry. The Lower Colorado River Basin was defined to include those parts of the states of Arizona, California, Nevada, New Mexico, and Utah within and from which waters naturally drain into the Colorado River system below Lees Ferry, and all parts of these states that are not part of the river's drainage system but may benefit from water diverted from the system below Lees Ferry.

The compact did not apportion water to any one state; however, it did apportion to each Upper and Lower Basin the exclusive, beneficial consumptive use of 7,500,000 acre-feet of water per year from the Colorado River system in perpetuity. Further, the compact gave to the Lower Basin the right to increase its annual beneficial consumptive use of such water by 1,000,000 acre-feet. The remaining 1,500,000 acre-feet of the Colorado River's estimated 17.5 million acre-feet of normal year flows were left for Mexico (Horton, 1995).

It would be 26 years before the Upper Colorado River Basin states would reach an agreement on the specific allocation of their 7.5 million acre-feet, and another 14 years after that for the allocation of the water to the states comprising the Lower Colorado River Basin. Because the Lower Basin states could not come to an agreement on apportionment on their own, the U.S. Supreme Court ruled in October 1962, almost 40 years after the signing of the original Colorado River Compact, that of the first 7,500,000 acre-feet of mainstream water in the Lower Colorado River Basin, California is entitled to 4.4 million acre-feet (58.67 percent), Arizona to 2.8 million acre-feet (37.33 percent), and Nevada to 300,000 acre-feet (4.00 percent) (Figure 2).

At the time, the water allocation was based on each state’s potential agricultural needs and seemed appropriate. But, today, the states have dramatically grown, and while Nevada has tripled its population figures, the allocated amounts remain the same. As a divisive political debate, few topics have captured the attention of western states the way water has. In spite of the Las Vegas Valley’s burgeoning population, the region is still living on its 1920 allotment of Colorado River water: 300,000 acre-feet per year. The SNWA is currently negotiating to increase this amount.

At the completion of the Hoover Dam project on March 1, 1936, no one could remotely envision that within only 50 years Nevada's seemingly generous annual allocation of 300,000 acre-feet (97.756 billion gallons) of Colorado River water would prove to be a potentially serious constraint to the future growth in Las Vegas.

By 1946, growth in the valley resulted in more water being withdrawn from groundwater aquifers than was being naturally recharged from snowmelt in the Spring Mountains. The natural recharge rate in this area is approximately 35,000-acre feet per year. In 1947, the Nevada State Legislature passed a bill creating the Las Vegas Valley Water District (LVVWD). The first task of the LVVWD was to purchase from the Union Pacific Railroad the Las Vegas Land and Water Company to bring Colorado River water to the Las Vegas Valley from Lake Mead. The purchase of the Land and Water Company was finalized in 1954.

As the population continued to grow, so did the need for additional water supplies. The Alfred Merritt Smith Water Treatment Facility was built and put on line in 1971, and water from Lake Mead was delivered to the valley. The Southern Nevada Water Project provided Colorado River water from Lake Mead to Las Vegas, North Las Vegas, Henderson, Boulder City, Nellis Air Force Base, and surrounding unincorporated areas within Clark County. While most of our drinking water comes to us via pipeline from Lake Mead, additional wells were drilled into the groundwater aquifer to keep up with demand. Many private domestic wells are also in operation in the Valley.

USE OF WATER IN THE LAS VEGAS VALLEY

Competition for urban water has resulted in an increasing interest in conservation worldwide. As water becomes more scarce and increasing demand drives up the price, ways of reducing demand become more attractive. Water management goals can't be achieved by public policy alone. Life in the nation's driest state calls upon residents and businesses to consider what they can do individually to protect our most precious resource.

Many urban areas simply have no feasible way of balancing supply and demand without conservation and more-efficient water use. Conservation makes sense for many reasons, and a different mix of measures will be best in different situations. In almost every case, however, successful efforts to curb domestic water use permanently will include some combination of economic incentives, regulations, and public outreach that together promote the use of water-saving technologies and behaviors. These measures are mutually reinforcing, and together they constitute a water supply option as reliable and predictable as a new dam and reservoir. As water becomes increasingly scarce, they often emerge as the least costly, most environmentally sound way of meeting community water needs when compared on an equal footing with traditional engineering approaches focused on expanding the supply (Postel, 1997).

Why should we in the Las Vegas Valley conserve water? Southern Nevada, with an average annual rainfall of just four inches, is one of the most arid regions in the United States. It is also home to some of the fastest growing communities in the nation. Water in this arid desert community is a limited and precious resource. Southern Nevada's current available water resources are limited to a consumptive use allocation from the Colorado River of 300,000 acre-

feet per year (afy), approximately 45,000 afy in groundwater rights, and 21,800 afy in reclaimed water use. A reliable water supply, now and in the future, is essential to maintain the economic prosperity and quality of life Southern Nevada residents enjoy. A responsible water conservation/efficiency strategy is one of the solutions needed to ensure Southern Nevada has adequate water resources to meet future demands (SNWA, 1994).

It's easy to worry that amid the golf courses and the greenbelts, the hotel fountains and palm trees, Nevadans are squandering water, our scarcest commodity. Yet, water management entities across the state are formulating strategies for effective stewardship of Nevada's water resources. The prescriptions call for management steps ranging from expanding delivery systems and discovering additional water sources to conservation (Robison, 1998).

Who uses water in Southern Nevada? Most visitors and residents of Southern Nevada see extravagant uses of water at local hotels and casinos and assume that is where most of our water is used. Hotels and casinos, however, use only eight percent of the water. Irrigation of golf courses and parks use another eight percent. The business community, including schools and government, use twenty percent of the supply. The other sixty-four percent, or two-thirds of the available supply to the Las Vegas Valley, is supplied to residential customers for use both inside and outside the home (Figure 3). Since the home is where the most water is used, it is also the place where the most water can be conserved. But is also the place where most of the waste occurs. Sixty percent of the total amount supplied to residential customers is wasted as a result of outdoor lawn watering and inefficiency; that figure can climb to ninety percent of total residential use during the hot summer months (Robison, 1998, p. 33).

Landscape irrigation water is one of the largest single users of water for most

purveyors. In many dry regions, the sprinkling of lawns accounts for a third to half of residential water demand. This water has a particularly high economic and environmental price, since it is most needed during hot summer days when utilities experience their highest level of use. Meeting this “peak” demand requires planners to develop more water sources and treatment capacity than is needed to meet the amount of water typically used during most of the year (Postel, 1997).

The challenge is to deliver the appropriate amount of water to the root zone at the correct time. Climatic conditions relating to the level and time of precipitation and the amount of evapotranspiration are important in establishing lawn watering needs. Evidence of poor landscape management includes dry patches or ponding on turf areas, water running in the streets and excessive peak demand (Bureau of Reclamation Lower Colorado Region, 1997).

Exterior uses of water are predominantly the amounts of water used for lawn irrigation. Landscape experts estimate that more than 60 percent of the water supplied to Las Vegas Valley residences is used outdoors, and almost half that amount is wasted through inefficient watering practices. Sprinkling only when the lawn requires water, rather than on a regular basis, promotes water use efficiency. For a given type of groundcover, irrigation requirements per square foot can vary greatly depending on the type of soil, the slope of the land, the amount and timing of precipitation, temperature, wind, and other factors. The type of landscaping also has a substantial effect, for example, turf versus xeriscape. Hanemann notes that the type of turf itself can make a difference; warm-season turfgrasses such as Bermuda grass require about 20 percent less water in California than cool-season turfgrasses such as Kentucky bluegrass (p. 55). Moreover, in addition to the physical considerations associated with soil type and plant type, as with indoor

water use, there is an essential behavioral component in outdoor water use. People choose to adopt one style of landscaping rather than another, and they water their landscape with different degrees of knowledge, care, and attentiveness (Hanemann, 1998).

Through efficient watering techniques, watering requirements can be reduced dramatically. In addition, advanced techniques of lawn irrigation have been devised. Among these are the uses of drip or trickle irrigation. Conventional losses such as runoff, deep percolation and soil water evaporation are minimized. Over-watering depletes our water supply; makes plants pest prone; contributes to weed invasion, and disease problems; adds to runoff that pollutes our water systems; and is the largest waste of water in Southern Nevada (SNWA, 1995). Over-watering will saturate the soil well beyond the root zone of the plant, and water is wasted. In many cases, the water reaches a compacted layer of soil and runs off, without seeping into the ground.

Horticultural changes that are aimed at using less water, but still maintain the aesthetic appeal that homeowners wish of their lawn areas are socially acceptable depending on personal preferences and social attitudes toward lawn areas. Some people seem to prefer desert landscaping, while others prefer traditional lawn areas. Conversion to desert landscaping or native scenes as well as adoption of water efficient sprinkling methods by an entire neighborhood could drastically reduce average and peak day use, and could result in significant water savings (Flack, 1982).

A water-saving practice many communities in the United States have turned to in recent years is “xeriscape” landscaping. From the Greek word “xeros”, meaning dry, xeriscape designs draw on a wide variety of attractive indigenous and drought-tolerant plants,

shrubs, and ground cover to replace the thirsty green lawns found in most suburbs. A xeriscape yard typically requires 30-80 percent less water than a conventional one, and can reduce fertilizer and herbicide use as well (Postel, 1997, p. 159).

INFLUENCES OF WATER COST INCREASES

Water used by households for drinking and cooking, bathing, washing clothes, and other acts, varies greatly with both income levels and the way in which water is supplied. In urban households with piped water available at the touch of a tap, daily use typically ranges between 100-350 liters per person. Households with water-intensive appliances, such as dishwashers and washing machines, and those where water is used to irrigate large lawns and gardens can use over 1000 liters per person daily. In many developing countries, where water is supplied through a public hydrant, daily use ranges between 20-70 liters per person per day. Areas such as Kenya, where women may walk several kilometers to draw water for their families, can record use close to the biological minimum—2-5 liters per person per day (Postel, 1985).

The irrigation water need within a water district is based on climate and varies by region and season. The water need for interior uses by residential, commercial, industrial and institutional customers does not vary by region or climate. The change in water use in response to a change in water price is termed “demand elasticity”. Factors affecting demand elasticity include customer awareness of water cost, cost of water relative to other commodities, and degree of customer efficiency (Baumann, et al., 1998).

Would an increase in the cost of water induce residents to decrease the amount of water used for landscaping purposes, thereby increasing conservation? Pricing policy changes may be

viewed with suspicion by the public. Changes in the methods of allocating charges to the customer should be kept simple and easy to understand so that the affect of making the price-sensitive public is achieved (Flack, 1982). Raising the price of water to better reflect its true cost is one of the most important steps any city can take. Proper pricing gives consumers an accurate signal about just how costly water is, and allows them to respond accordingly.

Raising water prices can often be politically difficult to do. But, if accompanied by public outreach explaining the need for the price hike and the steps consumers can take to keep their water bills down, it can have a strong positive effect. When faced with dire water supply conditions in the mid-70's, for instance, officials in Tucson, Arizona, raised water rates sharply to make them better reflect the true cost of service. At about the same time, they ran a public education campaign (called "Beat the Peak") with a goal of curbing water use on hot summer afternoons, when the supply was most in danger of running short of demand. The result was a 16 percent drop in per capita use within a few years, which, along with the lowered peak demand, allowed the Tucson water utility to cut its water supply expansion costs by $75 million (Postel, 1997, p. 157).

Many people claim that water use does not respond to changes in price. Various reasons have been given for this opinion. One is the myth that water is a necessity and therefore not a normal economic good. Another theory is that water use is determined by matter of habit; in other words, that most water users do not examine or analyze activities that use water. If it were true that water is indeed a necessity, the scope for water demand management would be drastically reduced. Price would be judged ineffective as a management tool, since users are obliged to pay any price in order to obtain the water needed for survival. Water conservation

would be restricted to seeking out and stopping water waste, where waste is defined as water that does not provide any service to man (leakage, for example). Perhaps demand management could be applied to certain uses, such as lawn and garden irrigation, which do not support human life. Otherwise, urban water management is confined to providing sufficient supply.

Baumann argues that, like other urban water myths, this one rests on a simple misunderstanding. It is true that water is necessary to life. But urban water supply is not. It is possible to sustain life in the absence of a public, piped water supply. In many areas of the world, the several liters of water per day actually necessary to life are collected by individuals and families from rivers, lakes, wells, and cisterns. Urban water supply is essential to the quality of life we have become used to, not to life itself (Baumann et al., 1998).

Although elevating price is not the only solution to the country's poor stewardship of water, it would have powerful ramifications. No state can be expected to refuse a dam or waterway as long as the federal government promises to foot the bill, even though such schemes may delay its coming to grips with the true sources of a shortage. No consumer in any category can be expected to use less water as long as water bills do not reflect the need. The consumers of water must be made aware of its costs for any effort at conservation to succeed (Rogers, 1983).

One does not have to be an economist to see the problem of underpricing. Common sense tells us that people waste commodities that they do not value highly or commodities that, though valued highly, are supplied cheap (Rogers, 1983). Grossly underpricing water perpetuates the illusion that it is plentiful, and that nothing is sacrificed by wasteful practices (Postel, 1997). Benjamin Franklin once said, "When the well's dry, we know the worth of water" (p. 166). A

key challenge is to begin valuing it appropriately and using it more wisely so as to avoid learning Franklin's lesson the hard way (Postel, 1997).

WATER CONSERVATION AND EFFICIENCY EFFORTS

By 2010, Southern Nevada, one of the fastest-growing urban areas in the West, will have committed nearly 100 percent of its water resources. Early in its history, Las Vegas developed a reputation for high per capita water use, compared to other major cities in the arid West. This arose from a belief by its residents that the Valley was situated on an inexhaustible supply of water, enticements from the state to drill wells for urban development, the attraction of tourists, and a lack of enforcement of passed or existing laws. Metering, local ordinances, research, and educational programming are impacting water use by addressing the problems of overdrafting and conservation (Morris et al., 1997).

Striving to do more with less would place options to reduce water demand on equal footing with conventional engineering projects aimed at continuously expanding human access to nature's supply. Despite a wealth of evidence showing conservation and efficiency to be among the most economical and environmentally sound alternatives, these are often still perceived as only minor additions to the water supply package. Installing low-flush toilets, lining irrigation canals, and recycling factory water lack the fanfare and political appeal of a big new dam. But they are at the core of cost-effective and sustainable solutions to achieving water balance (Postel, 1997).

The SNWA, as part of its long-range resource plan, has committed to a conservation rate of 25 percent by 2010. With household use comprising 65 percent of the total, simple math says the savings have to begin at home.

"We're trying to find what is a reasonable level of water use in a desert environment that is still responsible and that is not a reaction to a drought. Southern Nevada's image throughout the Southwest is important," said Pat Mulroy, General Manager of the Las Vegas Valley Water District. "For many years we were flogged internationally for being extremely gluttonous and extremely water wasteful. It's taken a long time to even begin to change that perception and to show we have a very real need" (McKinnon, 1998, 3B). While water use figures clearly show Las Vegans use far more water than other cities, water district officials say one has to consider in that equation that Las Vegas is a much drier place, which gets less rainfall. They also contend that comparisons are only valid involving strictly residential use and not per-capita use, since Las Vegas gets many more tourists per capita than other cities.

The SNWA has held conservation as a core purpose since its inception in 1990. The SNWA was created through a cooperative agreement among the seven regional water and wastewater agencies: Big Bend Water District, City of Boulder City, Clark County Sanitation Department, City of Henderson, City of Las Vegas, Las Vegas Valley Water District, and the City of North Las Vegas. The purposes of the SNWA are to seek new water resources for Southern Nevada, to manage existing and future water resources, to construct and manage regional water facilities, and to promote responsible conservation.

The SNWA performs free sprinkler clock adjustments and commercial and residential site reviews and maintains a water waste reporting hotline, which individuals may call 24 hours a

day. The Conservation Hotline provides information about water use and conservation. It is a popular local resource. Its hours are extended in the summer to accommodate the increase in requests due to increased water usage. Information can be obtained about proper outdoor watering, how to conserve water, what conservation programs currently exist in the Valley, and educational opportunities that are available. Speakers and public displays can be arranged and information is available to train employees of landscaping companies (UNLV, undated).

In addition to the Conservation Hotline, clock adjustments, and site reviews, consumers may obtain information at the Desert Demonstration Gardens. With more than 1,000 species of plants in eleven theme gardens, the Desert Demonstration Gardens is an excellent community resource for Southern Nevadans. It is a facility dedicated to water conservation through education and demonstration of water efficient landscaping. Each month it sponsors free lectures, tours, and workshops on water conservation methods and techniques. Topics such as increasing irrigation efficiency, designing and installing drip systems, converting to xeriscape, and other such topics are discussed regularly, and the public is notified through various media of the dates and times. Visitors quickly find that these gardens dispel the belief that desert landscaping is limited to cacti and rock. Water conservation is a top priority in the Mojave Desert. A wide range of attractive plant material, native to and appropriate for the area, can make the community attractive while saving precious water resources.

"Our goal is to achieve 25 percent conservation over 1990 usage by the year 2010," noted David Riggleman. "We're not asking people not to use water. We're asking that they use it more efficiently." The SNWA reached their objective in 1997 of 13 percent conservation, and recently achieved its goal of 15 percent conservation (Robison, 1998, p. 33).

Because outdoor water use accounts for up to 90 percent of the usage during the summer months, the SNWA also provides an irrigation clock rebate program (Figure 4). Many older sprinkler clocks are mechanical versions that wear out causing inaccurate timing and overwatering. Additionally, many of these clocks do not have the flexibility to water separate areas of landscaping differently. Solid state controllers provide accurate run times and greater programming flexibility to allow customers to water their landscaping more efficiently.

Conservation Awareness Patrol members roam the Las Vegas Valley regularly in an effort to promote conservation and compliance with the various water waste ordinances. They also investigate water waste complaints and contact customers who have water waste problems. The Patrol's primary purpose is to offer assistance and provide suggestions on how to water a property more efficiently. In most cases, this educational approach solves the problem quickly. If an individual makes no effort to correct a problem, the situation may be turned over to an enforcement officer, and a citation may be issued.

The SNWA also produces and distributes dozens of publications to help customers conserve water, including lawn watering guidelines (Figure 5). It has an aggressive public outreach and education program, including irrigation workshops, a Speakers Bureau, and an educational television program, "Water Ways" airing daily at 7:00 a.m. on Channel 4.

Children are an important target in conservation campaigns. Water conservation videos shown in the schools contribute to a grass roots effort towards continuing education. Local elementary school children receive visits from "Deputy Drip", a large water droplet mascot from the SNWA. More than 5,000 children have joined the Deputy Drip Fan Club and received items such as badges and coloring books.

What are the social perceptions of water conservation? The first indication of widespread interest in urban water conservation appeared shortly after 1970. The National Water Commission conducted a study of the potential for water use reduction through conservation practices, including pricing policy, and discussed water conservation as an alternative to, or adjunct of, water supply augmentation. Some urban water suppliers began to encourage conservation practices by their customers (Baumann et al., 1998). In a June 1978 water policy message to the nation, President Carter resolved to make conservation a national priority. Government agencies began to make federal grants and loans for water projects conditional upon inclusion of cost-effective conservation measures (Postel, 1985).

Increasing income has an important effect on residential water use levels. While indoor residential water usage depends crucially on the types of appliances owned and how these are used, outdoor residential water usage depends crucially on lot size, climate, and the style of landscaping. Rising income levels have influenced increased water used through ownership of larger home lots and the consequent larger amounts of residential area being allocated to lawns (Flack, 1982).

It is not likely that urban water conservation will come about because of some technological breakthrough. Rather, it will be through the application of known technology and adoption of a conservation ethic by urban water utilities and their customers. With the realization that new water supplies are extremely costly to develop and in the face of predicted low water years ahead, increasing numbers of water utility managers are coming to the realization that a concerted program of water conservation is needed (Flack, 1982).

Critical to stretching Nevada's supply of water is conservation. The Southern Nevada

Coalition 2000 (SNC2000), a Las Vegas group composed of thirty business, environmental, gaming and government leaders, is forging the way in "educating the public on who uses water and how we can save it," explained Bill Martin, SNC2000 chairman (Robison, 1998). It was formed in 1994 to conduct a public information campaign to promote efficient water use. This is done through speeches, television appearances, and employee education kits (Martin, 1998).

"We primarily take our message to residential users because that's where we can bring about the greatest savings," Martin explained (p. 33). SNC2000's solution is a plan asking county and city governments to adopt turf restriction ordinances on new construction. The regulations would limit front yards of homes to 50 percent sod, while sod use in public facilities (except schools, parks and cemeteries), would be confined to 25 percent of total landscapable area. Golf courses would be restricted to five acres of grass per hole (compared with a national average of 8.3 acres per hole), and finally, grass cannot abut sidewalks or streets, preventing sprinklers from uselessly watering cement. SNC2000 estimates the plan will save more than 35,000 gallons of water annually on a single 6,000 square foot lot. "Society has developed an ethic for recycling—we do it because it's right," Martin explained. "We have to foster that same attitude toward water conservation" (Robison, 1998, p. 33).

As Postel notes, the xeriscape concept has spread rapidly, and several states, including several in the more humid East, actively support xeriscape landscaping as a way of conserving water. Tucson, Arizona, gave it a boost in early 1991, by forbidding new developments from having more than 10 percent of their landscape area planted in grass (Postel, 1997, p. 159). The Las Vegas City Council recently voted unanimously to enact a similar policy (Bill No. 98-35, Amendment to the Las Vegas Municipal Code). It limits the amount of turf allowed in a new

development within Las Vegas city limits, sending a strong message to city residents that water conservation is a significant issue that warrants new public policy in Southern Nevada (McKinnon, 1998).

The decision came during a city council session that featured compelling testimony in favor of turf limits from valley residents, landscape architects, nursery managers, homebuilders, and homeowners associations. The ordinance does not impact existing landscaping and goes into effect immediately. It does, however, affect all new residential homes, new businesses, new commercial buildings and new golf courses throughout the valley.

According to Martin, the city council members took an admirable stance of both leadership and stewardship in addressing the matter. “Not only did they take the lead in stepping forward for the right reasons, but they also acted with a sense of stewardship by realizing that they are as responsible as the rest of us for Southern Nevada’s future supply of this resource” (1B). The idea to promote a turf-limiting ordinance was devised to increase water efficiency throughout the Las Vegas Valley by decreasing the amount of water usage necessary for outdoor irrigation. One homeowners association in Las Vegas testified that, by eliminating 15,000 square feet of turf, the association was able to save five million gallons of water last year (McKinnon, 1998). In similar articles, Martin was quoted as saying, “The time has come to realize that water is a profoundly exhaustible resource” (Zapler, 1998), and, “Judicious water use is essential to maintaining our quality of life” (Fink, 1998).

Though limited, opposition to the initiative has arisen since Martin formally announced SNC2000 support of turf limits two months ago. However, no opposition was presented at this particular city council hearing. “With the rate of population growth taking place in the Las Vegas

Valley, it is time to take more dramatic measures such as this to supplement voluntary conservation activities," said Martin (McKinnon, 1998, 1B).

In conjunction with SNC2000, the SNWA is working to improve water use efficiency throughout Southern Nevada. The group is now in talks with Clark County, North Las Vegas and Henderson about similar measures (SNC2000, 1998). "You have to address the turf issue if you're going to make that goal," stated Pat Mulroy, general manager of the SNWA. "And the cheapest way is to cut back on turf now instead of waiting until later and providing incentives to take it out" (3B). It doesn't take a huge amount of effort to conserve water. When referring to Tucson, Arizona's strict turf restrictions in a recent article, Mulroy stated, "We're trying to find a balance. We're trying to find what is a reasonable level of water use in a desert environment that is still responsible and that is not a reaction to a drought" (McKinnon, 1998).

RESULTS

I found that increasing the cost of water could reduce the volumes of water used for residential landscaping in the Las Vegas Valley. More importantly, though, educating the residents of this arid valley on the merits of conservation could reduce the amount of water used, while providing them with the tools to be better stewards of their environment.

Typically, water is so inexpensive relative to other consumer costs that changes in water prices lead to only small changes in the quantity of water used. Thus, water demand has been considered fairly "inelastic". Due to steadily increasing rates and the growing awareness that water is a scarce resource, the water consumer is beginning to become more aware of the role

water plays in his life. Pricing levels have been correlated to reductions in water usage (Flack, 1982).

While conservation efforts since 1990 have focused primarily on information and education programs, they also included establishment of a four-tiered rate structure in which the more used, the more paid. The LVVWD encourages efficient water use by increasing the unit price of water as deliveries increase. With incentive pricing, a base price per unit of water is charged for all water deliveries up to a certain amount, or rate block. Water use in excess of this block is then charged at a higher unit price. Four pricing levels (or "tiers") currently exist within their pricing structure. The size of the consumer's meter and the rate of their consumption are calculated into each tier (Figure 6).

In addition to the influences of price increases, residents may recognize that supplies diminish with demands. Very few people view conservation as a supply, and seldom give it a thought when watering their lawns, and taking showers. Thus, even where water is least plentiful in the United States, prices rarely reflect supply. Moreover, a rise in price does not seem to provoke a commensurate decline in demand. Perhaps American prices are so low that even when they are raised, they fail to make an impression on consumers (Rogers, 1983) (Figure 7).

Since economic incentives and public outreach will not motivate everyone to conserve, setting water efficiency standards for common fixtures—toilets, showerheads, and faucets—can be a critical component of a reliable conservation strategy. Standards establish technological norms that ensure a certain level of efficiency is built into new products and services. Mexico has established nationwide standards, and Ontario, Canada, is including standards in its conservation strategy as well (Postel, 1997).

Newly released statistics on water use by the U.S. Geological Survey (USGS) show that the nation is using less water—2 percent less than in 1990 and nearly 10 percent less than in 1980, despite a continuous increase in population over that same time period. The USGS has compiled and reported national water-use statistics once every 5 years since 1950. After continual increases in the nation's total use of surface and ground water for the years reported from 1950 to 1980, water use declined and has remained fairly constant since the mid-1980s, according to the USGS report.

Studies reported that price increases resulted in more savings in lawn sprinkling use than in household use. It appears that residential water price increases will reduce exterior uses more than interior uses (Flack, 1982).

Water use does respond to changes in price. When sufficient data are collected and controlled for other influences on water use, the effect of price emerges quite clearly. A 1984 survey reviewed more than 50 studies of urban water use which considered the possibility of a price effect (Boland et al., 1984). While the observed sensitivity of water use to changes in price (the price elasticity of demand) varies substantially from study to study, no study concluded that price had no effect on water use. Since 1984, at least 50 additional studies have appeared in the literature, documenting price effects in still more places and other various conditions. The overall conclusion is the same: no study in the peer-reviewed literature concludes that price does not affect urban water use (Baumann et al., 1998).

The economic theory is that, in the long run, price is the reason that people reduce their water usage, while conservation measures are the means to reducing their usage. However, other theories suggest there are non-price reasons that may cause people to reduce their water usage—

conservation education, peer pressure, a “conservation ethic”, and mandatory restrictions. Because the elasticity figures are only fully applicable in the long run, there is thought to be a mix of conservation education and measures—some voluntary and some not, that affect usage prior to and as increases in price are beginning to take effect. The 26.5 percent reduction expected to be achieved by 2020 is based on existing conservation achieved plus full estimated effects of price elasticity, as determined from the SNWA’s elasticity analysis (SNWA, 1998).

DISCUSSION

It is unfortunate that most people are only vaguely aware of the role water plays in their lives. Most of us give little thought to water, except when we are thirsty, or in need of a hot shower. Yet we all know how essential water is to life. We owe our existence to water. While many people become more aware of conservation during periods of shortage, or drought, their awareness usually fades once the shortage passes. Conservation should not be a reaction, but should be a “pro-action”, a way of life for all of us.

At the heart of the matter is modern society’s disconnection from water’s life-giving qualities. For many of us, water simply flows from a faucet, and we think little about it beyond this immediate point of contact. We have lost a sense of respect for the wild river, for the complex workings of a wetland, for the intricate web of life that water supports. By and large, water has become strictly a resource to be dammed, diverted, and drained for human consumption (Postel, 1997).

Much of the entire world experiences problems with water availability. Increasing populations have put strains on many of our resources, and much of our standard of living is closely related to water. Water is used not only for drinking and bathing, but also in agriculture, and the many industrial processes that provide us with our clothing, shelter, and transportation.

Technological advances have made it possible to live here in the arid desert. We are dependent on the development of water resources, and one rarely gives a thought as to whether water will be available when we go to the tap. And if it isn’t, our immediate reaction is to call

our local water authority to see why it isn't available. I believe we place too much emphasis on technology, and not enough what I'll call an "ethical awareness".

To be ethically aware, we must take responsibility for our actions. I believe the old adage, "waste not, want not", applies to water, as well as a multitude of other things. The challenge to each and every one of us is to become water literate. We need to educate ourselves and others on the delicate relationship between people and water, and our relationship to the environment in general. We must recognize that we were intended to steward the land, to protect the natural resources available to us, so that they may be available for future generations to enjoy and use.

With the population boom here in the Las Vegas Valley, we have seen and will continue to see impacts on outdoor residential water use. The more people moving in, the more homes and subsequent yards and greenbelts with turf that will be established. It is imperative that the new residents to the area be made aware of the conservation efforts and ordinances in place so that they may be good neighbors and conscientious users of our limited supply of water.

Indoor conservation actions range from simple to complex. There are many ways to conserve water inside. The easiest, of course, is to simply use less. This can be as basic as turning off the water while brushing teeth or scrubbing hands, or by taking shorter showers. Free water conservation kits are available from the SNWA to residential customers who live in homes built before 1989. These kits include low-flow showerheads, faucet aerators, and leak detection tablets. Residents can participate in the free site surveys to determine how they can conserve water in their home, no matter what age the home is.

Restrictions on total usage are by far the most effective, but also the most costly in terms of social and political considerations. Implementation of restrictions requires that the restrictions be simple in nature and easily understood. The use of monetary penalties is the most effective method to enforce regulations. Restrictions on lawn watering and other exterior water uses are the easiest to implement and enforce (Flack, 1982).

Lawn and drip irrigation systems should be checked frequently to make certain they are working properly and supplying the right amount of water to plants. One of the most common watering problems we have here in Southern Nevada is water running off properties into streets, gutters, or adjoining property. With a little effort, this waste of water can be stopped. Consumers can use the watering practices determined by the SNWA to be most effective for this area. Simply shortening the run cycles per station on their irrigation clocks can save a large amount of water. Many people think that they must water their lawn during the day, but in this arid desert climate, the water evaporates and doesn't do the lawn any good.

Will water conservation increase with education? Public education is a necessary part and the linking component of any conservation program. The consumer must first be made aware of water waste and then of the means to reduce this waste. Many water users are unaware of potential benefits from improvements in water use efficiency. They give little thought to their water use habits. Only in times of shortage to they examine the ways in which they utilize water. Because water has traditionally been an inexpensive commodity, a change in value judgment is often necessary. Dispersal of hard data and information is the most efficient method to acquaint the public with a water problem and the possibilities of inadequate supplies in the future. The use

of bill inserts to promote conservation, and the mailing of residential handbooks and other conservation guides is one method of exposure the SNWA currently uses.

We have been quick to assume rights to use water, but slow to recognize obligations to preserve and protect it. Better pricing and more open markets will assign water a higher value in its economic functions. We also need a water ethic—a guide to right conduct in the face of complex decisions about natural systems we do not and cannot fully understand (Postel, 1997, p. 184).

The essence of such an ethic is to make the protection of water ecosystems a central goal in all that we do. Water is the basis of life, and our stewardship of it will determine not only the quality but the staying power of human societies.

Adopting such an ethic would represent a historic philosophical shift away from the strictly utilitarian, divide-and-conquer approach to water management and toward an integrated, holistic approach that view people and water as related parts of a greater whole. It would make us stop asking how we can further manipulate rivers, lakes, and streams to meet our insatiable demands, and instead to ask how we can best satisfy human needs while accommodating the ecological requirements of healthy water systems. This would inevitably lead us to deeper questions of human values—in particular, how to narrow the unacceptably wide gap between the haves and have-nots while remaining within the bounds of what natural systems can sustain.

Living by such an ethic would mean using less whenever we can, and sharing what we have. It is about being good neighbors—as individuals, companies, communities, states, provinces, and nations, and it establishes norms of responsible behavior against which to judge

the actions of each global citizen. It would require a reordering of economic goals and priorities. As water becomes scarce, sustainable development depends on raising its productivity—getting more value out of each liter used—while leaving enough in rivers, lakes, and aquifers to keep natural systems functioning well (Postel, 1997).

Water is integral to life, and to the continued growth and development of the Las Vegas Valley. But its availability is limited. With education, conservation, proper pricing, and regulation of use, we can balance our needs against our supply.

CONCLUSION

Taking heed of water's limits, and learning to live within them, amounts to a major transformation in our relationship to fresh water (Postel, 1997). In a long-range effort to meet ever-increasing water needs, our region must learn to better use the water we have. The solution to reducing our water use lies within each of us—it's a grassroots effort (SNWA, 1995). Doing more with less is the first and easiest step along the path toward water security. Historically, we have approached nature's water system with a frontier philosophy, manipulating the water cycle to whatever degree engineering know-how would permit. Now, instead of continuously reaching out for more, we must begin to look within—within our regions, our communities, our homes, and ourselves—for ways to meet our needs while respecting water's life-sustaining functions.

By using water more efficiently, we in effect create a new source of supply. Each liter conserved can help meet new water demands without damming another stretch of river or depleting more groundwater. Most investments in water efficiency, recycling, reuse, and conservation yield more usable water per dollar than investments in conventional water supply projects do. But they will not materialize until policies, laws, and institutions begin to foster such measures rather than hinder them (Postel, 1997).

There is a limited amount of water on our planet. Only a small percentage of it can be used, and it is important for each of us to use water with care (Branley, 1982). What matters most is not whether a country has enough water to satisfy its theoretical needs; what matters is how people can best adapt their use of water to provide the greatest benefits from what is available (Clarke, 1993). In the quest for better living standards and economic gain, modern society has come to view water only as a resource that is there for the taking, rather than a living

system that drives the workings of a natural world we depend on. Harmonizing human needs with those of a healthy environment will require new ways of using and managing water, and will require adjusting our production and consumption patterns so as to remain within ecological limits (Postel, 1997).

Water scarcity challenges us to adopt a new ethic to guide our relationship to the earth's natural system, to other species, and to each other. Recognizing ourselves as part of the life-support network we depend on and learning to live within water's limits are integral aspects of creating a society that is sustainable in all respects. Measures to conserve water and use it more efficiently are now the most economic and environmentally sound water supply options available for much of the world—and they have barely been tapped. Together, they constitute our "last oasis" (Postel, 1997, p. 24).

The current use of water in the Las Vegas Valley could be reduced by increasing the cost of water and by educating the residents as to the value of conservation. Conservation, once viewed as just an emergency response to drought, has been transformed in recent years into a sophisticated package of measures that offers one of the most cost-effective and environmentally sound ways of balancing urban water budgets. As we learned through the energy crisis that it is cheaper to save energy by investing in home insulation and compact fluorescent lights, than to build more power plants, we must now recognize that water efficiency measures can yield permanent water savings and, thereby, delay or avert the need for expensive new dams and reservoirs, groundwater wells, and treatment plants. Managing demand, rather than continuously striving to meet it, is a surer path to water security–while saving money and protecting the environment at the same time (Postel, 1997).

The range of water savings is highly variable. Reductions from 35 to 50 percent could result, depending on the combination of strategies used. Social and psychological factors have been stated as the overriding determinants of the success of horticultural change methods (Flack, 1982, p. 89).

Water, as a commodity, follows the laws of economics. Rising costs of water can be an influential factor on how much an individual uses. The basic mechanism of pricing is that the more units consumed of a commodity, the less valuable is the last unit consumed. Simply stated, the greater the amount of water used, the less the last unit is valued. As price is increased, consumption should decrease.

Education of the residents of the Las Vegas Valley as to the various methods of conservation available to them can increase the levels of awareness, and, in turn, increase the levels of conservation achieved. In a USGS report, chief hydrologist Robert Hirsh said,

> "Enhanced citizen awareness of the value of water and conservation programs in many communities across the country have helped to cut water use in spite of continued population growth. Improved irrigation techniques and more efficient use of water by industry have contributed to reduced water use as well" (USGS, 1998).

Falling freely from the sky, water has deluded us into believing it is abundant, inexhaustible, and immune to harm. The challenge now is to put as much human ingenuity into learning to live in balance with water as we have put into controlling and manipulating it. The “last oasis” of conservation, efficiency, recycling, and reuse is large enough to get us through many of the shortages on the horizon, buying us time to develop a new relationship with water systems and to bring consumption and population growth down to sustainable levels (Postel, 1997).

Conservation is not merely a short-term strategy to alleviate droughts and other immediate crises. Increasing the efficiency of water use is imperative if growth is to continue. Conserving water poses less environmental disruption than developing new supplies. The potential of conservation will never be realized until it is analyzed as a viable long-term option comparable to drilling a new well or building a new reservoir.

We must examine our lifestyles and consumption patterns. Water provides an essential ingredient in most manufacturing operations, and is the receptacle for much of our waste. It has a role in virtually every product we buy and is polluted by much that we throw away. We rarely think about water when we see an automobile, for example, but producing a typical U.S. car requires more than 50 times its weight in water (Postel, 1997).

An understanding of water, water management, and related issues is basic to solving present and future water problems. Water is a precious resource and reducing water waste is critical. The public plays a vital role in conserving our resources and protecting our water quality. It is important for everyone in the Las Vegas Valley to conserve water to ensure our future water supplies. Simple and easy steps taken in and outside of the home can save water and money. It just makes sense!

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APPENDIX A

List of Articles

11/1/98 "Valley water use facts", Las Vegas Review-Journal

10/15/98 "Builders help spread word about water conservation", Las Vegas Review-Journal

10/19/98 "Thank you for saving an all-time record 10.5 billion gallons of water…", Las Vegas Review-Journal

9/20/98 "Local landscaping awards encourage water conservation", Las Vegas Review-Journal and Las Vegas Sun

9/10/98 "Local landscaping pros to host mini-seminars", Las Vegas Review-Journal and Las Vegas Sun

9/10/98 "Now that it's hot it's time to…", Las Vegas Review-Journal

8/17/98 "Turf rules rooted in possible drought", Las Vegas Review-Journal, McKinnon

7/30/98 "Businesses join in water conservation", Henderson Home News

7/22/98 "Common sense for desert living", Las Vegas Sun

7/21/98 "Division over plan to limit grass grows", Las Vegas Review-Journal, Zapler

7/19/98 "Is it time for Las Vegas to restrict the use of grass?", Las Vegas Review-Journal, Zunino and Flint

7/16/98 "Xeriscaping saves water", Las Vegas Review-Journal

6/14/98 "Group trading grass to aid water savings", Las Vegas Sun

6/11/98 "Water conservation group seeks support to limit new homes' turf", Las Vegas Review-Journal, Zapler

6/10/98 "Water crunch time hits Clark County", View, Gulbransen

5/14/98 "Watering restrictions are now in effect", Henderson Home News

5/12/98 "Xeriscape an alternative to grass", Las Vegas Review-Journal

5/5/98 "Water district banking on residents to save water", Las Vegas Review-Journal, McKinnon

5/98 "Picture this!", Las Vegas Life

5/98 "Evaluations save H2O and dollars", Home Scene, Riggleman

5/98 "Conserving water", Southern Nevada Coalition 2000, Martin

4/26/98 "Water board urging use of xeriscape", Las Vegas Review-Journal and Las Vegas Sun

4/26/98 "Water conservation contest opens", Las Vegas Review-Journal and Las Vegas Sun

4/5/98 "Las Vegas water organizations spread the word on Web sites", Las Vegas Review-Journal and Las Vegas Sun , Crowley

3/19/98 "Water experts foresee changing West", Las Vegas Review-Journal, McKinnon

3/16/98 "Water expert to lead public forum", Las Vegas Review-Journal

1/22/98 "Conservation still the key to secured water supplies", SNWA Press Release, Martin and Riggleman

1/16/98 "Solid water supply is seen until 2035 in Arizona Plan", Las Vegas Review-Journal, Bates

12/4-5/97 "New hotline number for Water Authority", Henderson Home News

11/26/97 "Water awareness calendar features student artwork", Las Vegas Sun, Sun Staff Report

11/16/97 "By 2007, Las Vegas will be all tapped out", USA Today, Cauchon

9/97 "Water use awareness key to valley's shortage issue", Real Estate Journal

9/5/97 "Coalition 2000 aims to educate valley on water use", Las Vegas Sun, Martin

6/26/97 "Stop the constant spilling of our precious water supply", Las Vegas Sun, Brennan

6/24/97 "Water world", Las Vegas Review-Journal

6/22/97 "Western water wars", Las Vegas Review-Journal and Las Vegas Sun, Manning

6/22/97 "Author fears dam catastrophe will cause water crisis", Las Vegas Sun, Manning

6/20/97 "Residents penalized while others squander their water", Las Vegas Sun, Vartan

5/23/97 "Saving water: It's so easy you can make a game of it", Las Vegas Review-Journal, SNWA and SNC2000

5/4/97 "Events help with water awareness", Las Vegas Review-Journal and Las Vegas Sun, Manning

3/25/97 "No end to water flow", Las Vegas Review-Journal, Vogel

3/23/97 "Biggest water waster", Las Vegas Review-Journal

3/6/97 "Water Wise – Las Vegans begin to see benefits of conserving precious commodity", Las Vegas Review-Journal, White

2/10/97 "Las Vegas: Are there no limits?", The Washington Post National Weekly Edition, Cannon

1/25 – 2/7/97 "Water, water, anywhere?", Scope, Manning

APPENDIX B

Las Vegas Municipal Code. Title 13, Chapter 13.04.030. Running water—Broken pipes. Restricts the flow of water over or into any sidewalk, street, alley or public place.

Las Vegas Municipal Code. Title 13, Chapter 13.08. Water Conservation. Restricts the use of water from May 1st until October 1st.

Las Vegas Municipal Code. Title 14, Chapter 14.08. Water Regulations. Irrigation exceptions and responsibility for waste.

Code of Clark County, Nevada. Chapter 24.12. Use of Turf for New Developments.

Code of Clark County, Nevada. Chapter 24.34. Water Use Restrictions. Restricts the use of water from May 1st until October 1st.

Code of Clark County, Nevada. Chapter 25.10. Building Water Conservation Code of Clark County. Limits the types of plumbing devices for residential and commercial properties.

Ordinance No. 1018, City of North Las Vegas, Nevada. Ordinance to prohibit waste of water.