

# Las Vegas Water Crisis: Causes and Effects of Overconsumption

## An Analysis of Water Usage and Availability in the Southwest United States

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### Abstract

With a growing population and a decrease in available water resources, the city of Las Vegas is in the midst of a water crisis. Data regarding withdrawal rates, artificial recharge rates, and water table height over time, as well as usage specifications and potential solutions will be used to form conclusions as to the severity of the current crisis. Not only is the scarcity of water important from a survival standpoint, but it also poses a threat to the biodiversity and land stability as well. A study of the current situation in Las Vegas will create a further understanding of the relationship between Las Vegas's rapidly growing population and economy and the arid region in which it exists, as well as the impacts that the water shortage will have on its society and potential solutions to save the iconic city. Many factors have contributed to that water crisis that is currently occurring in southern Nevada. Population growth, which tripled between 1985 and 2000, led to overconsumption of water resources. In an area that receives on average 4 inches of rain a year, the consumption levels of the residential, industrial, and commercial aspects of the city brought Las Vegas to the state it is in today. 90% of Nevada's total water is drawn from the Colorado River, which is apportioned by the Law of the River compact. The remaining 10% is from groundwater. The Southern Nevada Water Authority has done much to mitigate the issue – enplacing regulations that limit the amount of water that goes to waste, and devising ways to treat sewer water and return it to Lake Mead, which in turn allows more water to be pulled from the Colorado River. This Nevada policy, called 'return-flow credits', allows the state to draw more than it's designated Colorado River allocation of .3 million acre-feet/year. The city itself has gone to great lengths to alter its lifestyle for the arid region in which it is located. Although southern Nevada is in a definite crisis regarding water resources, the measures taken have made a significant impact on the consumption levels, and if continued, might be enough to bring the region back to stability. A close examination of water usage, allocations, and preventative measures of the Las Vegas area will be taken in this project.

### I. Introduction

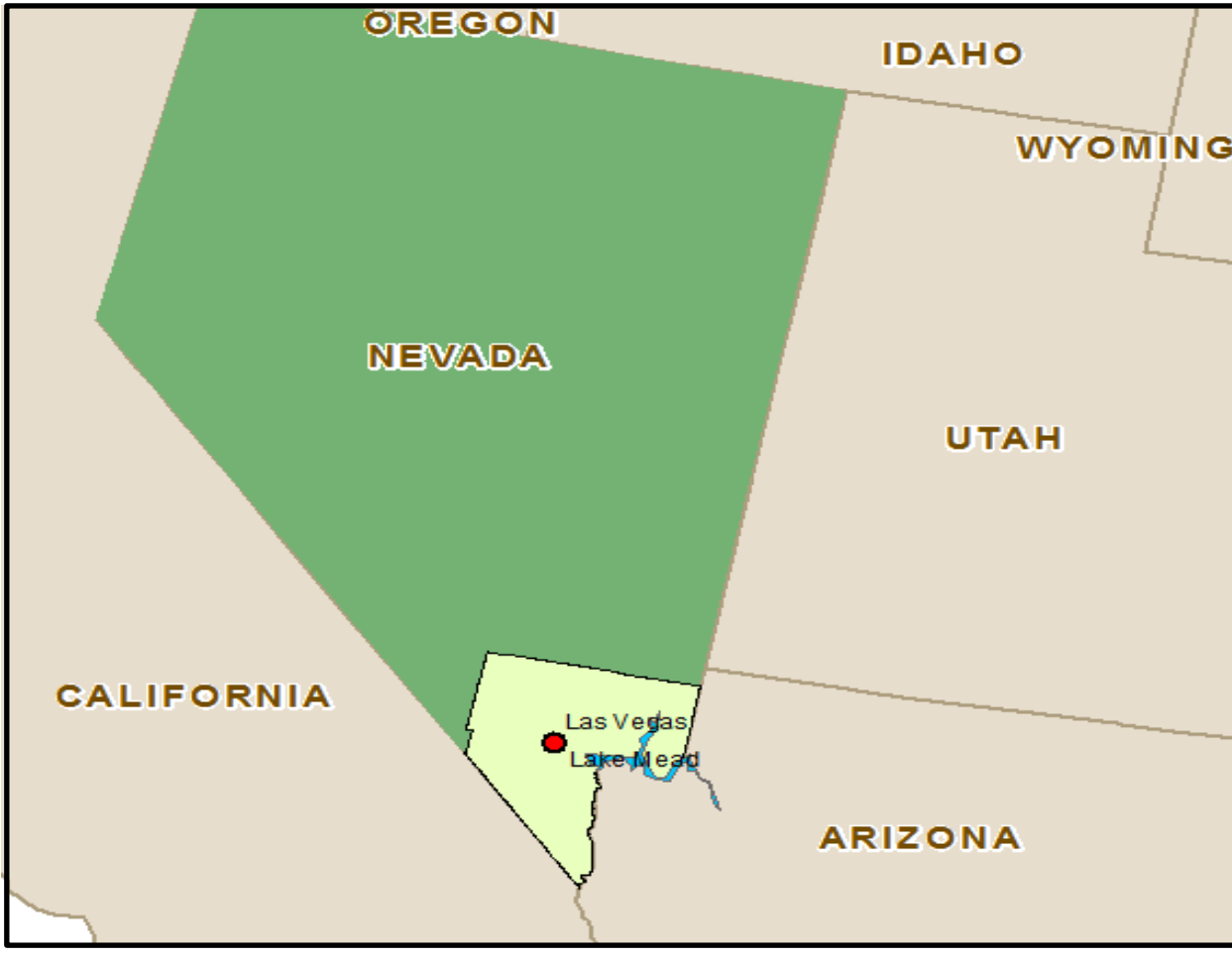
Concerns for groundwater depletion in the southwest U.S. arose in the early 1930s (Morrison), following the previous misconception that the Las Vegas Valley sat upon a large underground lake. Water cops were hired beginning in 1936 – a practice that continues today. Continuing population growth has increased the total water usage of the area, leading to a deficit in the water budget. Water sources for the area include groundwater, accounting for nearly 10%, Colorado River allocations, and water drawn from Lake Mead. The groundwater in Nevada typically is found in basin and range aquifers, formed of volcanic and carbonate rocks and of which the basin-fill deposits provide the most productive aquifers (USGS). Return-flow credits are issued by the Southern Nevada Water Authority, allowing the state to draw water beyond their allocations provided that highly-treated wastewater is returned to Lake Mead. Artificial recharge began in the early 1990s to maintain a constant water table height. Despite efforts put forth by the community, the high rates of water consumption by the ever-growing city have caused a decrease in the water table height and have led to what is today considered a severe water shortage in the southwest United States. Effects of this crisis include higher drilling costs for new wells and land subsidence, threatening the city itself. This study serves to compare data regarding water usage to practices used for conservation, with the hopes of evaluating the overall standing of the southwest United States.

### II. Literature Review

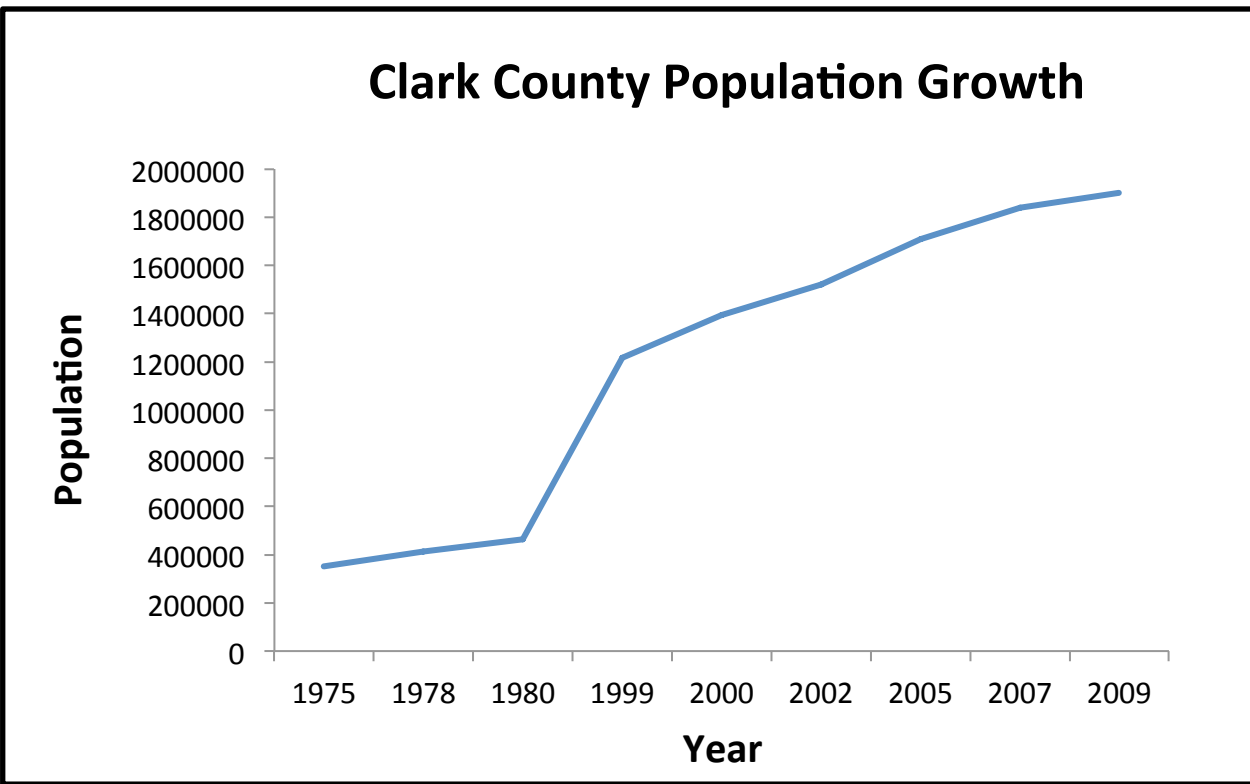
Literature tells us much about the present conditions of the Las Vegas water crisis. Devitt et al. explain that the population of Las Vegas had tripled between 1987 and 2002, and offer groundwater outflow estimates of "1,200 to 16,00 AFY" (1746). The water reserve is described as being recharged solely by precipitation in the form of rain or snow. Groundwater pumping began in the 1950s, and has continued so that at present there are about 4,000 wells in the LVV. Donovan et al. discuss the artificial recharge process in Las Vegas Valley, stating that "artificial recharge began in the 1980s, and it is stated that the two reasons in support of this process are "relief of overdraft and use of the aquifer as storage" (385). This process involving drawing water from the Colorado River treatment plant and injecting it into the groundwater system through previously drilled wells. The purpose of such a project is to store water for future use, and it has "slowed the decline in water levels and has resaturated much of the previously dewatered aquifer system" (359). The article states that the water pulled from the Colorado River for Nevada's use amounts to about 4% of the annual flow of the river, showing that it is insignificant in the big picture of the river. Kenel's article cites USGS research in the statement "USGS has documented land use change as the primary factor causing water quality and habitat degradation" (81). By enplacing regulations on water usage, over-usage and degradation of quality can be controlled. It is stated, "the total consumption of water is increasing as the population continues to expand" (83) – although per capita consumption has equalized, the growing population poses a threat to our finite water supply. This article suggests regulations such as low-flush toilets and reduced-delivery showerheads to lessen consumption and therefore increase or stabilize water conservation. Although Lake Mead has been used as a source of water for Las Vegas, "concerns have surfaced that the plume from the highly treated effluent will someday affect the water quality of Lake Mead" (84). Since all water uses of a hydrologic unit are interdependent, it is crucial that we rely on one another for the correct usage and treatment of the water. Morris draws attention to the issue of land subsidence, explaining that decreased groundwater leads to higher land instability. The connection between surface water and groundwater use is also made, as an overuse in surface water leads to a subsequent decline in groundwater.

### III. Methodology

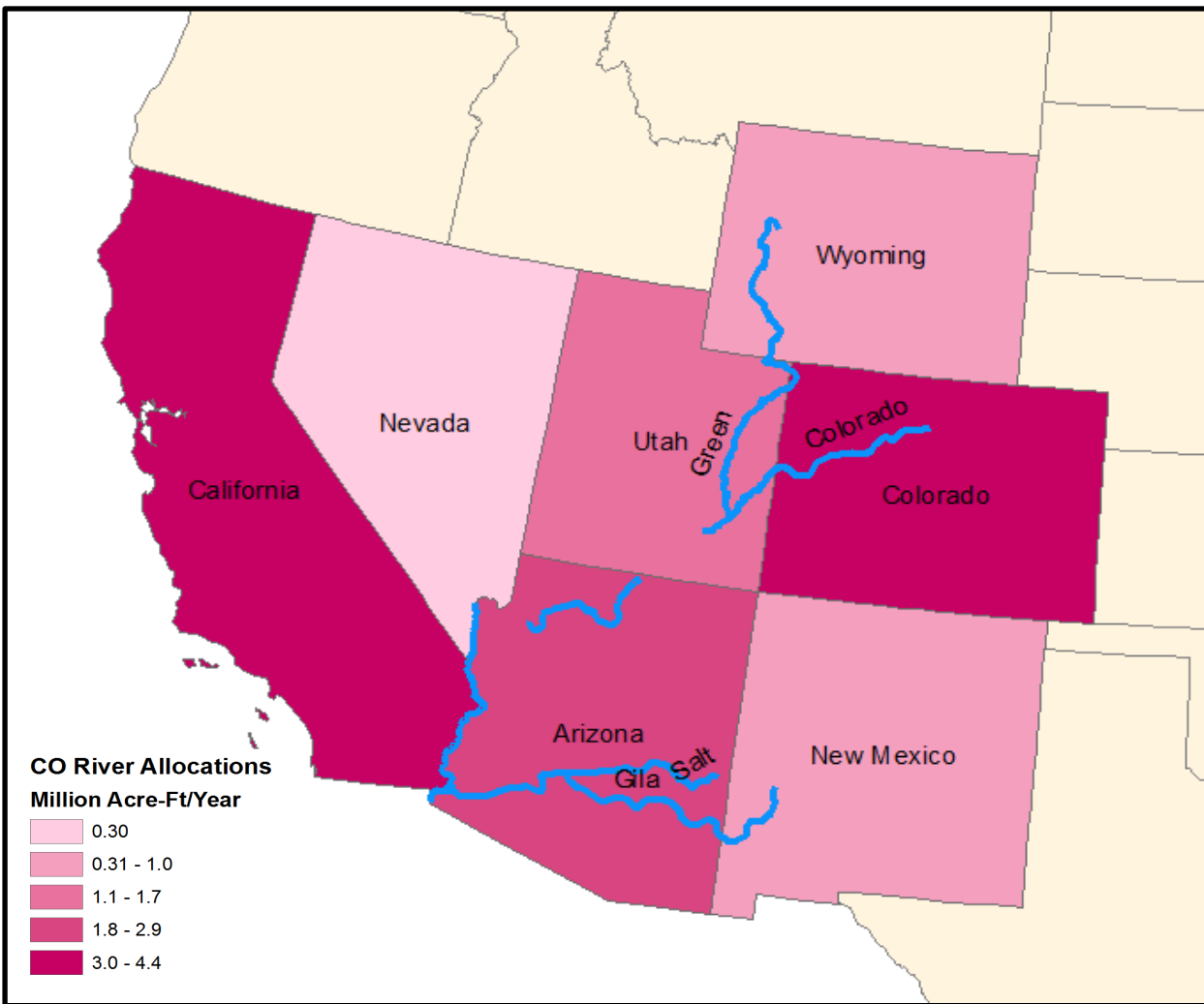
In order to properly study the water use changes over time, one of the first variables needed was the population change over time. Data collected from the US Census Bureau provided populations of Las Vegas between the years of 1975 to current. These data were compiled onto a graph (Figure 2) to indicate how population has increased over time, so the city growth and water usage rates could be compared. Aerial photos over a span of these years (Figure 5) show physical expansion of the city. The Southern Nevada Water Authority provided data regarding allocations of the Colorado River, which serves as a major water source for the Las Vegas Valley. Each state and it's respective allocations are shown in Figure 3. Data regarding water height in Lake Mead were found on The United States Bureau of Reclamation website between the years of 2000 to current, and the decrease of the water table over time is shown in Figure 4. Information regarding water usage rates and artificial recharge in



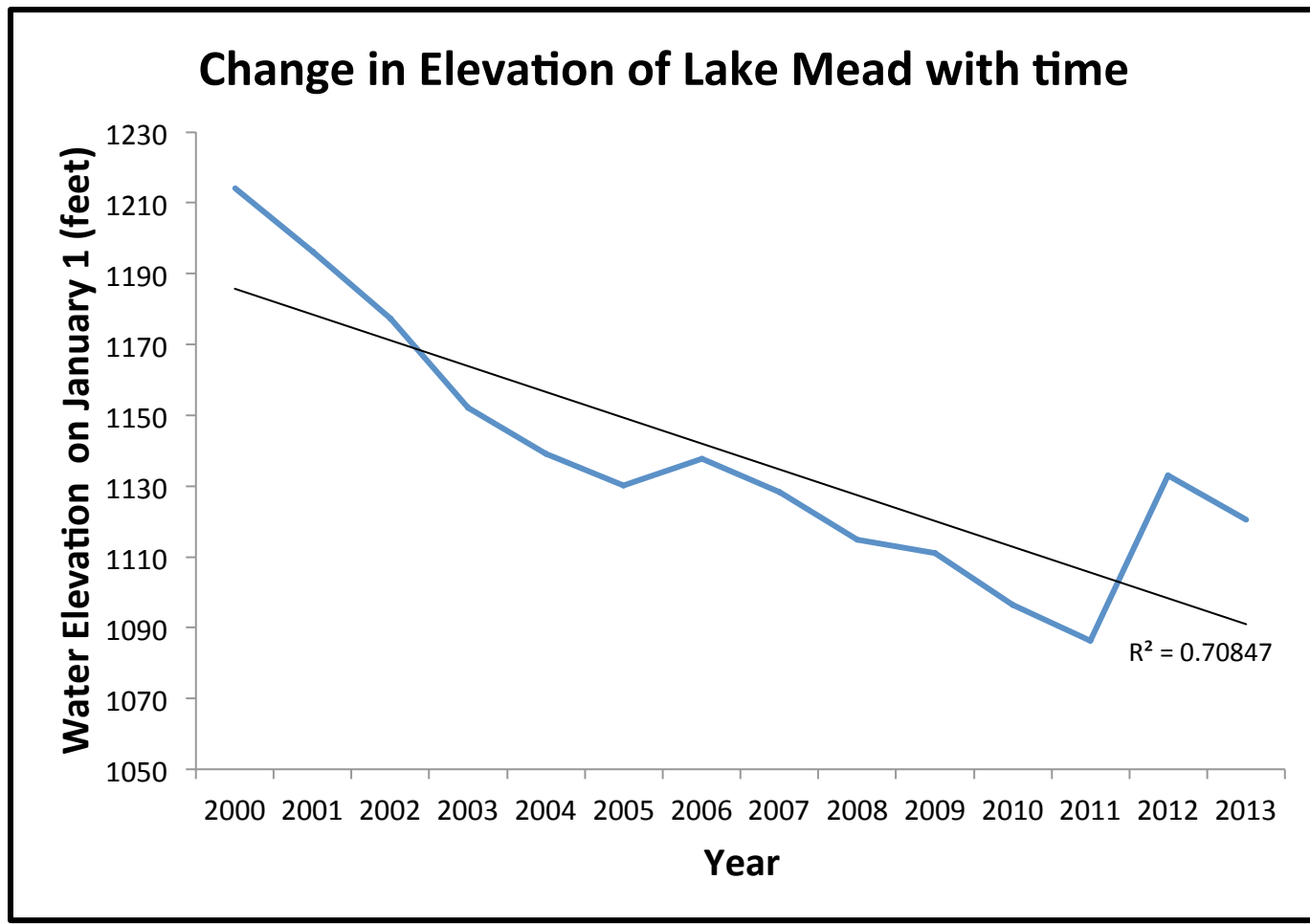
**Figure 1.** Map indicating Clark County's location within the state of Nevada, as well as Las Vegas's proximity to Lake Mead. Lake Mead which is fed mostly by the Colorado River and is responsible for about 85% of Las Vegas's residential water supply.



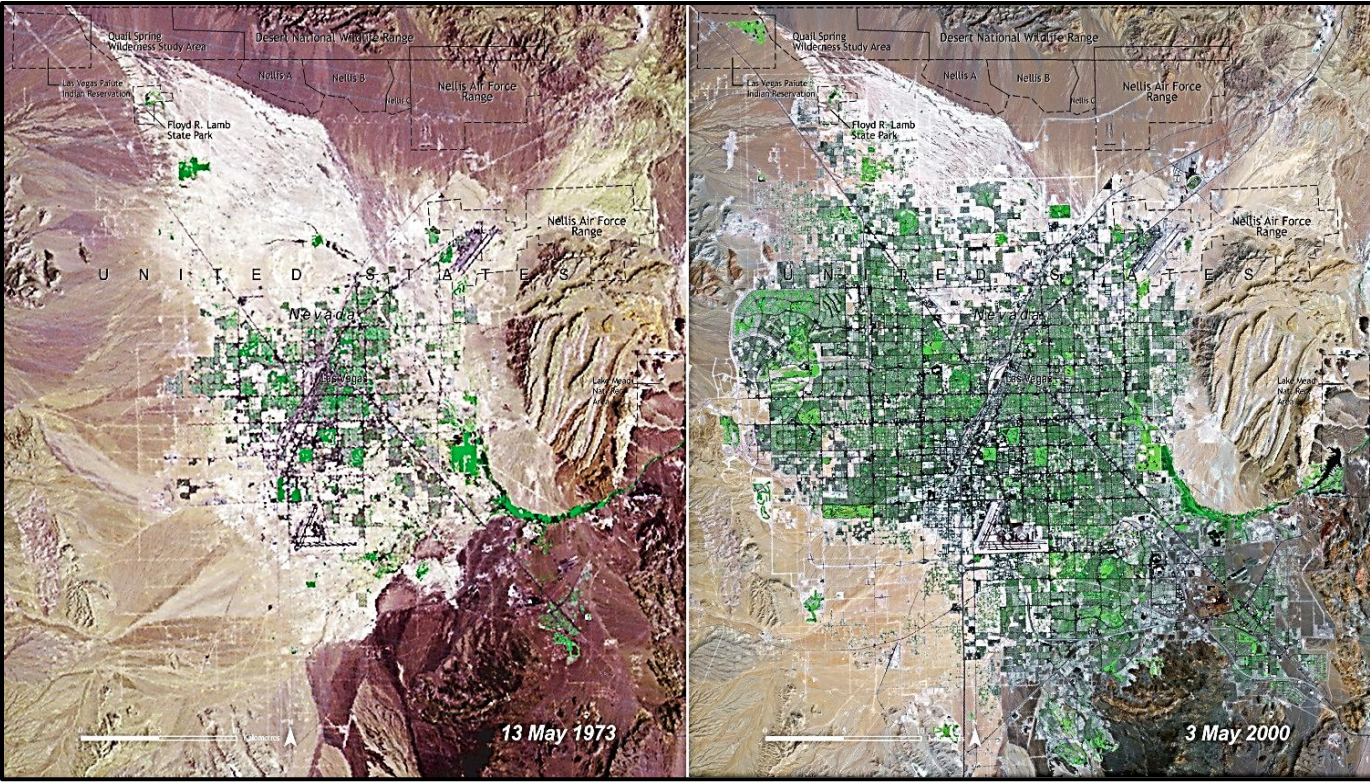
**Figure 2.** Graph indicating Clark County's population growth from 1975 to 2009.



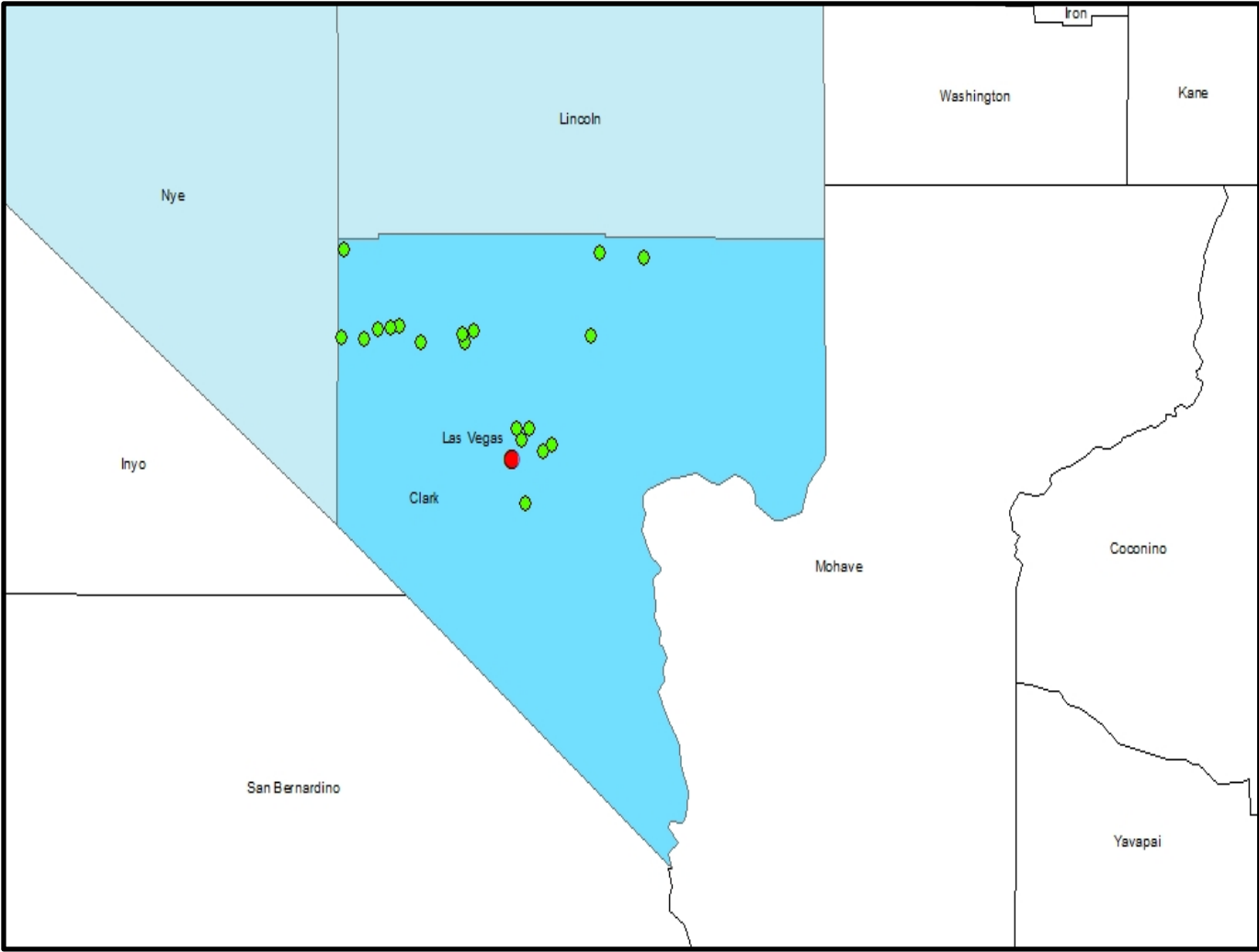
**Figure 3.** Choropleth map indicating yearly allocations of the Colorado River to states in the southwest United States. Amounts are shown in million acre-feet, and one acre-foot is equivalent to 325,851 gallons of water. Allocations are determined by the Law of River compacts. Data was collected from the SNWA.



**Figure 4.** Graph indicating the elevation of Lake Mead between the years 2000-2013. Water height measurement for the first day of January each year.



**Figure 5.** Aerial photo of the Las Vegas area, showing urban expansion of the city between the years of 1973 and 2000.  
[http://www.grid.unep.ch/activities/global\\_change/atlas/images/LasVegas.jpg](http://www.grid.unep.ch/activities/global_change/atlas/images/LasVegas.jpg)



**Figure 6.** Groundwater sites in Clark County, Nevada. Groundwater accounts for about 10% of total water usage in the Las Vegas Valley. These sites are aquifers from which groundwater is drawn for residential and industrial use. Site locations were collected from the USGS Water Use database.

Clark County, Nevada were found on the USGS databases, and SNWR and LVWD websites. These data were used in our overall evaluation of water usage in Las Vegas, Nevada. Groundwater site locations were found on the USGS Water Use database, and their positions were placed on a map of Clark County to show proximity to Las Vegas. These sites were noted as usable aquifers in Las Vegas Valley, providing groundwater, which accounts of 10% of Las Vegas's water usage.

### IV. Results and Discussion

Results show that there has been a consistent increase in population in Clark County, Nevada. This increase is due to the urbanization of cities such as Las Vegas. With this increase in population, there is an expected increase in consumption of water. Clark County retrieves 90% of their water from Lake Mead, and the remaining 10% from groundwater sources. The water level in Lake Mead, which Las Vegas began importing water from in 1971 (Pavelko 1999), is continuing to drop as of January 2013. Between the years of 2011 and 2012, there was a sporadic increase in elevation, most likely due to increased precipitation and snowmelt in the headwater of the Colorado River. It was followed by a sharp decrease in Lake Mead elevation. Lake Mead supplies water to not only Las Vegas, but also major cities in the Southwest such as Los Angeles, California and San Diego, California. California and Colorado receive the most water with 3.0-4.4 million acre-feet/year, while Nevada receives the least, with only 0.30 million acre-feet/year. The Law of the River Compact divided the Colorado River into an upper and lower basin, allocating 7.5 million acre-feet to each. In 1928, the Boulder Canyon Project Act furthered this by allocating Nevada 300,000 acre-feet/year, the least amount of water of any states that draw from the Colorado River. At the time, state officials thought the allocation was reasonable, but as the city has expanded, the need for water is greater. Figure 6 indicates the locations of active groundwater wells in Clark County, Nevada. These wells provide 10% of Las Vegas's total water use. The locations were drawn from USGS logs. In 1990 Clark County began artificially recharging not only Lake Mead, but also their underground aquifers with highly treated water. This recharge to Lake Mead is important, but the other counties taking water from the reservoir must also do so in order to see a visible change in the stability of Lake Mead. Prior to the artificial recharging to the system, land subsidence was becoming a large problem. Between the years of 1935 and 1999, land subsidence due to drilling caused 6 feet of subsidence to occur (Pavelko 1999). This subsidence can cause fissures in the land and damage to landscapes and buildings, resulting in damages costing the county and the residents millions of dollars. The rise in urbanization is visible in Figure 5. In this figure, the city of Las Vegas in May of 1973 is compared to May of 2000. There is obvious urbanization that correlates directly to population growth of the city, and subsequently the current water crisis. Urbanization, along with water consumption of underground aquifers will further increase the land subsidence. With urbanization comes more residents, attractions, tourists, and therefore, consumption of water.

### V. Conclusion

The current water crisis of Las Vegas Valley, NV has been caused by population growth and urbanization over a span of almost a century. As the most arid state in the country, Nevada lacks the water resources to support the city's growing water needs. The states of the Colorado River Basin must acquire less water from the Colorado River as well as return treated water to Lake Mead. By returning highly treated wastewater to Lake Mead, the elevation of the lake will be kept constant, and less subject to fluctuations caused by population growth and urbanization in the valley. MacDonald (2010) believes that the water from the Colorado River should be used for agricultural purposes rather than recreational purposes, such as those seen in Las Vegas. Halich et al. (2009) presents the idea that water consumption will decrease for recreational and residential purposes once mandatory programs are in effect and more information is provided to the public. Many mandatory programs and schedules are already in effect, and are regulated by the city. Fines for misuse of water can range anywhere from \$80 to \$5,120, depending on number of offenses and amount of water used. Water stored in Lake Mead is expected to dry out 10-30% with the next 30-50 years (Barnett and Pierce 2008). Las Vegas acquires 90% of their water from this source, and as long as they keep depending on this source, the city will be without water soon. By setting forth certain limitations and restrictions on residential and commercial water usage, the SNWA hopes to conserve the amount of water wasted each year. In order for the city to sustain itself regarding water usage. In order for Clark County to no longer have a water crisis, they must limit urbanization, decrease population growth, and the states of the Colorado River Basin must implement a program to recharge Lake Mead rather than deplete it.

### V.I. Future Research

This research project may be extended by future research to create a more comprehensive view of the water crisis taking place in the southwest United States, specifically Las Vegas. In order to maximize information coverage, aquifer and groundwater pumping rates may be collected through USGS data over a span of twenty years. By comparing data from the early 1990s to data from recent years, a comparison of water usage and its effects on the area could be made.

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