

JOINT WATER CONSERVATION PLAN



SOUTHERN NEVADA WATER AUTHORITY

City of Henderson | City of Las Vegas | City of North Las Vegas
City of Boulder City | Clark County Water Reclamation District
Big Bend Water District | Las Vegas Valley Water District



Photo: Southern Nevada

SOUTHERN NEVADA WATER AUTHORITY

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General Manager



MISSION

Our mission is to provide world class water service in a sustainable, adaptive and responsible manner to our customers through reliable, cost effective systems.

GOALS

Assure quality water through reliable and highly efficient system.

Deliver an outstanding customer service experience.

Anticipate and adapt to changing climatic conditions while demonstrating stewardship of our environment.

Develop innovative and sustainable solutions through research and technology.

Ensure organizational efficiency and manage financial resources to provide maximum customer value.

Strengthen and uphold a culture of service, excellence and accountability.

The Southern Nevada Water Authority (SNWA) is a cooperative, not-for-profit agency formed in 1991 to address Southern Nevada's unique water needs on a regional basis.

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Photo: Mojave Desert

A Message from the General Manager

The Southern Nevada Water Authority and its member agencies work diligently to maximize the availability of existing water supplies and reduce overall water demands in Southern Nevada through aggressive water conservation programs and policies. Our community has made great strides in water efficiency over the years and these efforts will continue to be of paramount importance, particularly as drought and climate change are anticipated to reduce the availability of water supplies, and as our economy continues to thrive.

I believe the challenges we face today will follow us into the future. The Southwest is getting warmer and soil conditions are getting dryer, which means less water is flowing into the Colorado River and Lake Mead – our primary water source. As we face an increasingly water-scarce future, there is more our community can and must accomplish. I am asking all Southern Nevada residents to join me with increased resolve to protect our community's limited water supply and help to meet our water conservation goals.

Increased water efficiency remains a critical step towards the long-term prosperity of our desert community. This plan describes the importance of ongoing conservation in Southern Nevada and details the steps we've taken to increase water efficiency. It also provides insights and results for our past success, discusses the tools and resources we're implementing to support achievement of our water conservation goal, and explores the steps we are asking residents and businesses throughout the region to take to help ensure the long-term sustainability of Southern Nevada.

While hard work remains, I have tremendous confidence in our collective ability to do more with less and to take actions that will sustain Southern Nevada for current and future generations.



John J. Entsminger
General Manager

Photo: Southern Nevada landscape



Plan Introduction

The Southern Nevada Water Authority (SNWA) is a regional, not-for-profit agency. Formed in 1991 by a cooperative agreement among seven water and wastewater agencies, SNWA works to address Southern Nevada's unique water needs on a regional basis. Collectively, the SNWA member agencies serve more than 2.2 million residents in the cities of Boulder City, Henderson, Las Vegas, North Las Vegas, Laughlin and areas of unincorporated Clark County.

AUTHORITIES

As the region's wholesale water provider, the SNWA is responsible for managing current and future water resources. This includes managing all water supplies available to Southern Nevada through an approved water resource plan and water budget; managing regional conservation programs; ensuring regional water quality meets or exceeds state and federal standards; and building and operating regional facilities to provide a reliable drinking water delivery system to its member agencies.

Although the SNWA plays a critical role in managing water, it does not have the authority to regulate water use by end-users or to establish customer rates. Such policies, codes and regulations are implemented through its member agencies. In terms of regulatory issues, the SNWA plays an important role in facilitating information sharing and collaboration. Past efforts have resulted in the creation of successful community-wide water-efficiency policies, such as permanent mandatory watering restrictions and limitations on lawn installation in new construction (see Chapter 4).

Education, outreach and incentive programs as described in Chapters 5 and 6 are largely developed and managed by the SNWA through committed involvement from its member agencies.

STATE AND FEDERAL REQUIREMENTS

This Joint Water Conservation Plan (Plan) meets state and federal conservation plan requirements prescribed under Nevada Revised Statutes (NRS) and

the Reclamation Reform Act (RRA). It addresses the regional conservation initiatives of the following wholesale and municipal water agencies:

- Southern Nevada Water Authority
- City of Las Vegas
- City of North Las Vegas
- City of Boulder City
- City of Henderson
- Big Bend Water District
- Las Vegas Valley Water District
- Clark County Water Reclamation District

Nevada Revised Statutes

NRS 540.121 through 540.151 requires all water suppliers in Nevada to prepare and adopt a water conservation plan that is based on the climate and living conditions of its service area, and to update the plan every five years. As outlined in NRS 540.141, the plan must include a drought contingency plan, water management measures, standards for efficiency in new development, conservation water rates, conservation measures, public education initiatives, a schedule for carrying out the plan, measures for evaluating plan effectiveness and a conservation savings estimate.

As required, the plan was submitted to the Nevada Department of Conservation and Natural Resources, Division of Water Resources for review and approval prior to its adoption. The plan also was made available for public inspection during regular business hours, both at SNWA's public offices and online at snwa.com. The next plan update is scheduled for August 2024.

Reclamation Reform Act

In addition to NRS, RRA Section 210(b), requires the SNWA to maintain a five-year conservation plan with the U.S. Bureau of Reclamation. This Plan meets these requirements and is effective for a period of five years from the date of SNWA Board approval.

PLANNING GUIDANCE

In addition to NRS and RRA, the SNWA reviewed other conservation guidance documents in preparation of its 2019-2024 Plan. These include the U.S. Environmental Protection Agency (EPA) Advanced Guidelines for Preparing Water Conservation Plans (for systems serving greater than 100,000 customers)ⁱ and the American Water Works Association's (AWWA) G480-13 Water Conservation Program Operation and Management Standards.ⁱⁱ

These tools were designed to assist water suppliers in developing effective water conservation plans. While compliance with EPA and AWWA guidance is voluntary, the SNWA has informed its 2019-2024 Plan with these valuable tools. Although additional information on facilities and resource planning has been included, this plan does not intend to specifically address all aspects of water resource management and development. Instead, it serves as a companion to other detailed planning documents as described in Chapter 2.

CONSERVATION PHILOSOPHY

The SNWA has a long history of setting and achieving its water conservation goals. Since its first plan was adopted in 1995, the agency's philosophy towards conservation has centered on important practical and principled considerations.

For many communities, including ours, conservation is a sensible approach that can extend the availability and use of limited water supplies. The SNWA's planning approach recognizes the intrinsic value of water for life and livelihood in our desert community.

Implementation of the conservation planning goals and strategies detailed within this plan will help to:

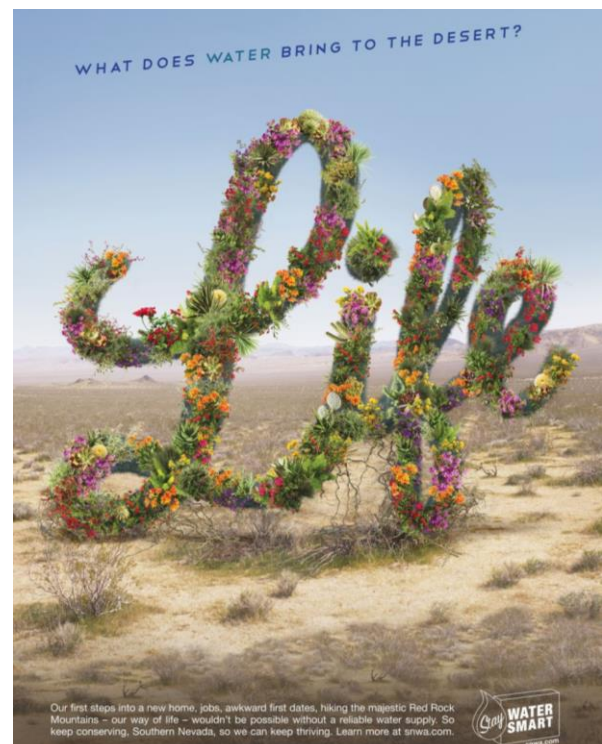
- Prolong the life and improve utilization of existing facilities, reduce variable operating costs, and delay new source water development costs.
- Extend the use of permanent resources and help grow temporary resources or banked supplies that can be used when needed to improve operational flexibility.

- Reduce the likelihood of federally imposed shortage declarations for Colorado River supplies and reduce the magnitude of curtailments.
- Build and maintain strong relationships among the public, other stakeholders and the river community with whom we share resources.
- Protect Southern Nevada's economy and jobs by ensuring short- and long-term water demands can be met sustainably.
- Demonstrate our deep understanding of the value of water and model responsible, innovative approaches for the stewardship of Southern Nevada's limited water supplies.

Public Involvement in Goal Setting

Since its inception, the SNWA has consistently relied upon public input. Citizen advisory committees convened by the SNWA Board of Directors have explored and deliberated a range of issues – from water quality and environmental initiatives to water conservation goals, and the development of water sources and infrastructure for Southern Nevada's future.

Image: SNWA's 2017 ethics campaign emphasizes the value of water for life, family, jobs and our future.



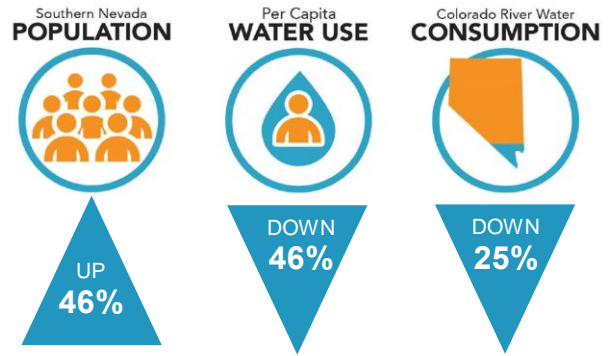
Water Conservation Goal

The SNWA is working to achieve its conservation goal of 105 gallons of water per capita per day (GPCD) by 2035.ⁱⁱⁱ As recommended by SNWA's 2015 Integrated Resource Planning Advisory Committee, a new conservation goal will be evaluated once the current goal is achieved. The SNWA's Water Resource Plan (visit snwa.com) provides an illustrative look at how additional conservation – beyond the current goal – might impact long-term (50-year) water demands, as well as short- and long-term water supply needs.

GPCD is a metric used by many communities to measure water use. It also is an effective tool to measure efficiency over time. GPCD varies across communities due to several factors, including differences in climate, demographics, water-use accounting practices and economic conditions. As such, it is difficult to compare GPCD rates for different communities for the purpose of evaluating efficiency.

For the 2019-2024 SNWA Conservation Plan, the SNWA has restated its conservation progress and goal in consumptive use terms to more accurately reflect the water resource implications associated with conservation progress.^{iv} SNWA GPCD is calculated by dividing all SNWA water sources diverted (excluding offstream storage) less corresponding Colorado River return-flow credits by total SNWA resident population served per day (GPCD = $\frac{\text{water diverted} - \text{return-flow credits}}{\text{resident population} / 365 \text{ days}}$). This approach recognizes that not all water that is diverted is consumed. This is because the SNWA recycles nearly all indoor water use, either through return-flow credits or direct reuse (see Chapter 2).

Southern Nevada has made significant progress towards its water conservation goal as detailed in Appendix 3. Between 2002 and 2018, per capita and Colorado River water use has decreased by about 46 percent and 25 percent, respectively. Meanwhile, population has increased by more than 46 percent.



Infographic: SNWA Conservation Progress (2002-2018)

Over the years, the SNWA has made several significant changes to its Water Conservation Plan and associated strategies to promote continued conservation and efficiency improvements. These include increased water management measures, financial increases to incentive programs, and targeted education and outreach initiatives as detailed in Chapters 4-6.

CONSERVATION STRATEGIES

The SNWA uses several demand management tools to promote conservation and reduce overall water use, including water pricing, incentives, regulations and education. These measures work in conjunction with one another to promote efficient water use. For example, water pricing (including water rates and water waste fees) provides a financial signal for customers to reduce water use, which, in turn, may lead some customers to improve efficiency.

Through passive and active education, customers learn about regulations (such as day-of-week watering restrictions and incentive programs), which, when acted upon, help the customer save water and reduce the impact of rates. Ideally, these measures yield higher levels of efficiency. A table of estimated water savings by specific conservation measures over the planning horizon is included in this Plan as required (Appendix 3). However, the complex and inter-related nature of these conservation tools makes it difficult to attribute specific water savings to any single measure.

As detailed later in this Plan, the SNWA maintains a suite of conservation programs for both indoor and outdoor water uses, while deliberately focusing its staff and financial resources on programs and efforts designed to reduce consumptive water use, such as water waste, landscape irrigation and evaporative loss. While significant funding is directed to reduce consumptive water uses, the SNWA maintains consistent water conservation messaging and program support to reduce all types of end uses. This is an important strategy that helps to build upon the community's strong and growing conservation ethic.

Other conservation strategies include:

- Engaging our community with information and programs that help individuals and organizations change their water use (retrofit).
- Building in future conservation savings by ensuring new development is water efficient.
- Transforming demand through new products and technologies that reduce water demand.
- Curtailing waste and losses by minimizing unproductive losses of water in both utility and customer applications.
- Advancing knowledge through investments that increase our understanding of new opportunities and the influence of existing programs.
- Valuing water appropriately by ensuring water rates and fees reflect the value of resources.

A CALL TO ACTION

Many of the conservation measures described in Chapter 5 are voluntary, which makes the public an essential partner as our community works to improve water efficiency and reduce water waste.

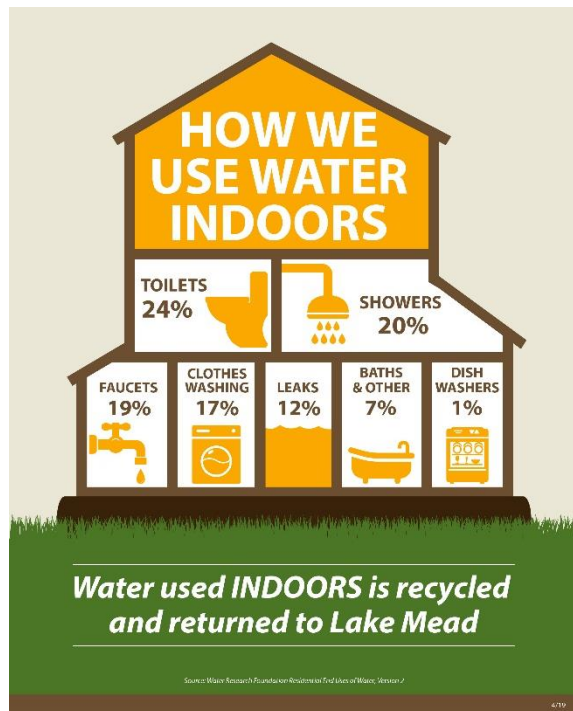
While this Plan describes many ways to improve water efficiency, the SNWA is specifically calling on residents and businesses to take three key actions that will together have a high impact on reducing water use:

- Remove ornamental turf – replace water thirsty grass with water efficient landscapes.

- Change your watering clock – follow mandatory time-of-day and day-of-week watering restrictions.
- Report water waste – help local water agencies to identify and address water waste in our community by reporting water waste.



Infographic: Most of our community's water is used outdoors.



Infographic: Water used indoors is recycled.

Water Service Overview

This chapter provides a general overview of the SNWA's water service area, including a description of major water facilities and supplies available to meet the community's short and long-term resource needs.

Southern Nevada Water Authority

The SNWA was formed in 1991 by a cooperative agreement among seven water and wastewater agencies (below). Collectively, the SNWA member agencies serve more than 2.2 million residents in the greater Las Vegas Valley.

- Las Vegas Valley Water District*
- City of Henderson*
- City of Las Vegas
- Big Bend Water District
- City of North Las Vegas*
- City of Boulder City*
- Clark County Water Reclamation District

As the region's wholesale water supplier, the SNWA is responsible for constructing and operating regional water facilities. This includes operations of the Southern Nevada Water System (SNWS), which has a total combined treatment capacity of 900 million gallons of water per day (MGD).

The SNWS is comprised of three raw water intakes and two raw water pumping stations that deliver SNWA's contracted Colorado River supplies from Lake Mead; two water treatment plants; approximately 30 pumping stations; more than 160 miles of large diameter pipeline; and more than 60 regulating tanks, reservoirs and surge towers. A new raw water pumping station is currently under construction to protect access to the community's water supply from effects of extended drought. This major addition is expected to be complete in 2020.

In turn, the SNWA's water purveyors (*), are responsible for municipal water service to residents and businesses in their respective service areas (Figure 2.1). As further described in Chapter 4, the SNWA member agencies meter all customer accounts and use increasing block tier conservation rates.

Las Vegas Valley Water District

The Las Vegas Valley Water District (LVVWD) is the region's largest municipal water purveyor, providing municipal water service to nearly 400,000 customer accounts in Las Vegas and portions of unincorporated Clark County. The system includes thousands of miles of pipelines, 53 pumping stations and 73 water storage reservoirs.

City of Henderson

The City of Henderson provides water, wastewater and reclaimed water services to approximately 98,000 customer accounts within the city's jurisdiction. The system includes more than 2,200 miles of pipelines, 43 pumping stations, and 55 water storage reservoirs.

City of North Las Vegas

The City of North Las Vegas provides municipal water service to more than 90,000 customer accounts in North Las Vegas and adjacent portions of Las Vegas and unincorporated Clark County. The system includes more than 1,100 miles of distribution pipelines, 10 pumping stations and nine water storage reservoirs. The City of North Las Vegas also operates facilities for direct and indirect reuse.

City of Boulder City

The City of Boulder City provides water service to more than 5,000 customer accounts in Boulder City. The system includes more than 145 miles of distribution pipelines and six water storage reservoirs.

Big Bend Water District

The Big Bend Water District provides municipal water service to approximately 2,000 customer accounts in Laughlin, Nevada. The water system is operated and maintained by the LVVWD under a cooperative agreement. The system includes more than 60 miles of distribution pipelines, six pumping stations and five water storage reservoirs.

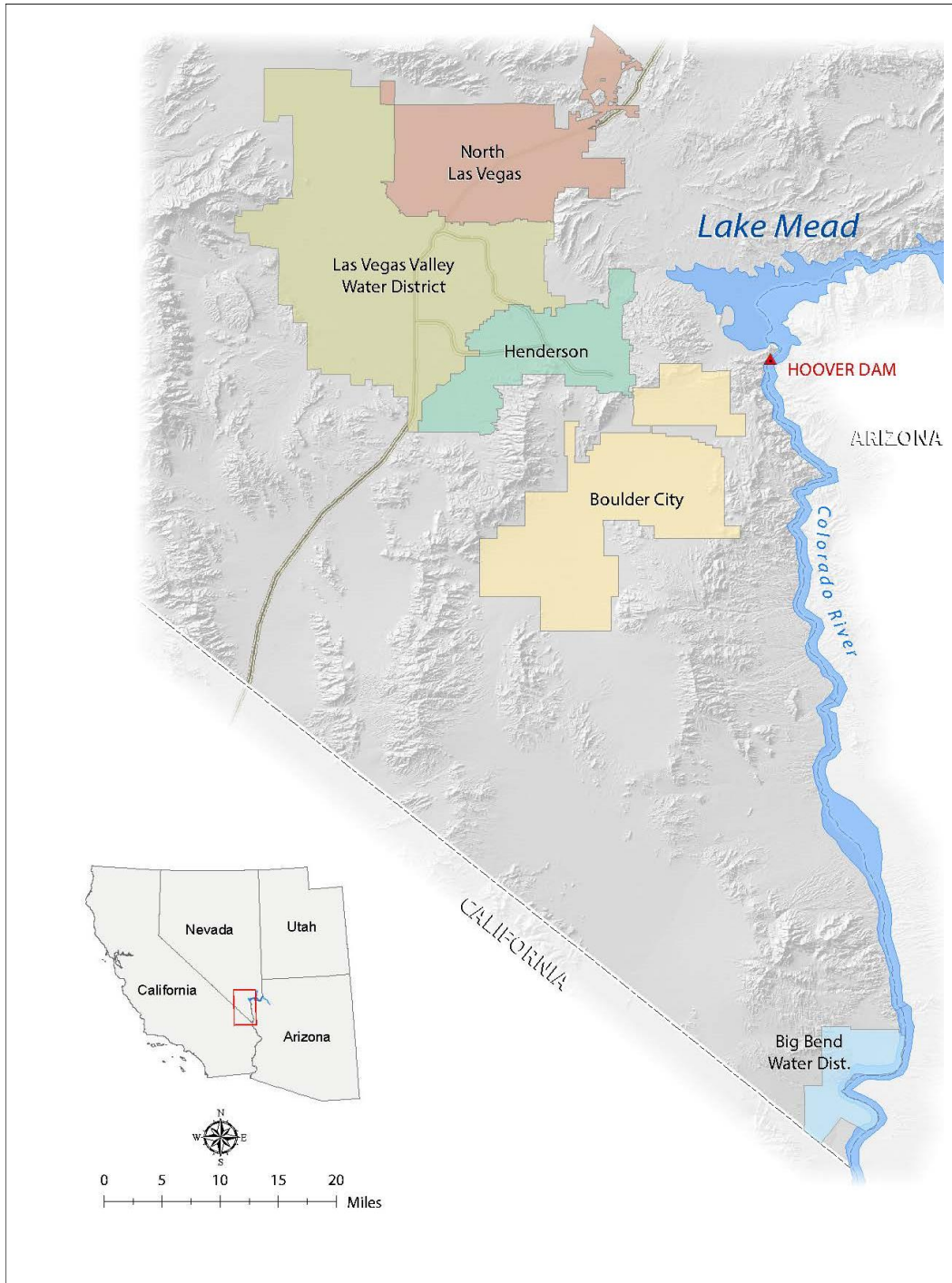
Clark County Water Reclamation District

The Clark County Water Reclamation District is the largest clean water agency in Nevada, collecting, treating and producing more than 105 million gallons of clean water each day. The majority of the clean water is returned to Lake Mead via the Las Vegas Wash and to the Colorado River at Laughlin for indirect reuse. It also provides a small portion of reclaimed water for irrigation and industrial coolant.

City of Las Vegas

The City of Las Vegas provides reuse water to customers within its service area. Municipal water supplies for the City of Las Vegas are provided by LVVWD.

Figure 2.1 SNWA and purveyor service areas



CUSTOMER CLASSES

As shown in Figure 2.2, residential customers make up the largest class of water users in Southern Nevada. Other customer categories include: commercial and industrial customers; resorts; golf courses; schools, government and parks; common areas; and other water users.

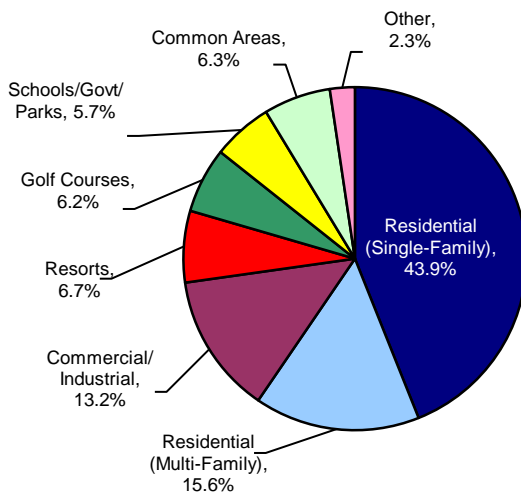


Figure 2.2 Municipal metered water use by customer class (2018)

MAJOR PLANNING EFFORTS

The SNWA conducts short- and long-range planning to ensure high-quality water supplies and reliable service to its customers. As noted in Chapter 1, the SNWA consistently relies on input from citizen committees to support planning efforts. Integrated resource planning initiatives have helped to inform and advance many of the planning processes described in the sections that follow.

Water Resource Plan and Water Budget

The SNWA conducts an annual review and update to its Water Resource Plan and Water Budget. These documents include a summary of projected water demands in Southern Nevada over a 50-year planning horizon, as well as the resources available to meet those demands over time. Further, the plans demonstrate the SNWA's ability to meet future water demands under variable supply and demand conditions and presents a detailed forecast of water demands by SNWA purveyor member over a short-term (4-year) planning horizon.

Conservation Plan

The SNWA develops and implements a water conservation plan that provides a comprehensive overview of SNWA conservation goals and achievements, and discusses efforts planned or under way to reduce water waste and promote water efficiency. While the Plan is updated on a five-year schedule as required, the SNWA conducts regular reviews of its programs and strategies, adjusting as needed to help keep the community on track to meet its water conservation goals.

Drought Plan

The SNWA adopted a Drought Plan in 2002 that identified staged conservation measures that could be implemented based on the severity of drought conditions observed. Drought response actions identified in the plan and subsequent amendments have since become permanent conservation measures as discussed in Chapter 4. SNWA's current drought response actions are discussed in Chapter 3.

Major Construction and Capital Plan

The SNWA implements a Major Construction and Capital Plan that reports the costs of completed projects and defines authorized projects and initiatives for new regional facilities. This includes acquisition of assets and other capital-related activities. The plan further identifies estimated costs and schedules for approved projects and initiatives.

Water Quality Plan

The Regional Water Quality Plan for the Las Vegas Valley details implementation efforts for seven goals and strategies designed to protect, preserve and enhance the quality and quantity of water resources in the Las Vegas Valley Watershed, and to sustain economic well-being and protect the environment for present and future generations.

Financial Plan

The SNWA's Comprehensive Annual Financial Report is updated annually to provide a comprehensive overview of SNWA financial statements, accomplishments and financial forecasts.

WATER SUPPLY DESCRIPTION

The SNWA works to develop and manage a flexible portfolio of diverse water resource options; many of these resources have resulted from years of in-state, interstate and international collaborations. The portfolio includes permanent, temporary and future resources that are described in detail in the SNWA's 50-year Water Resource Plan. The following provides a general overview of water supplies that are available or are expected to be available through the SNWA's long-term (50-year) planning horizon. Visit snwa.com for plan updates and more detailed discussions.

Permanent Resources

Colorado River Water. Nevada's 300,000 acre-foot per year (AFY) Colorado River apportionment continues to be Southern Nevada's largest and most critical permanent resource. Nevada's right to this water was established under the 1922 Colorado River Compact and the 1928 Boulder Canyon Project Act (BCPA), which together set forth where and how Colorado River water is used.

The SNWA has contracts with the U.S. Secretary of the Interior for 272,205 AFY of Nevada's 300,000 AFY allocation. As detailed in the SNWA's Water Resource Plan, the SNWA may also utilize the unused apportionment of other Nevada Colorado River contract holders, as well as flood control and surplus Colorado River waters, as available.

Intentionally Created Surplus.

Under the 2007 Record of Decision for the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead (Interim Guidelines), the SNWA can develop some of its surface and groundwater rights located in Nevada by allowing them to flow in Lake Mead in exchange Intentionally Created Surplus (ICS) credits. When needed, the credits can be withdrawn as Colorado River through SNWA facilities and returned to the system for return-flow credits.

Return-Flow Credits and Water Reuse. The BCPA defines all Colorado River apportionments in terms of "consumptive use." Consumptive use is defined as water diversions minus any water returned to the Colorado River. These returns are also referred to as "return-flow credits." With return-flow credits, Nevada can divert more than 300,000 AFY, so long as there are sufficient flows returned to the river to ensure the consumptive or 'net use' is no greater than 300,000 AFY.

In the Las Vegas Valley, nearly all water used indoors is recycled, either for direct or indirect reuse (Figure 2.3). Direct reuse involves collecting, treating and utilizing reclaimed water wastewater flows for non-potable uses such as golf course or park irrigation. Indirect reuse consists of recycling water by way of treatment and release to the Colorado River for return-flow credits. In 2018, Nevada's total consumptive Colorado River water use was 244,000 AFY.

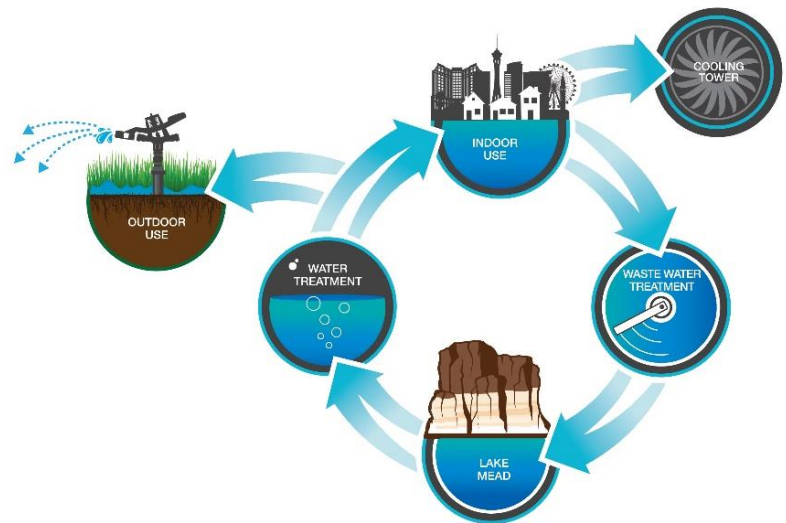


Figure 2.3: Uses of water

Las Vegas Valley Groundwater. The Las Vegas Valley Water District (LVVWD) and North Las Vegas have permanent groundwater rights totaling 40,760 and 6,201 AFY, respectively. These rights are among the most senior groundwater rights in the Las Vegas valley and remain a critical component of the SNWA's water resource portfolio.

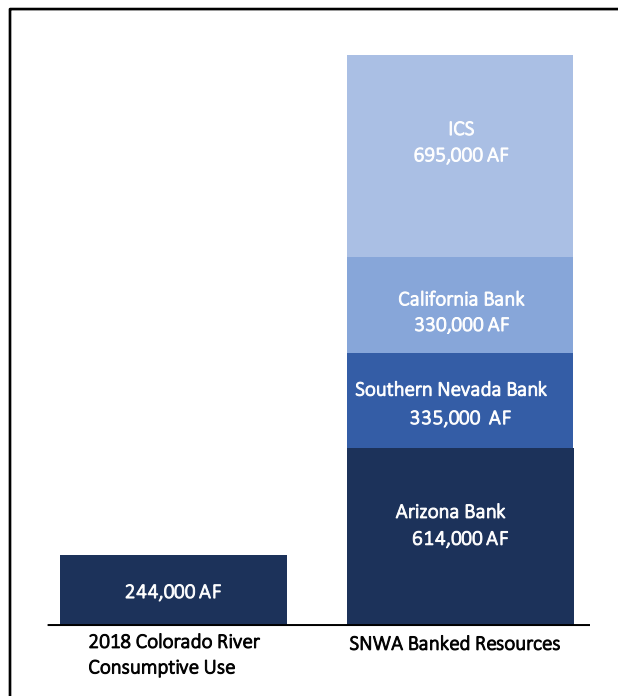
Temporary Resources

The SNWA reserves water in years when Nevada’s Colorado River allocation exceeds community water demands. These resources are “banked” as temporary supplies for future use and serve as an important management tool – resources can be used to meet potential short-term gaps between supply and demand, and serve as a bridge to meet demands while other future resources are being developed. In some cases, banked resources may be used to help offset future reductions in permanent supplies due to federally imposed shortages (see Chapter 3).

Water Banking. SNWA water purveyors began storing or “banking” unused Colorado River resources in the Las Vegas Valley through direct injection beginning in the late 1980s. Banking programs have been expanded to include in lieu storage in the Las Vegas Valley and interstate banking agreements for storage in Arizona and California.

Another form of water banking was established under the 2007 Interim Guidelines, which allowed for water storage in Lake Mead in the form of ICS credits. As shown in Figure 2.4, the SNWA has banked approximately two million acre-feet of water through 2018. This is more than eight times Nevada’s 2018 consumptive Colorado River water use.

Figure 2.4: Summary of banked supplies (in acre-feet) through 2018



The primary purpose of ICS is to encourage efficient Colorado River water use, increase storage in major system reservoirs, increase surface water elevations in Lake Mead, and minimize or avoid the potential for declared shortages. The SNWA accrues credits by conveying some of its surface and groundwater rights located in Nevada to Lake Mead in exchange for ICS credits. The SNWA also accrues credits by participating in Colorado River conservation and efficiency programs that save Colorado River water that would otherwise have been banked or lost from the system.

The 2019 Lower Basin Drought Contingency Plan Agreement (DCP) expanded Lake Mead water banking opportunities for Southern Nevada with the authorization of a new ICS project. The project allows SNWA to leverage its past and future conservation savings and to obtain ICS credits. Ongoing accruals will be based on conservation achievements since 2002.

Future Resources

Water resource conditions have changed significantly for many Western states over the years, including Nevada. As a result, the SNWA has worked to implement strategies that conserve and maximize the use of Colorado River and groundwater supplies and help to establish temporary resources that can be used flexibly to meet evolving supply and demand conditions. These strategies increase overall efficiency, provide operational flexibility, buffer potential impacts of drought conditions, and help delay the development of costly facilities that may not be needed in the future.

To prepare for the future, the SNWA has identified a number of resources that are expected to be available at some point during the long-term planning horizon. These include desalination, in-state groundwater, Virgin River/Colorado River augmentation, and transfers and exchanges. In some instances, future resources are quantified, subject to water right permitting, while the availability and development of others require further research and analysis. The SNWA’s future

resource options are discussed in detail in the SNWA's Water Resource Plan.

Water Conservation

Water conservation is a resource but differs from other water supplies described in the preceding sections. Unlike other resources that are acquired and conveyed to meet demands, conservation reduces demands and extends the availability of existing, temporary and future water supplies.

WATER DEMAND PROJECTIONS

Forecasting water demands is a critical part of SNWA's resource planning process. The SNWA projects water demands over a 50-year planning horizon and reviews/revises its forecasts annually.

Precise accuracy rarely occurs in projecting water demands, particularly during periods of significant social and economic challenges. While making assumptions is a necessary part of the planning process, the SNWA recognizes that assumptions are unlikely to materialize exactly as projected. Likewise, climate variations, policy changes and/or implementation of new regulations can also influence water demands over time.

In response to this inherent uncertainty, the SNWA considers two water demand projections. An upper and a lower water demand projection are used to bracket the range of demand conditions expected to be experienced over SNWA's 50-year planning horizon. Detailed discussion about SNWA water demand projections are included in the SNWA's Water Resource Plan. The plan, including demand projections, is updated annually and include assumptions about conservation goals and achievements (see Water Resource Plan, Chapter 4).

Lower Demand Projection

The lower demand projection was derived from a population forecast and expected conservation achievements. The Clark County population forecast was obtained from the University of Nevada, Las Vegas Center for Business and Economic Research (CBER). The forecast is based on CBER's working knowledge of the economy and the nationally recognized Regional Economic Model Incorporated.

The lower water demand projection was derived using the latest CBER population forecast and trending through the balance of the planning horizon. The historical share of Clark County population attributable to the SNWA's service area was multiplied by current year water-use levels to represent expected achievements of the community's water conservation goal and further reductions in demand to reflect the potential for additional conservation once the current goal is met.

Upper Demand Projection

The upper demand projection was developed for planning purposes to reflect increased uncertainties related to possible changes in demand associated with climate variability, economic growth, increased population and water use patterns.

Drought Response

LOCAL CLIMATE

Nevada falls within two of North America’s desert regions: The Great Basin Desert covers the northern, central and south-central portions of the state, while the Mojave Desert covers Nevada’s southernmost tip where Southern Nevada is located. While topography and temperature vary greatly within these regions, Nevada is the driest state in the nation overall and is classified as semi-arid to arid.

Southern Nevada experiences temperature extremes that range from 8°F to 117°F^v. High temperatures are moderated by dry air/low humidity conditions, typically below 40 percent year-round. Within this region, rainfall totals vary significantly, both seasonally and from year to year. The highest annual precipitation total on record occurred in 1941, measuring 10.72 inches. In contrast, the lowest occurred just twelve years later (1953), measuring 0.56 inches. On average, Southern Nevada receives 4.19 inches of precipitation annually. Nearly half of the last 15 years, however, have measured rainfall less than 2.65 inches.

Summer months (June – September) are extremely hot with normal average temperatures ranging between 82.6°F and 92.5°F – daytime temperatures often exceed 100.0°F. Winter months (December – February) are chilly to mild with normal average temperatures ranging between 47.7°F and 52.9°F. Weather during spring and fall (March – May and October – November) is typically mild with normal average temperatures ranging between 56.4°F and 77.3°F.

In 2017, the region broke several of its former weather records: 25 consecutive days with a high temperature of 105.0°F or higher (June 15 – July 9) and 116 consecutive dry days (September 14 – January 7). 2017 was the hottest year on record with 86 days that reached or exceeded 100°F. Local climate conditions remained extremely hot and dry for 2018. September 2018 was the warmest month on record.^{vi}

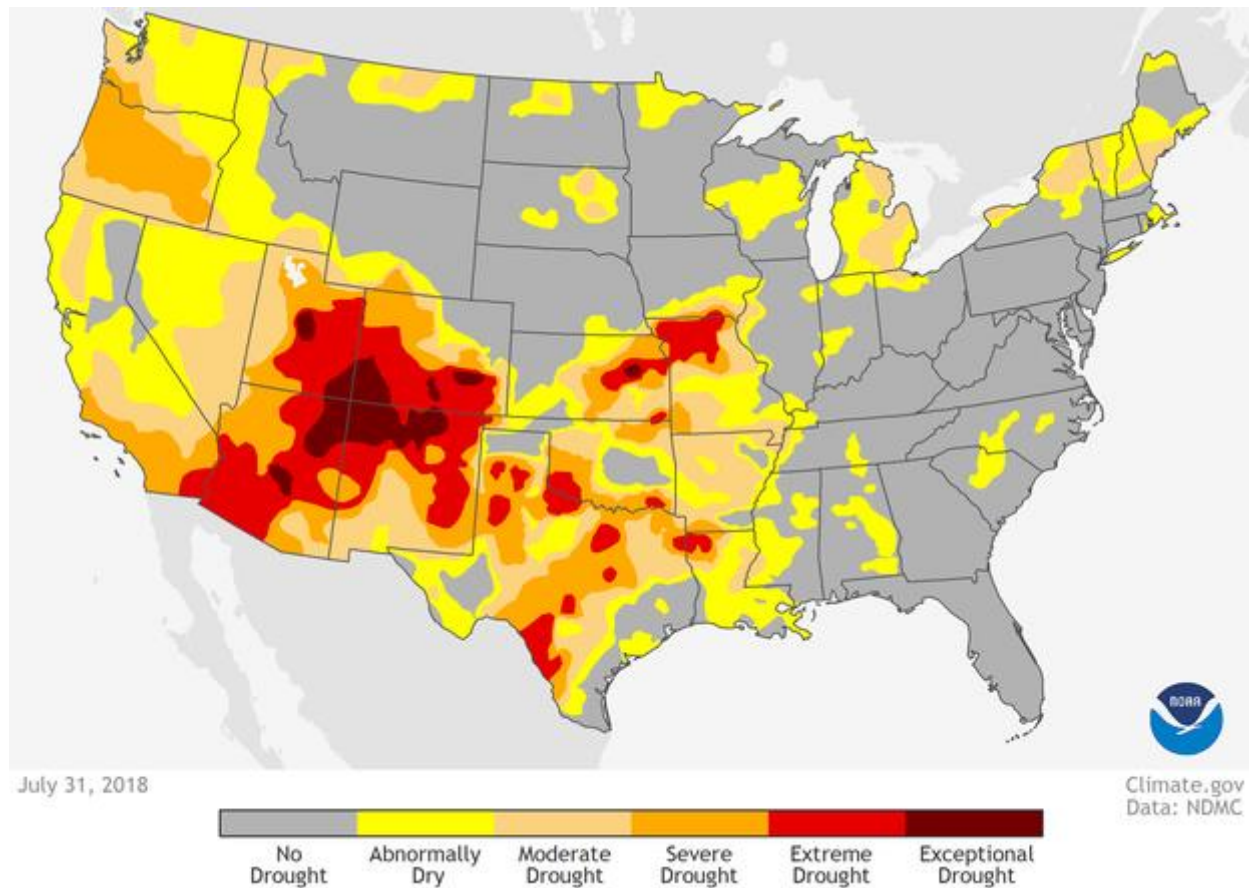
Temperature and precipitation data for the Las Vegas Valley is collected by the National Oceanic and Atmospheric Administration (NOAA) from the region’s official climate station at McCarran International Airport. The station is located in the valley’s urban core and frequently registers warmer low temperatures than outlying areas of the valley (+5° to 15°). This is due to increased urbanization of the Las Vegas Valley, which has resulted in a “heat island” effect.

Temperature and precipitation are variables that can significantly affect water use patterns in Southern Nevada, particularly for outdoor irrigation and large-scale air cooling facilities. Landscapes consume more water during high temperatures due to evaporation, evapotranspiration and overall plant water needs. Likewise, water used for air cooling increases when conditions are hot.

Photo: The Mojave Desert (below) is North America’s driest desert.



Figure 3.1: U.S. Drought Monitor (NOAA) - July 2018



DROUGHT AND CLIMATE CHANGE

The Southwest region has experienced both rising temperatures and drought conditions for nearly two decades. As shown in Figure 3.1, drought conditions in 2018 ranged from abnormally dry to exceptional drought.^{vii} Conditions have improved significantly with above-average snowfall in 2018/2019, however storage volumes in major system reservoirs remain below average.

In the Southwest, the persistence of drought and rising temperatures have resulted in changes to precipitation patterns; reduced snowpack and runoff to rivers, lakes and streams; drastic decreases to critical storage reserves; dry soil conditions and increased occurrence of wildfires; and the encroachment of non-native species. Average annual temperatures in the Southwest are projected to rise by an additional 3.5°F to 9.5°F by the end of the

century, with the greatest temperature increases expected in the summer and fall. Likewise, drought conditions are expected to become more frequent, intense and longer.^{viii}

As detailed in the water supply description, Southern Nevada’s principal water supply is derived from precipitation and snowmelt that originates primarily in the Rocky Mountains of the Upper Colorado River Basin and flows into the Colorado River. Beginning in 2000 and continuing today, the Colorado River Basin has experienced drought conditions that quickly developed into the worst drought in the basin’s recorded history.

According to the Fourth National Climate Assessment released in late 2018, changes in temperature have significantly altered the water cycle in the Southwest

region. With continued greenhouse emissions, higher temperatures could cause more frequent and severe droughts in the Southwest, and lead to drier future conditions in the region.^{ix}

Changes in air temperature and precipitation are likely to translate into diminished streamflow, drier soil conditions, increased water evaporation and evapotranspiration, and higher water demands for agricultural irrigation and landscaping uses.^x

Water Supply Conditions

Drought and climate change have taken their toll on the Colorado River, which supplies approximately 90 percent of Southern Nevada’s overall resource needs. Southern Nevada accesses a majority of its Colorado River supplies via Lake Mead, which was formed by the construction of Hoover Dam.

As shown in Figure 3.2, snowfall and runoff within the Colorado River Basin were well below normal between 2000 and 2019, representing one of the lowest 20-year averages on record. These conditions have resulted in significant water level declines at major system reservoirs. As of September 2019, the combined water storage in the Colorado River’s two primary reservoirs (Lake Mead and Lake Powell) was less than 47 percent.^{xi}

DROUGHT RESPONSE

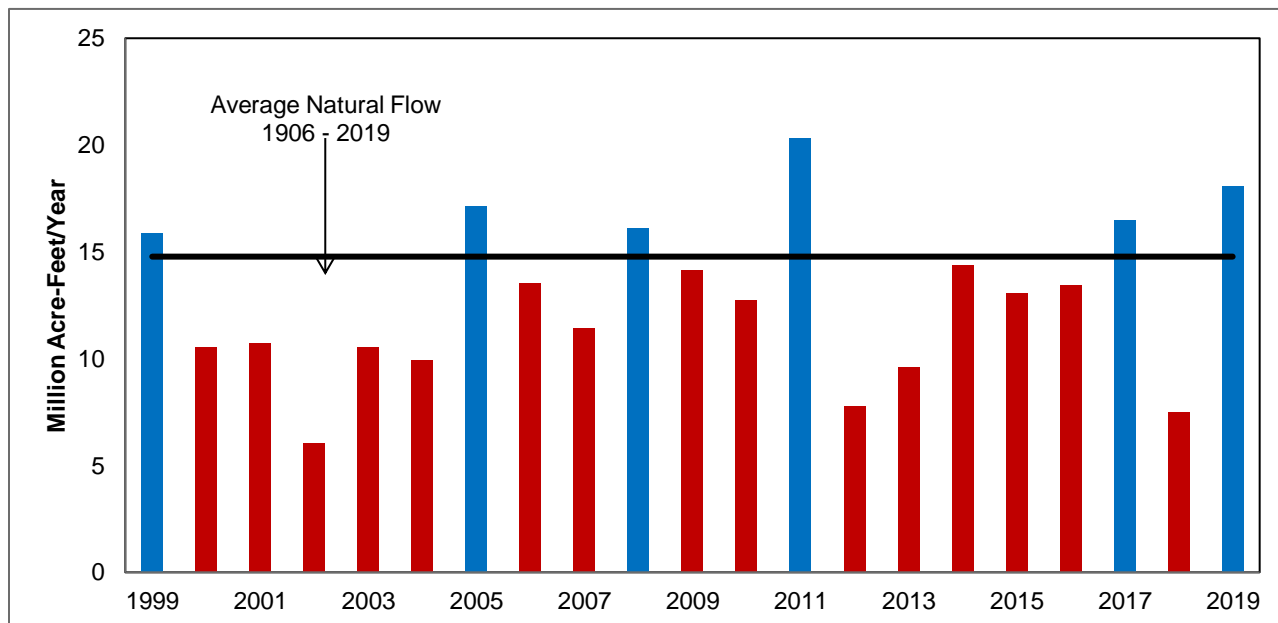
As described in Chapter 2, the SNWA and its member agencies worked to develop and implement a comprehensive Drought Plan in 2002 and 2003 as conditions in the Colorado River Basin worsened. Water management measures identified in the plan have since become permanent.

Since then, the SNWA has worked collaboratively with federal, state and municipal partners in the Colorado River Basin to implement new drought response measures designed to increase supplies, reduce demands and forestall the declaration of shortage. Likewise, the SNWA has worked to develop adaptive strategies and response efforts locally to mitigate continued impacts of drought. These initiatives are described briefly below.

Colorado River Interim Guidelines

The SNWA worked with federal, state and municipal water providers in the Colorado River Basin to develop and implement a shortage sharing agreement under the 2007 Interim Guidelines. Under current rules, the U.S. Secretary of the Interior will make a shortage declaration based on a projection of Lake Mead water levels as determined by the U.S. Bureau of Reclamation’s modeling efforts.

Figure 3.2: Colorado River inflows into Lake Powell (1999 – 2018). Since 2000, only five years have exceeded average inflows.



The forecast is reviewed annually in August to determine water supply conditions in the coming year; a shortage will be declared for the following year if the lake is forecasted to be at or below 1,075 feet elevation on January 1. The amount of Colorado River water available to the states of Nevada and Arizona will be reduced during a federally declared shortage. Nevada’s share of shortage is shown in Figure 3.3.

Modeling conducted by the U.S. Bureau of Reclamation in September 2019 indicate an approximate 4 to 43 percent probability of shortage in years 2021-2024.

Colorado River Drought Contingency Plan

In addition to the mandatory reductions defined by the Interim Guidelines, the SNWA and other Lower Colorado River Basin water users approved the Lower Basin Drought Contingency Plan Agreement (DCP) in 2019, which allows for additional voluntary contributions designed to reduce the magnitude and likelihood of continued Lake Mead water level declines and reduce risks of potential water supply interruptions for Lower Basin water users. Under the agreement, the states of Arizona, Nevada and California will make additional voluntary contributions. Like the Interim Guidelines, thresholds for voluntary contributions are based on Lake Mead water levels.

Implementation of the DCP will help to keep more water in the Colorado River for the benefit of all water users and the environment; help slow Lake Mead water level declines to preserve critical operations; and allow states to withdraw some of their contributions when Lake Mead water levels recover. Nevada’s voluntary DCP contribution ranges from 8,000 AFY to 10,000 AFY and is based on Lake Mead water levels as shown in Figure 3.3. The SNWA intends to meet its commitments under the Interim Guidelines and DCP with conservation savings and banked supplies as described in Chapter 2.

The SNWA has banked approximately two million acre-feet of water as storage credits through 2018 as part of its water banking and collaborative initiatives. Banked resources can be used flexibly to meet demands and/or offset supply reductions when

needed. Continued conservation will help to expand these stored water supplies and provide greater flexibility during times of drought

While federal, state and municipal partners are working to protect Lake Mead water levels, there is an ongoing risk that the lake could drop below 1,000 feet, a critical elevation for operations of Hoover Dam and Lower Basin water deliveries. With implementation of the DCP and other federal/international agreements, the risk of Lake Mead reaching this critical elevation has decreased substantially.

Figure 3.3: Nevada Shortage and DCP Contributions (in acre-feet)

Lake Mead Elevation (ft)	Shortage Amount (AFY)	DCP Contribution (AFY)	TOTAL (AFY)
Above 1,090	0	0	0
At or below 1,090	0	8,000	8,000
At or below 1,075	13,000	8,000	21,000
Below 1,050	17,000	8,000	25,000
At or below 1,045	17,000	10,000	27,000
Below 1,025	20,000	10,000	30,000

Adaptive Management

For nearly two decades, Southern Nevada has been preparing for and responding to drought and climate change impacts. From forging groundbreaking agreements for interstate banking and long-term resource planning to constructing massive-scale infrastructure projects and innovative conservation programming, the community has responded proactively, aggressively and in a sustained manner.

When the drought took hold in 2000, Southern Nevada was among the first Southwest communities to respond with advanced conservation measures, which have since become a permanent way of life for our desert community.

Through its adaptive management and response efforts, Southern Nevada has reduced its consumptive use of Colorado River water use by approximately 25 percent since 2002. As of 2018, Southern Nevada’s consumptive use of Colorado River supplies is 244,000 AFY. This is well below the maximum reductions prescribed under existing rules described in the preceding sections.

Long Term Planning

The SNWA revised its water resource planning approach in 2015. Since then, the SNWA has developed a series of annual planning scenarios for inclusion in its 50-year Water Resource Plan. The scenarios represent a range of future water resource needs under variable Colorado River supply and demand conditions.

These supply conditions were developed to reflect current and likely conditions in the Colorado River Basin, as well as the potential for more significant water resource shortages than are currently prescribed under existing rules. Under a stress test scenario, the plan illustrates how significant reductions in available water supply might impact the region’s long-term water resource picture, and what actions might be needed to balance supply and demand. These actions include:

- Potential changes to policy, pricing, education and incentive programs discussed in this plan to elicit an increased water conservation response.
- Accessing temporary water supplies to meet short-term gaps between supply and demand.
- Accelerating the development and/or use of future resources.

Southern Nevada’s adaptive response measures and continued conservation response will allow the community to face federally-imposed reductions and voluntary contributions as described in the preceding section without customer impacts. A sustained conservation effort is required as we work to maximize the efficiency of our community’s limited water supply and respond to ongoing drought.

Chapters 4-6 of this Plan detail the water management, conservation and education and outreach initiative managed by the SNWA to support Southern Nevada’s achievement of the community’s conservation goals. With a sustained conservation response and adaptive management efforts, Southern Nevada is well prepared to address the region’s current and future water resource needs.

Photo: Lake Mead



Photo: Water efficient landscape



Water Management Measures

The SNWA and its member agencies implement water management measures designed to promote water conservation. The following sections describe these measures and detail new initiatives and strategies developed by the organization for implementation under the 2019-2024 Plan. New additions are designed to build upon the community's prior conservation success and/or address opportunities to improve water efficiency.



Look for this symbol (on left) to learn more about new strategies being implemented by SNWA under the 2019-2024 Conservation Plan.

BEST MANAGEMENT PRACTICES

The SNWA Board of Directors and SNWA member agencies approved a Memorandum of Understanding (MOU) in 1994 regarding water conservation and efficiency programs. Amended in 1999, the MOU included 14 Best Management Practices (BMPs) for increased water efficiency in the SNWA service area.

As noted below, BMPs ranged from regulation and pricing to education and incentives:

- Water measurement/accounting system
- Incentive pricing and billing
- Water conservation/efficiency coordination
- Information/education program
- Distribution system audit program
- Customer audit/incentive program
- Commercial/industrial audit/incentive program
- Landscape audit program
- Landscape ordinances
- Landscape retrofit incentive program
- Wastewater management/recycling program
- Fixture replacement program
- Plumbing regulations
- Water shortage contingency plan

The MOU provided SNWA member agencies with the flexibility to prioritize and implement the BMPs on an individual basis, or to participate in joint programs that would cover some or all SNWA member agencies. The MOU served as a foundation for the agencies' subsequent water management,

conservation and education/outreach initiatives as further described below and in Chapters 5 and 6.

MUNICIPAL WATER MANAGEMENT

Progress towards the SNWA's water conservation goal is dependent in part upon the water management and business practices of SNWA's member agencies. Consistent with the BMPs detailed on left, water management efforts include universal metering, managing non-revenue water, implementing tiered rates and water reuse. As described briefly below, the SNWA and its member agencies will continue to use these base water management practices.

Universal Metering

SNWA member agencies fully meter all customer connections for all classes of water in accordance with AWWA standards. Metering efforts include: source-water metering; service-connection metering and reading; fixed-interval meter reading; and meter-accuracy analysis.

Photo: WaterWorks, a new exhibit at the Springs Preserve



Meter Repair and Replacement. All water purveyors participate in ongoing meter repair and replacement efforts. Small meters are subject to a planned replacement program based upon life expectancy, while large meters are regularly maintained and calibrated. Inaccurate or non-functioning meters are subject to repair or replacement.

Meter Reading and Monitoring. Meters are read monthly, and information is classified and retrievable based on customer class, meter size, land use and other relevant variables. Customer meters are monitored for consumption anomalies – such as spikes in consumption due to leaks – and this information is used to notify customers of unusual account activity.

Additionally, SNWA’s largest water purveyors (LVVWD, Henderson and North Las Vegas) have implemented automated meter reading (AMR) and/or advanced metering infrastructure (AMI) systems. These technologies eliminate the need for individual manual reads, improve meter-reading efficiency, provide higher resolution data for research and analysis, and provide customers with improved billing processes.

Incentive Pricing and Billing

While the SNWA’s member agencies set water rates independently, they use similar conservation rate principles to manage water demand. Over the years, SNWA water purveyors have compressed tier thresholds and significantly increased upper tier water rates. To maintain a strong pricing signal, the SNWA adopted the recommendation of a citizens’ committee in 2015 to promote water rates that sustain and advance conservation achievements by ensuring rates keep pace with inflation.

Conservation Rates. The SNWA’s purveyor members use incentive pricing to promote water conservation. Under an increasing block rate model, the unit price of water in each succeeding block or “tier” is charged at a higher price. In simple terms, as a customer’s water use increases, so too does the price they pay for that water. This pricing provides a financial incentive for customers to improve efficiency and eliminate water waste. The SNWA’s purveyors also implement a commodity charge, used to pay for

SNWA water system enhancements. The fee is based on water usage; higher users pay a higher proportional share. Customers are billed monthly based on metered use, and bills include consumption information (gallons of water used/billed under each tier).

While rates are an effective conservation measure, public water agencies also have an obligation to the well-being and vitality of the communities they serve. As such, the SNWA’s member agencies will consider further rate adjustments when warranted to achieve conservation goals or operational requirements, and work to ensure water pricing appropriately balances the need for conservation with economic factors.

Water Budget Surcharges. All golf courses in the SNWA service area are on an approved water budget. A surcharge is applied to golf courses that use more water than their budgeted amount. Surcharges are assessed on an annual basis in addition to the price paid for water.

Water Waste Fees. Customers are subject to fees if water waste issues are not resolved within a prescribed timeframe, or for recurring violations. The fees assessment doubles with subsequent violations.

Development Codes and Policies

The SNWA’s member agencies adopted landscape and development codes that are among the most stringent in the U.S. These include:

Landscape Watering Restrictions. All jurisdictions implement assigned watering groups that limit watering to one day/week in winter, three days/week in spring and fall, and six days/week in summer. Spray irrigation is prohibited from 11 a.m. to 7 p.m. from May – August 31.

Vehicle Washing. A positive shutoff nozzle is required for residential vehicle washing. Commercial vehicle washing is prohibited unless water is captured to the sanitary sewer, where it can be treated and reused.

Turf Provisions. Turf installation is prohibited in new residential front yards and is limited to a maximum of 50 percent of the landscape area in backyards. Except for schools and parks, the use of turf is prohibited in new non-residential development.

Mist Systems. Commercial use of mist systems is limited from May – August from 12 p.m. to 12 a.m.

Golf Course Water Budgets. Golf Courses are subject to mandatory water budgets that allow 6.3 acre-feet of water annually per irrigated acre. New courses are limited to 45 acres per 18-hole course, plus five acres for a driving range.

Water Waste. The SNWA works with its member agencies to implement ordinances and/or service rules that prohibit water waste, which includes:

- Allowing water to spray or flow off a property.
- Watering outside of assigned day(s).
- Failure to comply with landscape codes and service restrictions.
- Using sprinklers from 11 a.m. to 7 p.m. between May 1 and August 31.
- Failure to repair a malfunctioning irrigation system or supply line within 48 hours.
- Failure to discharge swimming-pool/spa drainage water into a public sanitary sewer, if available.

Water Waste Enforcement

Compliance with water waste rules is implemented by individual SNWA member agencies. Upon observance of water waste, customers are provided with notice and allowed time to correct problems; citations and fees may be issued if water waste violations are not resolved within the prescribed timeframe, or for recurring violations.

N Reduce Outdoor Irrigation

Following a comprehensive ordinance review process between the SNWA and its member agencies, the SNWA Board approved and implemented a voluntary change to summer watering restrictions in 2016 that prohibits Sunday watering. That restriction was made mandatory and permanent in 2017, limiting irrigation to six days a week during summer months. It's estimated that eliminating landscape watering on Sundays will save the community up to 900 million gallons of water per year.

N Increase Water Waste Enforcement

The SNWA is working with its member agencies to investigate opportunities to increase water waste enforcement within their respective service areas – from deploying additional labor for compliance investigations to increased outreach and messaging for seasonal watering restrictions. Other purveyors are ramping up enforcement on an individual basis.

In late 2018, the SNWA's largest water purveyor (LVVWD) released a new mobile webpage using geo-location technology, which allows users to pinpoint the address of water waste with their phone – the application records the date, time and type of waste observed, and allows users to upload photos. The form sends users a confirmation email and prompts investigation by the water service provider. The City of Henderson has a similar application, and all SNWA municipal water providers have online systems to report water waste.

Water Efficiency Standards

Plumbing Fixtures. Plumbing fixtures in new residential or commercial buildings must incorporate state and federal standards for plumbing fixtures, including water-use standards for toilets, faucets, showerheads and urinals.

N Increase Water Efficiency Standards

The Nevada State Legislature approved legislation in 2019 to increase water efficiency standards for new development. The new standards will become effective in 2020. Figure 4.1 includes a comparison of current and future standards for residential toilets, showerheads and bathroom faucets, as well as commercial urinals. Efficiency standards are presented in terms of gallons per minute (gpm) and/or gallons per flush (gpf).

Figure 4.1: Proposed local water efficiency standards

Fixture/Appliance	Current Standards*	New Standards
Toilet	1.6 gpf	1.28 gpf
Urinal	1 gpf	0.5 gpf
Showerhead	2.5 gpm	2.0 gpm
Faucets	2.2 gpm	1.5 gpm

*gallons per flush (gpf) / gallons per minute (gpm)

Water Loss Management and Prevention

All water delivery systems experience losses. In the water industry, these losses are known as non-revenue water or unaccounted-for-water. Non-revenue water losses are typically associated with leaks, variations in meter accuracy and theft. The SNWA and/or its member agencies implement several strategies to minimize water loss within the regional and municipal water distribution systems. Described below, these efforts will continue to improve accounting accuracy for and minimize loss of non-revenue water.

- SNWA’s member agencies have created and adopted Uniform Design and Construction Standards for Potable Water Distribution Systems. These detailed construction standards assure that water delivery systems meet or exceed industry standards. ^{xii}
- Efforts are ongoing in all service areas to identify and proactively replace older infrastructure deemed susceptible to leaks. For example, most cast-iron mains are being systematically replaced, as are polyethylene service connections that do not appear to be meeting longevity expectations.
- Soil testing is conducted before facility installation to identify potential distribution system threats. For example, plastic sleeves are used to prevent corrosion in areas where testing indicates soil chemistry will be destructive to copper pipes.
- Reservoirs are thoroughly inspected at regular intervals to assure integrity, and special monitoring devices detect and report leakage.
- A substantial portion of purveyor distribution lines have permanent listening devices installed that can

signal patrolling employees of leaks that fail to surface and assist in accurately determining the leak location for excavation.

- Interagency collaboration speeds leak repairs through fast-tracking line location (“call-before-you dig”) and prompt repair. The estimated system loss for each leak repaired is tracked.

N Expand Water Loss Programs

The SNWA conducted a survey among its purveyor member agencies and is developing strategies to help purveyors reduce water loss through collaboration and a new interagency water loss management group. The near-term goals of the group are to develop research projects that evaluate the savings potential of leak detection technologies, and to potentially deploy new technologies within member agency service areas to test their effectiveness and results. The SNWA’s current water loss rate is approximately one percent; SNWA water purveyor’s distribution system water loss rate is approximately five percent, both well below industry norms.

In 2019, the SNWA launched a new program to include customer incentives for leak detection devices. The organization also is looking into the feasibility of implementing a water line repair assistance program. Additionally, emerging technologies have been deployed on a trial basis through SNWA and member agency collaborations with WaterStart (see Chapter 7) to test the effectiveness of water loss management and prevention technology advancements, among other priorities; technology is implemented on a case-by-case bases based on a review of cost/benefit and overall performance.

Water Reuse

Nearly all water used indoors within the SNWA service area is recycled, either as direct or indirect reuse. Direct reuse involves capturing, treating and reusing wastewater flows for non-potable uses such as golf course and park irrigation. Indirect reuse consists of recycling water by way of treatment and

release to the Colorado River for return-flow credits (see Chapter 2). Approximately 40 percent of water deliveries in the SNWA service area results in highly-treated wastewater. Of that, 99 percent is treated and recycled for water reuse.

As shown in Figure 4.2, nearly all the highly-treated wastewater from water used indoors is recycled for direct and/or indirect reuse. This reuse of water extends SNWA resources because it can be recovered and used again until that water is fully consumed. Consumptive uses – including water used for irrigation, evaporative cooling and other uses – comprise the largest consumptive use of water in Southern Nevada. The SNWA estimates that 60 percent of water delivered in its service area is not returned for wastewater treatment.

Although the SNWA supports and promotes water conservation, both indoors and outdoors, the organization specifically targets consumptive water use. By focusing on consumptive uses, SNWA can maximize conservation gains, as well as staffing and funding resources needed to support those gains.

feasible. There are few communities within the nation that implement water reuse as aggressively or effectively as the Southern Nevada community.

Water Pressure Management

Water pressure is related to the vertical distance between the property served and the reservoir providing service. Peak water use and routine water system operations can also cause water pressure to fluctuate. The vast majority of Southern Nevada water customers operate within a pressure range of 80-85 pounds per square inch (psi). In limited instances, pressure is higher or lower. Pressure reducing valves (PRVs) are located throughout the system to manage leaks and losses caused by high pressure. Most new buildings install PRVs as well.

The SNWA and its member agencies use Supervisory Control and Data Acquisition (SCADA) systems to monitor and adjust system pressure; conduct routine PRV calibration, and dispatch distribution crews to perform repairs.

N Maximize Reuse Outside the Valley

In 2017, the SNWA adopted a policy to address water use outside the Las Vegas Valley (Appendix 2). Among other things, the policy prioritizes the return of treated wastewater to Lake Mead for return-flow credits, and implementation of reuse to achieve full beneficial use of SNWA water resources where returning treated wastewater to Lake Mead is not

Figure 4.2: Wastewater reuse

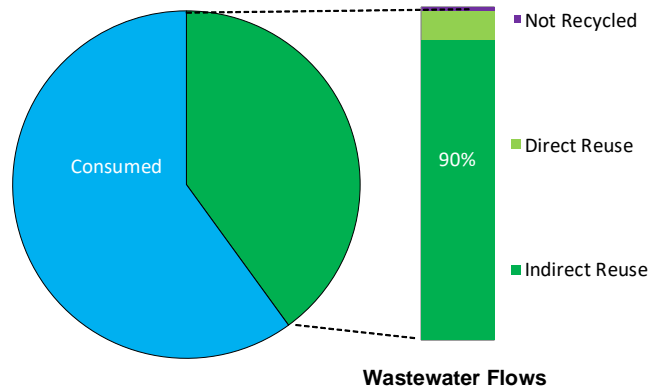


Photo: Landscape conversion



Specific Water Conservation Measure

This chapter describes specific water conservation measures that fall outside of the water management measures and education/outreach efforts described in Chapter 4 and Chapter 6, respectively. Many of the specific conservation measures detailed in this chapter rely on voluntary behaviors, product upgrades or mandatory behavior changes through enforcement of ordinances or conservation rules. These conservation measures address residential and commercial water use in Southern Nevada, as well as indoor and outdoor water uses. Estimated water savings by each specific conservation measure is provided in Appendix 3.



Reminder: Look for this symbol to learn more about new strategies being implemented by SNWA under the 2019-2024 Conservation Plan.

INCENTIVE PROGRAMS

The SNWA has developed an extensive suite of tools to help customers in its service area improve water efficiency and reduce water waste. Below is a description of incentive programs the SNWA plans to offer over the five-year planning horizon.

WSL Landscape Rebate Program

The Water Smart Landscapes Rebate Program (WSL) offers financial incentives to residential and commercial customers in the SNWA service area that replace water-thirsty lawns with water-efficient landscaping. Since the majority of Southern Nevada's water is used outdoors on landscaping, the WSL program targets the largest consumptive use of water as a top priority.

Increased in 2018, the current rebate amount is \$3.00 per square foot of grass removed and replaced with desert landscaping, up to 10,000 square feet, and \$1.50 per square foot thereafter. The maximum annual award for any property is \$500,000. To sustain results, participants must grant a conservation easement that promises the project will be sustained in perpetuity.

The WSL program is projected to remain a major demand-reduction tool as the community works to achieve its conservation goal. In addition to the financial incentives, the SNWA offers many free planning tools and resources to help residents and

Photo: Water Smart Landscape after conversion. More than 60,500 projects have been completed under SNWA's WSL program since 1999.



businesses prepare for their turf conversion.

- An online plant list that includes more than 500 trees, shrubs, groundcovers and other desert-adapted plants suitable for desert environments.
- An online plant search database that includes plant photos and characteristics (such as water and maintenance needs).
- Tools for landscape design, including a needs assessment, step-by-step design worksheet and design planning tips.
- Sample landscape designs with suggested plant selections, layouts and tips for success.
- Free landscaping and irrigation design classes offered by SNWA experts.
- Online and print resources for: qualified landscape contractors; installing/maintaining; managing pests; installing and maintaining drip irrigation; and setting irrigation controllers.

N Boost Participation in WSL

The SNWA's Water Smart Landscapes Program has been highly-effective in reducing outdoor consumptive water use. Since program inception in 1999, residents and businesses have completed more than 60,500 conversions, resulting in the removal of nearly 190 million square feet of turf.

Increased Incentive Amount. The SNWA monitors participation in its incentive programs and has made adjustments to maintain public interest and participation over time. The SNWA increased the WSL program incentive amount in 2018 due to

plateauing annual enrollment and has experienced a significant rise in interest and applications since. SNWA will continue to monitor program results and support applicants through the conversion process.

Targeted Outreach. Since 2015, more than 4,400 customers began the application process but did not complete a conversion through the SNWA's WSL program. The SNWA began targeted outreach to these customers in 2018 to promote completion of the application and conversion process. The SNWA will monitor the effectiveness of its targeted outreach efforts and continue to employ these or similar outreach strategies if efforts are effective in drawing WSL program enrollment and project completion.

N Target Median/Streetscape Turf Removal

Turf has long been a popular landscaping choice for medians, traffic circles and streetscapes. These applications of turf, however, drain our community's water resources and provide no functional value for our residents. Grass requires more than four times more water than desert-adapted landscapes. SNWA estimates there is approximately 5,000 acres of non-functional turf left within the service area. The replacement of non-functional turf, particularly in streetscapes and medians, is a high priority for the SNWA and the community, since these applications provide no practical benefit.

The SNWA does not anticipate removing all turf within the region, but rather seeks to encourage the use of turf in only those applications where it is functional, or regularly utilized.

Image: WSL program facts. The program has saved more than 119 billion gallons.



The SNWA is developing tactics to reduce non-functional median and streetscape turf, and to limit new turf installations to functional applications such as sporting and recreational fields at schools and parks. While current building codes restrict turf installation for new development, many projects were authorized under prior rules and additional outreach is required.

The SNWA continues to develop its tactics for this program goal but has begun targeted outreach to homeowner associations and other commercial customers that have entry, sidewalk or median turf. Targeted outreach is a high priority and the SNWA is investing significant time and effort to set up and conduct tailored meetings and/or formal presentations that include individualized information about potential water and cost savings to these customers. Additional strategies to reduce and replace median and streetscape turf are currently being evaluated and/or are under development.

N Replace Cool Season Grasses

The SNWA expanded WSL provisions in 2018 to allow for schools and parks to replace cool-season grass with warm-season varieties. Replacing cool-season grasses (such as bluegrass, fescue and ryegrass) with warm season varieties (such as Bermudagrass or seashore Paspalum) in functional play areas can significantly reduce irrigation water use. Warm season grasses are known to thrive in warmer climates and are durable for high-traffic play.

To support this effort, the SNWA conducted a basic assessment to determine the number of eligible parcels and program potential. The SNWA will monitor water savings to determine if ongoing implementation or program expansion is warranted.

Water Efficient Technologies Rebate Program

The SNWA's Water Efficient Technologies (WET) program offers financial incentives to commercial and multi-family property owners that install water-efficient devices. Consumptive-use technologies earn



Photo: Streetscape turf. Replacing turf along streets and in medians will improve water efficiency and reduce water waste.

a one-time payment of \$45 per 1,000 gallons conserved annually or up to 50 percent of the product purchase price, whichever is less. Non-consumptive use technologies earn a one-time payment of \$15 per 1,000 gallons conserved annually or up to 50 percent of the product purchase price, whichever is less. The rebate amount excludes labor and installation costs.

Businesses can work directly with the SNWA to implement custom technology that meets their needs or select pre-approved water saving technologies with predictable savings and a defined monetary incentive for technology improvements.

Some of the pre-approved technologies include:

- High-efficiency toilet retrofits
- Efficient showerhead retrofits
- Waterless and high-efficiency urinal retrofits
- Conversion of sports fields to artificial surfaces
- Retrofits of standard cooling towers with qualifying, high-efficiency drift elimination technologies



Boost Participation in WET Program

Like the SNWA's WSL program, WET works to reduce consumptive and non-consumptive water use. More than 300 WET projects have been completed at commercial properties since program inception. The following new strategies are being employed under the 2019-2024 Plan to achieve continued conservation gains, increase program participation and/or expand offerings.

Increase Incentive Amount. In 2018, the SNWA increased the WET incentive amount to achieve continued conservation gains and increase program participation. Likewise, the SNWA removed the maximum annual rebate amount for schools and parks to further incentivize their participation in the program, and to obtain data that can help to inform potential program changes in the future.

Support Athletic Field Conversions/Park Conversions
As noted above, the SNWA removed the maximum annual rebate amount under WET for schools and parks in 2018. Schools and parks represent a significant opportunity for turf conversions since athletic fields are only in use seasonally and/or large portions of turf in many parks is not utilized for recreation and play.

The SNWA began investigating the feasibility of offering an increased incentive to schools within the Clark County School District (CCSD) for the conversion of high school football fields from grass to artificial turf. A typical field includes 94,000 square feet of play area and a single field conversion could yield a seven-million-gallon annual water savings. Benefits include water savings, operational cost savings for schools from reduced water/maintenance fees, and year-round aesthetic appeal. The SNWA will work with CCSD to identify candidate schools, implement conversions and monitor results to gauge effectiveness of this conservation measure.

Likewise, the SNWA began investigating opportunities for the conversion of underutilized park turf to more water-efficient surfaces such as sport court hardscapes and skate parks; splash pads

with recovery and reuse systems; playground and picnic areas; and more efficient turf grasses or ground covers at recreational facilities. Anticipated benefits include improved quality of life, higher utilization of play areas, and cost and water savings. The SNWA will work with park managers to identify candidate parks, implement conversions and gauge the effectiveness of this conservation measure.

Partner to Test New Technologies. Through collaborations with WaterStart (see Chapter 7), the SNWA is testing the effectiveness of new water saving technologies. Based on the results of pilot programs, the SNWA may add technology options to its list of pre-approved technologies or share program results with the businesses community as an opportunity under the WET program.

Conduct Targeted Outreach. Outreach efforts to businesses include letters and/or formal presentations that present individualized information about potential water and cost savings under the new WET incentive amounts. The SNWA will monitor the effectiveness of its targeted outreach efforts and continue to employ these or similar outreach strategies if efforts are effective in drawing WET program participation.

Coupons and Rebates

The SNWA offers a variety of instant coupons and rebates for single-family, residential property owners. The programs contribute to water use reductions within the community and offer customers easy access to water efficiency tools while minimizing the SNWA's program time and management costs.

Water Smart Car Wash Coupons. As of 2018, coupons are available from 17 partners for use at 39 valley-wide locations. The SNWA's Water Smart Car Wash partners recycle water used on-site or send it to a water treatment facility, where water is treated and returned to Lake Mead for reuse.

Smart Irrigation Controller Rebates.

As of 2018, rebates are available for the purchase of 25 qualifying products. Smart controllers can improve water efficiency by helping homeowners

automatically adjust their watering schedule according to weather and plant demands. Customers can save up to \$100 or 50 percent off the price of a smart controller, whichever is less. For commercial properties and HOAs, the SNWA's rebate pays up to \$40 per valve or 50 percent off the product costs for smart controllers.

Pool Cover Rebates. An exposed pool can lose approximately 50 gallons of water per square foot to evaporation annually. Pool cover rebates are available for use at eight valley-wide retailers. The SNWA's rebate pays up to \$50 for the purchase of a temporary pool cover or 50 percent off the purchase price, whichever is less. For permanent, mechanical pool covers, the SNWA pays up to \$200 or 50 percent off the purchase price, whichever is less.

N Offer Rebates for Leak Detection

Water Leak Detection Rebates. New to the program as of 2019, the rebate pays up to \$200 for the purchase of a leak detection unit or 50 percent, whichever is less. The unit monitors water flow and pressure going into the home and can provide early warning of potential problems.

Other Resources

The SNWA offers several resources to help residential water users become more efficient, both inside and outside the home. From how-to leak detection videos to indoor water saving tips, online resources provide customers with information on new high-efficiency products as ways to maximize the water savings. Other offerings include:

Indoor Water Audit Kits. The SNWA provides free indoor kits for residential customers located within the SNWA's member agency service area. Kits include a kitchen faucet fixture, bathroom sink aerators, a water flow testing bag, leak detection tablets, thread-sealing Teflon tape and a water-efficient shower head.

Water Use Estimator. This free online tool helps customers calculate their water footprint based on the size of their home, number of occupants, existing appliances and outdoor landscaping. The water use estimator projects water usage by month and provides customized tips for reducing indoor and outdoor water use.

Photo: Pool cover. An exposed pool can lose more than 50 inches of water per year to evaporation.



Demonstration Gardens. The SNWA and its member agencies operate, support and/or promote several desert demonstration gardens throughout the Las Vegas Valley, and support the development of smaller demonstration projects.

Likewise, the SNWA promotes the Springs Preserve's demonstrative gardens, its water-efficient landscaping, and its classes by master gardeners and horticulturists. Regular programming (that is free to the public) includes irrigation system maintenance and drip irrigation basics.

N Offer Site Appraisals to High Water Users

The SNWA has designed a new program for single-family residential properties. Select high water-use customers will be invited to participate in an on-site appraisal, based on their water use history. The review will include an audit of indoor plumbing and appliances, and outdoor water uses. The goal of the program is to help single-family residential customers with unusually high water use to identify conservation opportunities and implement solutions.

SNWA staff will provide information on irrigation controller management, as well as information on SNWA rebates, incentives and other programs designed to help customers save water and money. The program launched in 2019 and will be evaluated for continued implementation based on program results.

As part of the appraisal, multi-family and commercial properties receive a water use analysis based on their landscape area and five years of water use history. The results help property owners/managers identify opportunities to reduce landscape overwatering.



Photo: Outreach. SNWA's Conservation Team launched a new program in 2019 to offer site appraisals to select customers.

Public Education and Outreach

In addition to its water management and incentive programs, the SNWA continues to maintain education and public outreach programs designed to keep residents and businesses informed of current conditions and encourage ongoing conservation. Education and outreach efforts are extensive and are described briefly below.

ADVERTISING, PUBLICATIONS & MEDIA

The SNWA executes a comprehensive campaign of television, print and radio ads designed to educate the community on the value of water, need for conservation, and specific programs.

The SNWA's current ethics campaign focuses on the value of water. Key messages for the campaign are 'every drop makes a difference in our community' and 'every drop counts.' The agency's compliance campaign focuses on compliance with seasonal watering restrictions, including no watering on Sunday. A new compliance campaign launched in early 2019. The campaign emphasizes that irrigation restrictions are mandatory. Campaign materials can be found in paid advertising (television, print and radio), as well as online at SNWA.com and on social media outlets.

Direct Mail. In coordination with its member agencies, the SNWA distributes bill inserts that contain useful information and conservation tips. Bills provide easy-to-read information about assigned watering days and comparative water use information/graphics that help customers identify possible problems.

Additionally, the SNWA distributes a Landscape Watering Schedule and Water-Smart Living to residential water customers throughout the Las Vegas Valley. The latter is a tri-annual publication mailed to more than 700,000 single and multi-family homes in Southern Nevada. It includes drought updates, information on conservation programs and incentives, and tips for landscape care and water efficiency.

Interactive Website. The award-winning snwa.com features videos, infographics, multimedia demonstrations and other features to help residents and businesses save water. Customers can find their watering group, submit a water waste report, sign up for rebate programs, print coupons, and calculate potential water savings of converting grass to water-smart landscaping. A plant list, sample landscape designs and other landscape resources discussed in this plan also are available.

Water Ways. This monthly television program airs daily on local government cable channels and includes information on current water supply conditions and water conservation topics.

Videos and Multimedia. Instructional videos are available free of charge at snwa.com and youtube.com. They feature how-to multimedia demonstrations that aid customers with finding and fixing leaks, converting grass to water-efficient landscape, setting irrigation clocks, and other topics.

Photo: SNWA advertising campaign. Recent campaigns have focused on humor to attract and hold audience attention.



Social Media. The SNWA has an active online presence, engaging customers through Facebook, Twitter and other social media platforms daily. Followers receive conservation tips, weather-related landscaping information and how-to photos and videos.

Education, Engagement and Support

WaterSmart Innovations. The SNWA hosts an international peer-to-peer conference annually that allows attendees to obtain the most current information about water efficiency concepts in urban environments, as well as water conservation education. Since its inception in 2008, the program has featured more than 1,000 professional sessions, panel discussions, and pre-conference workshops. More than 8,300 attendees and 550 exhibitors have attended.

Youth Education. The SNWA's youth education program provides training and materials to teachers so they can help students learn about our region's unique water resource issues.

- Desert Discovery is published twice annually and features articles and activities about desert conservation and water resources. Newsletters are available for grades K-2 and 3-5. It is distributed free of charge to about 250 local public and private elementary schools. The newsletters are accompanied by a teacher's edition.
- The SNWA established a Youth Advisory Council comprised of local high school students who have been appointed by their principals based on academic and leadership skills, as well as an interest in environmental issues. The council provides a forum for local youth to research water-related issues and suggest fresh ideas to the SNWA Board of Directors.
- The SNWA mascot, Deputy Drip, makes free presentations to schools upon request. Designed for students in kindergarten through second grade, the interactive presentation teaches students about the value of water conservation.

School Grants. The Water Conservation Education Grant Program is a partnership with educational

organizations in the SNWA service area that encourages resource stewardship. Eligible projects may receive grants up to 50 percent of project costs, up to a maximum of \$5,000.

Other. Public educational and outreach activities focus on the SNWA's incentive programs and may include technical classes, speaking engagements, and community events.

Conservation Helpline. The Conservation Helpline (702-258-SAVE) serves as a point of contact for residents interested in available incentive programs and to request various education and literature resources.

Photo: 2018 Water Smart Innovations Conference



PARTNERSHIPS & COLLABORATIONS

Community Partnerships

Water Smart Home. Developed by the SNWA and the Southern Nevada Home Builders Association, the Water Smart Home (WSH) program promotes water efficiency, requiring homes built through the program to include water-smart landscaping and water-efficient appliances.

Homes built in the WSH program adhere to stringent water use efficiency requirements. WSH builders

must utilize high-efficiency toilets, dishwashers and washing machines, efficient faucets and showerheads, and install water-efficient landscaping, low volume irrigation and efficient hot water delivery systems. Water Smart Homes use approximately 49 percent less water than homes built between 1990 and 2003.

Water Smart Contractor. The SNWA offers a Water Smart Contractor program. Companies participating in the program ensure their staff members are trained in water-efficiency practices through free, SNWA-sponsored workshops. In turn, SNWA features these companies in its Find a Landscaper application.

Contractors must complete at least eight hours of SNWA water-efficiency training, comply with business standards, maintain good standing with the Nevada State Contractors Board, and be licensed and insured. Training provided includes a detailed overview of the SNWA’s programs, xeric principles, efficient irrigation design and scheduling. Annual refresher training is required.

Water Conservation Coalition. This public-private partnership was formed by community leaders to help increase water-efficient practices within the Southern Nevada business community and to promote community-wide water conservation. Through initiatives such as its speakers bureau, Business-to-Business Challenge and various public projects, the Coalition works closely with the SNWA to identify areas of conservation that are most beneficial to local businesses and the community’s overall water conservation goal.

Water Upon Request. The SNWA, Water Conservation Coalition and Nevada Restaurant Association partnered to create the Water Upon Request program for restaurants. Partners agree to serve water only when patrons request it. Every glass not served saves up to 1.5 to 3 gallons of water.

WaterStart. The SNWA is a WaterStart partner. Formerly known as the Nevada Center for Excellence, WaterStart formed in 2013 as a partnership between public and private sectors to foster economic growth in the water industry (see also Chapter 7).

The SNWA has participated in several pilot projects designed to improve leak monitoring and notification, pressure surge monitoring and flow meter/pump flow efficiency. After successful testing, new technologies have been adopted/deployed within SNWA service area and/or within member agency distribution systems.

N Conduct Targeted Outreach

As noted in Chapter 5 and detailed in Figure 6.1, The SNWA began to ramp up its targeted outreach efforts in late 2018 to promote conservation programs with the largest water-saving potential for various customers/customer classes. The table below summarizes past and planned efforts.

Figure 6.1: Outreach initiatives

Targeted Outreach Initiative	2018 (Complete)	2019 (Planned)
Reengage customers that enrolled in WSL but did not complete conversion.	2,600	1,800
Promote WSL to customers with landscapes suitable for conversion.	20,000	36,000
Meet with HOAs to promote WSL and benefits.	18	36
Watering schedule reminders to customers based on meter usage data (LVVWD).	16,000	Based on meter data.
Watering schedule reminders (general).	332,000	All service areas.
Promote Pool Cover rebate to pool owners.	N/A	100,000
Offer site appraisal to high water users to promote efficiency and program enrollments.	N/A	1,000 per month.



400

waterSMART
300

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WATER MANAGEMENT INC.
Contract #GS-21F-0038T

Executive Order 13423:
In FY 2008, reduce water consumption 1 percent annually through the end of fiscal year 2010 and 16 percent by the end of fiscal year 2015.

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Research Initiatives

The SNWA has a long history of conducting conservation research and collaborating with other organizations to advance knowledge and water efficiency. The SNWA's Conservation Division provides full-time support for research and analytical services. In addition to supporting and tracking Conservation Plan implementation and conducting customer use analyses, the team helps evaluate new techniques/technologies that hold promise for water savings and efficiency, particularly related to consumptive water uses

Past research efforts were largely focused on irrigation efficiency. For example, the SNWA's best-known research initiative was the Xeriscape Conversion Study. To date, the study represents the largest and most comprehensive study on the water demand influence of landscape style on water demand. As detailed below, the Division's research focus has expanded over time as various SNWA conservation programs and initiatives have matured.

TECHNOLOGY RESEARCH

New and expanding technologies represent a growing tool for conservation and efficiency enhancements. The following describes the SNWA's current areas of exploration.

Cooling Technology

While landscaping remains the principal consumptive use of water in the Las Vegas Valley, commercial cooling represents another major consumptive demand. Although the SNWA has long supported cooling efficiency programs, the organization recognized a need for more comprehensive technical information.

The Alliance for Water Efficiency (AWE) works to explore the potential for water conservation in urban areas. As a member of the organization, SNWA is leading a bi-national study to gain foundational knowledge needed to support greater efficiency in cooling systems. The results of the study are expected to expand existing knowledge for AWE members and the SNWA hopes to use information

gained to support development of effective, targeted and appealing incentive and outreach programs related to cooling. The initial research phase aims to:

- Develop best practices for identifying water-cooled facilities in urban areas.
- Develop best practices for estimating consumptive and non-consumptive water demands for cooling.
- Determine the conservation potential for various improvements to traditional cooling technologies such as cooling towers.
- Determine the conservation potential of alternative cooling technologies.
- Develop practical guides, incorporating study results, to increase the effectiveness of cooling incentive and outreach programs.

Image: Commercial cooling tower



Nine AWE members from the U.S. and Canada have made monetary, data and informational commitments to support this effort. Current study participants include:

- Southern Nevada Water Authority (Lead Agency)
- City of Guelph (Canada)
- Metropolitan Water District of Southern California
- San Antonio Water System
- City of Tucson
- City of Santa Fe
- Santa Clara Valley Water District
- California Water Service
- Denver Water

Smart Leak Detection

Smart leak detectors are a new class of smart consumer devices that have recently emerged in the marketplace. The technology is designed to monitor water use 24/7 and provide real-time information to their owners via smartphones. The SNWA is evaluating the technology under a new program to determine the potential smart leak detectors have to reduce water demand in residential households, as well as to reduce or avert major leak events and modify consumer water use behavior through engagement.

Remote Sensing

The SNWA has developed methodologies to identify irrigated turf using remote sensing technology. The data derived from this process allows the SNWA to monitor annual progress in the reduction of high-water demand landscaping. The data has also been used to improve the effectiveness of program marketing by allowing the SNWA to specifically target property owners who have a significant amount of ornamental turf on their properties.

Automatic/Advanced Meter Reading

Understanding the dynamics of customer water demand through higher frequency data is a growing opportunity as the SNWA's member agencies

increase the use of Automatic Meter Reading and Advanced Metering Infrastructure. The SNWA is developing methods to utilize data to provide more insight into how and why residents use water, and subsequently develop customer engagement strategies.

EMERGING TECHNOLOGIES RESEARCH

The SNWA collaborates with the business sector to evaluate and boost adoption of new water efficiency technologies. These efforts include:

WaterStart. The SNWA is a member agency of WaterStart, formed as a Governor's Office of Economic Development initiative. WaterStart works to identify technology needs of its partners, recruit companies with novel solutions, and provide expertise and funding to test and demonstrate the variability of emerging technology products. The organization aims to help scale effective solutions, faster.

The SNWA supports WaterStart by evaluating proposals and conducting evaluations of promising new technologies. The SNWA and LVVWD have both participated in several innovation projects to pilot new technology. The following technology innovations have been deployed by the SNWA and/or the LVVWD permanently based on the value and success of pilot studies:

- Leak monitoring and real-time notification (Echologics and APANA)
- Pressure surge monitor and analyzer/leak detection (Syrinix)
- Flow meter/pump flow efficiency (Riventa)

Innovative Conservation Program. The SNWA previously partnered with the Metropolitan Water District of Southern California's Innovative Conservation Program. The program objective is to evaluate the water savings potential and reliability of innovative water savings devices, technologies and strategies. More than a dozen projects have been completed under the program since inception. SNWA continues to look for cost-effective opportunities to evaluate new technology.

WaterSmart Innovations. Since 2008, the SNWA has hosted the world's largest water efficiency conference and trade show. The event structure facilitates collaboration and exchange between the private and public sector. In 2018, more than 50 trade show vendors participated to showcase water-efficiency products, programs or other conservation and outreach initiatives.

OTHER RESEARCH INITIATIVES

Below is a brief summary of other related initiatives SNWA is involved in as of 2019.

National and International Code, Standards and Rating Systems Development

As a world leader in water efficiency, the SNWA has consistently engaged in the development of codes, policies and standards for water efficient devices, programs and rating systems. The SNWA will continue this work throughout the 5-year planning period.

Collaborative Research Subscriptions

The SNWA frequently provides technical and financial support to national and international initiatives relating to water efficiency. As of the release of this Plan, the SNWA is a partner to multi-agency projects studying the savings of landscape transformation, case studies in drought response measures, and technologies and practices for evaporative cooling system management.

Ongoing Program Evaluation

The SNWA's Conservation Division conducts frequent evaluations of existing programs. For example, SNWA monitors the cost of clients' landscape projects to ensure rebate incentives remain meaningful, and conducts analyses of customer response to program outreach efforts. These types of program support research and will continue throughout the duration of this Plan.

Photo: Landscape conversion at Griffith Elementary School



Plan Implementation & Schedule

PROGRAM STAFFING

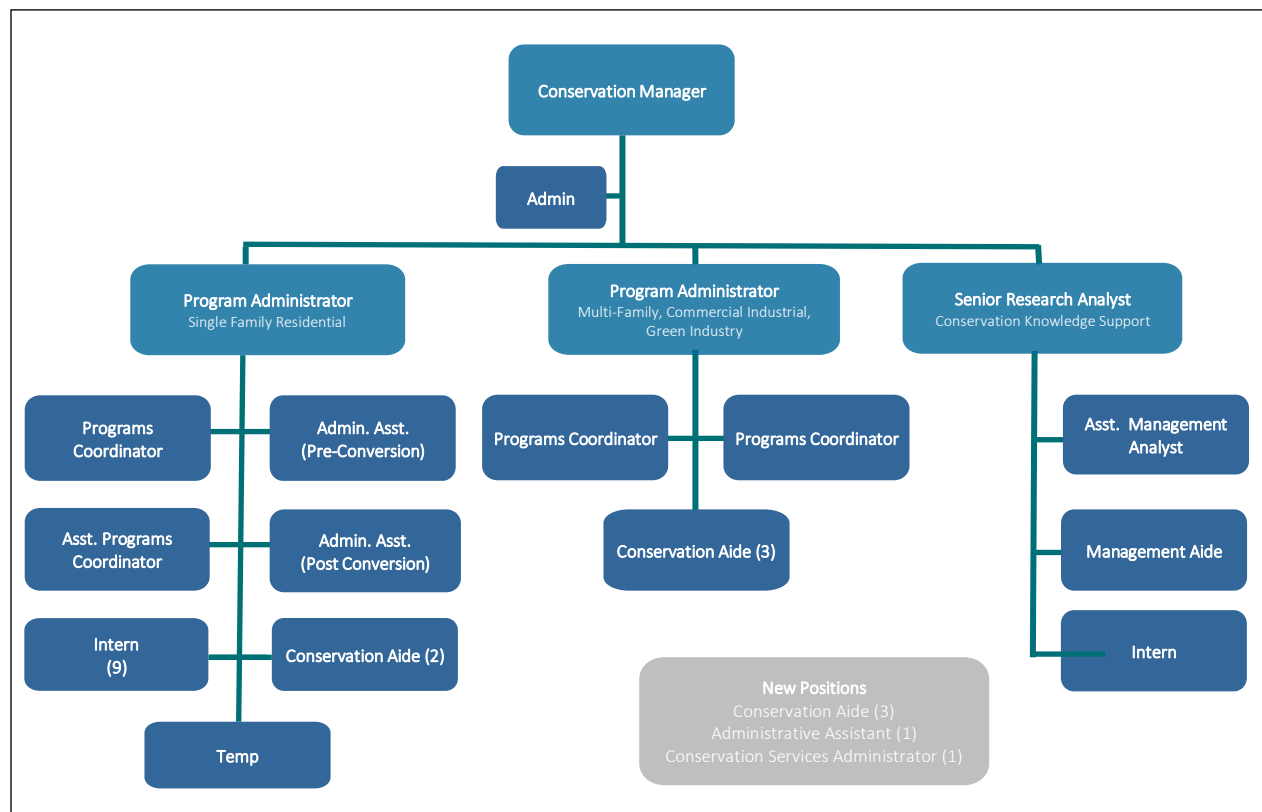
The SNWA's Conservation Division falls under SNWA's Water Resources Department. The division is led by a Conservation Manager and is supported by a team of knowledgeable conservation and program experts. As of late 2018, the division consisted of 18 full-time employees (Figure 8.1). Core staffing is augmented by interns and/or limited-term employees to support outreach, water waste enforcement and other conservation program initiatives. Likewise, the SNWA Board approved several new positions for Fiscal Year 2019/2020.

The Conservation Division is responsible for formulating and implementing the SNWA's Water Conservation Plan; developing new programs and administering existing programs as described; tracking and evaluating program progress; and making recommendations for program changes based on ongoing reviews of program performance.

Likewise, the team provides regional coordination on conservation issues and programs, with dedicated technical assistance to its member agencies. Each SNWA member agency has an appointed conservation coordinator. The SNWA also has established management and technical workgroups comprised of member agency participants that meet monthly to discuss and coordinate efforts. Discussions include ongoing implementation and maintenance of water efficiency programs and standards across jurisdictions.

Other SNWA workgroups within the organization provide support to: development and implementation of advertising, publications and media; education, engagement and support activities; partnerships and collaboration; and water waste enforcement efforts.

Figure 8.1: Conservation Division organizational chart



IMPLEMENTATION SCHEDULE

The SNWA offers conservation programs to residential and non-residential customers, targeting both consumptive and non-consumptive water uses. Consumptive water uses typically related to outdoor landscaping and non-consumptive uses are typically related to indoor uses.

As shown in Figure 8.2, existing programs are planned for continued implementation over the 5-year planning horizon. New strategies are

anticipated for launch in the 2018/2019 timeframe. These will be monitored for overall performance and results. Based on ongoing assessment of conservation gains, implementation cost and other factors, the SNWA will make decisions about continued implementation, modifications or discontinuation.

Testing new strategies and tactics helps the SNWA to determine which efforts are most effective at reducing water demands.

Figure 8.2: Plan implementation schedule

PROGRAM	CUSTOMER TYPE		WATER USE TYPE		MEASURE		5-YEAR SCHEDULE (2019-2023)				
	Residential	Non-	Indoor	Outdoor	Existing	New*	1	2	3	4	5
		Residential									
INCENTIVES											
Water Smart Landscapes	x	x		x	x						
<i>Increase incentive amount (2018)</i>						x					
<i>Targeted outreach to program dropouts</i>						x	..				
<i>Targeted streetscape turf removal</i>						x	..				
<i>Cool Season-Turf Incentive</i>		x				x					
Water Efficient Technologies		x	x	x	x						
<i>Increased incentive amount (2018)</i>						x					
<i>Removed annual cap for parks/schools</i>						x	..				
<i>Partner to test new technologies</i>						x	..				
REBATES											
Car Wash Coupons	x	x		x	x						
Smart Irrigation Controller	x	x		x	x						
Pool Cover	x			x	x						
Water Leak Detection	x	x	x	x		x	..				
RETROFITS AND AUDITS											
Indoor Retrofit	x		x		x						
Targeted Audits for SFR Turf Customers	x		x	x		x	..				
WATER MANAGEMENT MEASURES											
Universal Metering	x	x	x	x	x						
Incentive Pricing and Billing	x	x	x	x	x						
Development Codes and Policies	x	x	x	x		x					
<i>Landscape Watering Restrictions</i>											
<i>Lawn installation</i>											
<i>Mist systems</i>											
<i>Golf Course Water Budgets</i>											
<i>Fountains/Ornamental Water Features</i>											
<i>Water waste</i>											
Water Waste Enforcement	x	x		x	x						
Water Efficiency Standards	x	x	x	x	x	x					
<i>Water audit/loss prevention committee</i>						x					
Water Loss and Prevention	x	x	x	x	x						
<i>Enhanced new development codes</i>						x					
Water Reuse and Recycling	x	x	x	x	x	x					
<i>Out-of-Valley Reuse Policy</i>						x					

Figure 8.2 (Cont.): Plan implementation schedule

PROGRAM	CUSTOMER TYPE		WATER USE TYPE		MEASURE		5-YEAR SCHEDULE (2019-2023)				
	Residential	Non-Residential	Indoor	Outdoor	Existing	New*	1	2	3	4	5
EDUCATION AND OUTREACH											
Classes, Speaking Engagements & Events	x	x	x	x	x						
Demonstration Gardens/School Grants	x	x		x	x						
Publications and Media	x	x	x	x	x						
Conservation Helpline	x	x	x	x	x						
Youth Education			x	x	x						
PARTNERSHIPS AND COLLABORATION											
Water Smart Home	x		x	x	x						
Water Smart Contractor	x	x	x	x	x						
Water Conservation Coalition	x	x	x	x	x						
Water Upon Request	x	x	x		x						
Water Start Partner	x	x	x	x	x	x					
WaterSmart Innovation	x	x	x	x	x						

(*) New to the 2019-2024 Plan.
 (..) Based on performance monitoring.

PLAN FORMULATION

The SNWA conducted a conservation strategic planning exercise in mid-2018 to identify opportunities to generate additional conservation and water efficiency savings. More than 70 measures and/or tactics were discussed and organized into six key strategic arenas:

- Engaging our Community
- Transforming Demand
- Building a Smarter Community
- Curtailing Waste and Losses
- Advancing Knowledge
- Valuing Water Appropriately

Conservation measures/tactics were evaluated on a weighted scale based on a number of factors including: overall conservation potential, public acceptance, regulatory difficulty, cost and other factors. The team considered both new initiatives and existing program enhancements. The team used this exercise as a basis for selecting new programs and/or program enhancements discussed in this Plan.

PLAN MAINTENANCE AND EVALUATION

The SNWA updates its conservation plan every 5-years as required and conducts assessment and maintenance of its program offerings on an ongoing basis.

Evaluation is an important tool that helps to inform the organization’s staff and financial investments. The SNWA tracks incentive/rebate program enrollment and participation on a weekly, monthly and annual basis. Metrics evaluated by program type include: number of inquiries, projects completed, gallons of water saved, and expenditures by program type.

Program performance trends are used to identify which programs have the largest impact on reducing water demands, and which programs are drawing the highest levels of public interest/participation. Likewise, evaluation helps guide and inform public education and outreach efforts, as well as potential changes to program incentive amounts, staffing needs, and program funding.

In recent years, these metrics have identified areas of diminishing returns. As a result, the SNWA has made several changes to programs (most notably to WSL and WET) to help maintain and boost participation levels, and associated water conservation gains.

As noted in this Plan, the SNWA also monitors and tests new water-saving technology within its distribution system, monitors advancements in plumbing fixtures and appliances, and actively seeks out opportunities to advance and employ new strategies. The programs, strategies and results discussed in this Plan are evidence of the SNWA's ongoing commitment to helping the Southern Nevada community improve water efficiency and achieve its conservation goals. The next Plan update is scheduled for August of 2024.

Reporting

The SNWA reports information on conservation achievements to its Board of Directors and proposes program funding as part of its annual budget process. Likewise, information on drought, water resources and/or water conservation are typically standing items on the Board's regular meeting agenda. A summary of past performance and program benchmarks for 2019-2023 is provided in Appendix 3.

Appendix 1

MUNICIPAL WATER WASTE ORDINANCES

Water waste ordinance, building codes and other water management measures described in this plan are implemented by the SNWA's member agencies.

Boulder City

- Section 9-8-17

Clark County

- Chapter 24. 30
- Chapter 24.34
- Title 30
- Las Vegas Valley Water District Service Rules

City of Henderson

- Section 14.14.020
- Chapter 14.14

City of Las Vegas

- Section 14.08
- Section 14.08.040
- Section 14.11
- Las Vegas Valley Water District Service Rules

City of North Las Vegas

- Section 13.08.040
- Section 13.08.030
- Section 13.08

Appendix 2

POLICY REGARDING OUT-OF-VALLEY WATER USE

Managing Southern Nevada’s water resources responsibly is critical to the continued vitality of the region. The ongoing risk of supply reductions underscores the need for responsible and sustainable management of Southern Nevada Water Authority (SNWA) water resources. This policy is designed to maximize the productivity of all SNWA water resources. To provide for the long-term sustainable development of resources and reduce demand impacts to Colorado River resources, the SNWA Board of Directors agrees to support the following principles for the use of Colorado River water and other SNWA water resources outside areas that are currently served by SNWA members’ wastewater systems.

- Adoption of service rules and development codes by SNWS Purveyor Members that rely on industry best practices to minimize consumptive use of water resources.
- Returning treated wastewater to Lake Mead to receive return-flow credits should be accomplished whenever feasible.
- If returning treated wastewater to Lake Mead is not feasible, Colorado River water and other SNWA water resources should be reused either through direct or indirect reuse to achieve full beneficial use of recycled water similar to existing practices within the Las Vegas Valley.
- Wastewater will be treated to levels sufficient to allow the water to be reused.
- Implementation of localized, beneficial direct reuse within the development area for industrial and commercial uses, and school and community parks where feasible should displace the need for SNWA water resources.
- Implementation of aquifer storage and recovery programs, where possible.
- Limitation on the use of evaporative coolers.

Introduced and passed by SNWA Board of Directors on May 18, 2017.

Appendix 3

SUMMARY OF PAST PERFORMANCE AND ESTIMATED WATER SAVINGS/PROGRAM BENCHMARKS FOR 2019-2023 PLAN BY SPECIFIC CONSERVATION MEASURE.

Figure A-1 includes a summary of historical SNWA water use and progress towards the SNWA’s conservation goal. The pages that follow include a series of tables that provide a summary of past performance by Specific Conservation Measures as detailed in Chapter 5.

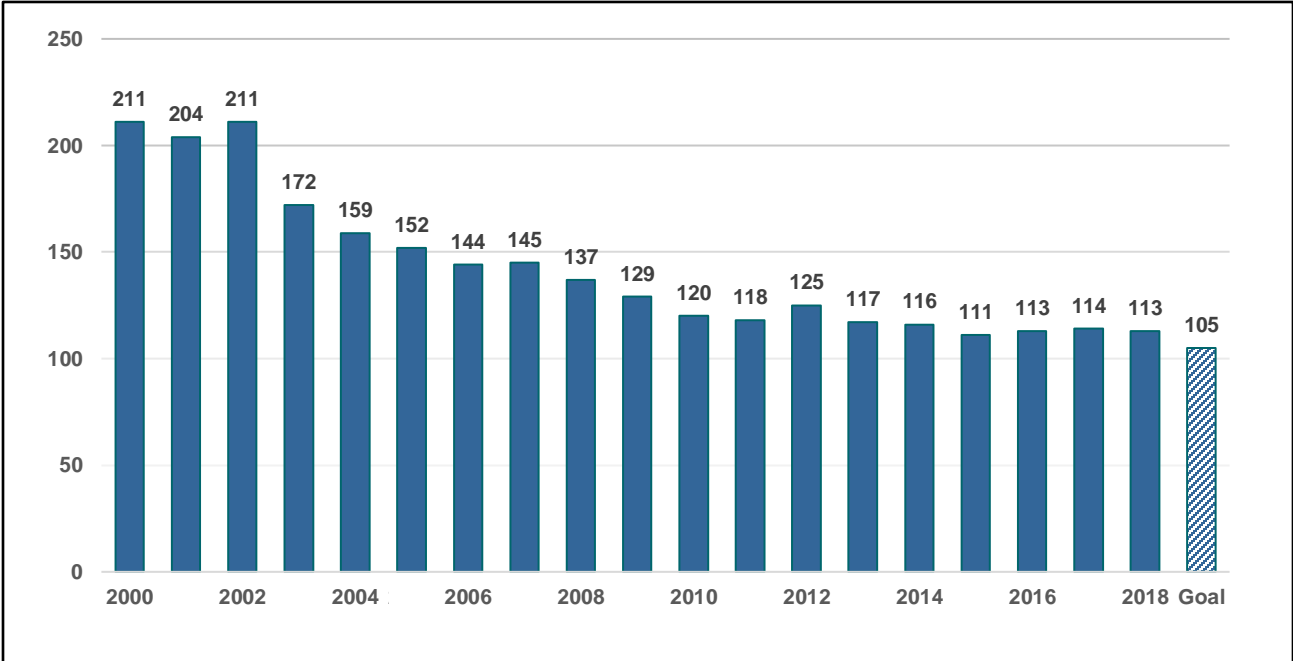
The tables include participation figures (projects completed, coupons received, etc.), associated water savings data and SNWA investment amounts by program type since individual program inception. Program statistics for the years covered under the prior water conservation plan (2014-2018) are shaded in light blue. The tables are followed by a brief narrative on estimated water savings under the current plan, as well as an explanation of how benchmarks for the 2019-2024 Plan were determined.

While benchmarks play an important role for tracking progress and setting performance targets, it is important to note that there are significant outside

factors that can influence participation and results. Economic conditions are one such factor. Given that many of the SNWA’s conservation incentive programs pay only a portion of the costs to purchase or upgrade landscapes, tools or technologies, economic factors can significantly influence participation levels. During the most recent economic downturn, participation levels in the SNWA’s incentive offerings were significantly lower than in years prior.

It also is important to note that the SNWA has reached many of the community’s most willing participants through its incentive programs and other offerings over the years. It also follows, that the well of opportunity has diminished through the success of prior efforts (i.e. there is less available turf to convert/pools to cover, etc. due to prior program enrollment). While future gains are anticipated, the SNWA recognizes they are likely to come slower than in prior years, and potential participants may be harder to compel towards change.

Figure A-1: SNWA water use and conservation goal in GPCD



PAST PERFORMANCE SUMMARY

Figures A-2 through A-4 include a summary of performance for specific water conservation measures since individual program inception. The shaded blue areas in each table correlate to the SNWA's 2014-2018 water conservation plan and provides a basis for water savings estimates/benchmarks as further described in this section.

Figure A-2: Water Smart Landscapes program performance summary 1999-2018

Year	Projects Completed	Annual Savings (Gallons)	Cumulative Savings (Gallons)	Annual Savings (AFY)	Cumulative Savings (AFY)	Dollars Rebated	Turf Converted (SF)
1999*	298	N/A	N/A	N/A	N/A	\$ 77,817	N/A
2000	262	37,214,091	37,214,091	114	114	\$ 368,830	666,919
2001	490	128,389,495	165,603,586	394	508	\$ 894,314	2,300,887
2002	602	195,104,477	360,708,063	599	1,107	\$ 1,358,253	3,496,496
2003	2379	662,176,384	1,022,884,447	2,032	3,139	\$ 10,284,527	11,866,960
2004	8618	1,900,975,958	2,923,860,405	5,834	8,973	\$ 28,669,569	34,067,670
2005	5735	858,585,460	3,782,445,865	2,635	11,608	\$ 14,236,924	15,386,836
2006	3466	597,643,640	4,380,089,505	1,834	13,442	\$ 10,964,885	10,710,460
2007	5862	1,031,129,662	5,411,219,167	3,164	16,606	\$ 23,961,354	18,479,026
2008	7528	1,572,958,621	6,984,177,788	4,827	21,434	\$ 43,429,187	28,189,223
2009	4938	954,473,508	7,938,651,296	2,929	24,363	\$ 22,879,317	17,105,260
2010	3187	483,549,743	8,422,201,039	1,484	25,847	\$ 10,753,972	8,665,766
2011	2729	364,543,353	8,786,744,392	1,119	26,966	\$ 8,321,126	6,533,035
2012	2445	309,113,028	9,095,857,420	949	27,914	\$ 7,084,378	5,539,660
2013	2283	270,262,334	9,366,119,754	829	28,744	\$ 6,226,191	4,843,411
2014	2192	245,692,143	9,611,811,897	754	29,498	\$ 5,732,305	4,403,085
2015	2113	248,696,471	9,860,508,368	763	30,261	\$ 6,123,405	4,456,926
2016	2277	245,197,588	10,105,705,955	752	31,013	\$ 7,094,233	4,394,222
2017	2016	196,069,426	10,301,775,381	602	31,615	\$ 5,927,138	3,513,789
2018	1223	102,067,909	10,403,843,291	313	31,928	\$ 3,943,377	1,829,174
Totals	60,643	10,403,843,291	118,961,421,709	31,928	365,079	\$ 218,331,099	186,448,805

*The SNWA began tracking turf removed/gallons saved under the WSL program in 2000.

Figure A-2: Water Efficient Technologies program performance summary 2001- 2018

Year	Projects Completed	Annual Savings (Gallons)	Cumulative Savings (Gallons)	Annual Savings (AFY)	Cumulative Savings (AFY)	Dollars Rebated
2001	2	8,293,107	8,293,107	25.45	25	\$ 24,277
2002	1	19,600,000	27,893,107	60.15	86	\$ 20,783
2003	2	41,968,592	69,861,699	128.80	214	\$ 161,796
2004	11	98,152,157	168,013,856	301.22	516	\$ 251,676
2005	6	69,901,506	237,915,362	214.52	730	\$ 113,283
2006	9	79,193,774	317,109,136	243.04	973	\$ 32,671
2007	17	107,441,724	424,550,860	329.73	1,303	\$ 490,833
2008	4	114,851,967	539,402,827	352.47	1,655	\$ 243,836
2009	9	14,604,974	554,007,801	44.82	1,700	\$ 159,520
2010	33	261,594,823	815,602,624	802.81	2,503	\$ 459,998
2011	22	257,135,835	1,072,738,459	789.12	3,292	\$ 212,264
2012	25	116,552,466	1,189,290,925	357.69	3,650	\$ 290,547
2013	23	44,133,533	1,233,424,458	135.44	3,785	\$ 186,665
2014	27	108,763,954	1,342,188,412	333.78	4,119	\$ 237,966
2015	33	102,154,169	1,444,342,581	313.50	4,433	\$ 295,167
2016	31	58,508,976	1,502,851,557	179.56	4,612	\$ 435,987
2017	46	36,198,761	1,539,050,318	111.09	4,723	\$ 283,762
2018	6	7,575,453	1,546,625,771	23.25	4,746	\$ 180,953
Totals	307	1,546,625,771	14,033,162,855	4,746.42	43,066.20	\$ 4,181,981.87

Figure A-3: Pool Cover program performance summary 2005 – 2018

Year	Clocks Rebated	Annual Water Savings (Gallons)	Cumulative Water Savings (Gallons)	Annual Water Savings (AFY)	Cumulative Water Savings (AFY)	Dollars Rebated
2005	3,910	49,852,500	49,852,500	153	153	\$ 183,357
2006	3,942	50,260,500	100,113,000	154	307	\$ 297,183
2007	3,388	43,197,000	143,310,000	133	440	\$ 164,191
2008	3,452	44,013,000	187,323,000	135	575	\$ 173,451
2009	3,985	50,808,750	238,131,750	156	731	\$ 204,957
2010	4,158	53,014,500	291,146,250	163	893	\$ 215,087
2011	3,743	47,723,250	338,869,500	146	1,040	\$ 193,588
2012	3,290	41,947,500	380,817,000	129	1,169	\$ 175,113
2013	2,953	37,650,750	418,467,750	116	1,284	\$ 154,907
2014	2,904	27,588,000	446,055,750	85	1,369	\$ 153,353
2015	3,006	28,557,000	474,612,750	88	1,457	\$ 160,141
2016	1,877	17,831,500	492,444,250	55	1,511	\$ 104,001
2017	2,060	19,570,000	512,014,250	60	1,571	\$ 116,078
2018	1,222	11,609,000	523,623,250	36	1,607	\$ 70,073
Totals	43,890	523,623,250	4,596,781,000	1,607	14,107	\$ 2,365,481

Figure A-4: Smart Controller program performance summary 2006-2018

Year	Clocks Rebated	Annual Water Savings (Gallons)	Cumulative Water Savings (Gallons)	Annual Water Savings (AFY)	Cumulative Water Savings (AFY)	Dollars Rebated
2006	10	97,100	97,100	0.30	0.30	\$ 26,228
2007	41	359,270	456,370	1.10	1.40	\$ 25,119
2008	14	106,810	563,180	0.33	1.73	\$ 27,925
2009	10	48,550	611,730	0.15	1.88	\$ 18,974
2010	21	116,520	728,250	0.36	2.23	\$ 75,628
2011	30	213,620	941,870	0.66	2.89	\$ 9,168
2012	42	339,850	1,281,720	1.04	3.93	\$ 22,097
2013	23	155,360	1,437,080	0.48	4.41	\$ 21,622
2014	75	495,210	1,932,290	1.52	5.93	\$ 57,398
2015	228	1,767,220	3,699,510	5.42	11.35	\$ 120,991
2016	836	7,855,390	11,554,900	24.11	35.46	\$ 152,008
2017	941	8,952,620	20,507,520	27.47	62.94	\$ 168,278
2018	599	5,728,900	26,236,420	17.58	80.52	\$ 359,455
Totals	2,870	26,236,420	70,047,940	80.52	214.97	\$ 1,084,889

ESTIMATED WATER SAVINGS/PROGRAM BENCHMARKS

Figure A-5 provides a summary of estimated water savings by specific conservation measure for the five-year planning horizon and Figure A-6 provides a cumulative water savings for the five-year period. These tables are followed by a short explanation on how estimated water savings/ program benchmarks were derived, by program initiative. Figure A-7 includes a summary of other program benchmarks, including current and future (target) service levels.

Figure A-5: Annual water savings estimate/program benchmarks by specific conservation measure 2019-2023 (in gallons)

Program / Initiative	2019 Benchmark	2020 Benchmark	2021 Benchmark	2022 Benchmark	2023 Benchmark
Water Smart Landscapes	195,300,000	175,770,000	158,193,000	142,373,700	128,136,330
Water Efficient Technologies (WET)	40,000,000	40,000,000	40,000,000	40,000,000	40,000,000
Smart Controller	8,156,400	8,156,400	8,156,400	8,156,400	8,156,400
Pool Cover and Developing Coupons	14,250,000	14,250,000	14,250,000	14,250,000	14,250,000
Site Evaluation	1,400,000	2,100,000	2,800,000	3,500,000	4,200,000
Indoor Retrofit	6,000,000	6,000,000	6,000,000	6,000,000	6,000,000
Water Efficiency Code Enhancements	-	40,906,700	61,814,600	52,724,200	52,724,200
Total	262,387,600	284,464,300	288,495,200	264,285,500	250,748,130

Figure A-6: Cumulative water savings estimate by specific conservation measure 2019-2023 (in gallons)

Program / Initiative	2019 Savings	2020 Savings	2021 Savings	2022 Savings	2023 Savings
Water Smart Landscapes	195,300,000	371,070,000	529,263,000	671,636,700	799,773,030
Water Efficient Technologies (WET)	40,000,000	80,000,000	120,000,000	160,000,000	200,000,000
Smart Controller	8,156,400	16,312,800	24,469,200	32,625,600	40,782,000
Pool Cover and Developing Coupons	14,250,000	28,500,000	42,750,000	57,000,000	71,250,000
Site Evaluation	1,400,000	3,500,000	6,300,000	9,800,000	14,000,000
Indoor Retrofit	6,000,000	12,000,000	18,000,000	24,000,000	30,000,000
Water Efficiency Code Enhancements	-	40,906,700	102,721,300	155,445,500	208,169,700
Total	262,387,600	546,851,900	835,347,100	1,099,632,600	1,350,380,730

Water Smart Landscapes: Continued implementation of the SNWA’s Water Smart Landscapes program is estimated to generate between 128,136,330 and 195,300,000 gallons of water annually over the five-year planning horizon for a cumulative water savings of 799,773,030 during the same period. The projection includes an assumed ten percent year over year reduction in water savings as the program moves closer to maturity.

Water Efficient Technologies: The SNWA estimates an annual water savings of 40,000,000 gallons for the Water Efficient Technology program between 2019-2023, which would result in a cumulative water savings of 200,000,000 gallons during the same year period. The projection includes a slight increase to 2017/2018 program results, sustained for the five-year planning horizon.

Smart Controllers: The SNWA estimates an annual water savings of 8,146,400 gallons for the Smart Controller Rebate program between 2019-2023, which would result in a cumulative water savings of 40,782,000 gallons for the same five-year period. The projection is based on the five-year program average.

Pool Cover and Developing Coupons: Continued implementation of the SNWA’s Pool Cover Rebate program and the introduction of new coupons (Leak Detection Rebate) are estimated to save 14,250,000 annually between 2019 and 2023 for a cumulative water savings of 71,250,000 during the same five-year period.

Site Evaluations: The SNWA launched a new site-evaluation program in 2019. This invitation-only initiative targets the community’s highest water users. The program is estimated to save between 1,400,000 – 4,200,000 annually, increasing year over year as program startup, launch and maintenance activities are underway. Over the five-year planning horizon, cumulative water savings are estimated at 14,000,000 gallons.

Indoor Retrofit: Continued distribution of indoor retrofits kits is estimated to generate 6,000,000 gallons of water annually over the five-year planning horizon for a cumulative savings of 30,000,000 during the same period.

Water Efficiency Code Enhancements: Proposed water efficiency code enhancements are expected to become effective December 31, 2019 with dwellings impacted in by change occupied in mid-to-late 2020. Water savings/benchmark calculations assume 114,500 residents in more than 44,000 dwellings will be affected by code changes. Estimated annual water savings range from approximately 41,000,000 - 53,000,000 gallons per year for a cumulative water savings of 208,169,700 gallons over the five-year period.

Figure A-7: Other program benchmarks

Program/Initiative	Current Levels (2018/2019)	5-Year Benchmark (target)
Continue to meter new service connections.	All accounts metered	Maintain current service level
Continue to conduct incentive pricing and billing and evaluate pricing structures to ensure a strong pricing signal is maintained to promote conservation.	All customers on conservation pricing structure	Maintain current service level
Continue to implement development codes and policies that restrict landscape watering, lawn installation, use of mist systems, fountains/ornamental water features, and water waste.	Codes/ordinances in place	Maintain current service level
Continue to require water budgets for golf course customers.	All golf courses on water budgets	Maintain current service level
Continue to conduct water waste enforcement and collaborate to identify possible opportunities to for increased compliance through regional coordination.	Active enforcement	Increase compliance
Support increased water efficiency standards through changes to state law and/or local ordinances.	EPA WaterStart standards in effect	Implement higher standards (see pg. 20)
Continue to implement aggressive water reuse, including implementation of SNWA's 2017 Out-of-Valley Reuse Policy.	99% of reuse treated of wastewater flows through direct and indirect reuse.	Maintain current service level
Conduct ongoing meter repair and replacement.	Ongoing	Maintain current service level
Notify customers of high-water use/possible leaks based on meter data.	Ongoing	Maintain current service level
Inspect and assess water delivery infrastructure and develop plans to proactively replace assets deemed susceptible to leaks, as practical.	Ongoing	Maintain current service level
Continue to implement leak detection programs as described and seek opportunities to further reduce water loss within the SNWA service area. Establish a water audit/loss prevention committee to increase coordination of efforts.	Ongoing	Maintain current service level
Monitor and adjust system pressure, conduct routine PRV calibration.	Ongoing	Maintain current service level
Prioritize and expedite leak repairs to reduce magnitude of water loss.	Ongoing	Maintain current service level
Continue to implement existing incentive and rebate programs; expand program offerings where feasible.	See Figure 1.17-1.20	Maintain current incentive amount and/or evaluate for continued effectiveness
Continue to promote conservation through advertising, publications and media (including direct mail, website, videos/multimedia/social media).	Ongoing	Maintain current service level and conduct targeted outreach
Continue to track GPCD progress annually and make program adjustments as needed.	Ongoing	Maintain current service level
Continue to maintain education, engagement and support programs.	Ongoing	Maintain current service level

PLAN REFERENCES

ⁱ “Water Conservation Plan Guidelines. Part 5 Advanced Guidelines - designed for use by water systems serving over 100,000 people.” Retrieved 8/8/18. <https://www.epa.gov/sites/production/files/2017-03/documents/part-5-advanced-guidelines.pdf>.

ⁱⁱ “AWWA G480-13 Water Conservation Program Operation and Management.” American Water Works Association, 2013.

ⁱⁱⁱ The 2014-2018 Water Conservation Plan presented SNWA’s conservation goal and progress in “Total System” (or gross) GPCD terms. The SNWA has changed its approach for its 2019-2024 Conservation Plan. The SNWA’s formerly noted conservation goal of 199 Total System GPCD has been translated to 105 Consumptive Use GPCD. This methodology reflects actual per capita SNWA consumptive use of Colorado River water excluding off-stream storage and well production including recovered storage (SNWA per capita “water resource footprint” vs. SNWA total per capita water deliveries including direct reuse). Historical GPCD goal progress also has been restated using the same methodology. This approach reduces the number of sources and inputs required to calculate SNWA GPCD, improving transparency and explanation. For consistency, this change is being made to other planning documents, including the SNWA’s Water Resource Plan.

^{iv} Ibid.

^v “Climate of Las Vegas, Nevada,” Updated January 8, 2018, National Oceanic and Atmospheric Administration (NOAA), National Weather Service.

^{vi} Las Vegas breaks record during hot, dry 2017.” Las Vegas Review Journal, January 3, 2018.

^{vii} U.S. Drought Monitor, NOAA. Retrieved 8/8/18. <https://www.climate.gov/maps-data/data-snapshots/data-source-drought-monitor>.

^{viii} USGCRP, 2018: Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. doi: 10.7930/NCA4.2018

^x US Global Change Research Program (2014). Ch. 20: Southwest. Climate Change Impacts in the United States: The Third National Climate Assessment. <https://nca2014.globalchange.gov/report>.

^{xi} “Lower Colorado Water supply Report,” September 9, 2019, U.S. Bureau of Reclamation.

^{xii} Uniform Design and Construction Standards for Potable Water Systems, 3rd Edition – 2010. Las Vegas Valley Water District, City of Henderson, City of North Las Vegas and City of Boulder City. www.lvwwd.com/assets/pdf/udacs-2010.pdf.