New Mexico State Water Plan
Part II: Technical Report

Gaining a Statewide Perspective through Analysis and Integration of Water Planning Activities, Including New Mexico's 16 Regional Water Plans

Office of the State Engineer

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Interstate Stream Commission

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New Mexico State Water Plan Part II: Technical Report

Prepared by the New Mexico Interstate Stream Commission

Office of the State Engineer

Interstate Stream Commission

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Forward

The Interstate Stream Commission (ISC) oversees the state water planning program, which includes both regional and statewide planning efforts. The New Mexico State Water Plan is comprised of three parts, including the *State Water Plan Part I: Policies*; this document, *State Water Plan Part II: Technical Report*; and the *State Water Plan Part III: Legal Landmarks*.

The State Water Plan Statute (§72-14-3) requires that the State Water Plan include an "inventory of the quantity and quality of the state's water resources, population projections and other water resource demands under a range of conditions." The ISC is tasked with integrating New Mexico's Regional Water Plans into the State Water Plan "where appropriate."

This report fulfills many purposes of the State Water Plan Act, in that it provides a summary of water supply and demand both statewide and by region and analyzes the gap between supply and demand by 2060 under "average" and "drought" conditions. Valuable insights, most notably information about policies, plans, and projects collected from the 2016-2017 Regional Water Plans are represented here in many sections. The key issues and strategies proposed by the regions to address water supply problems are summarized, along with the projected costs to implement the strategies.

Acknowledgments

This *State Water Plan Part II: Technical Report* relied heavily on the thorough documentation of water demand and supply from the 16 Regional Water Plans. Without the participation of the steering committees and the members of the public, the task of regional water planning would not have been possible. The 16 Regional Water Plans completed in 2016 and 2017 have provided a solid foundation for future revisions and improvements.

The 16 Regional Water Plans are listed and linked below.

Region 1	Northeast New Mexico
Region 2	San Juan Basin
Region 3	Jemez y Sangre
Region 4	Southwest New Mexico
Region 5	Tularosa-Sacramento-Salt Basins
Region 6	Northwest New Mexico
Region 7	Taos
Region 8	Mora-San Miguel-Guadalupe
Region 9	Colfax
Region 10	Lower Pecos Valley
Region 11	Lower Rio Grande
Region 12	Middle Rio Grande
Region 13	Estancia Basin
Region 14	Rio Chama
Region 15	Socorro-Sierra
Region 16	Lea County

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List of Acronyms and Definitions

ºF	degrees Fahrenheit
1994 Handbook	OSE (1994)
2013 Handbook	OSE (2013)
2016-2017 RWP updates	16 Regional Water Plans finalized in 2016 and 2017
ac-ft	acre-feet: amount of water that covers an acre of land with one-foot of water
ac-ft/yr	acre-feet per year
AFB	Air Force Base
AMO	Atlantic Multidecadal Oscillation
ASR	aquifer storage and recovery
AWSA	Arizona Water Settlements Act
CAP	Central Arizona Project
cfs	cubic feet per second
CIR	consumptive irrigation requirement
Closed Basin	Closed Basin can mean “closed to new appropriations” but in this document “closed basin refers to a “non-stream connected aquifer” which have no perennial streams.
COG	Council of Government
Demand	The amount of water necessary to meet the conveyance and consumptive needs of a water use category (including return flow and depletions)
Depletion	Amount of water consumed from the water withdrawn or diverted
ENMRWS	Eastern New Mexico Rural Water System
EOR	enhanced oil recovery
ft	foot *or* feet
GIS	geographic information system
gpcd	gallons per capita per day
HUC	Hydrologic Unit Code is a sequence of numbers that identify a hydrological drainage basin (also called watershed or catchment) into successively smaller units from the largest geographic area to smaller areas. The first level (HUC 1) divides the US into 21 major geographic areas or regions, the second level (HUC 2) divides the 21 regions into 221 regions.
IBWC	International Water and Boundary Commission
ICIP	New Mexico Infrastructure Capital Improvement Plan
IPCC	Intergovernmental Panel on Climate Change
ISC	Interstate Stream Commission
JPA	joint powers agreement
M	million
m^2	meters squared
MASS	Monitoring, Assessment, and Standards
MDWCA	mutual domestic water consumer associations
Mined Basin	Aquifer in closed (no through-flowing streams) basin where recharge is much less than the discharges (through pumping and spring flow)

MRGCD	Middle Rio Grande Conservancy District
MS4	Municipal Separate Storm Sewer System
NEPA	National Environmental Policy Act
NIIP	Navajo Indian Irrigation Project
NMBGMR	New Mexico Bureau of Geology and Mineral Resources
NMED	New Mexico Environment Department
NGO	non-government organization
NMSU	New Mexico State University
NRCS	National Resources Conservation Council
OCD	Oil Conservation Division, New Mexico Energy, Minerals, and Natural Resources Department
OSE	New Mexico Office of the State Engineer
PDO	Pacific Decadal Oscillation
PDSI	Palmer Drought Supply Index
PPP	Projects, Programs, and Policies
PWS	Public Water System
RWP	Regional Water Plan
SNOTEL	snowpack telemetry
State	State of New Mexico
State Water Plan Act	NMSA 72-14-3.1
TDS	total dissolved solids
TQCRWA	Tucumcari Quay County Regional Water Authority
TMDL	Total Maximum Daily Load
USGCRP	United States Global Change Research Program
USBR	United State Bureau of Reclamation
USGS	United States Geological Survey
USEPA	United States Environmental Protection Agency
UST	Underground Storage tank
Withdrawal	Amount of water diverted from the source of supply
WRRI	New Mexico Water Resources Research Institute

1. Introduction

A growing population, aging infrastructure, periods of extended drought, wildfires, multiple interstate compacts, the federal government's large involvement and role in water management in certain basins, and many (sometimes competing) water interests create a complex environment for water management in New Mexico. What at first glance may appear to be a single issue often reveals a web of interrelated matters, which are in turn part of or affected by other issues. Understanding the complexity of New Mexico's water situation will enable the State to develop strong, clear policy recommendations and strategies to address statewide issues.

1.1 PURPOSE OF THE TECHNICAL REPORT

This Technical Report is Part II of the *2018 New Mexico State Water Plan*. It provides background information regarding the condition of water resources and expected future demands in the state of New Mexico.

New Mexico State Water Plan Part I: *Policies* provides descriptions of proposed water resource management policies.

This *New Mexico State Water Plan Part II: Technical Report* provides foundational technical information about water resource conditions, including supply, demand, and strategies proposed by stakeholders to address key issues.

New Mexico State Water Plan Part III: Legal Landmarks provides summary information about historic decisions in New Mexico water law establishing the legal structure for water resource administration.

This Technical Report summarizes and integrates important information from New Mexico's 16 Regional Water Plans (RWPs) (Figure 1-1) which reflect the broader scope of issues addressed in this State Water Plan. Detailed technical information describing methodologies and data used to determine how the supply and demand were established throughout the state are explained. Key water issues, challenges, and strategies for addressing regional, multi-regional, and statewide water management problems are presented.

For the first time, the RWPs were written using a consistent methodology and have been integrated into this State Water Plan, enabling the connection between statewide and regional planning scales to be strengthened. Integrating regional information to inform the State Water Plan required careful consideration to ensure a representative multi-region and statewide assessment that takes into account differences and similarities among the regions. Information demonstrating regional, multi-regional, and statewide issues and trends was tailored for relevance and connectivity between the RWPs and this *2018 New Mexico State Water Plan*.

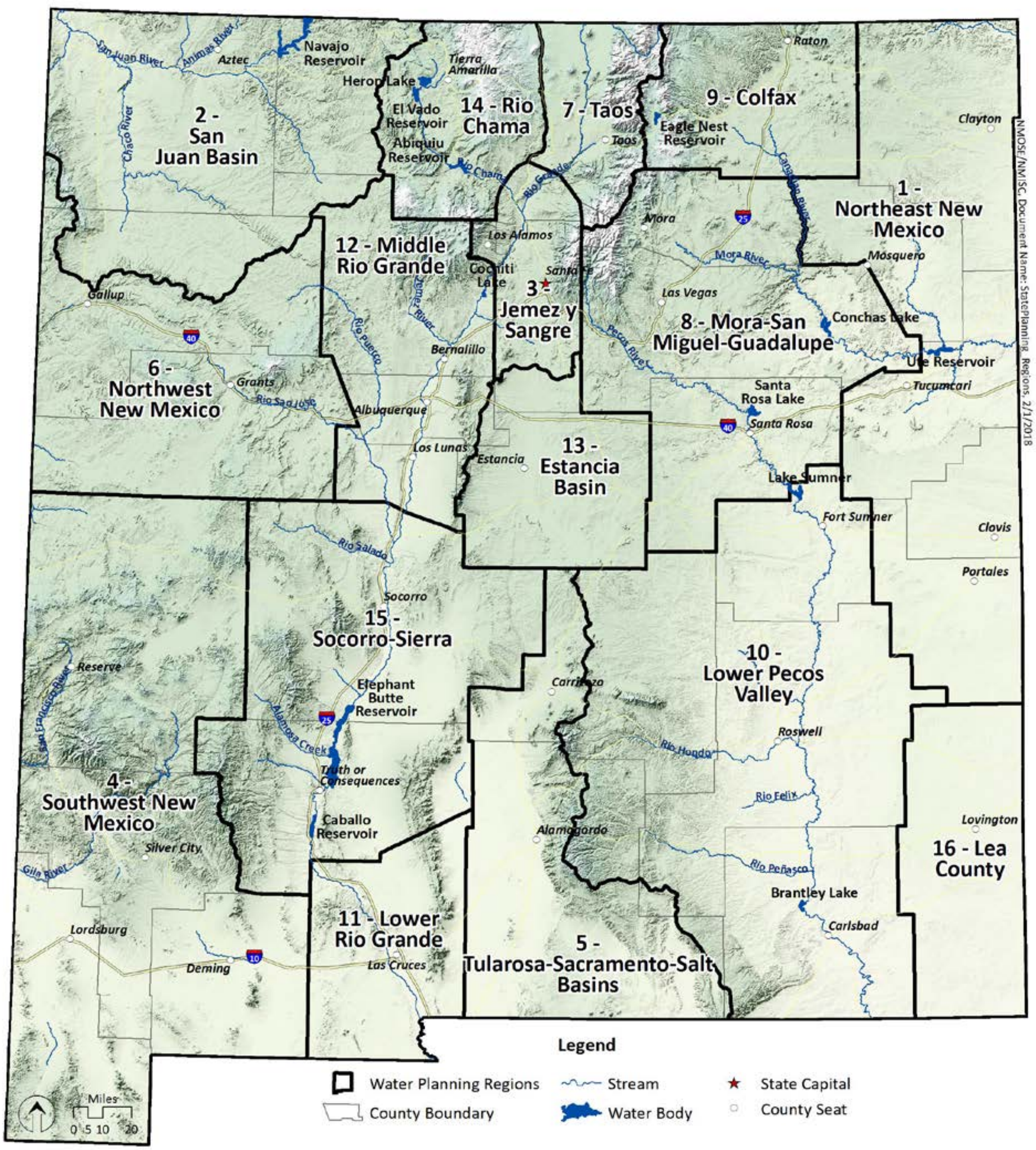

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Figure 1-1. Water Planning Regions in New Mexico.

1.2 OVERVIEW

New Mexico water resources consist of five major and three small river basins (Figure 1-2) and multiple groundwater basins. The eight river basins cross interstate boundaries, requiring interstate compacts approved by Congress, which equitably apportion each basins' water between New Mexico and the other states within the basins. These compacts require New Mexico to administer each basins' surface and groundwater supplies to ensure compliance with their respective compact obligations. Additionally, the US has entered into two treaties with Mexico (the Treaty Convention of 1906 on the Rio Grande and the 1944 Mexican Water Treaty on the Rio Grande along the border with Texas and Colorado River), which apportion the waters of those basins between the two countries. The federal government is also involved in the management of the surface water, particularly where endangered species habitat or other federal interests are affected. *New Mexico State Water Plan, Part III: Legal Landmarks* summarizes the legal landmarks involved in administering the state's river basins and groundwater resources statewide.

This report describes a brief history of water planning (Section 2), water supply (Section 3), water demand (Section 4) and the gap between supply and demand by 2060 (Section 5). While it may seem straightforward to quantify supply, the task is challenged not only with seasonal and yearly variability, but also by location: the surface water budget on a stream varies depending on numerous factors including proximity to headwaters, tributary inflows, return flows, spring flows, and storage. Depicting the demands on water downstream of a region due to priority of senior water rights or other legal obligations is particularly problematic when those obligations are continuously changing and dependent on multiple variables. In particular, providing a statewide or even regional summary of supply may mask a localized problem with meeting demand.

The approach utilized in this report results in the following conclusions:

- *All* planning regions in New Mexico are projected to have less than 75% of the necessary supply to meet demands in 2060 under the drought scenario.
- *Four* of those regions are projected to have less than 20% of the necessary supply under the drought scenario.
- The *Northeast NM* planning region is projected to have about 26% of the supply needed to meet 2060 demands under average water supply conditions due to the rapid depletion of the Ogallala/High Plains Aquifer.

The second half of this report summarizes key water resource issues (Section 6), strategies (Section 7), and recommendations to the state (Appendix A) to address these concerns. The strategies and recommendations were developed by each water planning region steering committee. The number one issue, not surprisingly, is insufficient water supply, followed by vulnerability to climate, water management, the need for a better understanding of water resources, water quality, and last, but not least, water infrastructure and maintenance.

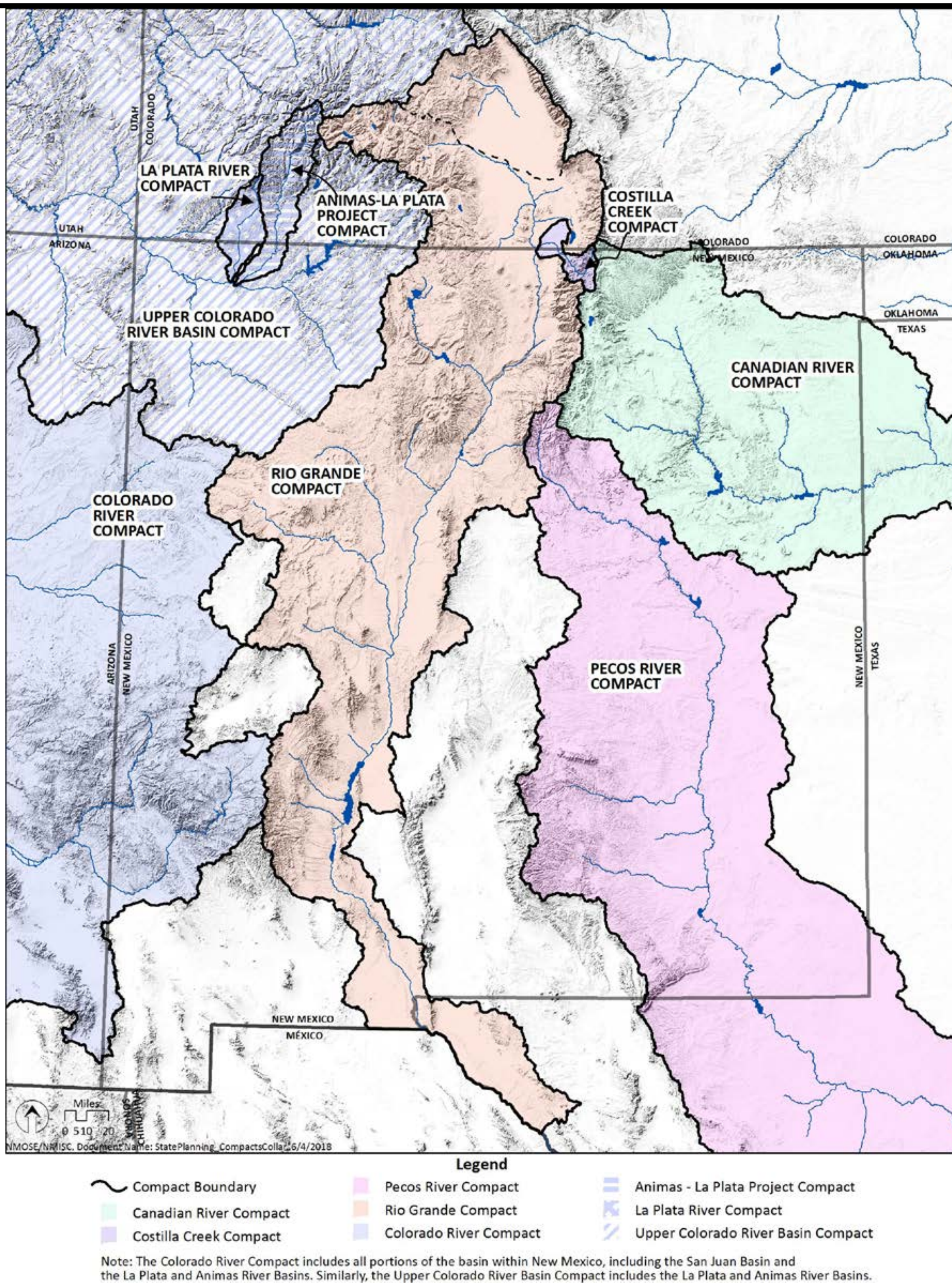

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Figure 1-2. Interstate Compacts with Neighboring States.

2. Description of Regional Water Planning History and Process

The boundaries of the 16 water planning regions follow some watershed boundaries and government borders, such as counties or Council of Government (COG) boundaries, and vary in size, ranging from 2,262 (Taos Region) to 17,337 (Southwest Region) square miles. Each region has unique issues based on the demographics, history, land use activities (including commercial and industrial development), and variability of water resources.

2.1 HISTORY OF REGIONAL WATER PLANNING

Regional Water Planning in New Mexico began in earnest in 1987, when the New Mexico legislature authorized the Interstate Stream Commission (ISC) to provide loans and grants for regional water planning activities. Jurisdictions seeking funding, whether a county, city, water board, or water commission, could define their planning region for their proposed planning study. Thus, through the process of seeking funding, the water planning boundaries began to emerge, originating from the ground up, and not through a statewide analysis or comprehensive approach. Several iterations of water planning regions developed, but since 1996, the 16 regions shown in Figure 1-1 have remained essentially the same (Water Dialogue, 1996).

Over the next decade, the regions worked to develop their regional water plans, retaining consultants to address the components of the *Regional Water Planning Handboo*k (the “1994 Handbook”) (ISC, 1994). Documents related to the first phase of water plans are available on the ISC’s website and provide a detailed summary of the water supply issues of each region. Each water plan developed a different approach to assessing water supply and demand, making compilation of the data into a state plan very challenging. In order to address this issue, ISC developed the *Updated Regional Water Planning Handbook: Guidelines to Preparing Updates to New Mexico Regional Water Plans* in 2013 (the “2013 Handbook”) (ISC, 2013). The technical information for each of the 16 regions followed a common technical approach so that the information could be synthesized into a state water plan.

In concert with the compilation of technical data, the ISC with support from various contractors coordinated the reconvening of existing (but not currently active) as well as new steering committees in each of the regions, which occurred between 2014 and 2017. Some regions already had long established water planning groups and the ISC asked these groups if they would be involved in the process to update the RWPs. Each steering committee was comprised of local and regional stakeholders and organizations, such as regional COGs, water providers, agricultural districts and acequias, elected officials, active water planning councils, local, state, federal, and non-government technical advisors and other water interests. Steering committees represent the different water user groups identified in the 2013 Handbook and have the associated water management expertise and experience as shown in Figure 2-1. Thus, the 2016-2017 RWP updates involved participation by a representative group of stakeholders within each region.

The regional steering committees provided feedback on the technical information and developed lists of PPPs (projects, programs, and policies) and recommendations to the state for improving water management in New Mexico. The “Public Involvement in the Planning Process” chapter in each RWP documents the public planning process used to update the plans and also lists strategies for future public involvement. The plans contain details about the committees’ formation, membership, and meetings; such as dates, locations, agendas, and summaries. All the RWPs are available on the New Mexico Office of the State Engineer (OSE) and ISC Planning web pages (OSE, 2017).

Throughout the regional planning update process, all meetings were open to the public. The ISC supported regional steering committees by preparing agendas for meetings, facilitating meetings, assisting with outreach, providing data, and keeping records of all the meetings. During the planning process, the ISC and the steering committees worked together to update the regional water plans. The ISC provided the regions with technical sections of the plan and the steering committees developed their strategies for addressing future water challenges.

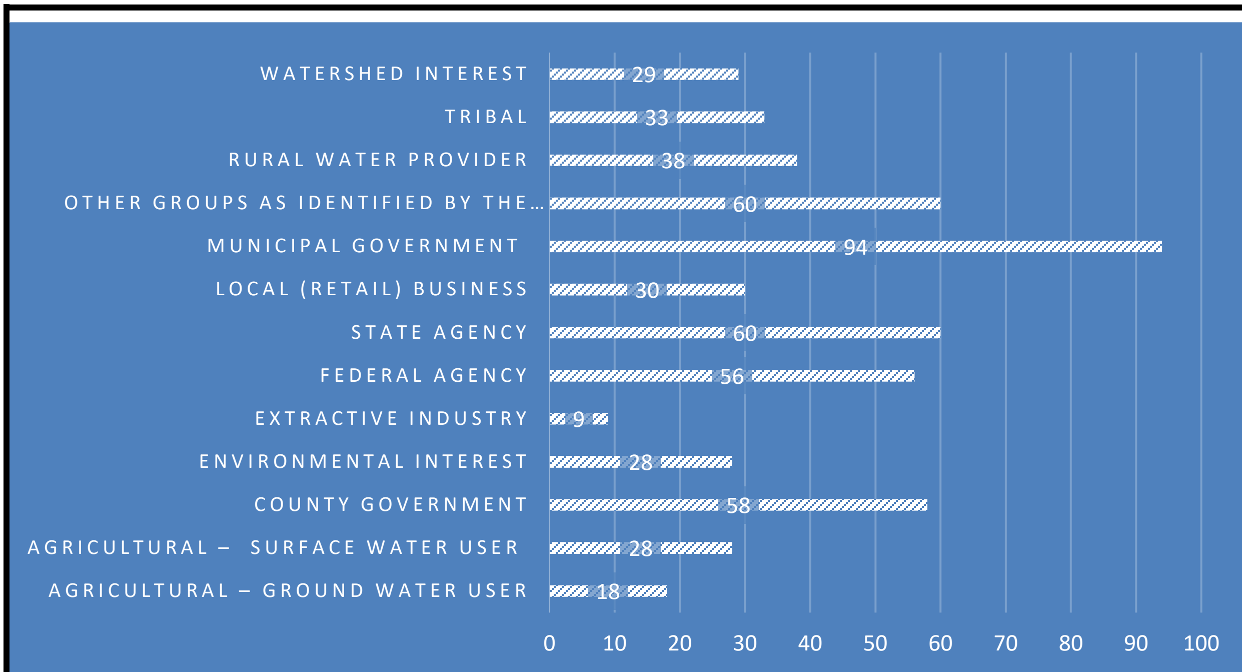

Figure 2-1. Statewide Steering Committee Representation by Total Numbers.

2.2 APPLYING THE COMMON TECHNICAL APPROACH

To update all 16 RWP concurrently and consistently, the ISC developed a set of methods for assessing the available supply and projected demand. This *common technical approach* outlines the basis for defining the available water supply and specifies methods for estimating future demand in all categories of water use. This common technical approach, described in more detail in Appendix B, was an important first step toward creating a methodology that better supports regional coordination and integration within a state water plan.

The objective of applying this common technical approach was to be able to efficiently develop a statewide overview of the balance between water supply and demand in both normal and drought conditions, so that the state can move forward with planning and funding water projects and programs that will address the state's pressing water issues. To calculate the balance of supply and demand in the RWPs, the estimated volume of water diverted in 2010 was utilized to estimate the physical and legal limitations of water supply available in a normal water supply year and was referred to as the "administrative supply". This approach for estimating the administrative supply as calculated in the RWPs, was based on the OSE's report *Water Use by Categories 2010* (Longworth et al., 2013). Details on how water use is estimated for each water use sector are provided in Longworth et al. (2013).

The physical supply in mined aquifers was reduced by 2060 to represent the diminishing supply in the non-stream-connected aquifers. Except for the Navajo-Gallup Water Supply Project in the San Juan and Northeast regions, no increase in supply is included in the administrative supply as presented here. As water planning evolves in New Mexico and additional resources are made available (including funding, hydrologic investigations, improved metering or other advancements) the estimates of supply and demand will be further refined.

3. Water Supply

New Mexico's water supply is highly variable throughout the state and is affected by climatic conditions as discussed in Section 3.1. The state's water supply includes both surface water supplies (Section 3.2), originating primarily in the higher mountain areas; and groundwater resources that are most extensive in eastern, southwestern, and the central valleys of New Mexico; with more minor resources throughout the state (Section 3.2). Regional dependence on surface water and groundwater, which developed because of the relative availability of each resource around the state, is illustrated in Figure 3-1.

The northern part of the state (including the San Juan, Upper Rio Chama and the Canadian basins) has minimal groundwater resources, but ample surface water in non-drought years. The regions along the Rio Grande and the Pecos River rely on surface water and have groundwater resources to meet a significant portion of the water demand. The far eastern portion of the state and the Estancia Basin rely entirely on groundwater from aquifers that are diminishing. The surface water/groundwater distribution as illustrated in Figure 3-1 is expected to shift by 2030 (when the Eastern New Mexico Rural Water Supply Project/Ute Reservoir Pipeline Project brings in surface water supplies to some communities in Eastern New Mexico, and the Navajo-Gallup Water Supply Project delivers additional surface water to Northwestern New Mexico).

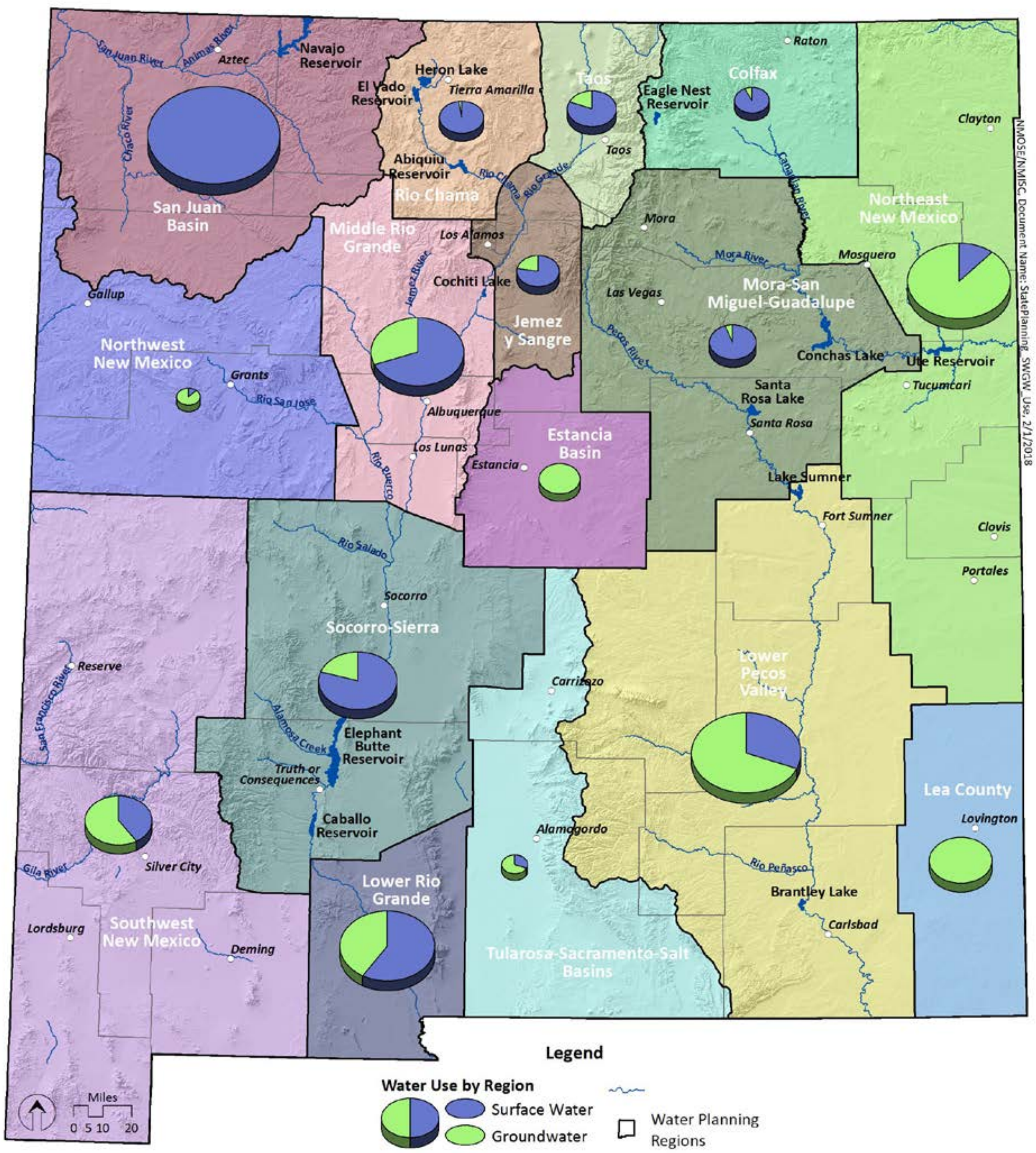

Figure 3-1. Surface Water and Groundwater Use in New Mexico Water Planning Regions in 2010.

3.1 CLIMATE OF NEW MEXICO

3.1.1 Precipitation and Evaporation

Except for its high mountains, New Mexico's climate is arid to semi-arid; and thus, precipitation is on average very low and highly variable. Figure 3-2 shows the average annual precipitation across New Mexico. In the lowest elevations, annual precipitation is much lower than the mountainous areas. Figure 3-3 shows the gross annual lake evaporation, which is almost the inverse of the precipitation map: greater evaporation potential at lower (and hotter) elevations and less evaporation at the higher (and cooler) elevations. Gross lake evaporation represents the maximum evaporation that would occur in a year from a free water surface (a standing body of water such as a lake or reservoir) in a given year.

The RWPs each summarized general climate patterns and the variability of temperature and precipitation at representative climate stations. Those regions with higher elevations and snowpack also included data from Natural Resources Conservation Service (NRCS) snow course and/or snowpack telemetry (SNOTEL) stations. A significant portion of New Mexico's surface water and recharge to aquifers is derived from winter precipitation. The snowpack analyzed from the RWPs illustrated considerable variability over time, with high precipitation years showing considerably greater precipitation than drought years. Summer thunderstorms, also a highly variable source of supply, contribute a significant portion of runoff and recharge to many areas of the state.

Figure 3-4, which shows the extent of the snowpack in a dry year (2018), average year (2010), and a wet year (2005), illustrates the snowpack variability.

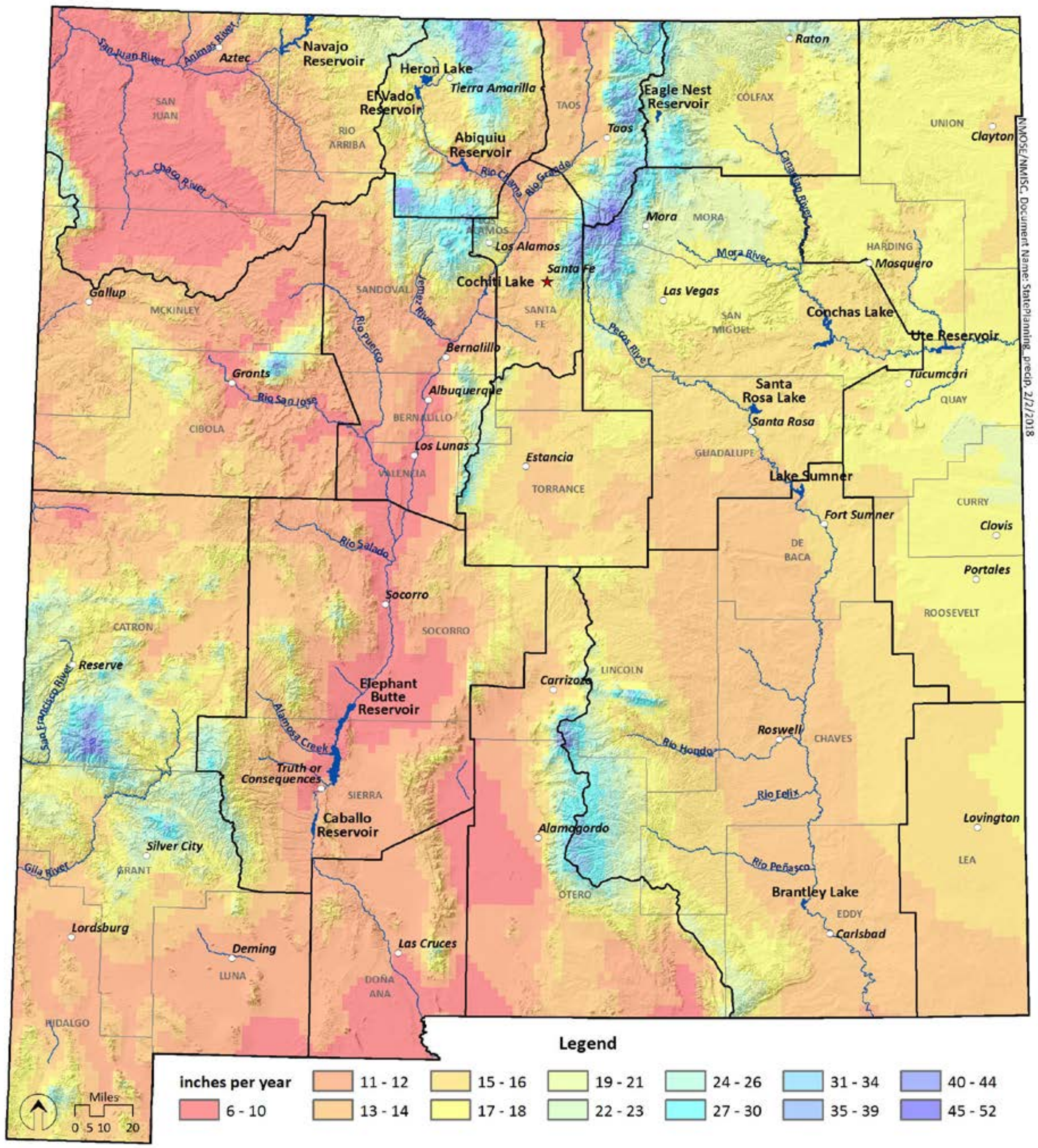

Figure 3-2. Average Annual Precipitation (inches) in New Mexico (average for 1981-2010).

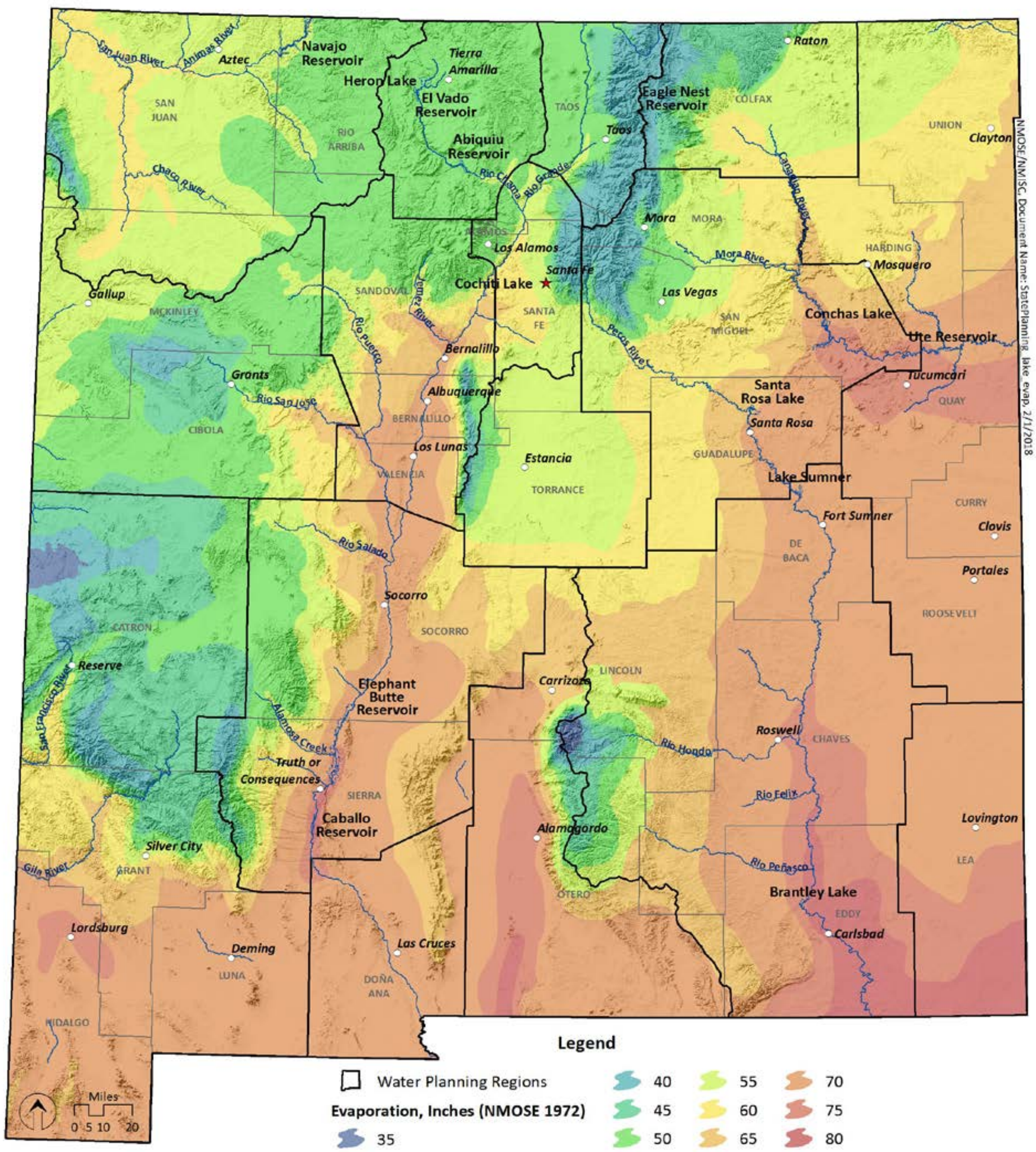

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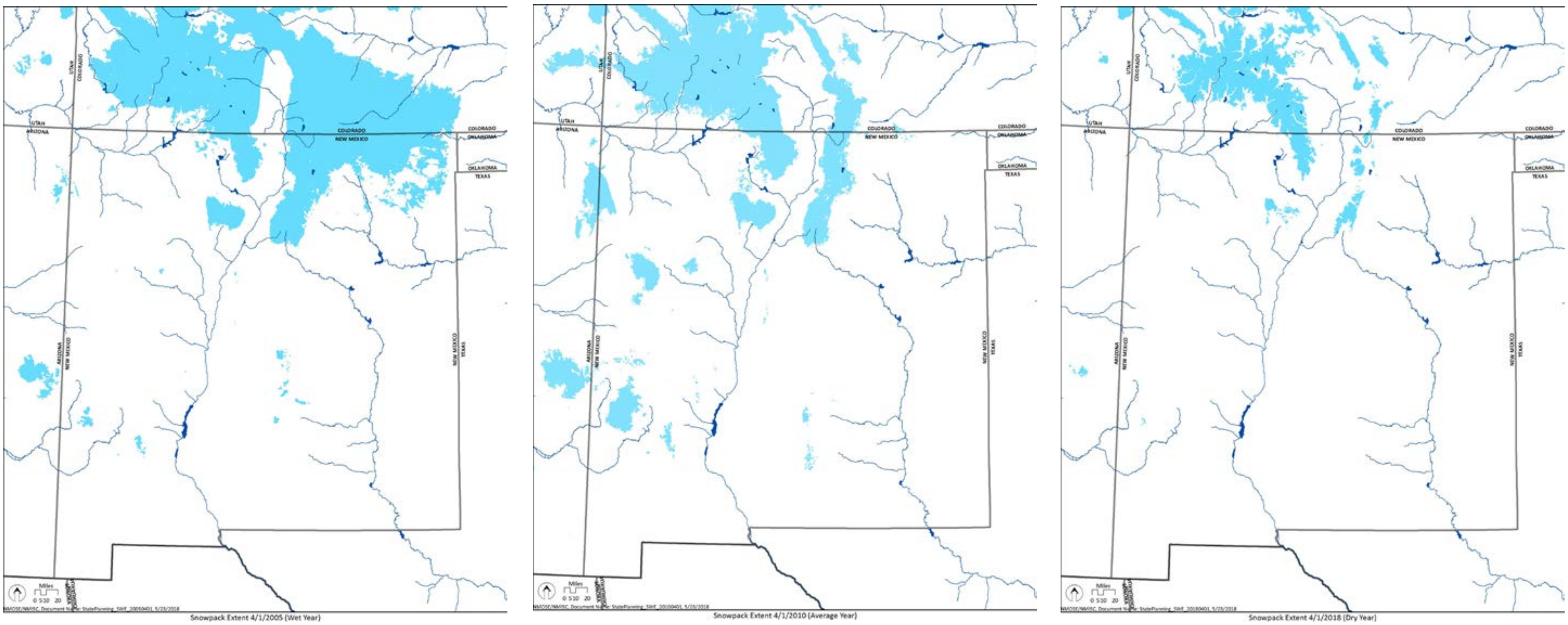
Figure 3-3. Gross Annual Lake Evaporation.



Wet (2005) Average (2010) Dry (2018)

Source Data: National Operational Hydrologic Remote Sensing Center. 2004. Snow Data Assimilation System (SNODAS) Data Products at NSIDC, Version 1. SWE. Boulder, Colorado USA. NSIDC: National Snow and Ice Data Center. doi: https://doi.org/10.7265/N5TB14TC. [May 2018].

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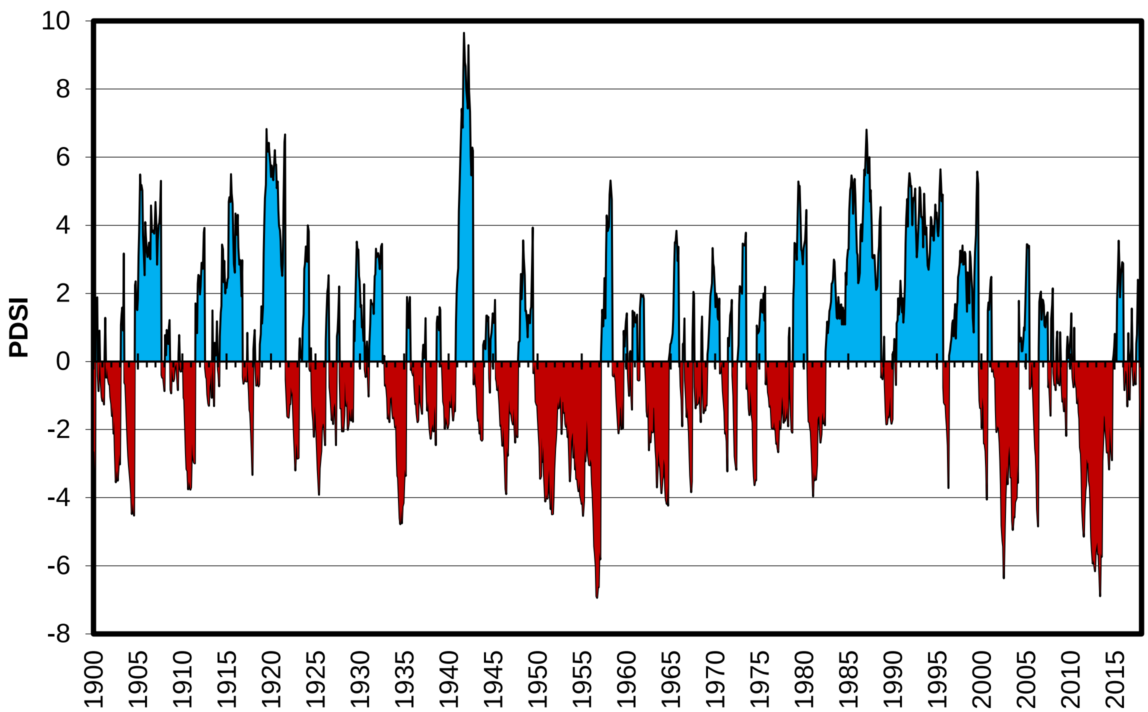
Figure 3-4. Snowpack on April 1 for a Wet (2005), Average (2010), and Dry (2018) Year.

3.1.2 Climate Variability and Drought

The RWPs also summarized long-term drought records based on the Palmer Drought Severity Index (PDSI). The PDSI is a drought index (a ranking system) derived from the assimilation of data—including rainfall, snowpack, streamflow, and other water supply indicators—for a given area. Long-term PDSI records are available for eight climate divisions in New Mexico, and these records were presented in each of the RWPs. The variability of this drought index for a Northern New Mexico climate division is included as Figure 3-5; a map of the climate divisions is included in Appendix B. The PDSI graph for the seven other climate divisions show the same trends with some local variations.



Notes:
Drought periods indicated in red; above average precipitation indicated in blue.

Figure 3-5. Palmer Drought Severity Index for New Mexico Climate Division 2 in Northern New Mexico.

As indicated by the variable PDSI, New Mexico's climate has historically exhibited a high range of variability. Periods of extended drought, interspersed with relatively short-term, wetter periods are common. Historical periods of high temperature and low precipitation have resulted in high demands for irrigation water and higher open-water evaporation and riparian evapotranspiration.

3.1.3 Climate Change

In addition to natural climatic cycles that affect precipitation patterns in the southwestern United States (i.e., El Niño/La Niña, Pacific Decadal Oscillation [PDO], Atlantic Multidecadal Oscillation [AMO] and the North American Monsoon), there has been considerable recent research on potential climate change scenarios and their potential impact on the southwestern United States, including New Mexico.

The consensus on global climate conditions is represented internationally by the work of the Intergovernmental Panel on Climate Change (IPCC), whose Fifth Assessment Report, released in September 2013, states, "Warming of the climate system is unequivocal, and since the 1950s many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased" (IPCC, 2013). Atmospheric concentrations of greenhouse gases are rising so quickly that all current climate models project significant warming trends over continental areas in the 21st century.

In the United States, regional assessments conducted by the United States Global Change Research Program (USGCRP) have found that temperatures in the southwestern United States have increased and are predicted to continue to increase, and serious water supply challenges are expected. Water supplies are projected to become increasingly scarce, calling for trade-offs among competing uses and potentially leading to conflict (USGCRP, 2014). Most of the major river systems in the southwestern United States are expected to experience reductions in streamflow and other limitations to water availability (Garfin et al., 2013).

Although there is consensus among climate scientists that global temperatures are warming, there is considerable uncertainty regarding the specific spatial and temporal impacts that can be expected. To assess climate trends in New Mexico, the OSE and ISC conducted a study in 2006 of observed climate conditions over the past century and found that observed wintertime average temperatures had increased statewide by about 1.5 degrees Fahrenheit (°F) since the 1950s. Several studies predict temperature increases in New Mexico from 5°F to 10°F by the end of the century (Forest Guild, 2008; Hurd and Coonrod, 2008; USBOR, 2011).

Predictions of annual precipitation are subject to greater uncertainty, particularly regarding precipitation during the summer monsoon season in the southwestern United States (OSE/ISC 2006). In parts of the state snowpack is expected to be lower and snowmelt is expected to be earlier (Gutzler, 2013, Gori et al., 2014).

Based on these studies, the effects of climate change that are likely to occur in New Mexico and the planning regions include (OSE/ISC, 2006):

- Temperature is expected to continue to rise.
- Higher temperatures will result in a longer and warmer growing season, resulting in increased water demand on irrigated lands and increased evapotranspiration from riparian and forested areas, grasslands, and forests, and thus less recharge to aquifers.
- Reservoir and other open-water evaporation is expected to increase. Soil evaporation is also expected to increase.
- Precipitation is expected to be more concentrated and intense, leading to increased projected frequency and severity of flooding.
- Stream flows in major rivers across the Southwest US, including New Mexico, are projected to decrease substantially during this century (e.g., Christensen et al., 2004; Hurd and Coonrod, 2008; USBOR, 2011, 2013) due to a combination of diminished cold season snowpack in headwaters regions and higher evapotranspiration in the warm season. The seasonal distribution of streamflow is projected to change as well: flows could be somewhat higher than at present in late winter, but peak runoff will occur earlier and be diminished. Late spring/early summer flows are projected to be much lower than at present, given the combined effects of less snow, earlier melting, and higher evaporation rates after snowmelt.

Forest habitat is vulnerable to both decreases in cold-season precipitation and increases in warm-season vapor pressure deficit (Williams et al., 2010, Williams et al., 2013). Stress from either of these factors leave forests increasingly susceptible to insects, forest fires, and desiccation. Greater temperatures also increase insect survivability and fire risk.

Climate change will have a significant impact on New Mexico's water resources, forests, and infrastructure. The projected decline in surface water supplies will undoubtedly result in greater reliance on limited groundwater resources. New Mexico and Colorado's forested lands, the primary source of much of our water supply, will be subjected to increasing potential for catastrophic forest fires and the debris flows that can follow after high intensity rainfall events. As discussed in Sections 6 and 7, many of the key issues and proposed strategies are in response to these projected changes. New Mexicans have a keen interest in expanding the knowledge of groundwater resources and exploring new potential sources through desalination. For several decades, New Mexicans have been implementing forest treatments and restoration strategies to improve the resilience of the landscape to forest fire, droughts and flooding. A better understanding of the statewide condition of New Mexico's forests and the vulnerability of infrastructure to flooding and debris flows from extreme precipitation events is universal desire from all regions.

3.2 SURFACE WATER

The major river basins located in New Mexico include the San Juan, Rio Grande, Pecos, Canadian and Gila. These major river basins, as well as other basins and the 2010 and minimum stream flow at key gages, are shown in Figure 3-6. Figure 3-6 illustrates that the greatest volume of surface water in New Mexico is in the San Juan basin, where flows primarily originate in the San Juan Mountains of southwestern Colorado. Planning regions of the state that rely primarily on surface water (Figure 3-1) include the Colfax, Mora-San Miguel-Guadalupe, Rio Chama, and San Juan, which receive more than 90% of their supply from surface water; these regions are particularly vulnerable to drought and do not have widespread abundant alternative groundwater supplies, although the San Juan Region benefits from more plentiful reservoir storage. Other regions with significant surface water use (60 to 80%) include Jemez y Sangre, Lower Rio Grande, Middle Rio Grande, Socorro-Sierra, and Taos; these regions also are vulnerable to drought, as are sub-areas within other regions.

Surface water in the state is fully appropriated and the diversion and storage of water is regulated by the OSE to protect senior rights to water including, where applicable, to ensure that the state of New Mexico is in compliance with its obligations under the interstate compacts to which the state is a signatory. The regulations generally require that withdrawals and consumptive use be limited or capped or offsets be provided, depending on varying hydrologic conditions. Thus, the flow at a stream gage does not necessarily determine the availability of water. To resolve this difficulty, the concept of the "administrative water supply" (Section 3.5) was formulated to provide reasonable estimates of the amount of water available for use to in each planning region. This concept removes compact obligations from the equation by examining what was diverted in a "normal year" when New Mexico's compact obligations were met.

New Mexico's Interstate Compacts

Canadian River Compact

Colorado River Compact

Upper Colorado River Basin Compact

La Plata River Compact

Rio Grande Compact

Costilla Creek Compact

Pecos River Compact

Animas-La Plata Project Compact

An important part of surface water supply is reservoir storage, allowing water to be saved during spring snowmelt and periods of high precipitation for later use. Major water supply reservoirs are present in all the major river basins except the Gila River. The RWPs also identified the status of both the larger and smaller dams in each region, indicating that seven out of 297 dams are in unsatisfactory condition and 180 dams around the state are in poor condition (New Mexico Dam Inventory, 2017).

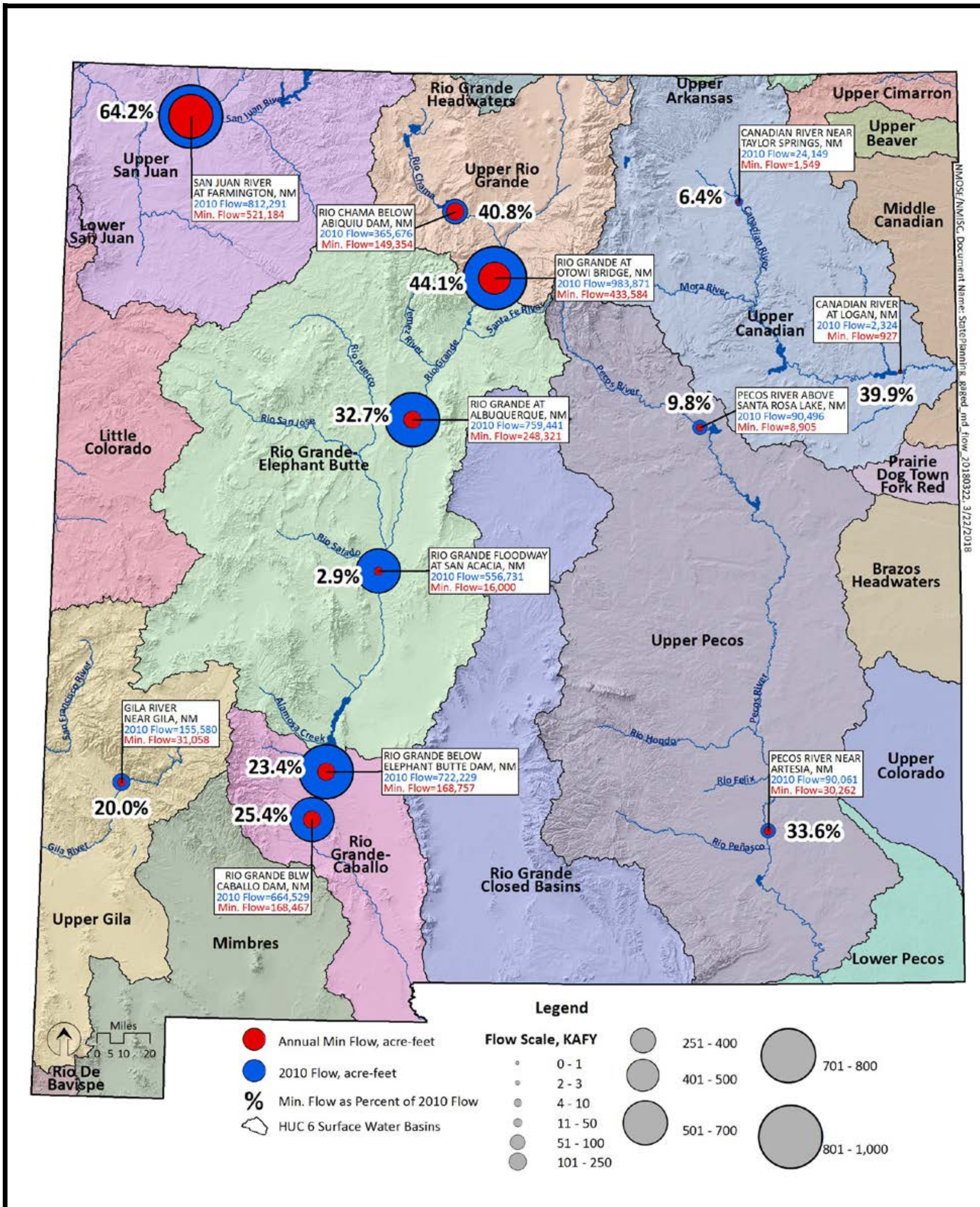


Figure 3-6 Surface Water Basins in New Mexico Showing Flow in 2010 and Minimum Flow at Key Gages for the Available Period of Record.

3.3 GROUNDWATER

Groundwater resources throughout New Mexico vary widely: from conceptually simplistic, bathtub-like basin-fill aquifers of the Ogallala in Eastern New Mexico, to highly complex and poorly understood water resources in the folded geologic layers and volcanic features of the Ortiz Mountains, to the well-studied shallow and confined aquifers of the Roswell Basin, to practically non-existent in the upper Chama Valley. Driven in part by interstate compacts and the goal of protecting senior water rights holders, the New Mexico State Engineer began managing the impact of groundwater pumping on surface water in 1956 by declaring groundwater basins.

A declared groundwater basin is an area of the state proclaimed by the State Engineer to be underlain by a groundwater source having reasonably ascertainable boundaries. By such proclamation the State Engineer assumes jurisdiction over the appropriation and use of groundwater from the source. The Rio Grande Basin was the first basin declared, in 1956. By 2005 all areas in New Mexico were incorporated into a declared area (OSE, 2005), as shown in Figure 3-7.

3.3.1 Sources of Groundwater

Major groundwater resources in New Mexico (depicted in Figure 3-8) include the well-defined formally named aquifers; such as the Ogallala/High Plains, Roswell Basin, Pecos alluvial, Estancia, and Capitan Reef aquifers. The Santa Fe Group and other groundwater resources in the northern, middle, and lower Rio Grande valley are not clearly defined in all sections and vary greatly in depth, lateral extent, and quality throughout the reach of the Rio Grande. Figure 3-8 shows the various aquifers and declared basins and depicts the extent of the basin fill, but not the saturated thickness of the aquifers. Likewise, the water resources of the Mimbres and other basin and range aquifers in southwestern New Mexico vary from “closed” to “stream-connected” and the extent of the resources is poorly understood. The water quality in closed basins, such as the basin fill in the Tularosa Basin, is generally saline towards the center of the basin and better quality where recharge from the mountain front enters the aquifer. Water in limestone and sandstone formations is variable in both quality and quantity but is generally better quality and more productive than the groundwater obtained from shale formations.

Limited groundwater supplies also occur in some regions that have a low potential to hold water (insufficient pore space in the rock, such as volcanic or crystalline rocks) or poor-quality groundwater resources due to the geologic nature of the rocks (shales and evaporites). Some wells can be drilled to deeper depths; however, local geologic conditions, and/or economic, or water quality issues often limit accessibility to deeper groundwater resources. Some limited aquifers occur in layers of Triassic and Cretaceous sandstone beds in the San Juan Basin and other parts of the state. Such aquifers, particularly those comprised of dipping sandstone beds like the San Juan Basin, are more complicated to map and require three-dimensional depiction of aquifers.

While the groundwater resources of some portions of the state have been extensively investigated and characterized, such as the Middle Rio Grande basin in the vicinity of the City of Albuquerque, the resource in large portions of the state are poorly defined or understood. As discussed in sections 6 and 7, the water planning regions are seeking more information about the extent and quality of groundwater resources in the state. The New Mexico Bureau of Geology and Mineral Resources (NMBGMR) has embarked on an aquifer mapping program to address this shortcoming. The NMBGMR program will provide details about the available studies on groundwater resources and they have already provided information on the general extent and quality of brackish aquifers in New Mexico (Land, 2016).

Outside of the major groundwater resource areas that are used to supply groundwater for agriculture, municipal and industrial use as well as local domestic supplies, limited groundwater resources are present in most locations. Most of the Public Water Systems (PWSs), including small water systems throughout the state, rely on groundwater. Of the total PWSs in NM, approximately 94% purchase or use groundwater as the primary source of drinking water and supply water to roughly 1,090,000 consumers, or approximately 54% of consumers who receive water from a PWS (NMED, 2016).

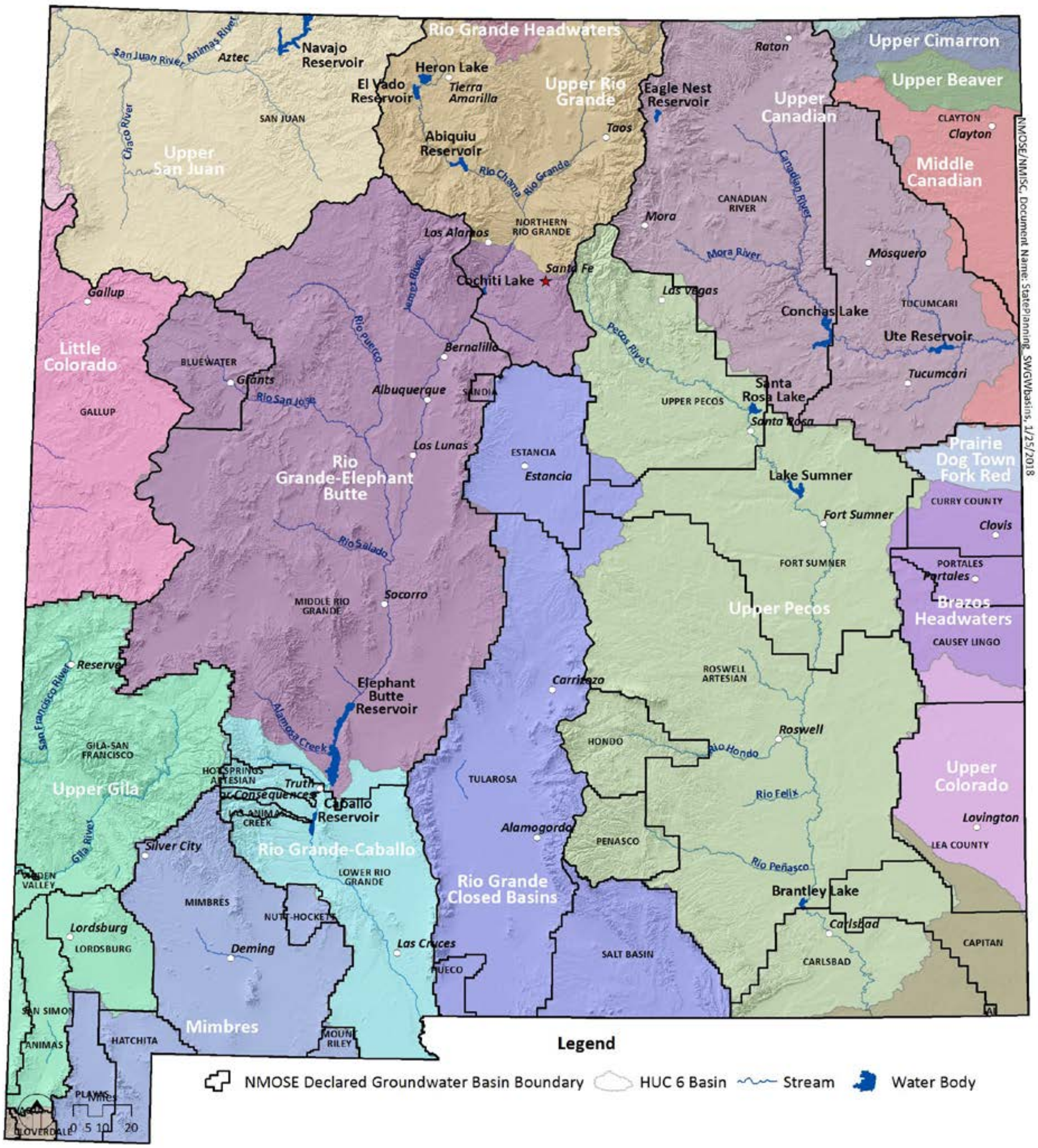


Figure 3-7. Surface Water Basins, Declared Groundwater Basins in New Mexico.

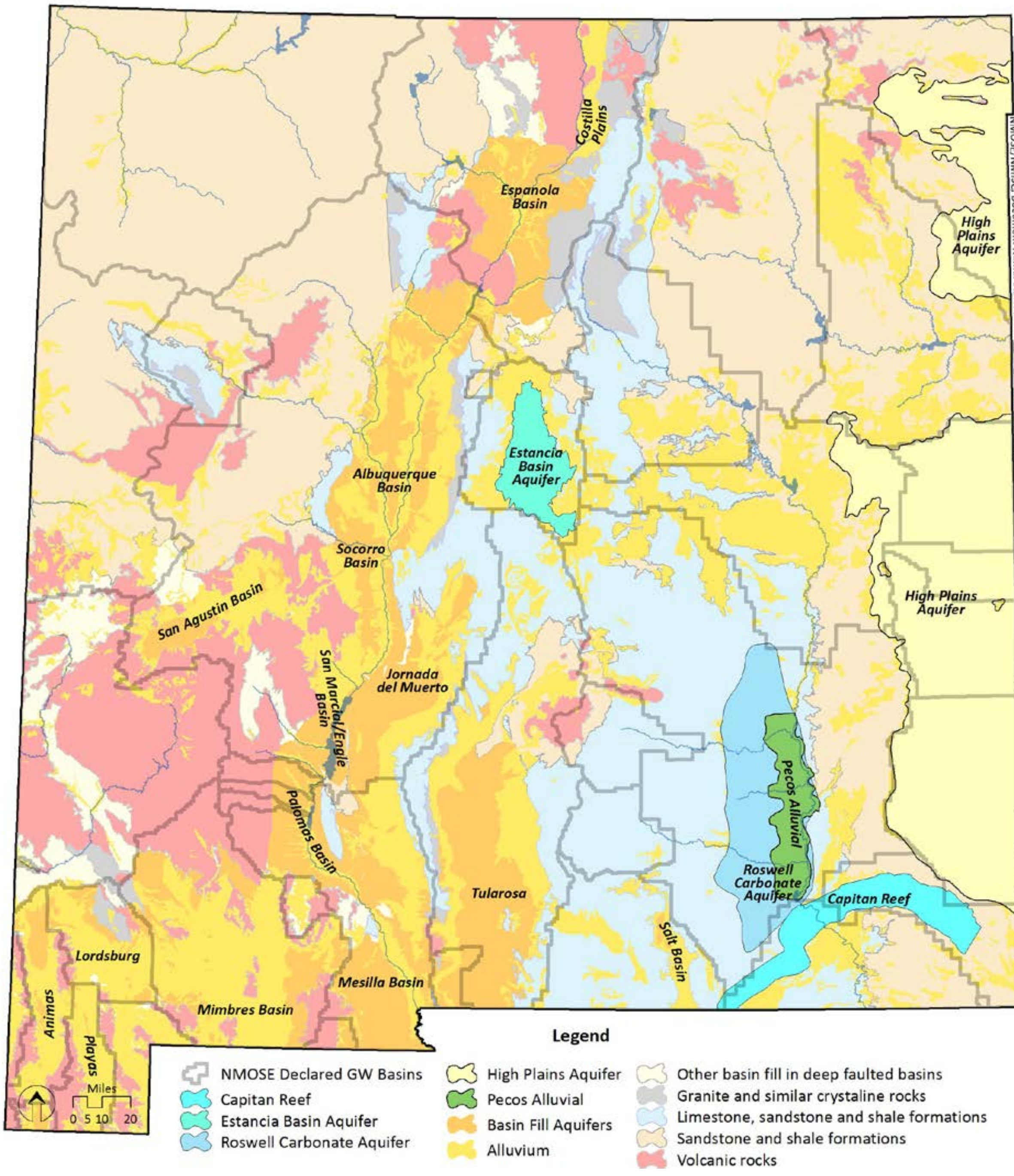


Figure 3-8. Declared Groundwater Basins, Geology and Aquifers in New Mexico.

3.3.2 Declining Groundwater Supplies

In general, groundwater provides a stable and reliable water supply to communities throughout New Mexico; however, in many locations groundwater pumping and other natural discharges exceed recharge, resulting in decline in groundwater levels. In other locations, the pumping is constrained by the OSE so that the effects of the pumping on a stream system are fully offset or constrained to some other degree (set amount per year per well or well system, etc.). Figure 3-9 shows the groundwater basins in New Mexico with declining aquifers (depicted as “select aquifers”) where recharge is much less than pumping, resulting in a “mined aquifer.”

New Mexico OSE has designated Critical Management Areas, also shown on Figure 3-9, to restrict pumping in some aquifers and manage water level declines. Stream-connected aquifers are also declining in some areas as illustrated by the average change in water levels outside of the mined aquifers. Several of the Critical Management Areas are within stream-connected aquifers. Water levels in a stream-connected aquifer may recover much more rapidly than a mined aquifer due to induced recharge from stream losses as a result of groundwater pumping. The future water supply discussed in Section 3.5 was adjusted for the groundwater basins with mined aquifers shown in Figure 3-9.

Some main areas that are affected by declining water levels and by limited alternative water supplies are identified in their respective RWPs. These areas include:

- The Ogalalla/High Plains aquifer in the Northeast and Lea County regions
- Portions of the Northwest Region (near Gallup)
- Portions of the Estancia Basin Region
- Portions of the Animas, Playas, Mimbres and other closed basins in the Southwest New Mexico Region
- Parts of the Jornado del Muerto basin in the Lower Rio Grande Region

The most dramatic and problematic groundwater mining is occurring in Eastern New Mexico where the Northeast and Lea County regions are dependent on the Ogalalla/High Plains aquifer. Water level declines are greater than 5 feet per year (ft/yr) in the most heavily pumped areas and the saturated aquifer thickness is less than 50 to 150 feet thick. Likewise, the aquifer in the Estancia Basin is declining at an average rate of one ft/yr with an average saturated thickness of 131 feet.

Declining groundwater levels in parts of the Animas, Mimbres, and Nutt Hockett basins (central and southern part of the Southwest New Mexico Region) due to heavy pumping for municipal and agricultural use present an issue for long-term sustainability of groundwater resources. However, groundwater level recovery has been observed in some areas where pumping has diminished.

Water level declines have also affected water supply in the Maxwell area of the Colfax Region, the Ojitos Frios area of the Mora-San Miguel-Guadalupe Region, the Magdalena area of the Socorro-Sierra Region, the Santa Fe, Eldorado and La Cienega area of the Jemez y Sangre Region, portions of the East Mountain area of the Middle Rio Grande Region, and the Mesilla Bolson of the Lower Rio Grande Region.

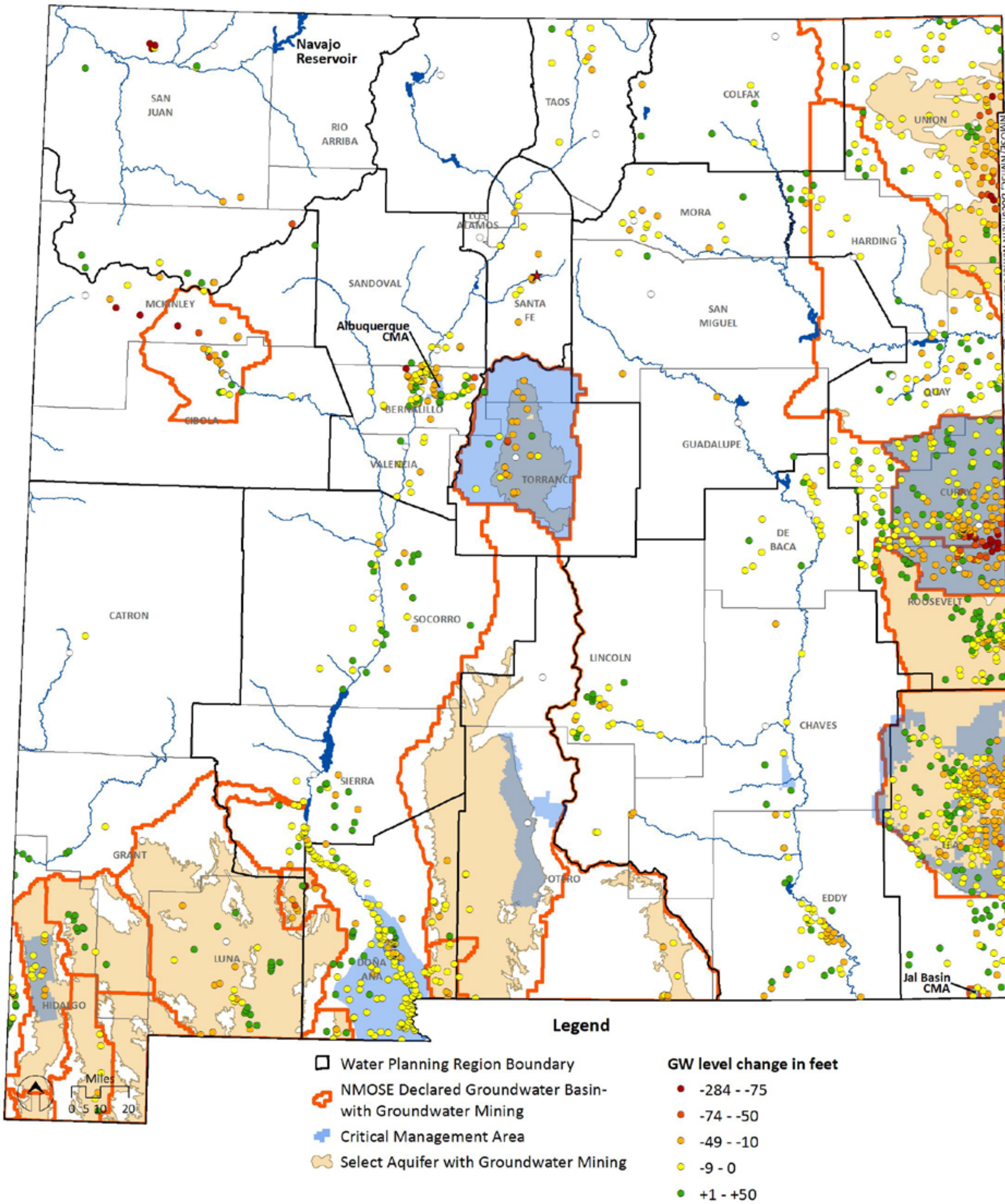


Figure 3-9. Critical Management Areas, Change in Average Water Level (1985-1995 to 2005-2014) and Declared Groundwater Basins with Mined Aquifers.

3.4 WATER BUDGETS

The State Water Plan Act directs the state to develop water budgets. Though the term 'water budget' is used in different ways, sometimes referring to an amount of water that can be legally used in a defined area or for a particular water system, physical water budgets typically refer to an understanding of the amount of water originating from various sources (i.e., precipitation, surface runoff, groundwater inflow to streams) and how much water volume is removed from the local system (i.e., evapotranspiration, groundwater withdrawals).

The recently completed RWPs did not attempt to develop water budgets in the traditional sense, but instead focused on the supply which is legally available in an average or “normal” precipitation year (2010) as determined by the estimated amount of withdrawals, as well as drought corrected supplies to represent a range of planning conditions (see Section 3.5 and 3.6).

The regional water planning boundaries do not lend themselves well to assessing a water budget for each region, because many regions overlap watersheds and some communities obtain water from different watersheds and different planning regions. Furthermore, determining the amount of water available for withdrawal and consumption is particularly challenging in the agricultural sector, where much of the water withdrawn by an irrigation district’s diversion structure or by an acequia returns to the stream as “waste” or “loss” (subsurface seepage return flow to the stream) which is rediverted by a downstream diversion within the same irrigation district or a downstream acequia. Thus, the water diverted by the agricultural sector (80% of the total withdrawals in New Mexico) likely includes water that is rediverted many times. And finally, the “water budget” is highly dependent on scale and location. Different water budgets exist at different locations on a stream because the supply and demand vary along a stream reach.

However, if one purpose of water planning is to evaluate the sustainability of New Mexico’s water resources, then examining the big picture of water supply and demand is necessary. A physical water budget was developed by the New Mexico Water Resources Research Institute (WRRI) with funding provided by the New Mexico Legislature (WRRI, 2017). This model could be used in future iterations of water planning to better characterize future water availability, particularly considering predicted increases in temperature that will impact water yield and demand.

3.5 DESCRIPTION OF ADMINISTRATIVE WATER SUPPLY

To prepare both the RWPs and the State Water Plan, the state developed a set of methods for assessing the available supply and projected demand for “normal” and “drought” supply conditions. As described in the 2013 Handbook (ISC, 2013) a common technical approach was used for RWP updates that were completed in 2016 and 2017. The objective of applying this common technical approach was to be able to efficiently develop a statewide overview of the balance between supply and demand under both normal and drought scenarios, so that the state can effectively plan and fund water projects and programs that will address the state’s pressing water issues.

The method to estimate the available supply, referred to as the *administrative water supply*, is based on withdrawals of water as reported in the *New Mexico Water Use by Categories 2010* report (Longworth et al., 2013), which provides a measure of supply that considers both physical supply and legal restrictions (i.e., the water is physically available, and its use is in compliance with water rights policies and other legal obligations) and thus reflects the amount of water available for withdrawal by a region. Details of this methodology are more fully discussed in Appendix B.

It is recognized that there are several considerations which introduce error into the approximations obtained via the administrative water supply approach. The approach was determined necessary due to the limited budgetary constraints under which the regional water planning process proceeded. It is anticipated that as water planning in New Mexico continues to progress, that more technically sophisticated and accurate evaluations of water supply available to each planning region will be conducted. Considering the actual withdrawals as a measure of supply allows for a reasonable estimate of available water, because it discounts physical supplies that may be present in a region but are required by legal or policy restrictions to be conveyed downstream for use. The administrative water supply was developed as a tool to provide an overview of water supply that incorporates both physical and legal supplies, for broad state planning purposes. It is not intended to replace or negate the need for more detailed water budgets, models, and other analyses to inform specific projects or local planning decisions. Some of the limitations with the administrative supply are discussed in Section 3.5.3.

3.5.1 Estimating Average Supply

The administrative water supply approach provides a reasonable approximation of the average annual water supply available to each planning region. The approach uses withdrawals for 2010, which was a more or less average year. These withdrawals, the overall amount of which are administratively capped due to the fact that the surface water supply (and inter-connected groundwater) in every basin of the state is fully appropriated, provide a reasonably good approximation of each planning region's available average annual water supply. In parts of the state that rely on groundwater resources, the administrative water supply may not be available in the future where the aquifer is in a non-stream connected aquifer and the finite resource is diminishing. In these cases, the future available supply was adjusted to account for the estimated decline in water availability in these aquifers. To estimate the future groundwater supply of closed basins by 2060, groundwater models were used where available, to predict water level declines. For those areas without a groundwater model and for comparison to the model results, the future decline was projected from water level hydrographs and compared to the available water column in existing wells as described in Appendix B.

3.5.2 Estimating Drought-Corrected Supply

An estimate of supply during future droughts was also developed for each region by adjusting the 2010 withdrawal data based on physical supplies available during previous severe droughts. The PDSI, which is an indicator of whether drought conditions exist, and if so, what the relative severity of those conditions is, indicates that for the 8 climate divisions present in New Mexico, five were near normal (where the PDSI is near to zero) and three were in incipient wet spells. Given that the water use data for 2010 represent a near normal to slightly wetter than normal year, it cannot be assumed that the average supply will be available in all years, in fact, half of the years will be drier than the "normal" water supply year. Thus, it is important to also consider potential water supplies during severe drought conditions.

There is no established method or single correct way of quantifying the water supply available during severe drought conditions, given the complexity associated with varying levels of drought and constantly fluctuating water supplies. For purposes of having an estimate of the water supply available during severe drought conditions for regional and statewide water planning, the state developed and applied a method (called a "drought correction") for surface water and for groundwater in regions with both stream-connected and non-stream-connected aquifers. The drought-corrected surface water supply is based on a review of historical stream gage records as detailed in Appendix B.

In non-stream-connected, or closed, basins, the administrative water supply was adjusted to consider potential long-term severe drought impacts on groundwater in conjunction with evaluating declines in groundwater levels due to pumping impacts. To estimate the vulnerability of closed basins to a prolonged severe drought within a planning region, groundwater models were used where available to predict the potential impact by 2060 of a drought lasting 20 years (in which no recharge occurred over the 20-year period). For those areas without a groundwater model, the future decline of the saturated thickness relied on an adjustment to the observed decline in water level hydrographs as described in Appendix B. In both approaches the predicted water level decline was compared to the available water column in existing wells.

3.5.3 Administrative Supply Limitations

As mentioned earlier, the supply estimates have limitations but provide an approximation of the "average" and "drought" supplies. The drought-corrected surface water supply and both approaches for evaluating groundwater sustainability are simplifications used to obtain an order of magnitude of expected changes in supply. The drought-corrected surface water supply provides a rough estimate of what may be available during a severe to extreme period of drought. The groundwater evaluations also represent an approximation of the impact of severe drought on existing wells by 2060.

Factors to consider when interpreting these results include:

- The project water and water rights held by PWS for future use was not considered in the RWP, except for the San Juan Region which incorporated the Navajo-Gallup Water Supply Pipeline in the administrative supply for that region. Other regional water supply projects that will provide future supply will provide water that was not included in the administrative supply, such as the proposed Ute Pipeline for communities in south of Ute Reservoir and San Juan-Chama Project water that has not been put to beneficial use.
- Public institutions, including PWSs, are allowed by statute (NMSA §72-1-9 [40-year plans]) to reserve rights for projected demands 40 years into the future; and thus, some communities have planned for development of new supplies in conjunction with retention or acquisition of water rights or project water, and thus, the amount a PWS diverted in 2010 does not necessarily represent the limit of their supply.
- The drought correction developed as part of the common technical approach to reflect limits to surface water supplies may not accurately represent the vulnerability of those PWSs that have developed a conjunctive use strategy. For example, it may appear that a PWS is very vulnerable to drought, when in reality that PWS has a conjunctive use strategy using a portfolio of water sources that allows the PWS to continue to provide water supply, even in severe drought conditions (such as the cities of Albuquerque and Santa Fe).
- Though the drought-corrected surface water adjustment is based on the minimum year of streamflow recorded to date compared to the flow in 2010, it is possible that drought-corrected surface water supplies could be even lower at times in the future.
- Water supplies downstream of reservoirs may be mitigated by reservoir releases in early phases of a severe drought, but longer-term severe droughts may exhaust those storage supplies and have potentially much more significant consequences and socio-economic impacts.
- In some parts of the state, particularly in some of the larger planning regions, surface water irrigators are far removed from developed groundwater sources, making use of alternative groundwater supplies difficult. Thus, severe drought may result in greater impacts to the portions of the region entirely dependent on surface water than to the other portions of the region.

The drought-corrected surface water and groundwater supplies identify an order of magnitude quantity of water that may be available in a severe drought without considering priority dates of water rights and how limited supplies may be administered under drought conditions. For example, the Rio Grande Compact constrains reservoir storage in northern New Mexico during times of drought when water levels are low in Elephant Butte Reservoir. Administration on the Rio Chama provides native flow to senior users but protects storage releases for downstream users. Thus, a linear adjustment to the surface water supply does not reflect the complexity of how river basins are managed. Actual physical supply may be sufficient to meet surface water supplies, even in drought years, depending on the point of diversion (or withdrawal) within the stream. For instance, the minimum stream flow on the mainstem of the Rio Grande above the Otowi gage is more than enough to meet the surface water demands of direct diversions from Pilar to Otowi.

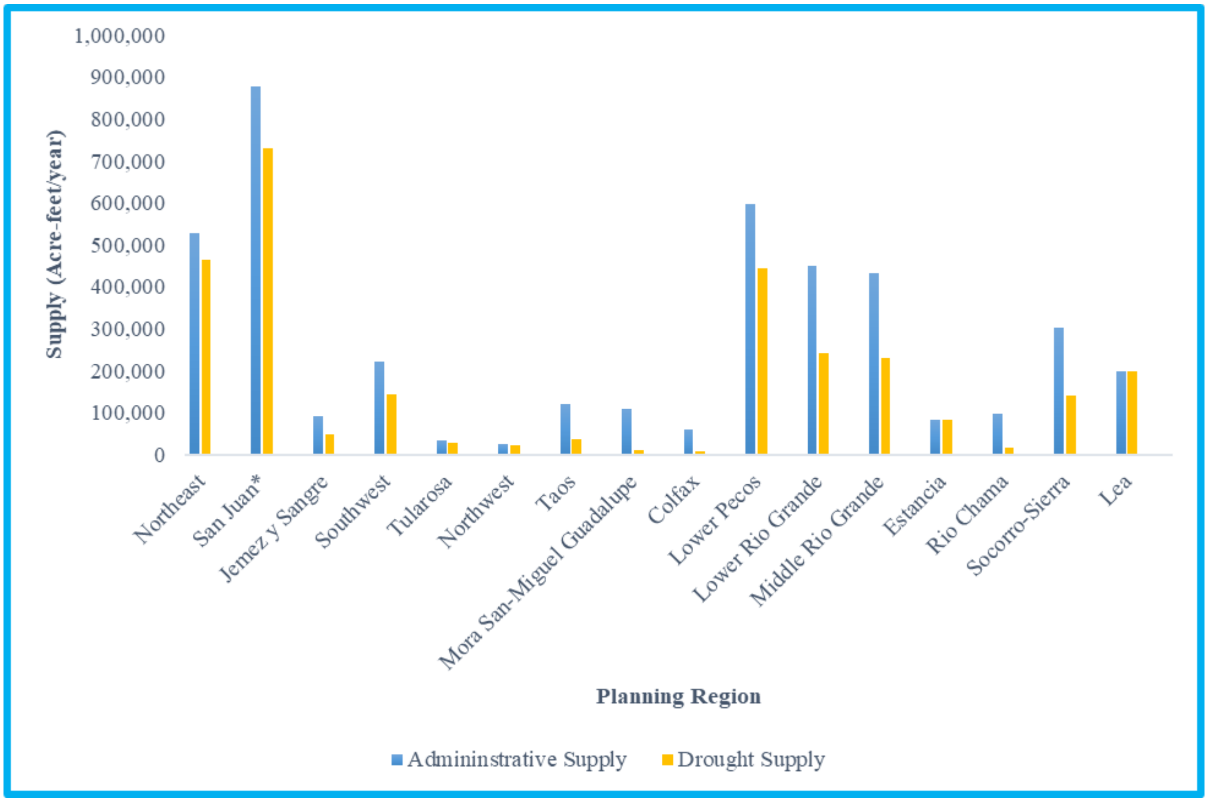
Groundwater declines are also occurring in some stream-connected aquifers. The long-term ability of groundwater to sustain existing pumping rates has not been examined for stream-connected aquifers. Spring flow from groundwater that discharges to surface water may also be declining in areas with groundwater pumping, an impact that may not manifest in a river for many decades. Quantifying these impacts require numerical models that simulate surface and groundwater interaction and could be performed for future planning efforts.

Compact obligations, priority administration, riparian evapotranspiration and instream flow to meet Endangered Species Act needs are not explicitly represented in the administrative supply. While the 2010 water diversions were used to represent “average” supply, that supply was dependent on the amount of water in storage and the other factors that allowed the state to meet legal obligations. Thus, changes in the volume of water in storage to meet the 2010 water demands or changes in total riparian evaporation, for instance, will impact the supply, even in an average year.

The water planning regions are large, and it is important to note that each entity within each region and water use sector must plan for their water supply future. Water is not necessarily shared, so although one PWS, for instance, may be resilient during drought, another may be severely impacted, even though both are in the same region. Currently unexercised water rights secured for future use and for conjunctive use by public water utilities will be incorporated in future regional and state water planning efforts.

3.5.4 Estimated Average and Drought-Corrected Supplies by Region

The administrative and drought-corrected surface water and groundwater supplies for the 16 planning regions are shown in Figure 3-10 (2010 only) and Table 3-1 (2010-2060). As shown on Table 3-1, the drought supply is significantly lower than the administrative water supply in regions that are heavily surface water dependent, especially the Mora San-Miguel Guadalupe, Colfax, San Juan and Upper Rio Chama regions, where more than 90% of the supply is from surface water.



Note:
*Available water supply calculated instead of administrative water supply due to unique conditions in the San Juan planning region; including
1) substantial reservoir capacity that was developed to allow the water in the San Juan River to be used,
2) authorized full development of federal water supply projects,
3) actual diversion practices and reservoir operations on the San Juan and Animas Rivers, and
4) the water apportionments made to New Mexico by the Colorado River and Upper Colorado River Basin Compacts, as detailed in Appendix B.

Figure 3-10. Administrative and Drought-Corrected Water Supply in 2010 as Reported in the Regional Water Plans.

Table 3-1. Administrative and Drought-Corrected Water Supply, 2010-2060 as Reported in the Regional Water Plans.

Region		Supply	Amount (ac-ft)					
			2010	2020	2030	2040	2050	2060
1	Northeast	Administrative	528,450	427,580	326,710	225,830	180,940	139,330
		Drought	463,330	351,660	240,000	138,090	90,030	63,950
2	San Juan*	Administrative	876,300	876,300	876,300	876,300	876,300	876,300
		Drought	729,630	729,630	729,630	729,630	729,630	729,630
3	Jemez y Sangre	Administrative	90,480	90,480	90,480	90,480	90,480	90,480
		Drought	48,390	48,390	48,390	48,390	48,390	48,390
4	Southwest	Administrative	222,540	212,190	201,840	191,490	181,140	175,020
		Drought	143,610	131,590	119,560	107,540	96,750	90,190
5	Tularosa-Sacramento-Salt	Administrative	32,810	31,500	30,180	28,870	27,550	26,240
		Drought	28,310	26,310	24,310	22,300	20,300	18,300
6	Northwest**	Administrative	26,140	26,140	35,990	34,340	32,690	31,040
		Drought	21,840	21,840	31,140	28,940	26,740	24,540
7	Taos	Administrative	120,510	120,510	120,510	120,510	120,510	120,510
		Drought	37,340	37,340	37,340	37,340	37,340	37,340
8	Mora-San Miguel-Guadalupe	Administrative	109,210	109,210	109,210	109,210	109,210	109,210
		Drought	10,680	10,680	10,680	10,680	10,680	10,680
9	Colfax	Administrative	60,570	60,570	60,570	60,570	60,570	60,570
		Drought	8,360	8,360	8,360	8,360	8,360	8,360
10	Lower Pecos	Administrative	597,280	597,280	597,280	597,280	597,280	597,280
		Drought	443,300	443,300	443,300	443,300	443,300	443,300
11	Lower Rio Grande	Administrative	450,000	448,630	447,270	445,910	444,540	443,180
		Drought	240,770	238,860	236,950	235,050	233,140	231,230
12	Middle Rio Grande	Administrative	431,640	431,640	431,640	431,640	431,640	431,640
		Drought	228,960	228,960	228,960	228,960	228,960	228,960
13	Estancia	Administrative	84,130	80,290	76,450	72,610	68,770	64,930
		Drought	84,070	76,840	69,610	62,380	55,150	47,920
14	Rio Chama	Administrative	98,090	98,090	98,090	98,090	98,090	98,090
		Drought	17,030	17,030	17,030	17,030	17,030	17,030
15	Socorro-Sierra	Administrative	303,720	303,720	303,720	303,720	303,720	303,720
		Drought	140,170	140,170	140,170	140,170	140,170	140,170
16	Lea	Administrative	197,100	186,800	176,510	166,210	155,920	145,620
		Drought	197,020	183,810	170,590	157,380	144,160	130,950

*Available water supply was calculated instead of administrative water supply in the San Juan Regional Water Plan as described in Appendix B.

** Groundwater supplies are expected to decline in the Northwest Region, but the available water supply is expected to increase beginning in 2024 due to the Navajo-Gallup Water Supply Pipeline coming online. See Northwest Regional Plan for details

4. Water Demand

To effectively plan for meeting future water resource needs, it is important to understand current trends in water use as well as any anticipated future changes. Each RWP included a summary of current water use by category; an evaluation of population and economic trends and projections of future population; a discussion of the approach used to incorporate water conservation in projecting future demand; and projections of future demand for water withdrawals. The RWPs represent the most current evaluation of population, economic changes, and water use forecasts, and are therefore summarized to reflect statewide water use forecasts.

Figure 4-1 shows the projected demand (for withdrawals) under high and low projections and the supply available to meet those demands in an average supply scenario and in a drought-corrected supply scenario. The supply increases in 2020 due to the Navajo-Gallup Water Supply Project. Water demand exceeds the available supply under the high projection during normal water supply conditions by 2040. Under both the high and low projections, water demand is exceeded throughout the projection period during drought-corrected supply conditions.

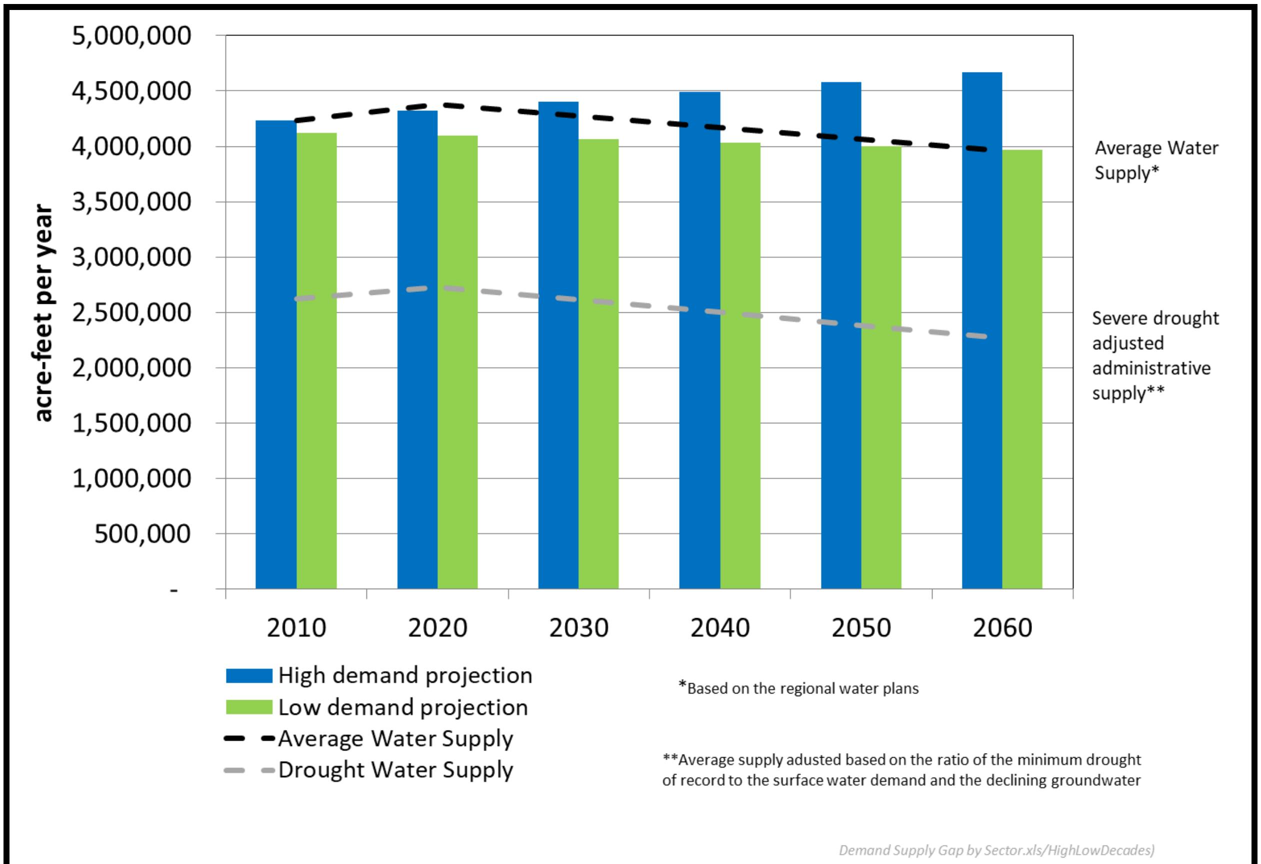


Figure 4-1. Statewide Supply and Demand under the High and Low Growth Projections.

4.1 PRESENT WATER USES

The most recent assessment of water use in the 2016-2017 RWP updates was compiled by the OSE for 2010. The *New Mexico Water Use by Categories 2010* report (Longworth et al., 2013) provides information on total withdrawals (diversions) for the categories of water use shown in Figure 4-2. In addition, there are other categories of unquantified and quantified water use, including riparian evapotranspiration, instream flow, and compact obligations, which are discussed below.

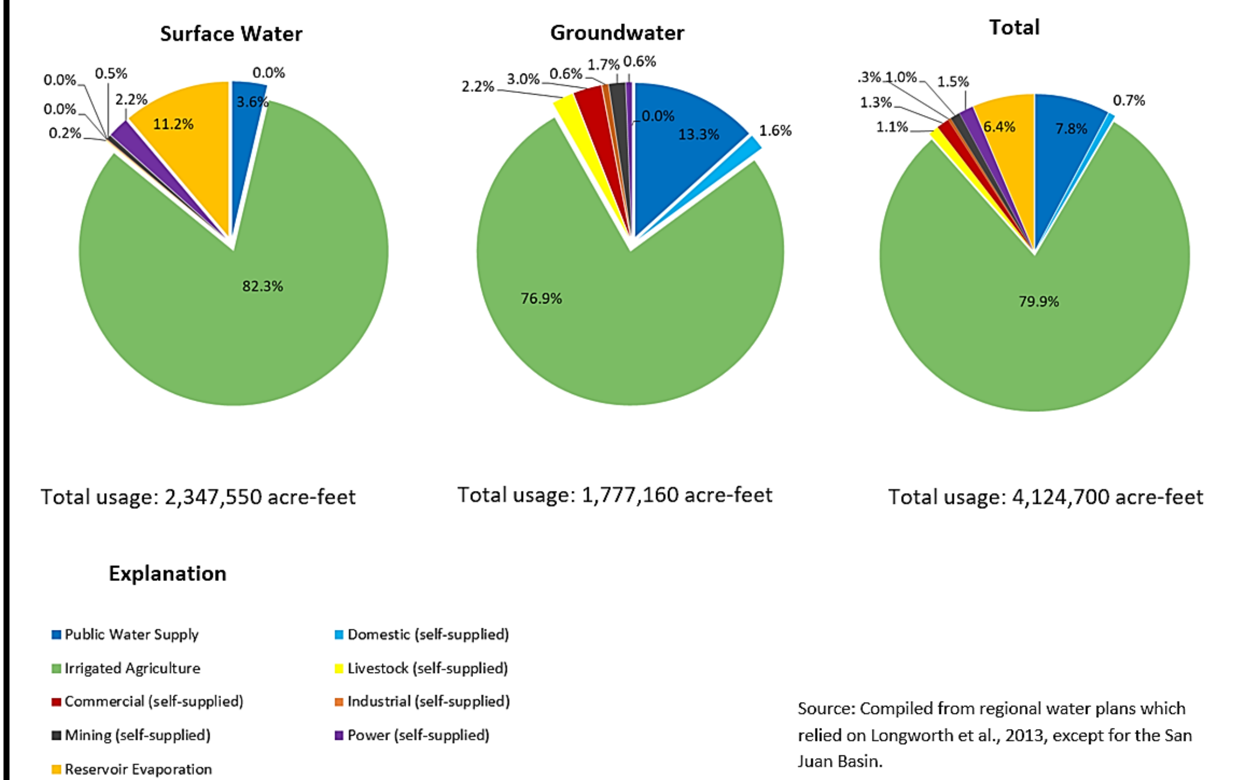


Figure 4-2. Statewide Water Withdrawals by Sector in 2010.

Irrigated agriculture diverted about 80% of the water diverted in 2010 in the state, with public water suppliers diverting 7.8%, and reservoir evaporation consuming 6.4%. It is important to note that the water use information compiled in the RWPs is an assessment of the diversions and not the depletions of water (except for reservoir evaporation). In many cases, some portion of diverted water returns to surface or groundwater; for example, agricultural runoff or seepage, or discharge from wastewater treatment plants, which can be 50% or more.

In those locations where there is return flow, the use of withdrawal data will add a margin of safety; thus, the use of withdrawal data is a conservative approach for planning purposes. *New Mexico Water Use by Categories 2010* report (Longworth et al., 2013) includes estimates of irrigation efficiency (on-farm and off-farm diversion requirements), and the consumptive irrigation requirement (CIR) per acre of crop irrigated. Longworth et al. (2013) does not include estimates of incidental depletions, which is the amount of water that does not seep back into the underlying aquifer or return to a stream or ditch, but is consumed through direct evaporation from ponded water, canals and laterals or evapotranspiration from vegetation along ditch banks.

Riparian evapotranspiration: Some research and estimates have been made for riparian evapotranspiration in selected areas, such as along the middle and lower Rio Grande (Thibault and Dahm, 2011; Coonrod and McDonnell, Undated; Bawazir et al., 2009); however, riparian evapotranspiration has not been quantified statewide. Though riparian evapotranspiration is anticipated to consume a relatively large quantity of water statewide, it will not affect the calculation of the gap between supply and demand using the method in this report, because supply and demand for evapotranspiration are removed from the equation. If the supply was based on flow in the streams and precipitation, then evapotranspiration would need to be included explicitly as a demand. The only impact to the gap calculation would be if evapotranspiration significantly changes in the future. There is potential for such a change due to warming temperatures; however, anticipated changes have not been quantified and would be subject to considerable uncertainty. Anticipated changes in riparian and stream evapotranspiration are both areas that should be considered in future regional and state water plan updates.

Instream flow: The analysis of the gap between supply and demand relies on the largest use categories that reflect withdrawals for human use, or on reservoir storage that allows for withdrawals downstream upon the release of the stored water. It is recognized that there is also value in preserving instream water for ecosystem, habitat, and tourism purposes. Although this value has not been quantified in the supply/demand gap calculation, it is an important use in many parts of the state, and instream/environmental flow protections and projects were identified in several RWPs.

Compact obligations: A legally binding set of rules regarding the amount of water that must be delivered to a downstream state or which place limitations on the amount of water that may be consumed within a region. Compact obligations are, in effect, another water use category that is not explicitly defined in the regional water plans. Instead, compact obligations were incorporated into the regional water planning process by not including the demand or the supply to meet interstate compact obligations. One argument for basing the administrative supply on the amount that was diverted in a “normal year” is that it represents the supply available after compact obligations are considered for the year 2010. If the supply was based on flow in the streams and capacity of wells, then the compact obligations would need to be included explicitly as a demand.

Figure 3-1 and Table 4-1 show the degree to which a region is dependent on surface water or groundwater in 2010. The northern part of the state has minimal groundwater resources, but ample surface water in non-drought years. The regions along the Rio Grande rely on surface water, but also have groundwater resources to meet a significant portion of the water demands. Lea County and the Estancia Basin rely entirely on groundwater from aquifers that are diminishing. The surface water/groundwater distribution as illustrated in Figure 3-1 is expected to shift in some planning regions by 2030 (when the Ute Reservoir Pipeline brings surface water supplies to some communities in eastern New Mexico and the Navajo-Gallup Water Supply Project delivers additional surface water to the Northwest planning region).

Table 4-1. Total 2010 Withdrawals in New Mexico Water Planning Regions.

Region Number	Region	Withdrawal (ac-ft)		Total Withdrawal (ac-ft)
		Surface Water	Groundwater	
1	Northeast	67,136	461,312	528,448
2	San Juan	872,171	4029	876,200
3	Jemez y Sangre	70,143	20,334	90,477
4	Southwest	87,693	134,842	222,535
5	Tularosa	10,005	22,810	32,814
6	Northwest	3,757	24,037	27,793
7	Taos	96,710	23,802	120,511
8	Mora-San Miguel-Guadalupe	101,990	7,215	109,205
9	Colfax	55,549	5,024	60,573
10	Lower Pecos Valley	181,157	416,123	597,279
11	Lower Rio Grande	271,717	178,279	449,996
12	Middle Rio Grande	302,514	129,126	431,640
13	Estancia	60	84,069	84,129
14	Rio Chama	95,362	2,726	98,088
15	Socorro-Sierra	240,515	63,205	303,719
16	Lea County	75	197,024	197,099

Notes:
ac-ft = acre-feet
Source Longworth et al. (2013), except San Juan Basin withdrawals, provided by ISC Colorado River Bureau, 2016; including 105,800 ac-ft of San Juan-Chama exports

The total use by category for the entire state of New Mexico is shown on Table 4-2. Total surface water and groundwater withdrawals for each planning region are shown in Table 4-1. The San Juan Basin Region included the category of "export water" to account for the trans-basin diversion of San Juan-Chama Project water out of the planning region. San Juan-Chama water is already accounted for in other regions, thus it is not included explicitly in Figure 4-2 as a separate category. Figure 4-3 and Figure 4-4 show the location of surface water and groundwater diversion points in New Mexico.

As shown in Figure 4-2 and Figure 4-5, irrigated agriculture is the largest water use category in New Mexico. The breakdown of categories, shown in Figure 4-5 and detailed in Section 5, indicates that most of the water is used for irrigated agriculture in all planning regions except the Northwest Region, where slightly more water is withdrawn for the public water supply category. Even in the Middle Rio Grande Region, where 132,000 acre-feet (ac-ft) were withdrawn for public water supply, the largest use category is irrigated agriculture. Figure 4-6 shows the detail of water demand for each region by sector without irrigated agriculture and reservoir evaporation.

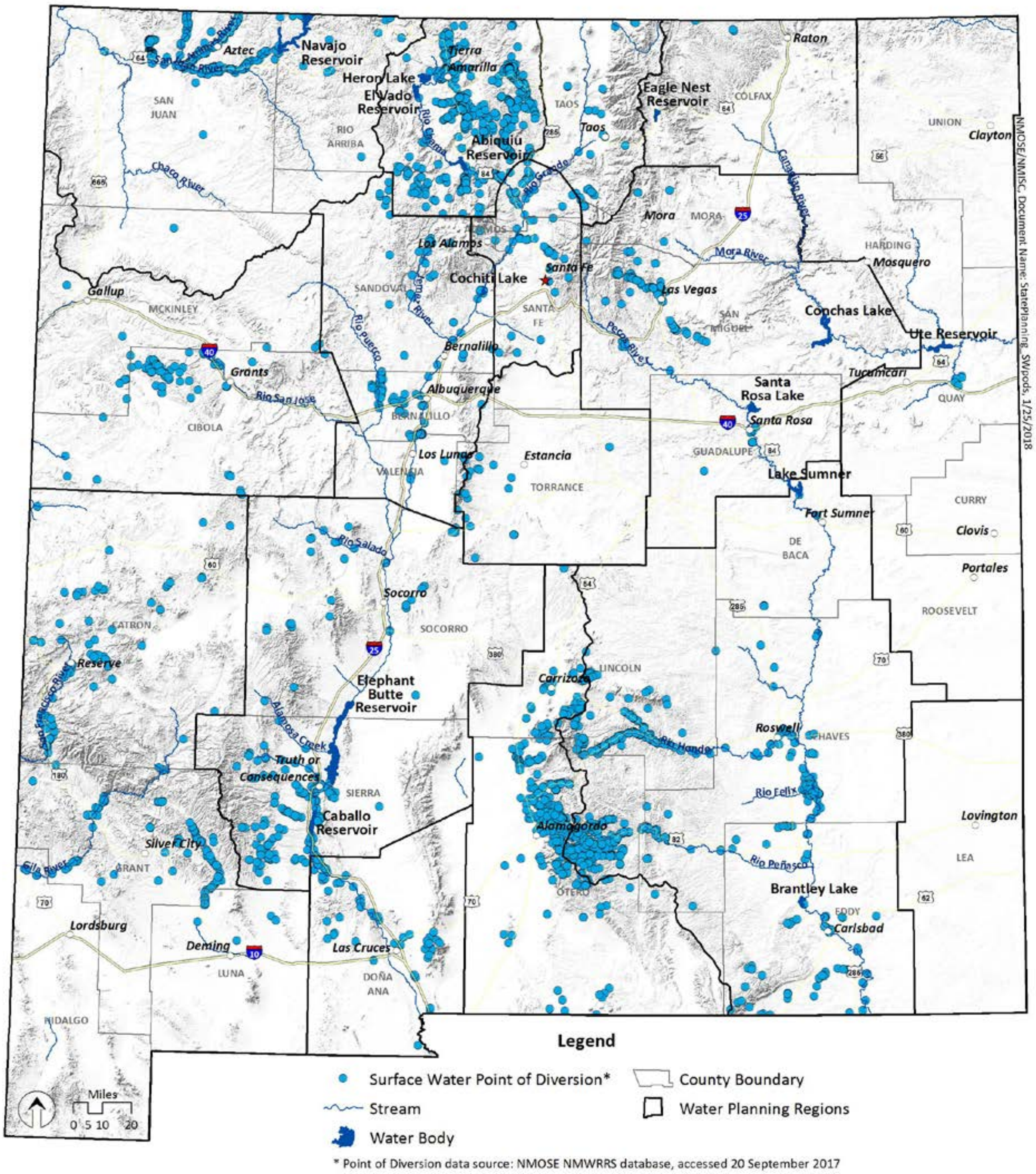


Figure 4-3. Surface Water Points of Diversion in New Mexico.

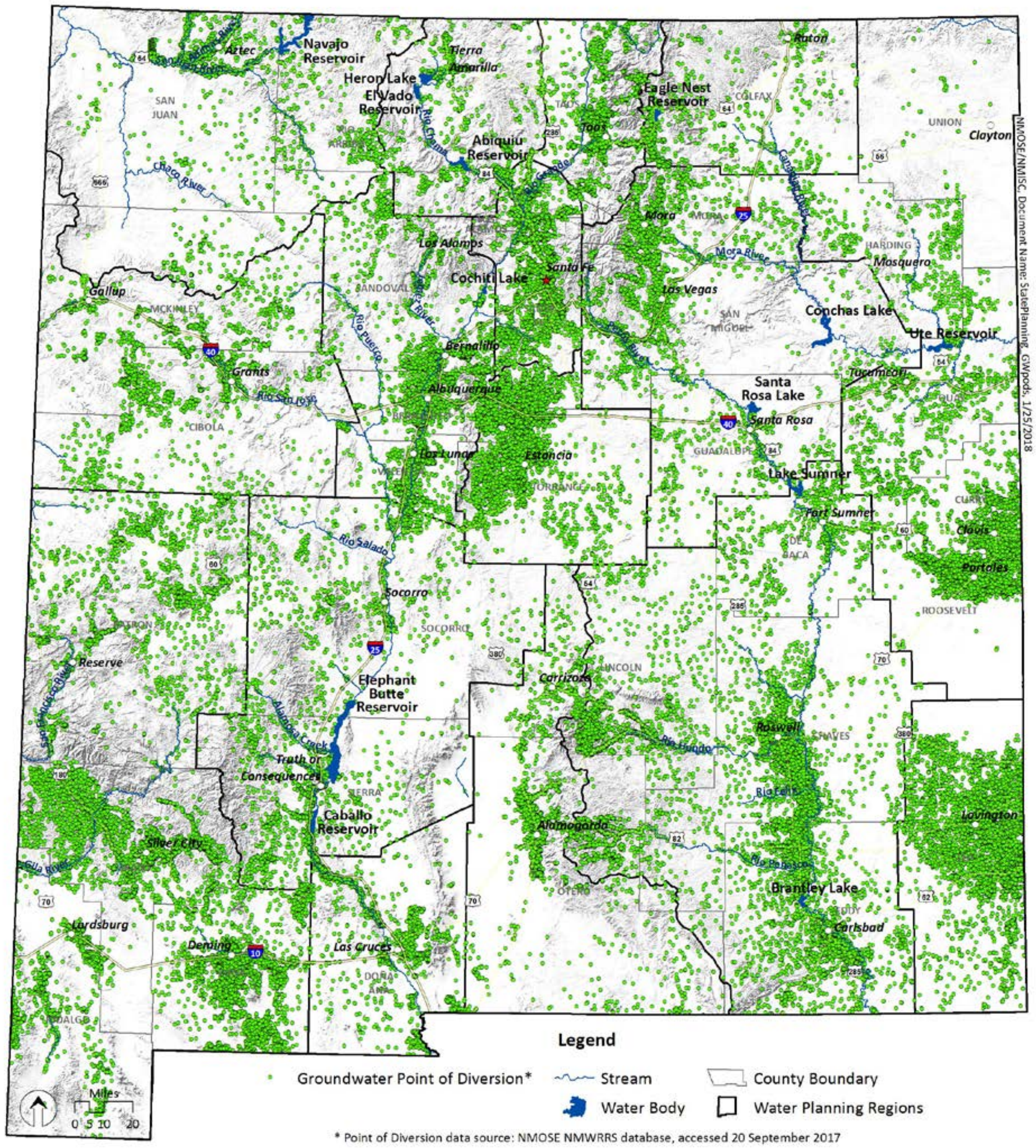


Figure 4-4. Groundwater Points of Diversion in New Mexico.

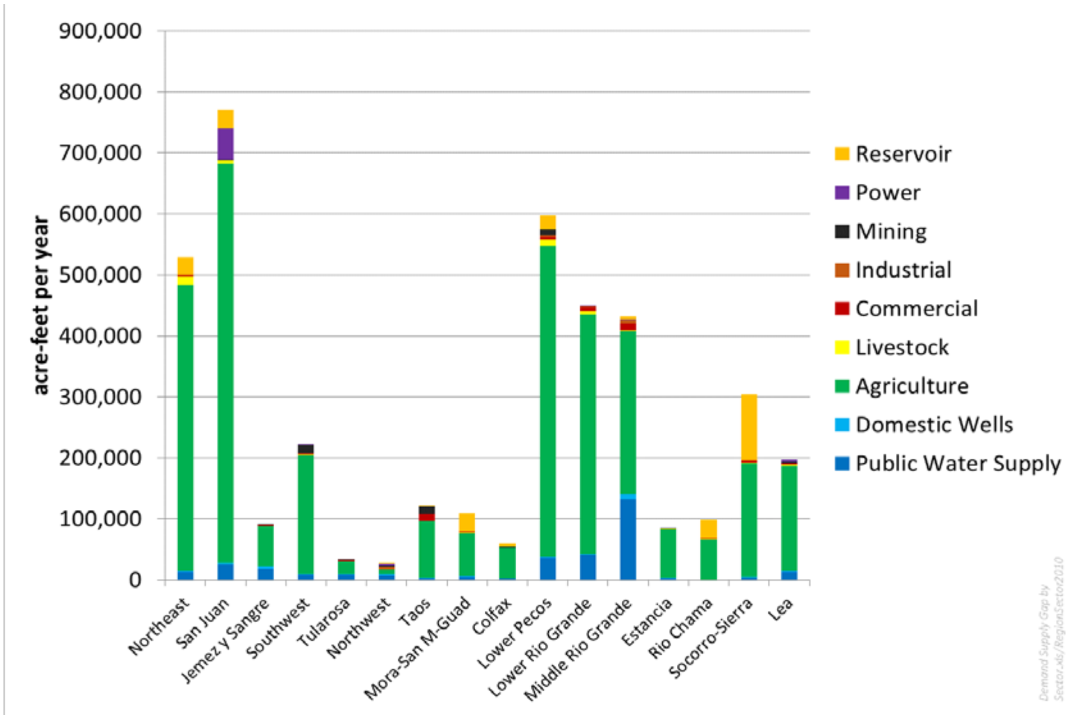


Figure 4-5. Water Demand by Sector and Region for 2010 for All Sectors.

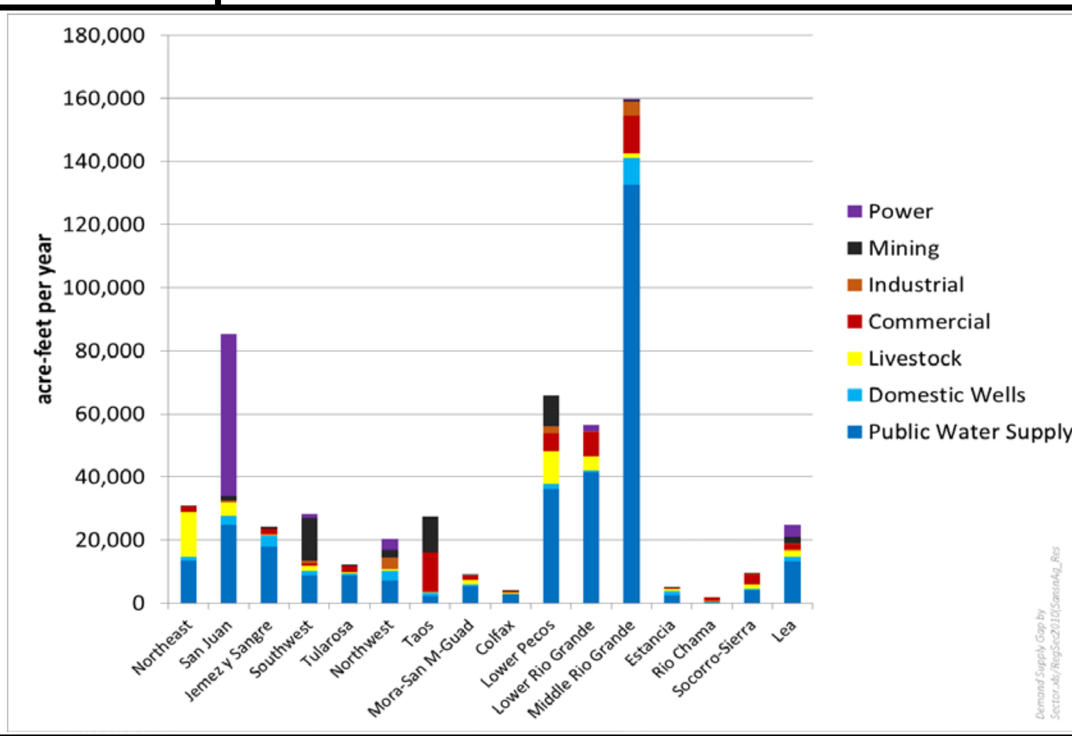


Figure 4-6. Water Demand by Sector and Region in 2010, without Irrigated Agriculture and Reservoir Evaporation.

4.2 DEMOGRAPHIC AND ECONOMIC TRENDS

To project future water demands, it is important to first understand demographics, including both population growth and economic and land use trends. The 2013 populations of New Mexico (Census, 2014) were included in each RWP. In addition, the difference in population between the 2000 and 2010 census and 2013 estimates was evaluated for each planning region and each county to help understand trends in population growth.

Relevant information was evaluated for the economic sectors of each region. The Arrowhead Center at New Mexico State University (NMSU) provided information on the basic industries (i.e. mining, oil and gas, tourism) that support the economy of New Mexico Counties (Arrowhead Center, 2013). Basic industries bring outside dollars into the economy. Other information included summaries of the largest employment categories in each region, agricultural information such as crop type, farm income and the average age of farmers, and comprehensive plans for communities within the region. To supplement the published information, a series of interviews were conducted with local business and government leaders who were familiar with the local economic conditions and drivers for economic growth in each region. The details about this research are provided in the appendices of the RWPs.

Based on the population trends and other information, a summary was developed as shown in Table 4-2 of the high and low population forecasts for each planning region.

The statewide population of New Mexico is expected to grow between approximately 500,000 (low projection, Figure 4-7) and 1,400,000 (high projection, Figure 4-8) by 2060, with the greatest growth expected in the Middle Rio Grande, San Juan, Jemez y Sangre, and Lower Rio Grande planning regions. Population growth is not expected to be significant in some rural regions, as shown on Figure 4-7 and Figure 4-8. Current trends in declining populations are expected to continue in some of the regions under the low projection.

Table 4-2. Projected Population Growth in New Mexico Water Planning Regions.

Region		Projection	Population					
			2010	2020	2030	2040	2050	2060
1	Northeast	High	82,510	92,590	104,530	114,350	121,270	126,140
		Low	82,510	87,300	91,920	97,520	102,570	107,050
2	San Juan	High	145,950	173,460	204,380	240,750	284,390	338,210
		Low	145,950	145,950	160,110	173,230	185,030	195,830
3	Jemez y Sangre	High	181,660	198,710	231,420	265,290	299,120	331,690
		Low	181,660	187,830	199,880	210,380	220,090	228,740
4	Southwest	High	63,230	69,230	77,850	87,060	97,390	108,960
		Low	63,230	66,210	69,450	73,110	74,820	76,670
5	Tularosa	High	61,980	64,650	65,700	66,180	65,940	64,950
		Low	61,980	62,510	62,620	61,440	60,460	59,240
6	Northwest	High	87,720	95,920	104,350	113,470	123,340	134,030
		Low	87,720	90,780	91,770	90,560	88,780	86,460
7	Taos	High	39,730	43,810	46,620	48,700	50,980	53,520
		Low	39,730	41,360	43,080	43,310	42,800	42,350
8	Mora-San Miguel-Guadalupe	High	38,960	38,720	39,190	39,810	40,670	41,850
		Low	38,960	36,410	34,360	32,650	31,280	30,310
9	Colfax	High	13,750	13,090	13,090	13,090	13,090	13,090
		Low	13,750	12,380	11,510	10,700	9,950	9,260
10	Lower Pecos	High	143,770	152,850	167,720	184,090	196,430	207,170
		Low	143,770	148,320	156,210	163,340	169,850	177,330
11	Lower Rio Grande	High	209,230	229,250	260,500	290,100	321,630	348,730
		Low	209,230	221,150	233,850	247,350	260,850	272,730
12	Middle Rio Grande	High	863,370	992,460	1,145,700	1,274,360	1,402,300	1,523,560
		Low	863,370	933,590	1,002,980	1,068,720	1,129,330	1,183,340
13	Estancia	High	32,690	35,410	37,220	38,750	39,670	40,300
		Low	32,690	32,450	32,640	32,140	31,870	31,540
14	Rio Chama	High	6,790	6,680	6,510	6,190	5,910	5,750
		Low	6,790	6,080	5,440	4,870	4,360	3,910
15	Socorro-Sierra	High	29,850	29,820	31,490	33,500	35,030	35,500
		Low	29,850	28,790	29,920	30,740	31,220	31,530
16	Lea	High	64,730	77,960	92,440	106,780	119,660	131,880
		Low	64,730	73,540	84,180	89,020	92,810	96,180
Total		High	2,065,920	2,065,920	2,314,590	2,628,700	2,922,450	3,216,810
		Low	2,065,920	2,065,920	2,174,650	2,309,890	2,429,090	2,536,040

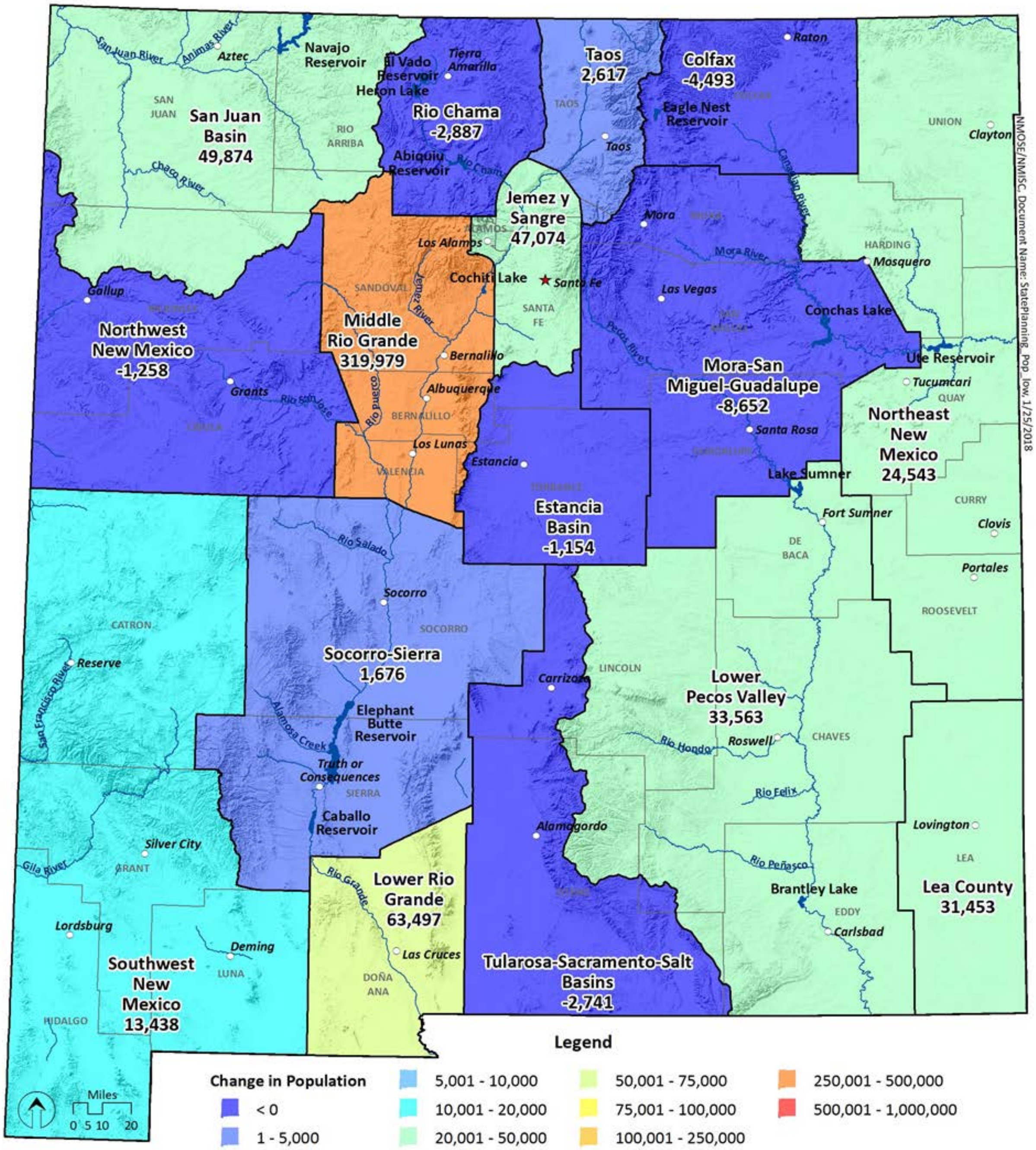


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Figure 4-7. Projected Change in Population 2010-2060, Low Projection.

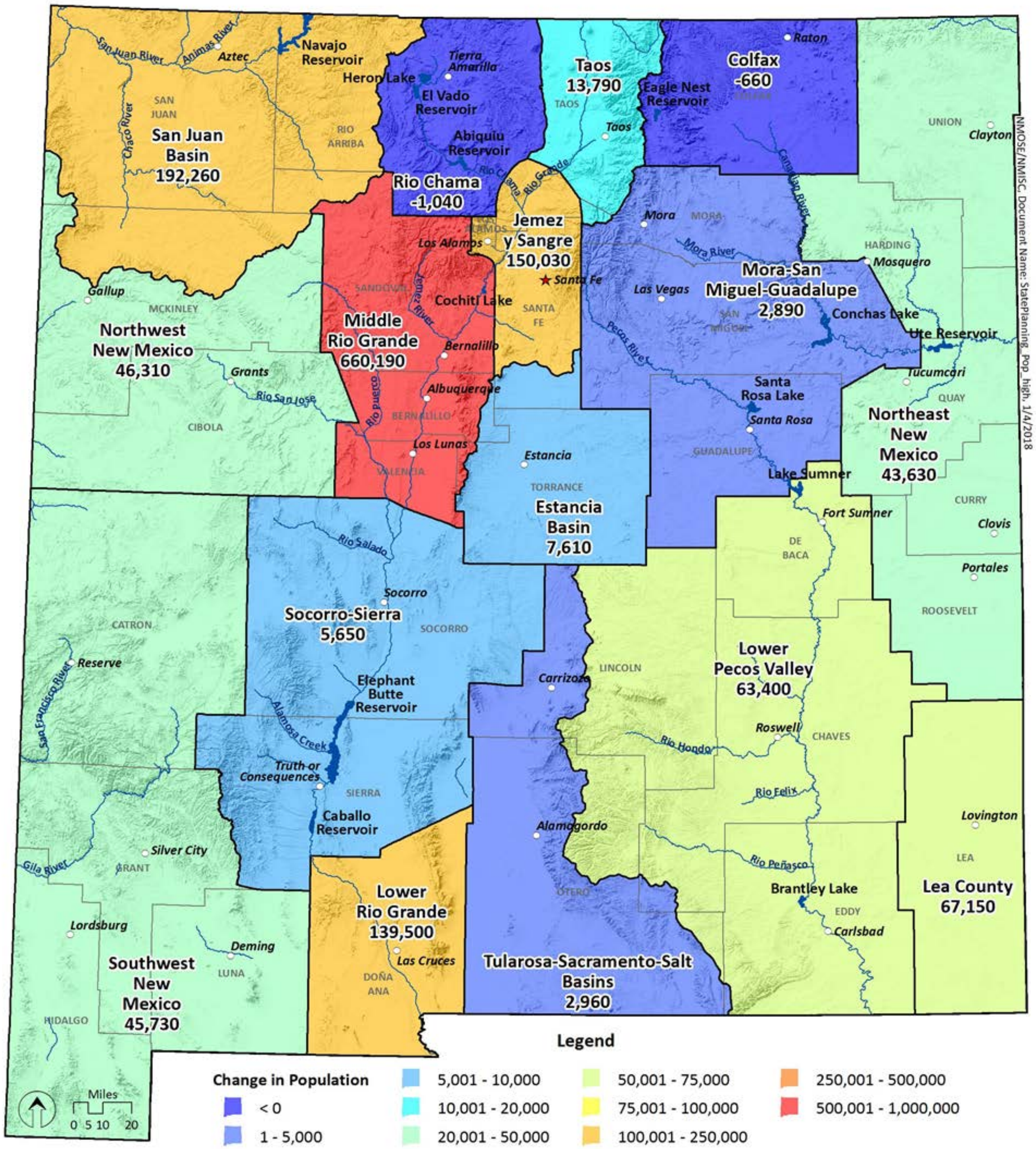

Figure 4-8. Projected Change in Population in New Mexico Water Planning Regions, High Projection.

4.3 WATER DEMAND FORECASTS

Projections of future demand in nine categories of water use are based on demographic and economic trends and population projections. Consistent methods and assumptions for each category of water use were applied across all planning regions. The projections began with 2010 data and were developed in 10-year increments (2020, 2030, 2040, 2050, and 2060). Projections for withdrawals for each of the nine categories included in the *New Mexico Water Use by Categories 2010* report (Longworth et al., 2013) were developed.

To assist in bracketing the uncertainty of the projections, both low- and high-water demand estimates were developed for each category in which growth is anticipated, based on demographic and economic trends as well as population projections, unless specific adjustments were applied based on local conditions. The projected growth in population and economic trends affects water demand in eight of the nine water use categories; the reservoir evaporation water use category is not driven by these factors.

The assumptions and methods used statewide to develop the demand projections for each water use category are detailed in Appendix B.4. Not all these categories are applicable to every planning region. The specific methods applied in the various planning regions are detailed in each of the RWPs. Population projections were converted to water demand projections for the public water use and domestic well sectors by assuming that the same per capita demand would continue for the existing population and that new population would be served at a lower rate of water use depending on the region's per capita demand. The San Juan and Northwest regions deviated from this approach based primarily on uncompleted and yet to be fully utilized federal water supply projects (the Navajo Indian Irrigation Project, the Animas-La Plata Project and the Navajo-Gallup Water Supply Project). These regions assumed that the increase in water availability would increase the water use because the availability of water will allow for economic growth, further increasing water use.

The projected water demand in each planning region is shown in Figure 4-9 and Table 4-3. The high projections for reservoir evaporation considers warmer temperatures as discussed in Appendix B. It is anticipated that increasing temperatures will contribute to increasing agricultural demand and increased losses (riparian evapotranspiration and open water losses along river corridors); however, statewide quantitative estimates were not available at the time the projections were developed.

The increase in water demand for all sectors ranges from 400 to 250,000 ac-ft/yr throughout the regions (as shown in Figure 4-9 from 2010 to 2060, under the high projection) and totals nearly 440,000 ac-ft of increased demands (including 15,100 ac-ft of increase in SJC exports from the San Juan Basin). In the high-growth scenario, the region with the largest projected increase (250,000 ac-ft/yr) in future demand is the San Juan Basin Region. The second-largest projected increase in demand is the Middle Rio Grande Region, where an additional 79,000 ac-ft/yr would be required to meet growing population.

By water use sector, the increase in demand is projected to be 236,000 ac-ft/yr by 2060 in the public water supply and self-supplied domestic, commercial, and industrial water use sectors, as shown in Figure 4-10. The forecast change in water demand for the agricultural and livestock sectors are shown in Figure 4-11, where most regions show little change, or a slight decrease and the San Juan Basin shows an increase of 159,000 ac-ft where the Navajo-Gallup Water Supply Project will provide water for agriculture. The projected increases in demand in the power and mining sector are shown in Figure 4-12, where most regions show little change, except for the San Juan, Northwest, and the Southwest Regions that predict increases in water demand.

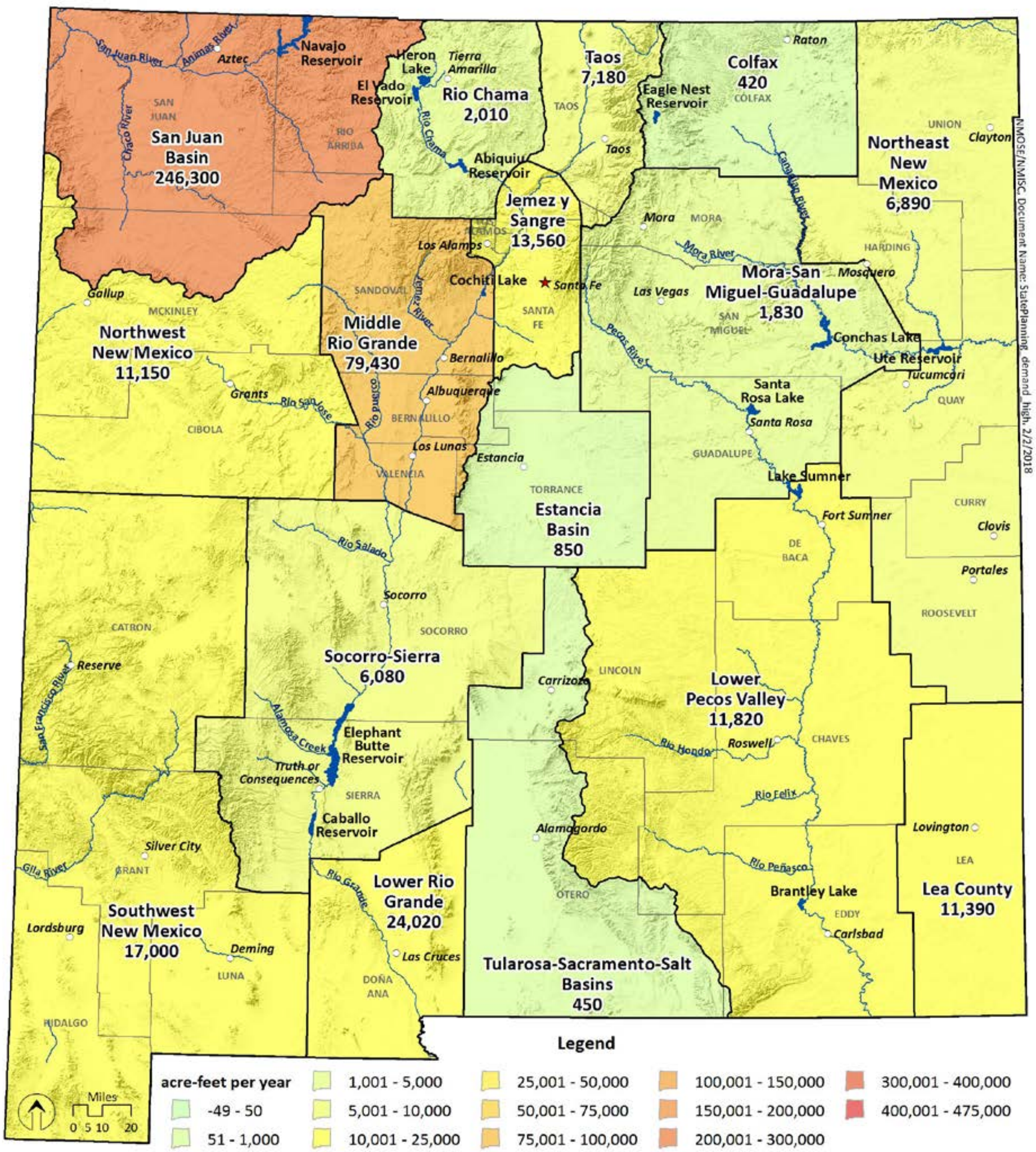

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Figure 4-9. Projected Increase in Demand from 2010 to 2060, High Projection.

Table 4-3. Reported Estimated (2010) and Projected Water Demand by Decade from 2020 to 2060 under the High and Low Projections.

Region		Projection	Projected Water Demand (ac-ft/ year)					
			2010	2020	2030	2040	2050	2060
1	Northeast	High	528,450	524,590	528,190	530,850	532,650	535,340
		Low	528,450	409,770	432,940	442,990	465,810	480,870
2	San Juan*	High	876,200	958,700	1,032,800	1,098,300	1,109,500	1,122,500
		Low	876,200	727,200	778,600	824,700	830,200	836,400
3	Jemez y Sangre	High	90,480	92,000	94,850	97,970	101,040	104,030
		Low	90,480	90,430	91,550	92,620	93,590	94,460
4	Southwest	High	222,540	232,520	234,180	236,110	237,650	239,530
		Low	222,540	199,120	204,370	200,450	206,470	212,630
5	Tularosa	High	32,810	33,010	33,140	33,210	33,250	33,260
		Low	32,810	29,540	30,390	30,410	31,230	31,250
6	Northwest	High	27,790	31,230	32,990	34,790	36,770	38,940
		Low	27,790	28,160	28,710	29,010	29,490	29,800
7	Taos	High	120,510	111,560	123,960	125,130	126,370	127,690
		Low	120,510	110,640	122,730	123,130	123,140	123,140
8	Mora-San Miguel-Guadalupe	High	109,210	108,920	109,420	109,910	110,560	111,040
		Low	109,210	107,900	107,960	108,180	108,400	108,700
9	Colfax	High	60,570	60,200	60,630	60,740	60,820	60,990
		Low	60,570	60,060	60,100	60,140	60,160	60,180
10	Lower Pecos	High	597,280	600,460	603,170	606,120	606,520	609,090
		Low	597,280	537,510	556,410	557,650	552,480	554,100
11	Lower Rio Grande	High	450,000	453,890	459,890	464,890	469,400	474,010
		Low	450,000	427,230	435,600	437,620	445,610	447,740
12	Middle Rio Grande	High	431,640	447,970	467,020	482,410	496,720	511,060
		Low	431,640	436,310	444,420	451,670	457,910	464,070
13	Estancia	High	84,130	84,150	84,430	84,670	84,850	84,970
		Low	84,130	67,950	68,050	72,080	72,120	76,150
14	Rio Chama	High	98,090	98,350	98,740	99,130	99,410	100,100
		Low	98,090	97,960	97,990	98,010	98,040	98,050
15	Socorro-Sierra	High	303,720	309,460	305,230	306,670	308,120	309,790
		Low	303,720	284,070	287,020	291,330	293,190	294,620
16	Lea	High	197,100	202,680	203,760	205,390	206,580	208,490
		Low	197,100	140,120	149,840	158,650	176,040	185,120
Total*		High	4,230,510	4,349,700	4,472,380	4,576,290	4,620,200	4,670,850
		Low	4,230,510	3,753,970	3,896,660	3,978,640	4,043,880	4,097,280

**Includes export water from the San Juan Basin to the Rio Grande Basin*

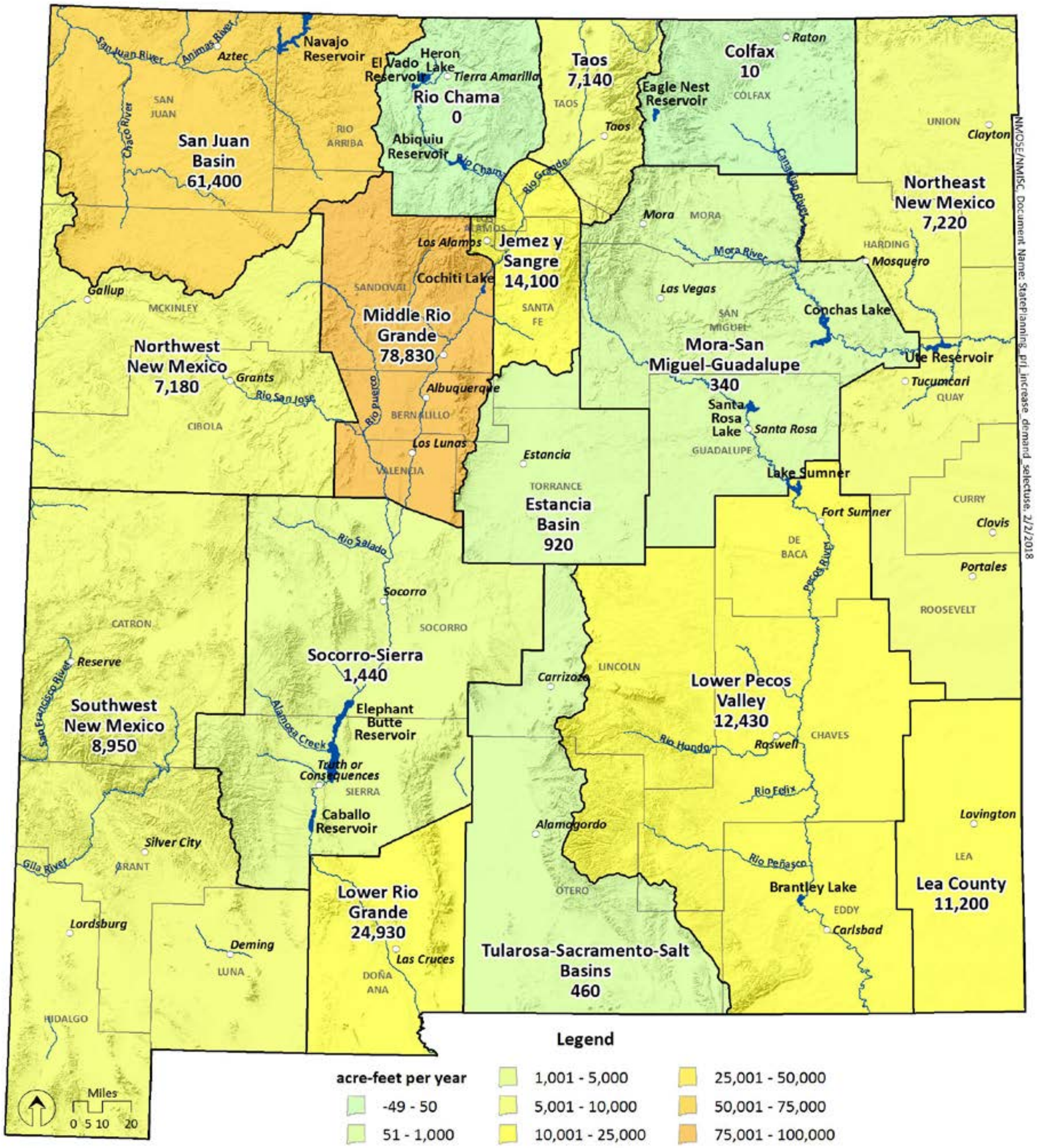


Figure 4-10. Projected Change in Water Demand from 2010-2060 for Public, Domestic, Commercial and Industrial Self-Supplied Water Use Sectors for High Growth Projection

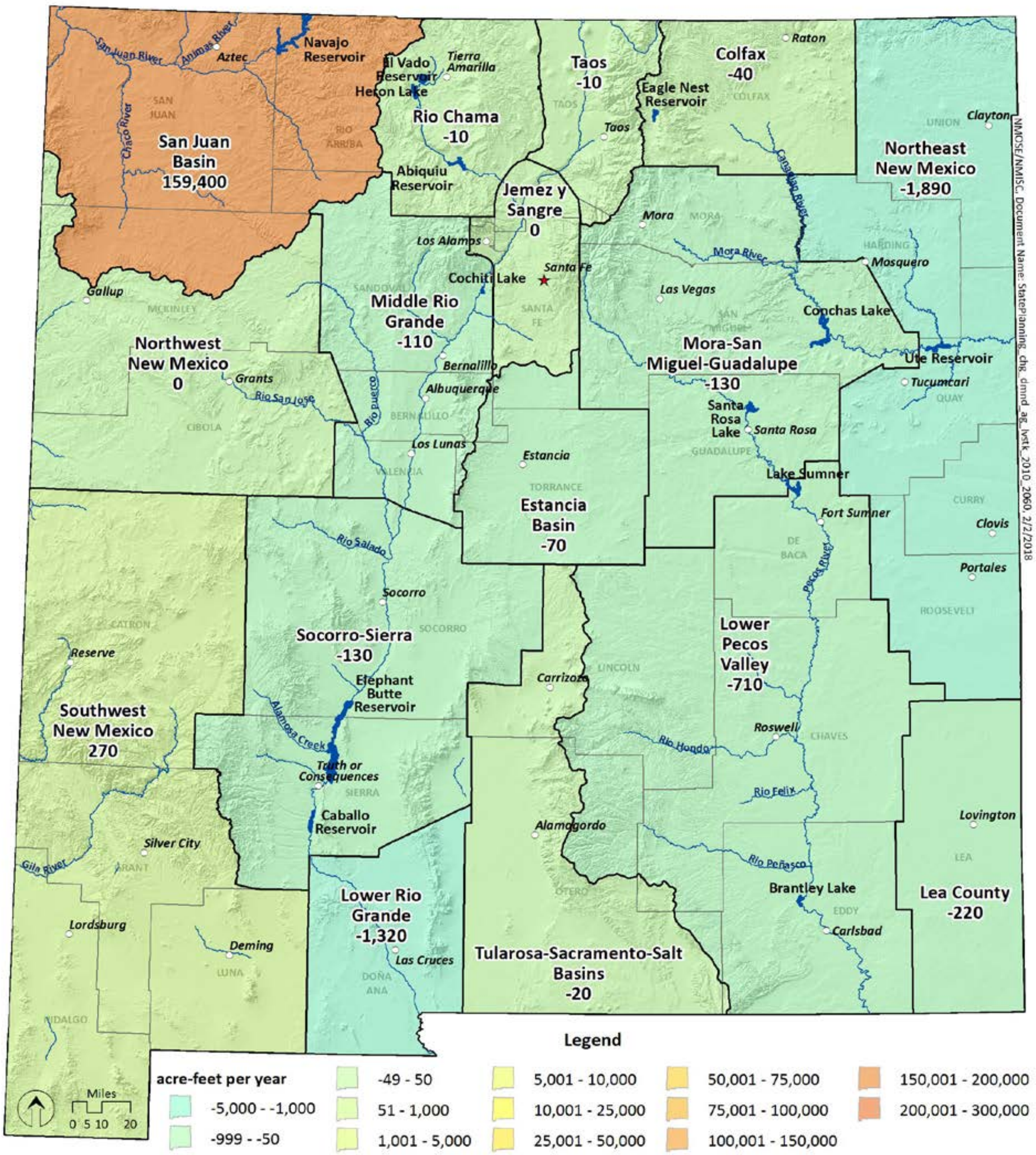


Figure 4-11. Change in Water Demand for the Agricultural and Livestock Water Use Sectors between 2010 and 2060.

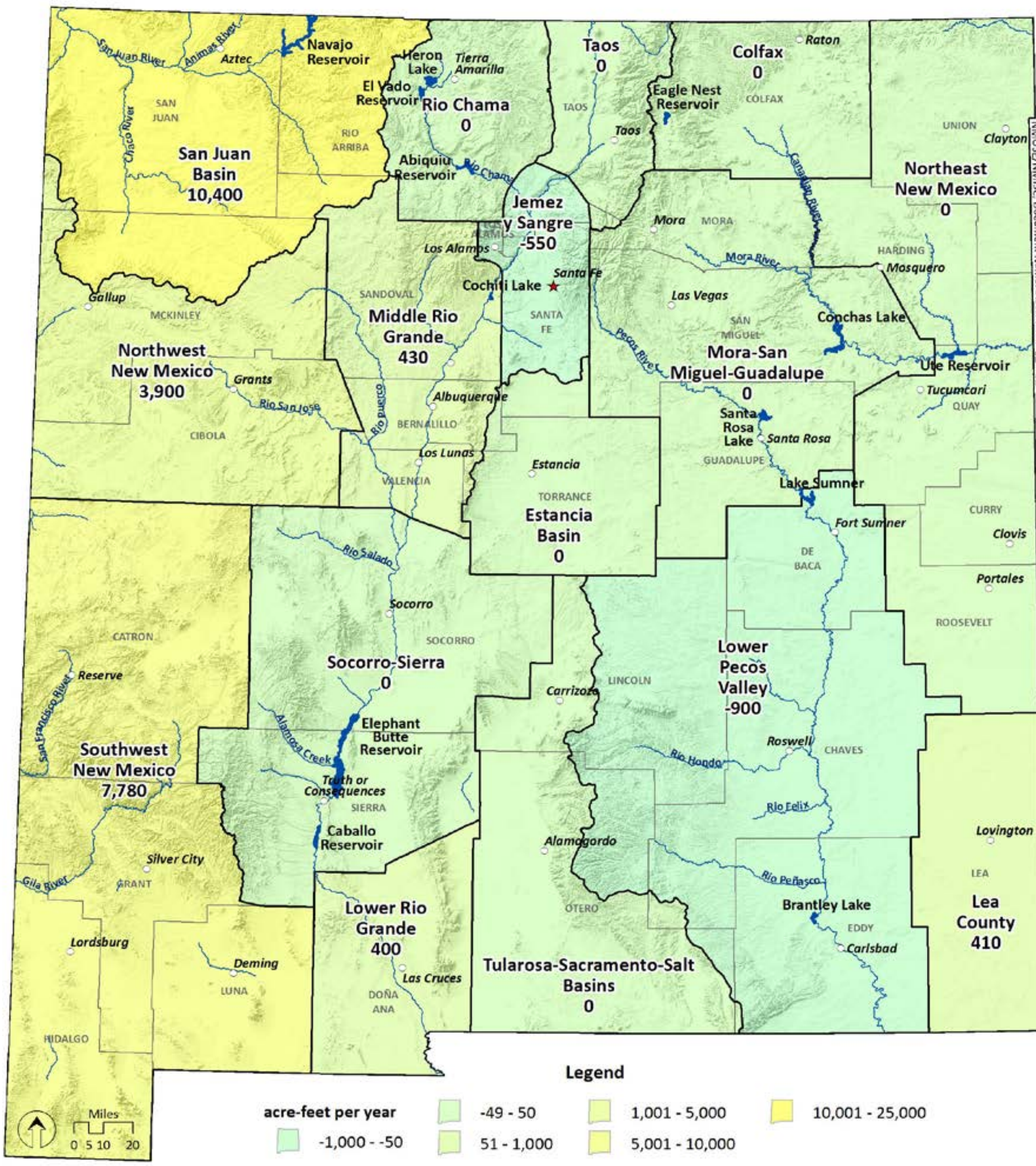


Figure 4-12. Change in Water Demand for the Power and Mining Sectors.

5. Supply-Demand Gap

Paramount to water planning is projecting future water demands and supplies. The analysis of the supply-demand gap presented in this chapter is based on the administrative supply described in Section 3.5. Section 5.1 presents a summary of supply-demand gaps for total regional demand and Section 5.2 summarizes the projected supply, demand by region and by sector statewide. Section 5.3 presents supply and demand by region.

When looking at the balance between supply and demand, it is important to recognize that on a statewide or regional scale, the true gap cannot easily be described as a single number. Summing total demand and supply for a region or the state can be misleading, and it is important to understand that individuals, companies, cities, tribes and farmers have independent rights to use water. Showing the totals for a region does not imply that the water held by one entity will be shared with another within the region, even if the infrastructure is available to share the water.

Other important considerations in the balance between supply and demand are listed below:

- The short-term variability in surface supplies results in a constantly fluctuating supply that triggers legal and policy constraints on water management.
- Supplies and demands are not independent variables that can be separately reconciled. Water use and development is much higher in areas where supplies are readily abundant. For instance, irrigated agriculture, with the largest use sector in the state, first evolved in areas where either surface water supplies were readily available and later expanded to areas where relatively shallow groundwater resources became economically available via high capacity pumps and wells. If supplies are economically available, then agriculture or other uses are likely to be developed. This means that in an arid state, there will probably be higher interest in using water supplies wherever they can be economically attained. Thus, the demand is not actually independent of the supply.

Reviewing and evaluating gaps or potential gaps on a statewide or regional basis should consider that distinctly different water resources may be present at considerable distances from each other and moving an available water supply from one location to another can be expensive. Additionally, legal constraints (such as interstate compacts that constrain use, limit storage, or otherwise affect water management) may limit the ability of supplies in specific locations to meet demands in other areas.

- It is also important to consider the accuracy of the estimated diversion and demand numbers. If the estimates are as accurate as plus or minus 15%, that translates to plus or minus almost 700,000 ac-ft for statewide diversions.

Because of these complexities, caution is advised in evaluating the gaps in a region or the entire state; this analysis is intended to provide an understanding of general trends to help inform water policy.

5.1 OVERVIEW OF THE SUPPLY-DEMAND GAP

The projected increase in demand of 440,000 ac-ft/yr by 2060 is one of the contributing factors creating a gap, but not the only one. Declining supplies in non-stream connected aquifers and periods of drought can also create a gap between available supply and projected demand. The groundwater supply in seven water planning regions is expected to decrease due to aquifer mining, widening the gap to about 700,000 ac-ft by 2060. Under the drought-corrected water supply scenario, the gap between supply and demand increases to 2.4 million ac-ft due to surface water shortages and accelerated groundwater mining. Figure 5-1 illustrates the projected gap under the high growth scenario for the average and drought-corrected supply scenarios. (The gap is calculated by subtracting the demands in Table 4-3 from the supply in Table 3-1.)

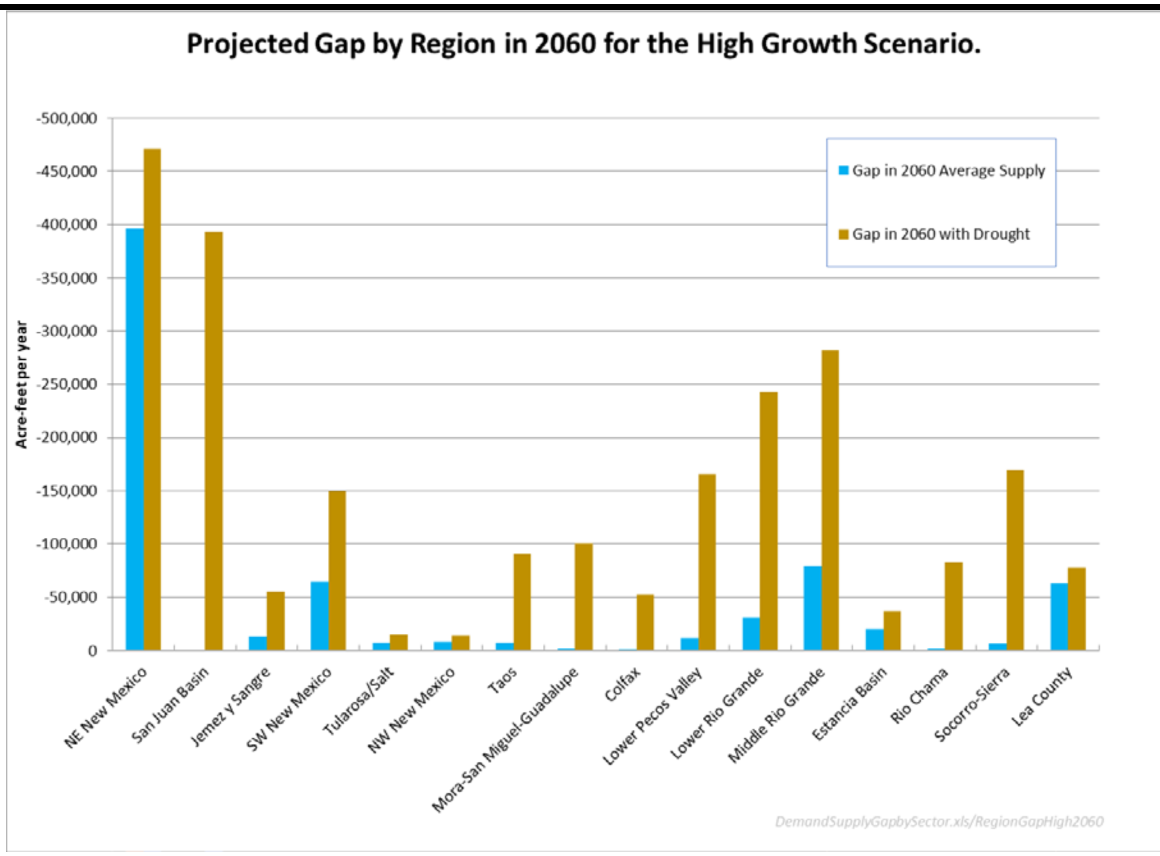


Figure 5-1. Projected Gap under the High Growth Scenario, with and without Drought in 2060.

The Animas-La Plata, Navajo Indian Irrigation, and Navajo-Gallup Water Supply Projects will provide an additional 250,000 ac-ft of water to the San Juan and Northwest Regions for agriculture and public water use sectors, an amount that was included in the water supply for those two regions.

In a normal or average water supply year a gap is projected for all the regions except four (San Juan Basin, Lower Pecos, Lower Rio Grande and Middle Rio Grande), in 2060. The most severely impacted regions in an average water supply year are the Northeast, Southwest, and Lea County. The overall statewide gap is, as expected, much greater in a drought-corrected water supply year than an average year. As illustrated in Figure 5-2 under the drought-corrected water supply scenario all regions are impacted.

However, the San Juan Region is dramatically impacted during a drought-corrected water supply scenario because of the region's projected large increase in demand and its significant dependence on surface water. Even though the San Juan Region has ample reservoir storage, that source of supply is surface water; and if it is not available, then the gap could be almost 400,000 ac-ft. Under the low projection, no gap is predicted for the San Juan Basin with the Navajo-Gallup Water Supply Project.

Though demand is not necessarily increasing significantly in some areas, the projected declines in supply in the closed basins (e.g. non-stream connected basins) are forecasting gaps for those regions well before 2060. In stream-connected basins, the OSE has considered the impact of pumping on the stream system when considering new appropriations, which limits the amount of groundwater decline, while the closed basins have been allowed to be mined.

The projected 2060 declines in the closed basins in these regions due to mining of the aquifer for an average year and for a drought-corrected water supply year are shown in Table 5-1.

The gap in the Northeast and Lea County regions is of particular concern because alternative supplies have not been identified. The Ute Reservoir Pipeline Project is anticipated to provide up to 24,000 ac-ft to some PWSs, but will not supply water to agriculture, which will be the most impacted by the projected decline in the Ogallala/High Plains Aquifer. In the Southwest Region, wells could potentially be deepened or developed in new locations; however, an evaluation of costs and feasibility has not been done.

Table 5-1. Annual Reduction in Groundwater Supply Estimated for Mined Basins.

Closed Basins in Region	Projected Reduction in Groundwater Supply in 2060 with No Drought (ac-ft)	Projected Reduction in Groundwater Supply in 2060 with a 20-year Drought (ac-ft)
1. Northeast Region	389,000	400,000
4. Southwest	48,000	53,000
5. Tularosa-Sacramento-Salt	6,600	10,000
6. Northwest	8,300	11,000
11. Lower Rio Grande	7,000	9,500
13. Estancia	19,000	36,000
16. Lea County	50,000	65,000

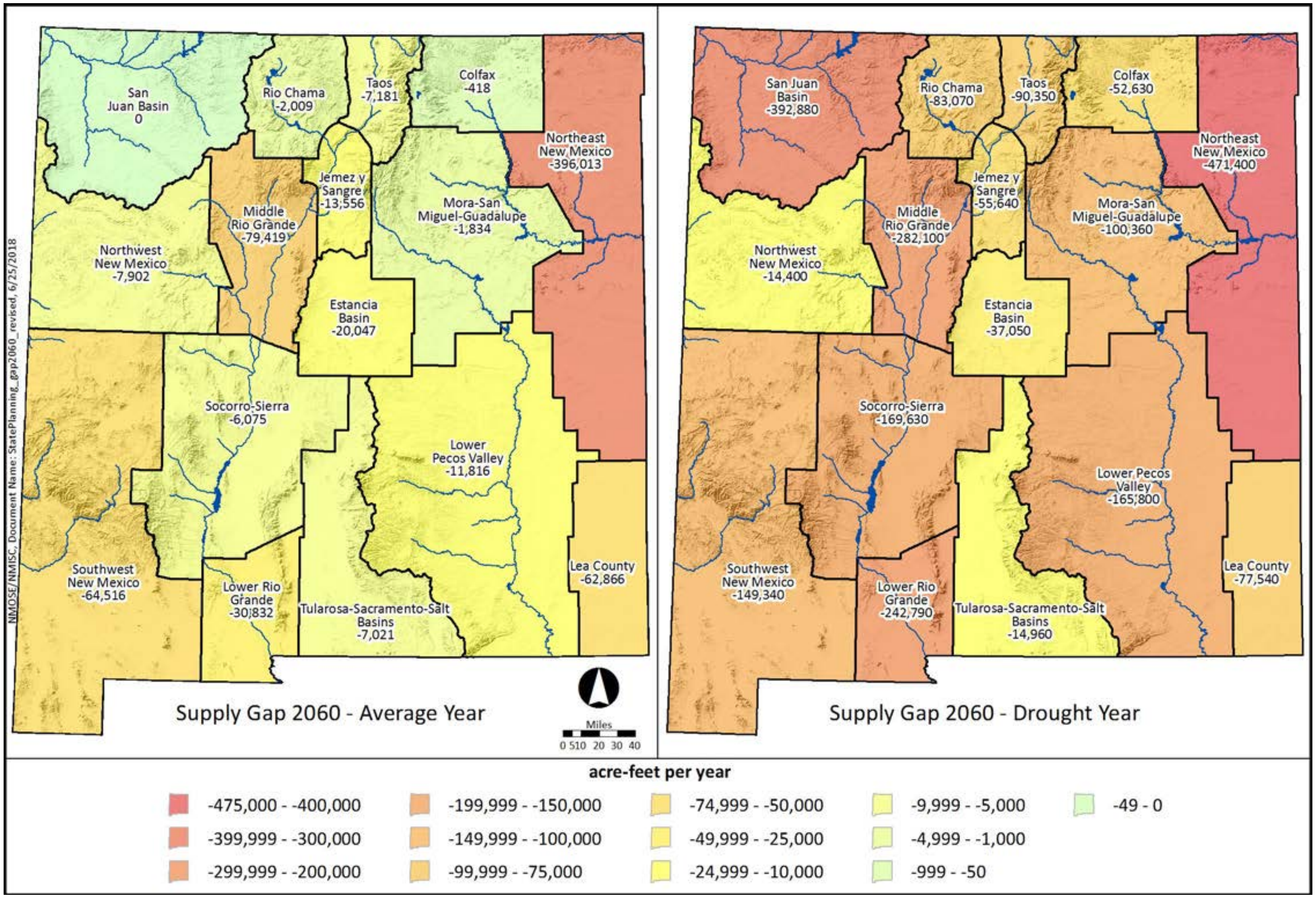


Figure 5-2. Estimated Water Supply Deficit or Surplus for All Water Sectors in 2060 for a) Average Water Supply and b) Drought for the High Projected Growth.

While Figure 5-1 and Figure 5-2 show the total gap in terms of ac-ft/yr, the supply relative to the demand is revealed in Figure 5-3. During drought, the heavily surface-water-dependent regions (Mora-San Miguel-Guadalupe, Colfax, and Rio Chama) would have only 10, 14, and 17%, respectively, of the revised administrative water supply, creating extreme stress on their water supplies. The Northeast Region drought supply is anticipated to be only 12% of the demand in 2060, due to the mining of the aquifer. While the total acre-feet of the gap is larger in other regions, addressing drought preparedness is vitally important in these three heavily surface-water-dependent regions.

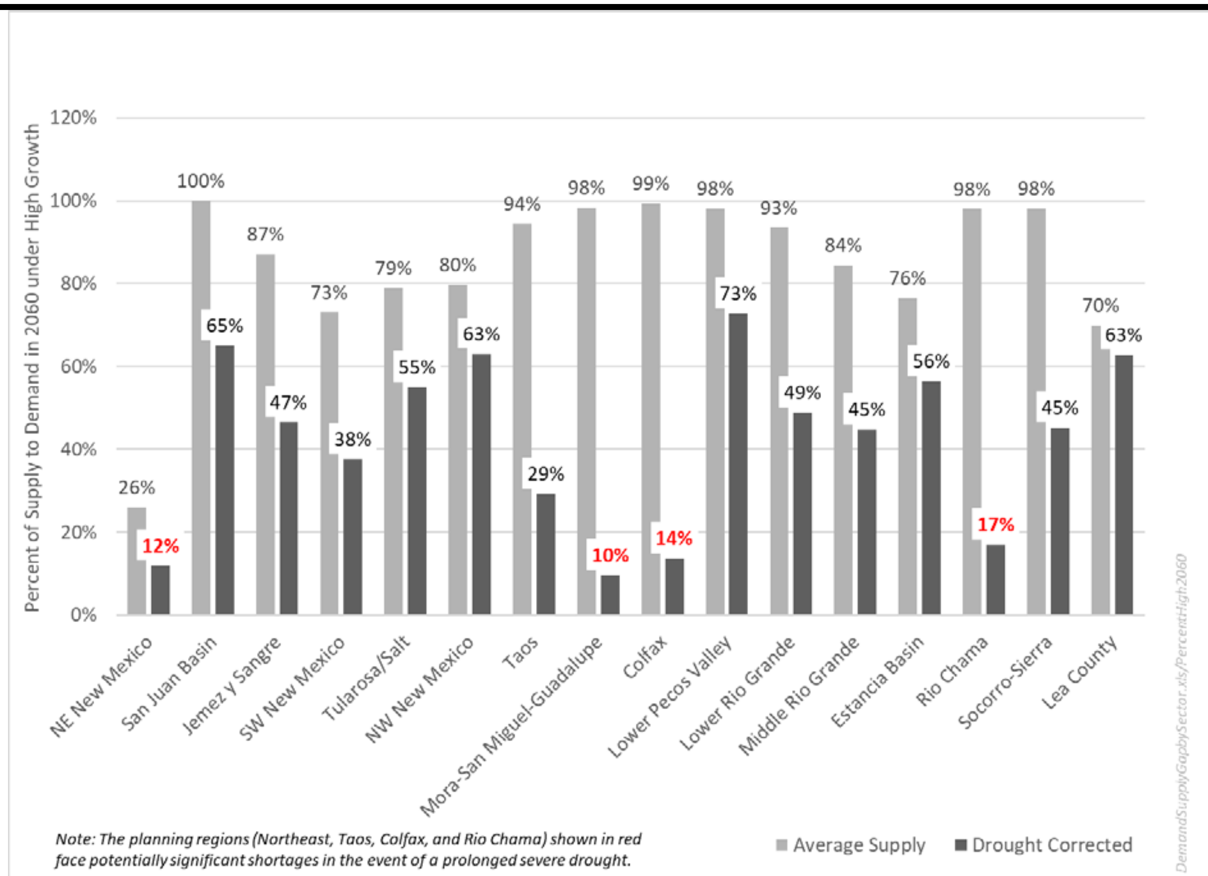


Figure 5-3. Percent of Supply Compared to Demand in 2060 by Region.

5.2 SUPPLY/ DEMAND GAP BY WATER USE SECTOR STATEWIDE

The combined water supply and demand statewide by sector for the high and low projections is shown in Figure 5-4 and Error! Reference source not found.. The gap in 2060 under the high growth scenario with all sectors of water use is estimated to be 700,000 ac-ft in an average supply year and 2,400,000 ac-ft in a prolonged severe drought scenario, respectively.

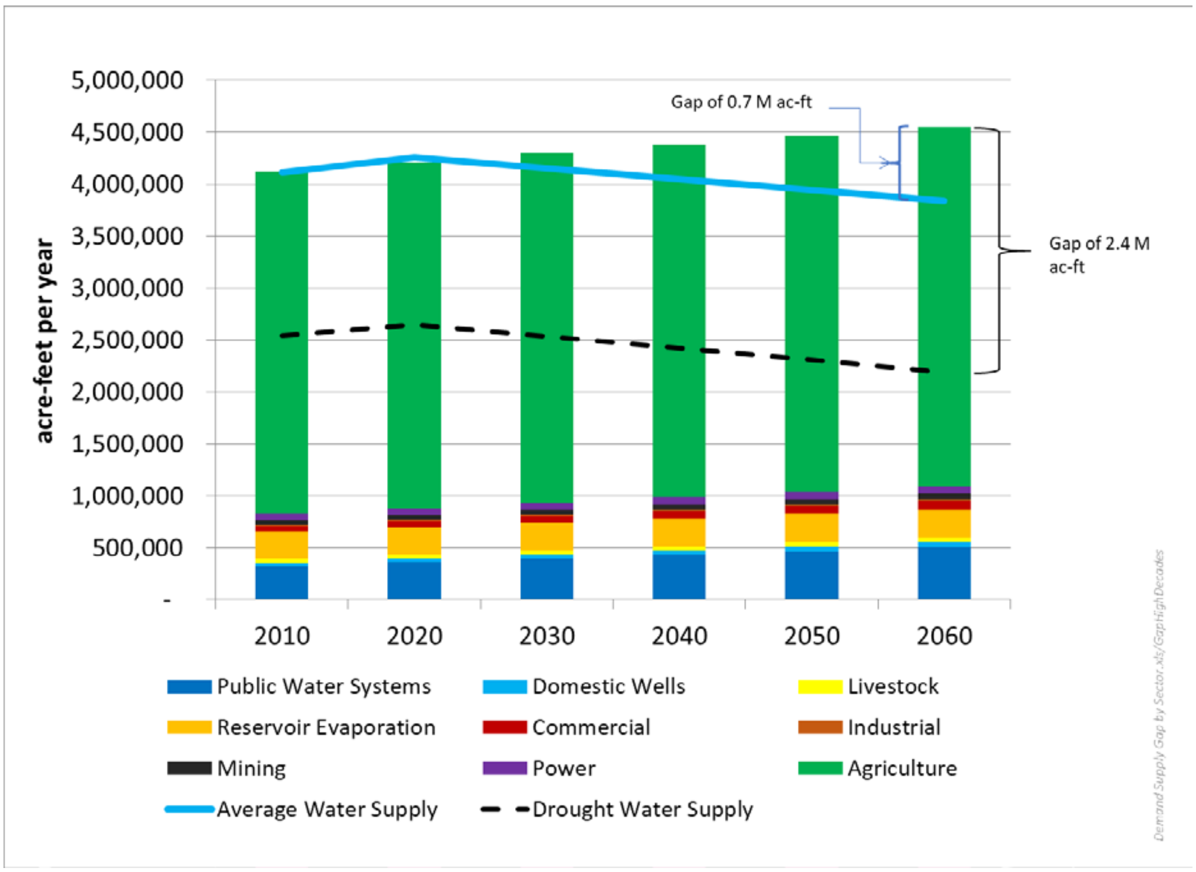


Figure 5-4. Supply and Demand under High Growth Projections for All Sectors Statewide

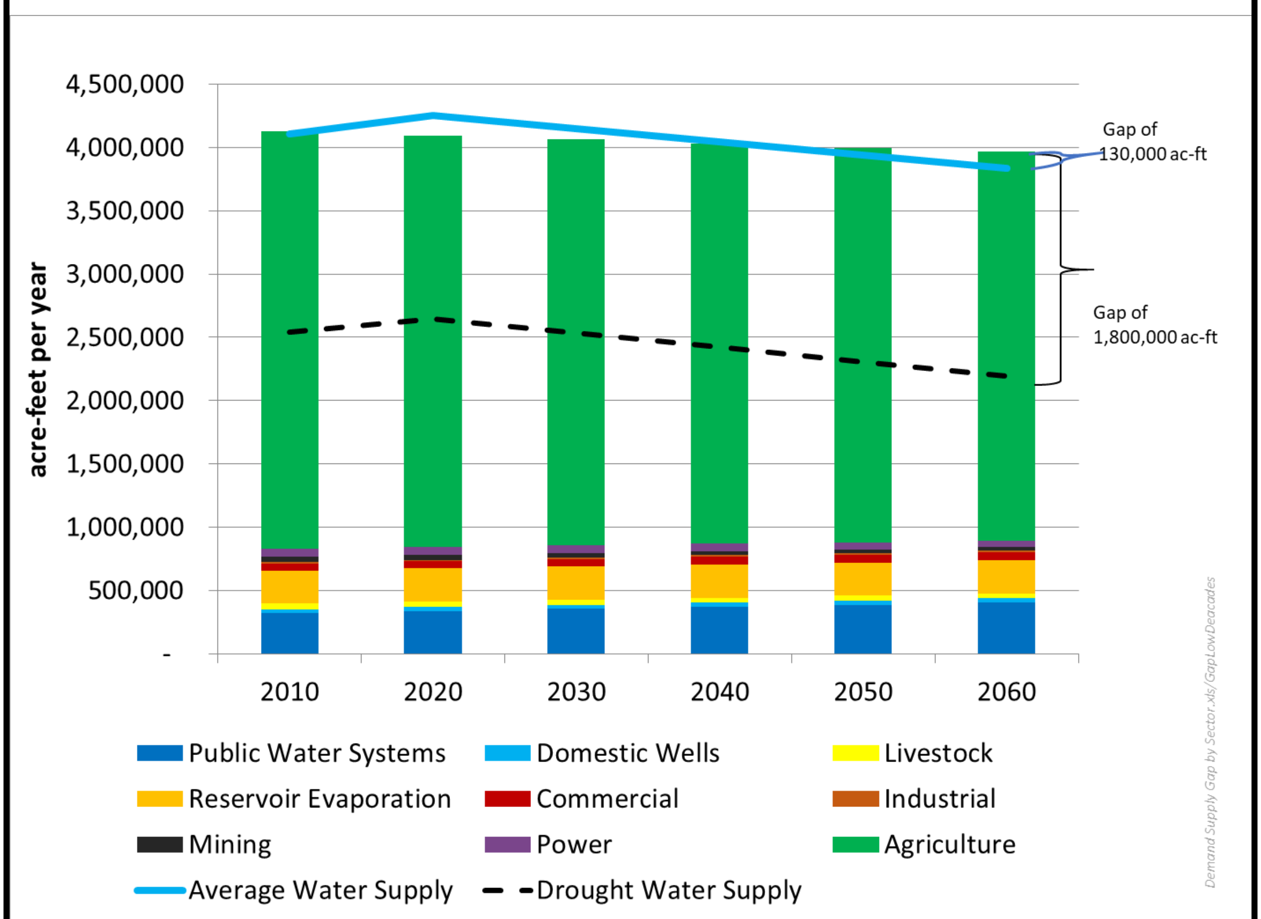


Figure 5-5. Supply and Demand under the Low Growth Projection for All Sectors.

Figure 5-6 shows the details of the projected gaps by sector between supply and demand. The gap is calculated by subtracting the demand from the supply, thus a negative value results when supply is insufficient to meet demand. The first stack shows the change in demand from 2010 to 2060 and is calculated by subtracting the demand in 2060 from the demand in 2010, thus a negative number represents an increase in demand. The second and third stacks show the projected gap in an average water supply year and the drought scenario.

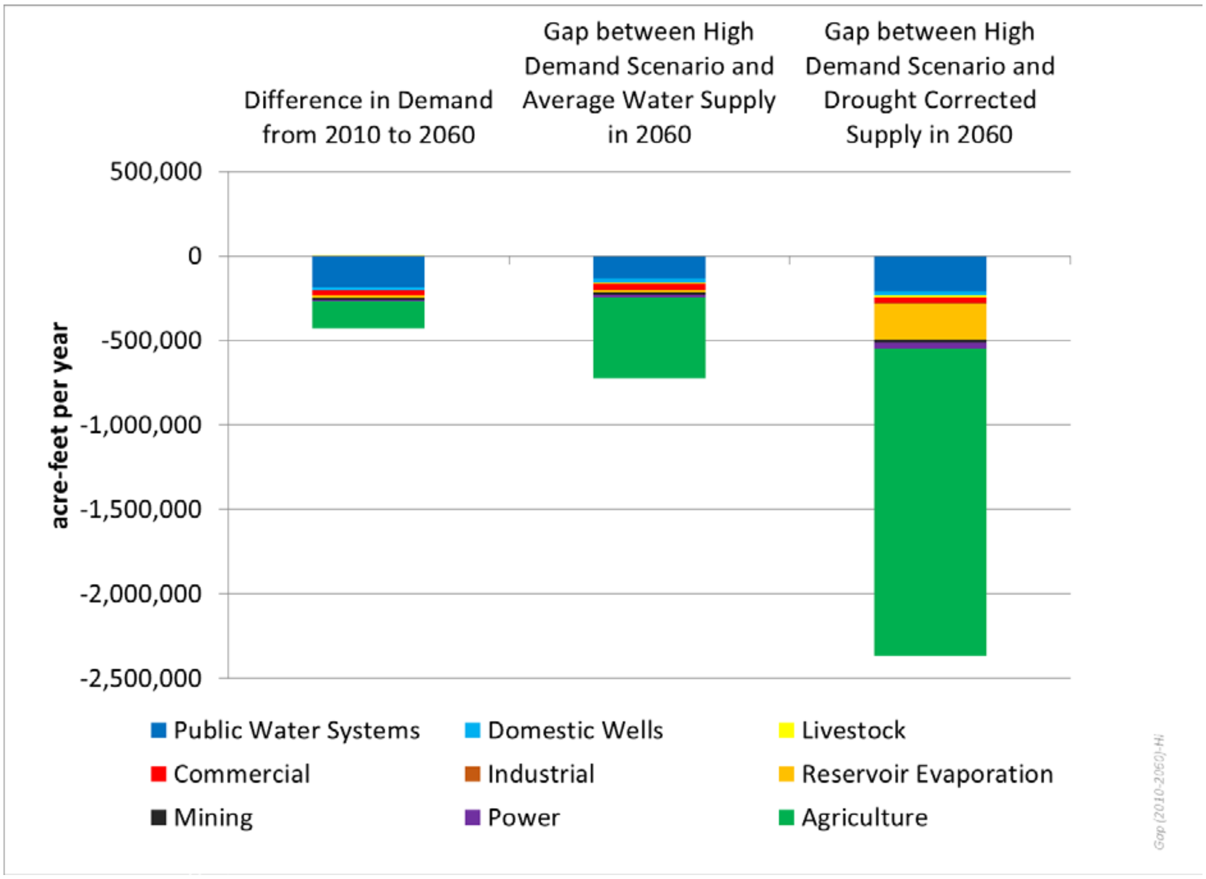


Figure 5-6. Statewide Summary of Increase in Water Demand and Gaps, with and without Drought in 2060 under High Growth Projection.

5.3 SUMMARY OF SUPPLY/DEMAND GAP

In summary, for average water supply years and areas not dependent on mined aquifers, the outlook for meeting water demand appears much more manageable than the outlook under the prolonged severe drought scenarios or in areas dependent on non-stream-connected aquifers. While the agricultural sector in many parts of New Mexico has lived with the variability of supply throughout the history of irrigation, PWSs, particularly those dependent on surface water, will need to be prepared for the dry periods. Some options are available for closing the gap, as discussed in Section 7 and Appendix C, such as water conservation, water supply projects, transferring water rights, and desalination. This summary of the supply-demand gap shown on Table 5-2 provides a general overview of the scale of the problem and the need to implement many of the proposed projects, programs and policies proposed by the regional water planning steering committees.

Table 5-2. Summary of Increase in Demand and Projected Water Supply Deficits by Sector Groupings in 2060.

Sector Groupings*	Increase in Demand under high growth scenario	Water Supply Scenario	
		Average	Drought-Corrected
	2010-2060	Deficit in 2060 (for regions with a gap)	
	Acre-feet per year		
Total*	425,000	-711,000	-2,400,000

Notes:

*Does not include “export” water included in the Table 4-3. The San Juan Basin Region assumed an increase in SJC exports of 15,100 ac-ft/yr above the 2010 diversion)

6. Summary of Key Water Issues: New Mexico Water Resource Challenges

New Mexico faces many challenges with providing reliable water supplies. During the 2016-2017 RWP update planning process, steering committee and stakeholder groups from around the state discussed key issues and challenges that affected their ability to secure long-term, reliable water supplies. A total of 278 key issues for each region were developed based on input from regional stakeholders and steering committee meetings. While specific details regarding issues and potential solutions varied from region to region, many common themes emerged from the regional water planning process, which can be summarized in the following categories:

- Insufficient water supply
- Vulnerability to climate
- Water management
- Need for better understanding of water resources
- Water quality
- Water infrastructure and maintenance

This chapter summarizes the key issues described in each of the RWPs. The issues are interrelated and do not always fall neatly into a single category. Drought can create insufficient water supply and is one aspect of climate vulnerability for the State. Likewise, improved groundwater models that help provide a better understanding of water resources will also improve water management.

6.1 INSUFFICIENT WATER SUPPLY

Both surface and groundwater supplies present unique challenges in securing future water supply: Surface water is renewable but highly variable both annually and seasonally; and whereas groundwater is often a reliable resource, in areas where recharge is much less than pumping, groundwater mining presenting a challenge for long-term sustainability. Population increases add stress to limited water supplies of PWSs and many of the projects, programs and policies (discussed in Section 7) are focused on reducing the gap between supply and demand.

In most parts of the state, the considerably lower surface water flows in drought years represent an important deficit in water supply. However, in some localities, such as Santa Fe and Albuquerque, conjunctive use plans have been implemented, allowing groundwater to be used in drought years and to be saved in the wetter years. Additional examples of efforts to ensure resiliency during drought include irrigation system efficiency improvements such as those completed by the Middle Rio Grande Conservancy District (MRGCD) and the shortage sharing agreement adopted by major water users in the San Juan Basin in 2003.

Another water supply project that will expand the supply for the agricultural water use sector is the Navajo Indian Irrigation Project (NIIP). NIIP is authorized for build out to irrigate up to 110,630 acres south of Farmington, but completion of the project will not likely occur until about 2040 given current rates of annual federal appropriations for project construction. The NIIP diverts water from Navajo Reservoir, and the annual diversion demand for the NIIP is anticipated to average about 353,000 ac-ft/yr at full buildout.

Insufficient surface water supply due to drought was a consistent issue identified in 14 out of 16 RWPs (Table 6-1) and is a concern in regions that are most heavily surface water dependent. Reservoir storage is a mitigating factor in some locations but under long-term drought the supply in storage may be depleted.

Table 6-1. Summary of Types of Insufficient Supply Issues.

Insufficient Supply Issue	Number of Issues	Number of Regions with Issue (Out of 16)
Drought	28	14
Mined aquifer	13	9
Increasing demand due to population growth	7	5
Low yielding aquifers	2	2

In general, groundwater provides a more stable and reliable water supply than surface water; however, in many locations groundwater pumping exceeds recharge, resulting in the decline of groundwater levels. Some wells can be re-drilled to deeper depths; however, local geologic conditions, and/or economic, or water quality issues in other areas limit accessibility to deeper groundwater resources. Some main areas that are affected by declining water levels and by limited alternative water supplies, as identified in their respective RWPs, include:

- The Ogalalla/High Plains aquifer in the Northeast and Lea County regions
- Portions of the Northwest Region (near Gallup)
- Portions of the East Mountain area of the Middle Rio Grande Region
- Portions of the Estancia Basin Region
- The Cienega area of the Jemez y Sangre Region
- Parts of the Jornado del Muerto basin in the Lower Rio Grande Region

Water level declines have also affected water supply in the Maxwell area of the Colfax Region, the Ojitos Frios area of the Mora-San Miguel-Guadalupe Region, and the Magdalena area of the Socorro-Sierra Region.

Some of the larger communities in the state, including Albuquerque and Santa Fe, have instituted conjunctive management to use surface water when available, preserving groundwater for drought periods and thus slowing the decline of groundwater levels. Conjunctive management and other strategies to address insufficient surface and groundwater supplies are discussed in Section 7.

6.2 VULNERABILITY TO CLIMATE

In addition to the existing challenges presented by historically variable climate conditions, variable surface water supplies, and declining groundwater supplies, other potential effects of climate change that are likely to affect New Mexico water resources identified in the RWPs included increased temperatures, evaporation, and evapotranspiration; increased risks of drought and wildfire; earlier runoff; and increased risks of extreme precipitation events, as discussed in Section 3.1. These climate-change impacts were discussed in all 16 of the RWPs as part of the common technical approach. Additional specific climate vulnerability issues that were identified in the 16 RWPs are summarized in Table 6-2.

Table 6-2. Summary of Climate Vulnerability Issues.

Climate Vulnerability Issue	Number of Issues	Number of Regions (Out of 16)
Drought	28	14
Increasing demand due to increasing temperatures	2	2
Flooding / stormwater/ sedimentation	12	11
Greater risk for catastrophic fires	9	9
Earlier runoff (and lack of storage)	1	1
Limitations on legal framework for water banking which could help address variability of climate	1	1

A major impact of ongoing climate change on water supply and availability is the timing each year of when peak snowmelt runoff occurs. The predicted change in peak snowmelt timing (1975-2040), for Hydrologic Unit Code (HUC) HUC 2 watersheds are shown in Figure 6-1. The change in peak snowmelt timing of up to three weeks earlier were derived by The Nature Conservancy (TNC, 2010).

Another significant impact of ongoing climate change is that warmer temperatures generally result in an increase in the vapor pressure deficit in the predominantly semi-arid climate of the southwest, which increases the vulnerability of forests to catastrophic wildfires and insect infestation (Williams et al., 2013). Vapor pressure deficit if a measure of the stress experienced by vegetation to increased temperature and decreased humidity. Figure 6-2 shows the wildfires that have occurred in New Mexico forests from 1996 to 2017, the PWSs dependent on surface water and the extensive efforts to thin forests to reduce the risk of catastrophic wildfires. PWSs that divert and treat surface water are particularly vulnerable to catastrophic fires due to the ash that clogs water treatment plant filter systems and the sediment carried by debris flows that reduces the storage capacity of reservoirs. In the Jemez Mountains, the Cerro Grande fire in 2000 burned 48,000 acres, destroyed 400 homes in Los Alamos, and filled Los Alamos Reservoir with debris. The high severity Track fire in 2011 burned nearly 28,000 acres in Sugarite Canyon, the primary water supply for the City of Raton. The Las Conchas fire in 2011 burned 150,000 acres and once again threatened Los Alamos National Laboratory and the town of Los Alamos and became the largest fire in New Mexico’s history at that time. By 2012, the Whitewater-Baldy Complex fire surpassed the Las Conchas fire, burning almost 300,000 acres, most of it contained within the Gila Wilderness.

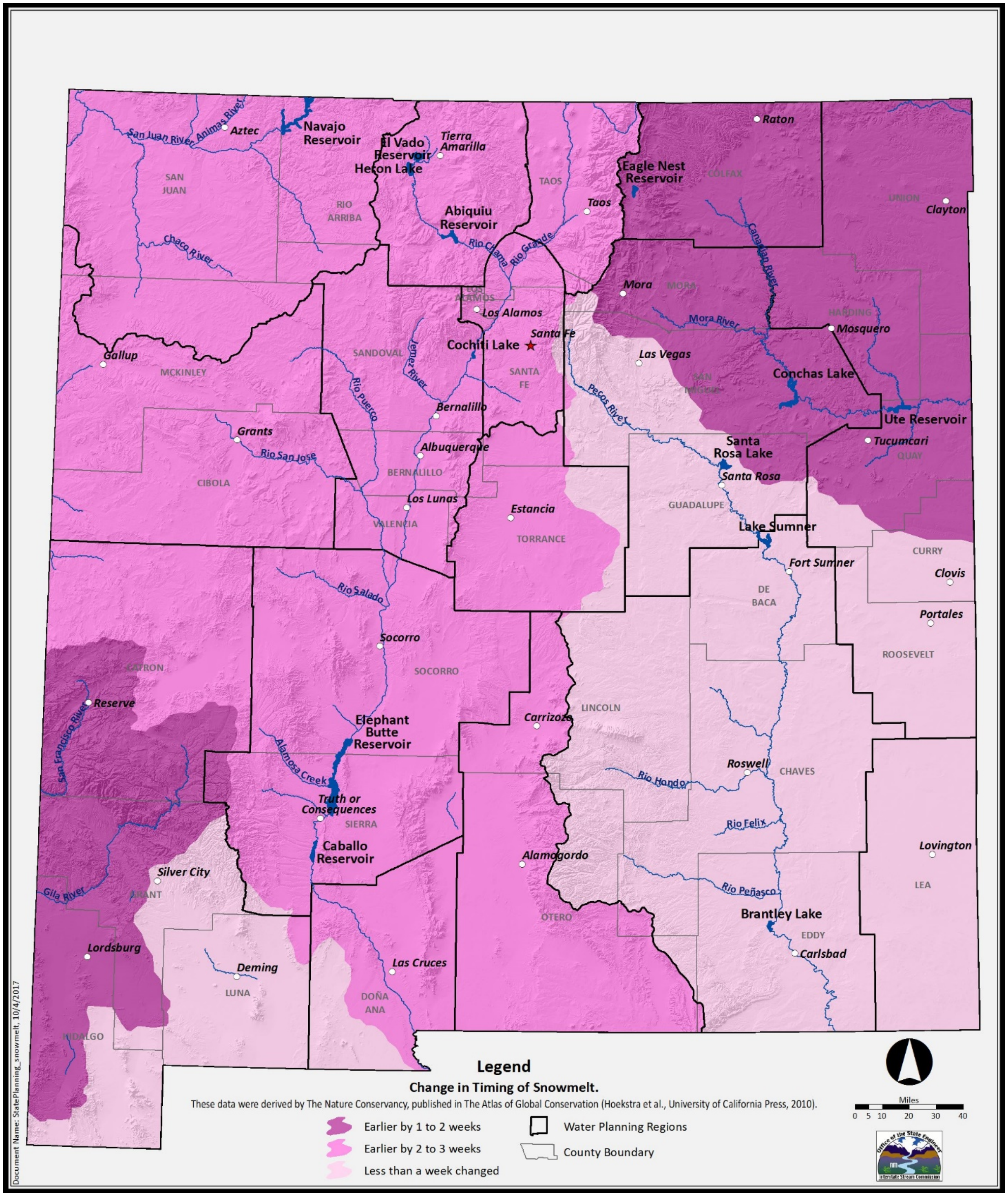


Figure 6-1. Predicted Changes in Peak Snowmelt Timing from 1975 to 2040.

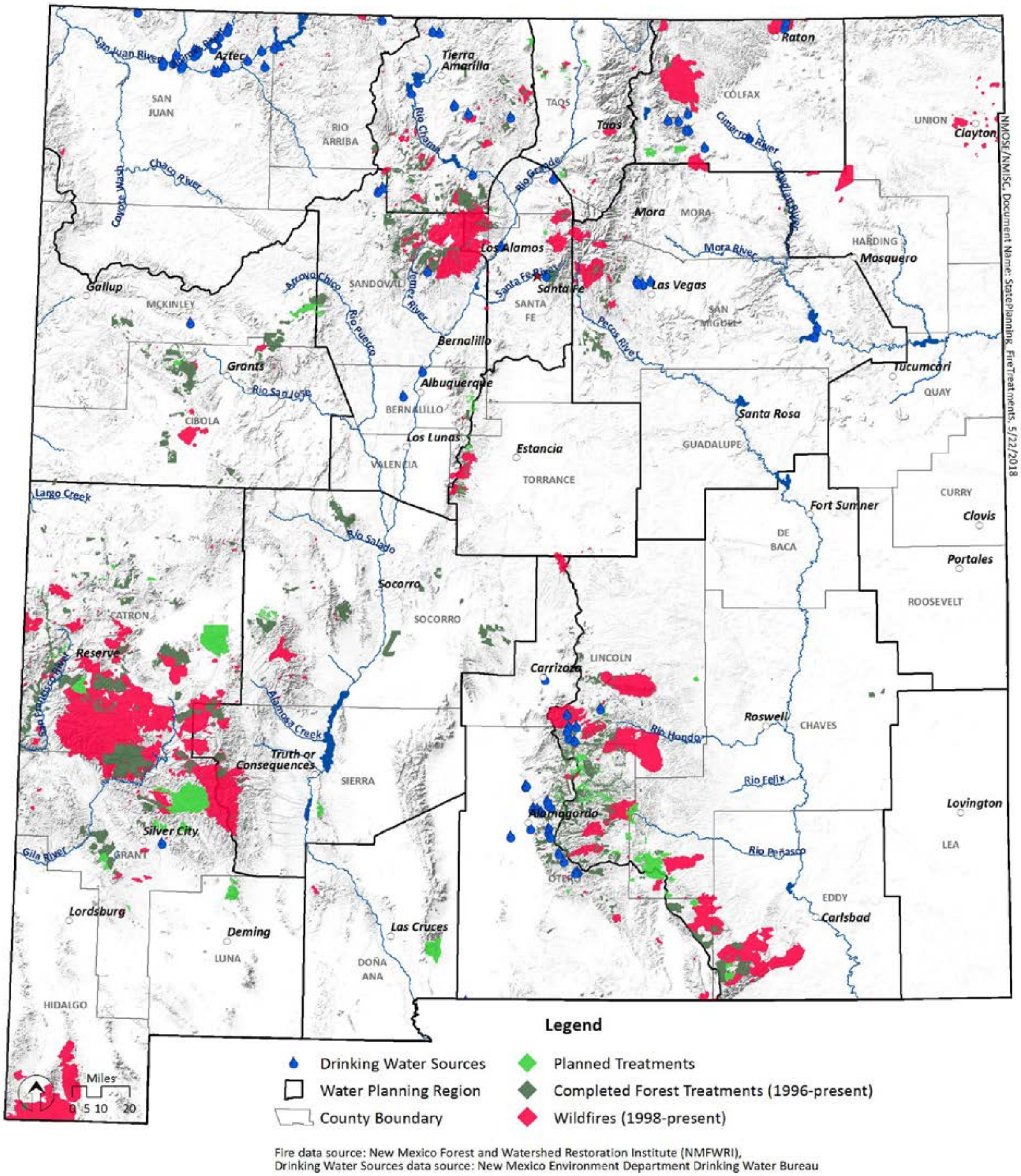


Figure 6-2. Forest Treatments, Forest Fires, and Public Water Systems Supplied by Surface Water in New Mexico.

6.3 WATER MANAGEMENT ISSUES

Legal and policy issues that guide water resource administration and provide a framework for water management in New Mexico were identified in 13 out of 16 regions. The RWPs identified Interstate Compacts, water rights adjudications and water right transfers, Endangered Species Act compliance, and other legal and policy issues governing administration of water resources that constrain their ability to utilize supplies available within their regions, as summarized in Table 6-3. One region raised the issue of the increase in water demand as farmers shift from low- to high-water demand crops without acquiring more water rights. Issues about impairment to senior water rights were raised in several regions due to depletion from domestic wells upstream of springs, oil and gas development in the Lower Pecos Region, increase in salinity from high levels of pumping in the Lower Rio Grande, and other issues related to operating agreements.

Table 6-3. Summary of Water Management Issues.

Water Management Issue	Number of Issues	Number of Regions (Out of 16)
Water rights transfers	17	9
Interstate compact compliance	13	8
Impaired Senior Water Rights from domestic wells, oil and gas development, operating agreements, groundwater pumping in Texas	9	6
Environmental flows	8	8
Completing adjudications	9	6
Reservoir operations	6	4
Out-of-basin transfers	5	5
Critical management areas	3	3
Increasing water demand due to changing cropping patterns	1	1

New Mexico water law governs water management, as outlined in *State Water Plan Part III: Legal Landmarks*. In the state water planning process, a variety of issues regarding water rights transfers were identified; including implementing recently completed water rights settlements, concerns about large development projects or water rights transfers moving water or water rights away from basins or regions of origin, concerns about protecting senior water rights in the transfer process, and concerns about legal mechanisms for establishing or maintaining environmental flows. Some regions noted the importance of completing adjudications so that water rights are defined.

One of the key issues for the Middle Rio Grande is the availability of water rights. No new appropriations are available in the region (and other portions of the Rio Grande basin). After the groundwater basin was closed to new appropriations in 1956, several entities applied for and were issued groundwater pumping permits with the condition that the effects of the pumping on the river would be offset when they occur. Municipal return flow, San Juan-Chama Project water, and the transfer of senior water rights are used as offsets as required by the specific permit requirements, with return flows comprising the greatest volume of offset. If all these permits are fully exercised, the amount of senior water rights needed to offset the effects of groundwater pumping on the Rio Grande is roughly equal to all the transferrable senior water rights from the irrigated land along the Rio Grande from north of Albuquerque to Elephant Butte (Schmidt-Petersen, 2011). Many of the municipal water systems have retained the needed rights, and under an average water supply year, water demand is met. The communities of Albuquerque and Santa Fe have in recent years reduced their dependence on groundwater, changing the projected impacts on the Rio Grande.

Interstate compacts on the Canadian River, Pecos River, Rio Grande, and the Colorado River Basin constrain water use and management and affect strategies for meeting demand in much of New Mexico. The regional plans also identified issues related to court decisions and programs related to the Endangered Species Act and other environmental programs that affect water management activities. Figure 6-3 shows the critical habitat for endangered species in New Mexico that impact water management throughout the state.

Recommendations included in the regional water plans for establishing critical management areas or other administrative guidelines by the OSE were directed at protecting groundwater resources and senior water rights, or in some cases existing guidelines were noted as constraining water resource development. The ability to develop new sources, particularly in stream-connected basins where water rights are fully appropriated creates a planning challenge, identified in several RWPs. In many areas any new diversion of surface water or stream-connected groundwater requires the transfer of a valid water right (aside from small individual diversions from new domestic or livestock wells), and the transfer is limited to the consumptive use portion of that right. The availability of water rights may thus be a limiting factor in meeting the future water needs of the regions.

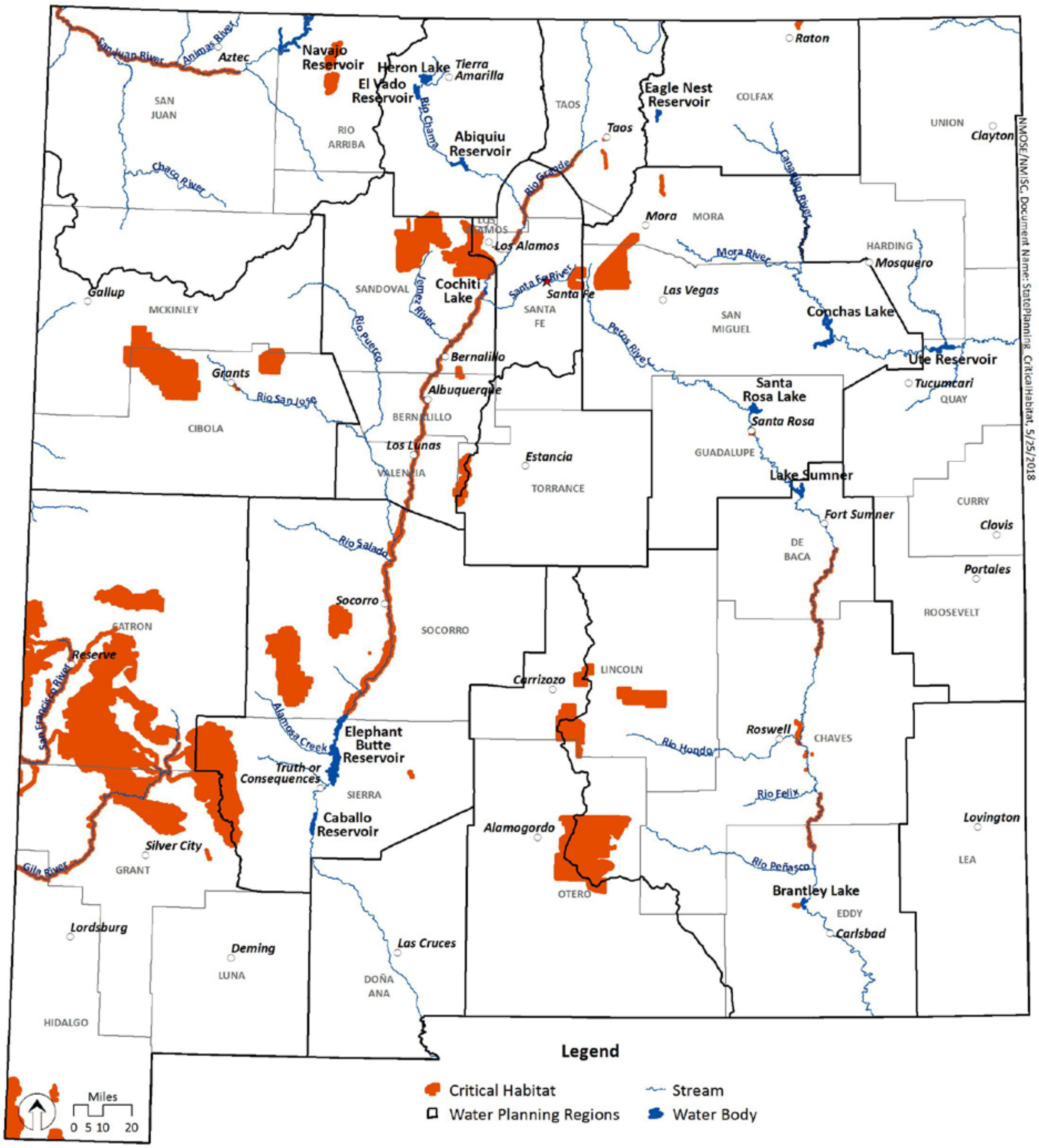


Figure 6-3. Critical Habitat for Endangered Species in New Mexico.

6.4 BETTER UNDERSTANDING OF WATER RESOURCES

Eleven (11) out of 16 water planning regions identified needs for additional data collection and monitoring, modeling, and analyses to better inform water resource decisions and policies regarding sustainability or longevity of groundwater resources. Issues regarding the need for better understanding of water resources identified in the RWPs are summarized in Table 6-4.

Table 6-4. Summary of Issues Related to Better Understanding of Water Resources.

Understanding Water Resources Issues	Number of Issues	Number of Regions (Out of 16)
Aquifer mapping to identify alternative water sources	8	6
Improved groundwater models for water rights administration and management	5	4
Aquifer decline, volume in storage, recharge rate, amount pumped needs to be better understood	4	3
Quantification of vegetation management on water resources	3	3
Quantification of water budget	3	2
Monitoring needed to better manage resources	2	2

As many regions struggle with drought and declining water levels, as well as the pressure of increased future demands in some areas, the need for a better understanding of potential new water resources was a common theme, and the RWPs showed widespread support for aquifer mapping that can help to inform decisions about potential alternative water supplies. For example, the Colfax Region has actively been seeking funding for aquifer mapping to identify alternative groundwater supplies to the drought-vulnerable surface supplies in the region.

Like the need for aquifer mapping, groundwater studies that provide more quantitative information on rates of groundwater decline and other aquifer impacts are important for understanding the sustainability of groundwater resources and can be used to develop improved groundwater models for water rights administration and management. Competition for water resources creates tension and the need to understand the impacts of one water user on another; and, as the Jemez y Sangre Region recommended, an updated administrative groundwater model is needed to better manage the aquifers and their connection to surface water. In the Estancia Region, critical information to better understand the water resources include the connection between the Madera Group and Valley Fill aquifers, the potential for subsidence in the Valley Fill and migration of water from area of high salinity to areas of lower salinity.

Several regions noted that though forest restoration efforts have helped to reduce the risk of wildfire, the net water supply impacts of physical watershed management techniques are not well documented or understood. Quantification of the effectiveness of riparian vegetation removal, upland conifer thinning, and other water salvage methods need further study and continued monitoring and will be crucial to understanding the role vegetation management plays on water budgets.

6.5 WATER QUALITY

Water quality was highlighted as an issue in 14 out of 16 water planning regions, an issue that in many cases results in additional limitations on water supplies. Many regions identified protecting and/or improving water quality as important; some of the key issues and challenges identified in the RWPs regarding water quality are summarized in Table 6-5.

Table 6-5. Summary of Water Quality Issues.

Water Quality Issue	Number of Issues	Number of Regions (out of 16)
Naturally occurring salinity, uranium	12	6
Surface and groundwater contamination from septic tanks	7	7
Groundwater contamination from mining and industry	6	6
Hydraulic fracturing	5	5
Degraded riparian area/need for restoration	4	4
Mercury in lakes/fish	3	3
Stormflows (MS4 permits impact on TMDLs)	2	2
E. coli in surface water	2	2
Surface water supplies contaminated from industry	2	2

Potential contamination of shallow groundwater, domestic wells, and in some locations surface water due to septic tanks is a concern in many rural areas in New Mexico. E Coli was specifically mentioned in two regions where high levels were detected in the Rio Grande and the San Juan and Animas Rivers due to human and wildlife waste products. The RWPs also identified water quality protection and/or restoration from leaking underground storage tanks (USTs), agricultural activity and dairy operations, existing or proposed mining operations, and contamination from oil and gas field operations as important issues. Several regions noted that high levels of mercury detected in fish and the resulting fish consumption advisories for many reservoirs in New Mexico, were significant water quality issues. The source of the mercury is most likely atmospheric deposition.

The RWPs also noted that increasing temperatures and evaporation rates can affect water quality. Concentrations of nitrogen, phosphorus, suspended solids, and salts may increase in the future in response to increased surface water evaporation rates and increased precipitation intensity. In addition, higher water temperatures can lead to less dissolved oxygen, which is a problem for many aquatic species.

Sedimentation is a key challenge for many water suppliers. During rain and flood events, both ephemeral tributaries and perennial water courses contribute substantial amounts of sediments into the rivers. Post-fire sedimentation and extreme precipitation events exacerbate the issue. Sedimentation and erosion issues contribute to degraded riparian areas.

Naturally occurring high concentrations of dissolved solids (brackish water) as well as uranium, arsenic, and fluoride in groundwater in many locations require treatment prior to use of the water, creating an economic barrier for use of those supplies in many cases.

6.6 WATER INFRASTRUCTURE AND MAINTENANCE

Maintaining, improving, and managing PWSs and agricultural infrastructure is one of the greatest funding challenges in New Mexico, an issue raised in 15 out of 16 water planning regions. Of the approximately 1,400 water systems that provide drinking water in New Mexico; more than 500 of those systems serve less than 100 people. In addition to the drinking water systems, thousands of small acequia/irrigation systems in New Mexico are also challenged with infrastructure issues.

Though not all regions listed specific infrastructure issues in their key issues, hundreds of infrastructure needs were identified, including dam safety issues. Therefore, this list is not inclusive of all infrastructure needs identified in the RWPs. Infrastructure challenges that were highlighted as key issues are summarized in Table 6-6.

Table 6-6. Summary of Water Infrastructure Issues.

Water Infrastructure Issues	Number of Issues	Number of Regions (out of 16)
Small public water systems	15	12
Public water system operations and maintenance	7	4
Large water projects	14	8
Wastewater	5	4
Sedimentation in reservoirs (loss of capacity)	5	5
Acequias	4	4
Agricultural irrigation	4	4
Dam safety	2	2
Regionalizing water systems	1	1
Flood control infrastructure	1	1

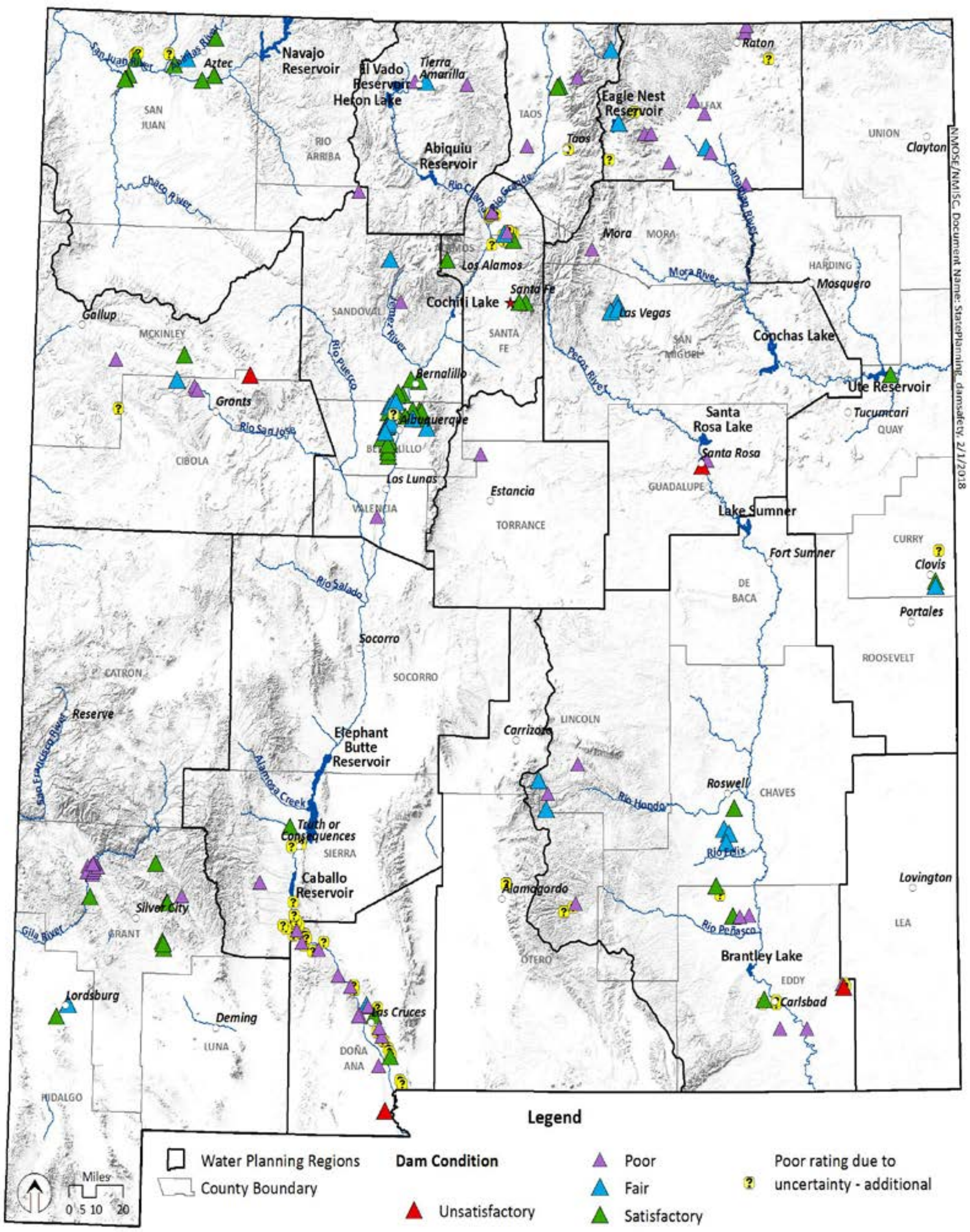
Most of the regions identified issues with small drinking water systems, including many small systems such as mutual domestic water consumer associations and mobile home parks. Many of these systems have issues with aging infrastructure, maintenance, upgrades, training, operation, and monitoring that is required to ensure delivery of water that meets drinking water quality standards. For example, in the Taos Region, achieving optimal efficiency in water system operation and infrastructure upgrades, through cooperative associations or other means, was identified as an important objective. Larger communities also identified extensive lists of infrastructure projects, and 14 large water projects were noted.

Flood control infrastructure along the Rio Grande (particularly in the Middle Rio Grande and Lower Rio Grande regions) is a significant issue. The existing flood control infrastructure along the Rio Grande between Espanola and Truth or Consequences is many decades old and nearing the end of its useful life. This flood control infrastructure in most instances consists of levees which were not designed to appropriate engineering standards, but instead consist simply of excavated material placed alongside the river. In many areas, due to sediment buildup along the bottom of the channel of the Rio Grande, the river is higher than the surrounding floodplain, and failure or breach of a levee would cause significant flooding. The cost to replace or reinforce the levee system throughout the Middle Rio Grande valley is estimated at more than $750 million. Also, in the Lower Rio Grande region, the International Boundary and Water Commission (IBWC) maintains a flood control system of levees along the length of the Rio Grande in New Mexico downstream of Caballo Reservoir. IBWC in recent years has completed some improvements to the system, originally constructed between 1938 to 1943, but more improvements are needed.

Dam Safety issues were summarized in each of the RWPs. Six regions have identified dam repair in their PPP (projects programs, and policies) lists, but only two regions listed dam safety as a key issue. The City of Raton in the Colfax Region is faced with a major infrastructure issue in that the spillway at Lake Maloya is only 9% of the required size to route governing inflow design.

Figure 6-4 shows the condition of dams with high or significant hazard potential ratings in New Mexico. Some dams receive a “poor” condition rating if comprehensive design information is not available. Based on the hazard potential rating and condition of the dams, more regions may want to add dam safety as a key issue in future water planning efforts. The OSE Dam Safety Bureau database identifies 170 dams with a high hazard potential rating, and 50 dams with a significant hazard potential rating that are under state jurisdiction. Three dams stand out as serious problems based on their high hazard potential rating and unsatisfactory condition. In the Northwest New Mexico Region, in Cibola County, San Mateo Lake Dam is classified as unsatisfactory due to the inadequate spillway capacity which is 27% of the required inflow design flood, embankment, cracking, severe seepage, and an overall lack of maintenance. In Guadalupe County, Power Lake Dam is classified as unsatisfactory due to an undersized spillway, with a capacity of only 11% of the required inflow design flood, and due to the partially breached condition of the dam. In Dona Ana County, Gardner Dam has no spillway or low-level outlet, has severe erosion, excessive woody vegetation and excessive seepage.

The preservation of traditional communities, agriculture, and the historical acequia system continues to be a key issue in several parts of the state. Funding for repair and maintenance of acequia infrastructure is an ongoing issue, and the New Mexico Acequia Association has identified hundreds of projects needing funding. In some areas agricultural efficiency was an important issue. In the Colfax Region where there is little shallow groundwater benefitting from ditch seepage losses, ditch losses are a key issue. Water seeping from ditches in the Colfax region does not return to the stream or recharge a viable aquifer.



High:	Dams where failure or faulty operation would likely result in loss of human life.
Significant:	Dams where failure or faulty operation would likely not result in loss of human life but could cause economic loss, environmental damage, disruption of lifeline facilities, or could impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but may be in populated areas with significant infrastructure.

Figure 6-4. Condition of State Regulated and Non-Federal Dams in New Mexico with Significant or High Hazard Potential.

7. Strategies for Addressing Key Water Issues

Regional steering committees identified and compiled lists of potential water PPPs (projects programs, and policies) as strategies for implementation to address key water planning issues in their respective regions. At steering committee meetings held in 2015 and 2016, each group discussed projects that would have a larger regional or sub regional impact and for which there is interest in collaboration to seek funding and for implementation. Each region used different methods of categorizing their PPPs. For purposes of comparing "apples to apples" in this State Water Plan, each PPP was assigned to a category with consistent names (i.e. Watershed Restoration instead of Forest Restoration; Riparian Restoration instead of River Restoration), and each was categorized based on one of eight strategy purposes, summarized below with examples:

Improve System Efficiency: Changes to existing infrastructure for agricultural and PWSs and wastewater systems; Increasing storage of reservoirs; Water Banking; Canal Lining; Water Planning

Protect Existing Supplies: Improvements to current wastewater systems (replacing septic tanks) to protect water quality; Watershed and Riparian Restoration, Dam Safety; Stormwater System Infrastructure, Environmental Flows, Erosion Control; Water planning; Water Quality Protection; Water quality treatment of existing supplies; Water Rights Protection

Increase Water Supply: Projects that would result in a reduction in the predicted gap between supply and demand (for non-agricultural sector) by increasing the amount of water available to a water system such as Aquifer Storage and Recovery (ASR). Projects that utilize water otherwise not relied upon by the water system; Desalination of water (including Produced Water from Oil & Gas) that is not otherwise associated with a declared groundwater basin such that use of the water would not impact existing water rights; Drilling new wells that expand the capacity of the water supply; Import water from another groundwater basin or surface water supply; Return flow credit for treated effluent that was not otherwise utilized by the water system; Transferring water rights (through purchase, lease or water banking) from agriculture to Municipal and Industrial; Using treated effluent for ASR projects; Community Cisterns

Reduce Demand: Projects that would result in a reduction in the predicted gap between supply and demand (for non-agricultural sector) by reducing the current or predicted demand such as all water conservation programs for PWSs (audits, fixing leaks, rebate programs, roof catchment); water conservation for agricultural systems where the project does not increase the consumptive use such as lining ditches where the water seeped into a deep unsaturated zone or laser leveling that reduces the incidental depletions of on-farm irrigation; metering wells or changes in crops or irrigation methods; reducing evaporative losses, using treated effluent instead of potable water on turf or other landscape

Improve Understanding of Water Resources: Data Collection/Hydrologic Studies including groundwater and geologic mapping, database & global information system (GIS) development, groundwater models, water quality testing, water level monitoring, weather data collection; Water Planning

Drought Mitigation: Projects or programs that provide temporary solutions to a drought emergency, such as shortage sharing agreements, emergency drought restrictions for public water supplies, drilling back-up wells, conjunctive use strategies to rest the aquifer and rely on renewables when available, thereby increasing the capacity of the well fields; water banking rather than a permanent transfer of water rights to address the temporary shortage

Public Outreach/Stakeholder Involvement: Development of water authority or water board, programs to pursue implementation of projects such as water conservation; public education about any aspect of water planning, improving relationships

Water Policy: Policies that address management of water resources including economic strategies, restrictions on water use

Nearly 50 categories of strategies were identified in the PPP lists, and some of the categories fall under multiple purposes, creating a challenge for categorizing and summarizing the lists. For instance, "water conservation" is most often implemented for reducing the overall demand of the water system, but it can also be implemented as a drought mitigation measure. The proposed projects with the purpose of reducing water demand or increasing water supply to address the supply-demand gap are described in more detail in Appendix C.

The degree to which each strategy will reduce the demand or increase supply was not included in the RWP (except for Jemez y Sangre). However, for this SWP, an estimate of the reduction in demand in the PWS sector for each region is calculated based on one of many possible scenarios. The total potential savings for the 1.7 million people who are served by PWSs statewide is 66,000 ac-ft/yr, if demand were reduced to 130 gallons per capita per day (gpcd) in areas where it is presently higher (see Appendix C-1 for details).

Water conservation PPPs proposed for other water use sectors are briefly described in Appendix C.1.2 through D1.1.5. Appendix C.2 describes PPPs to increase water supply proposed by the regions that involve developing new sources of water supply. Appendix C.3 describes actions related to transferring water rights, and Appendix C.4 addresses inter-basin transfers of water. And finally, Appendix C.5 discusses mitigating drought through reducing conflict with shortage sharing agreements.

7.1 KEY COLLABORATIVE STRATEGIES

To determine which projects might have the most momentum for implementation, the steering committee members identified PPP leads and partners as well as possible funding sources. The PPPs that lend themselves to collaboration are focused primarily on protecting existing supplies and improving understanding of the water resources, as shown in Table 7-1. Projects such as stormwater protection, watershed restoration, riparian restoration, data collections and improved models are projects that stakeholders can collaborate on and benefit everyone. Table 7-2 shows a summary of the types of key collaborative projects identified by the regions.

Table 7-1. Summary of Key Collaborative Strategies by Purpose from the 16 Regional Water Plans.

Strategy Purpose	Total	Number of Regions
Protect existing supplies	55	15
Improve understanding of water resources	42	15
Reduce demand	21	9
Improve system efficiency	21	12
Increase water supply	10	6
Water policy	6	4
Public outreach/stakeholder involvement	6	4
Drought mitigation	6	4
Total	167	

Table 7-2. Summary of Key Collaborative Strategies.

Strategy	Total PPPs	Number of Regions
Data collection/hydrologic studies	37	15
Watershed restoration	29	14
Water system infrastructure (M)	13	10
Water conservation (M)	12	8
Water planning	9	6
Riparian restoration	8	5
Water conservation (A)	8	7
Stormwater system infrastructure	7	7
Wastewater reuse	6	5
Water system infrastructure (A)	6	4
Create water authority/board	4	2
Water banking	3	3
Increase storage	3	2
Water rights protection	3	3
Water quality protection	2	2
Reservoir management	1	1
Desalination	1	1
Drill new well	1	1
Economic strategy	1	1
Environmental protection	1	1
Implementation	1	1
Dam safety	1	1
Import/export water	1	1
Metering	1	1
Policy recommendations	1	1
Produced water (oil & gas)	1	1
Aquifer storage and recovery	1	1
Protect water rights	1	1
Transfer water rights	1	1
Wastewater system infrastructure	1	1
Water treatment system (M)	1	1
Protect agriculture	1	1

Notes:
M = Municipal
A = Agriculture

7.2 ALL PROJECTS, PROGRAMS, AND POLICIES

In addition to identifying key collaborative efforts, each region discussed and compiled a list of new PPP needs. Information was requested during several open meetings, and requests for input were also emailed to all stakeholders who had expressed interest in the regional water planning process. Some water projects included on the PPP lists were already identified through the State of New Mexico Infrastructure Capital Improvement Plan (ICIP) process or other planning processes. The PPPs included water system infrastructure, acequia infrastructure, watershed management, water conservation, data collection projects, and other types of projects. The complete list of PPPs is appended to each RWP, available at http://www.ose.state.nm.us/Planning/regional_planning.php

The 2,635 PPPs from the 16 regions are summarized in Table 7-3 based on the purpose of the strategy. About 62% of the PPPs included a cost estimate (Figure 7-1). Most of the projects by cost and number are for water or wastewater system infrastructure for both public and agricultural water systems to improve the operations and efficiency. Protecting existing supplies, particularly through watershed restoration and stormwater protection, also represents many of the projects. Of the 62% of PPPs that provided costs, the total for all proposed projects and programs for the fiscal years 2018 through 2020 exceeds $4 billion. As shown in Table 7-4, about 50 strategy types were identified in the PPP lists, which shows again that the clear majority of projects and costs are for various infrastructure projects.

Table 7-3. Summary of Projects, Programs, and Policies from 16 Regions.

Strategy Purpose	Total Cost	Number of PPPs	PPPs with Cost	Percent of PPPs with Cost Provided
Improve system efficiency	$2,166,164,000	1412	868	61%
Protect existing supplies	$1,429,200,000	705	509	72%
Increase water supply	$342,528,000	135	85	63%
Reduce demand	$326,811,000	180	87	48%
Improve understanding of water resources	$13,941,000	151	64	42%
Drought mitigation	$10,350,000	15	3	20%
Miscellaneous	$4,391,000	6	3	50%
Public outreach/stakeholder involvement	$1,017,000	17	5	29%
Water policy	NA	14	0	0%
Total	$4,294,402,263	2635	1624	62%

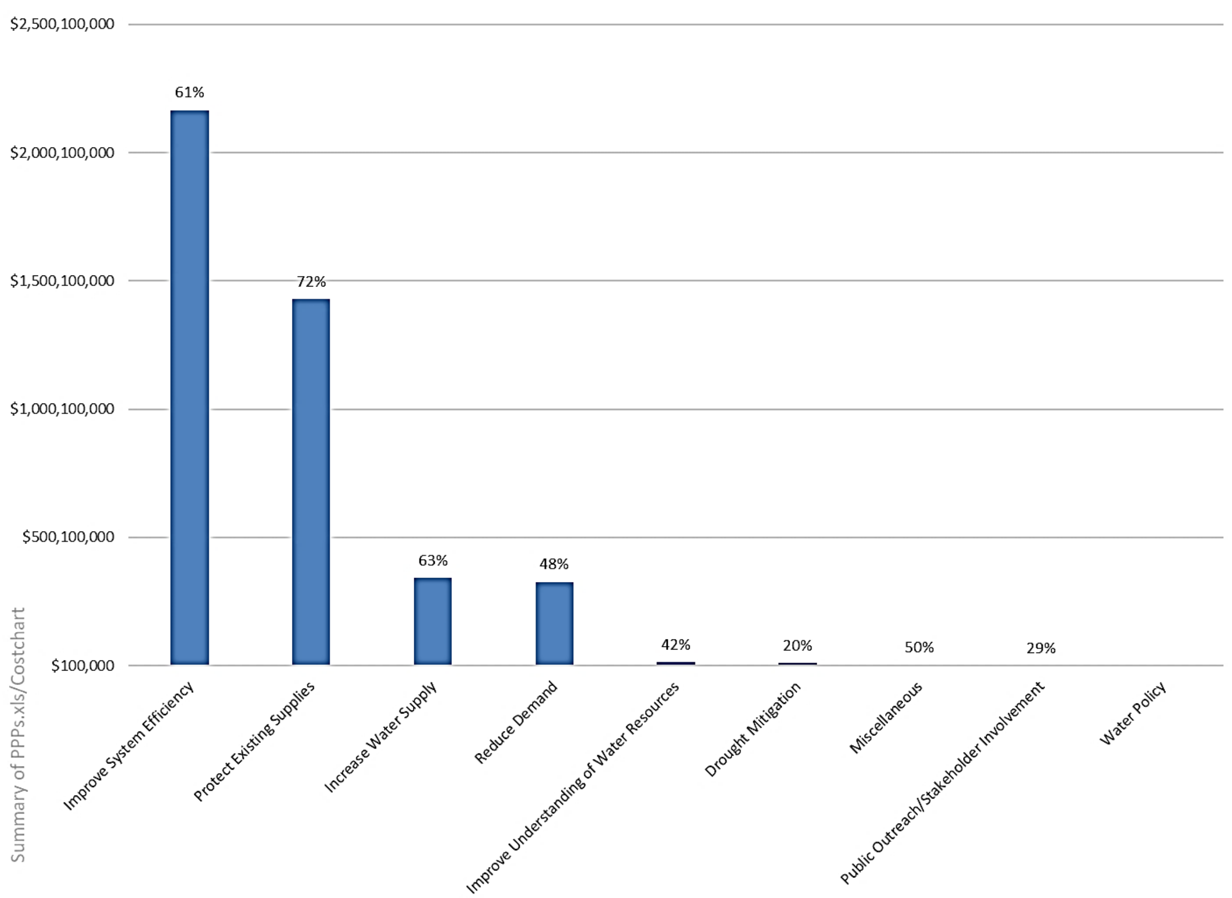


Figure 7-1. Summary of Estimated Costs by Projects, Programs, and Policies Category for the Percent of Projects that Provided Cost Estimates.

Table 7-4. Summary of Strategy Costs for All Projects, Programs, and Policies.

Strategy	Total Cost	Number of PPPs	Percent with Costs Estimates Provided
Water System Infrastructure (M)	$1,800,500,000	808	84%
Wastewater System Infrastructure	$917,005,000	256	90%
Water System Infrastructure (A)	$382,520,000	531	24%
Stormwater System Infrastructure	$360,459,000	138	80%
Wastewater Reuse	$173,461,000	50	72%
Riparian Restoration	$151,635,000	61	64%
Watershed Restoration	$142,698,000	233	62%
Drill New Well	$69,580,720	55	80%
Dam Safety	$58,915,000.	19	58%
Water Treatment System (M)	$53,237,000	41	78%
Water Conservation (M)	$49,766,000	58	40%
Transfer Water Rights	$26,499,000	27	70%
Desalination	$17,390,000	9	22%
Metering	$13,392,000	43	63%
Increase Storage (A)	$11,000,000	3	67%
Regional Water System	$10,900,000	2	50%
Regional Wastewater System	$10,000,000	1	100%
Dam Rehabilitation	$9,000,000	2	50%
Data Collection/Hydrologic Studies	$8,646,000	109	39%
Water Planning	$6,420,000	63	44%
Uncategorized	$4,391,000	3	100%
Reservoir Management	$4,050,000	2	50%
Increase Storage	$4,000,000	4	25%
Produced Water (Oil & Gas)	$3,500,000	3	33%
Water Conservation (A)	$2,300,000	29	10%
Water Banking	$1,200,000	7	29%
Water Rights Protection	$580,500	11	45%
Create Water Authority/Board	$500,000	5	20%
Education	$255,000	7	29%
Shortage Sharing	$250,000	2	50%
Cloud Seeding	$150,000	6	17%
Environmental Flows	$100,000	2	50%
Drill New Well (A)	$52,000	1	100%
Metering (A)	$30,000	4	25%
Water Quality Protection	$20,000	10	20%
Policy Recommendations		8	
Aquifer Storage and Recovery		4	
Environmental Protection		3	
Import/Export Water		3	
Reduce Evaporation Losses		3	
Implementation		2	
Import Water		2	
Protect Agriculture		2	
Economic strategy		1	
Industrial Water Reuse		1	
Protect Water Rights		1	
Return Flow Credit		1	
Water and Wastewater System Infrastructure (M)		1	

Notes:

M = Municipal, A = Agriculture

The estimated costs for the PPPs by region are shown in Table 7-5. The clear majority are for infrastructure projects for public water and wastewater systems ($3,100 million) and agricultural irrigation systems ($300 million). Figure 7-2 shows the distribution of need for financial resources for public water and wastewater infrastructure projects. Some regions may be further along in their planning efforts and better able to identify the projected costs for implementing projects.

The costs by region for 20 specific strategies are listed in Table 7-6. Figure 7-3 shows the distribution of estimated costs for agricultural infrastructure projects.

Table 7-5. Summary of Projects, Programs, and Policies Costs by Region.

Planning Region Number	Region Name	Total Cost	Number of PPPs	Percent with Cost Estimate
1	Northeast	$184,778,000	99	20%
2	San Juan	$333,398,000	154	84%
3	Jemez y Sangre	$266,266,000	206	76%
4	Southwest	$149,851,000	260	75%
5	Tularosa/Salt Basins	$331,941,000	101	45%
6	Northwest	$586,802,000	205	72%
7	Taos	$123,663,000	279	38%
8	Mora/San Miguel/Guadalupe	$263,381,000	337	39%
9	Colfax	$216,633,000	116	89%
10	Lower Pecos Valley	$287,383,000	161	60%
11	Lower Rio Grande	$524,568,000	288	74%
12	Middle Rio Grande	$564,467,000	178	50%
13	Estancia Basin	$145,712,000	33	91%
14	Rio Chama	$168,785,000	109	79%
15	Socorro/Sierra	$20,064,000	44	64%
16	Lea County	$126,712,000	65	69%
Total		$4,294,402,000	2635	62%

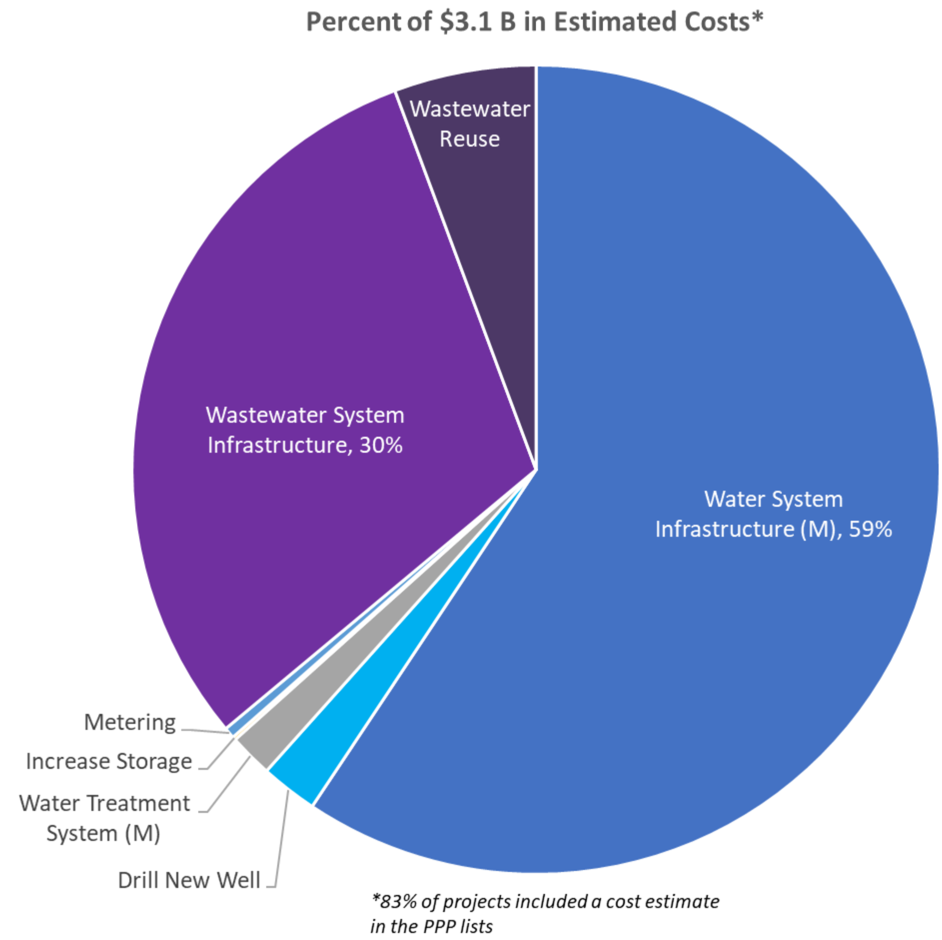


Figure 7-2. Estimated Costs for Public Water and Wastewater Infrastructure Projects

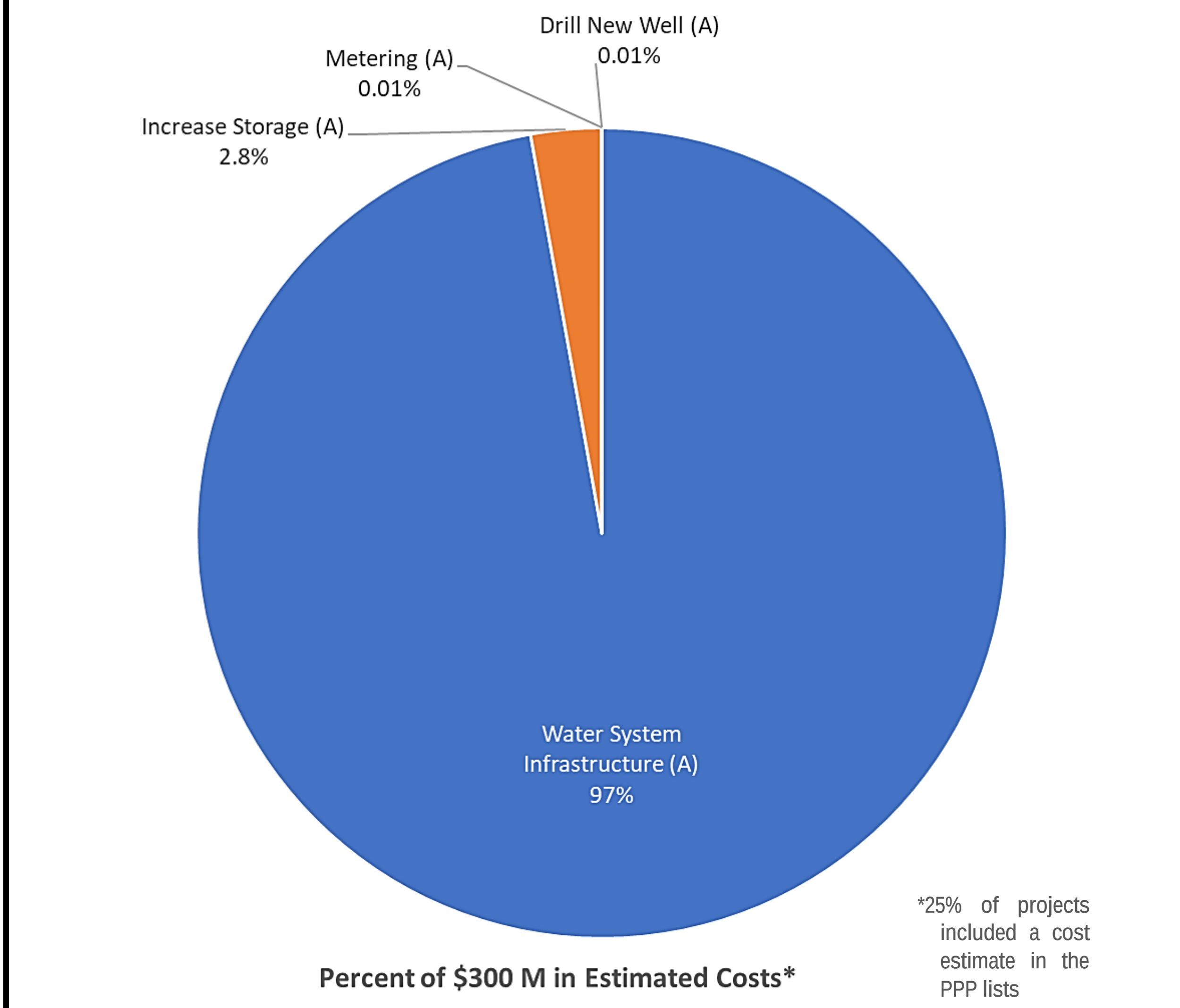


Figure 7-3. Costs by for Agricultural Water Infrastructure Projects.

Table 7-6. Summary of Costs by Region for 20 Strategies.

Strategy		1	2	3	4	5	6	7
Region		Water System Infrastructure (M)	Wastewater System Infrastructure	Water System Infrastructure (A)	Stormwater System Infrastructure	Wastewater Reuse	Riparian Restoration	Watershed Restoration
1	Northeast	107,109,000	--	--	--	68,450,000	2,310,000	--
2	San Juan	209,496,000	112,561,000	1,514,000	2,256,000	--	1,444,000	3,367,000
3	Jemez y Sangre	149,481,000	57,630,000	2,090,000	5,733,000	--	720,000	855,000
4	Southwest	77,347,000	6,978,000	14,264,000	5,106,000	14,061,000	390,000	17,680,000
5	Tularosa/Salt Basins	90,843,000	2,760,000	175,000,000	175,000	13,771,800	--	198,000
6	Northwest	429,408,000	108,338,000	1,090,000	10,468,000	6,800,000	662,000	7,700,000
7	Taos	49,791,000	53,652,000	7,887,000	435,000	--	3,338,000	5,098,000
8	Mora/San Miguel/Guadalupe	73,985,000	19,016,000	31,305,000	15,397,000	3,807,000	17,843,000	41,346,000
9	Colfax	127,917,000	45,996,000	3,336,000	4,710,000	2,055,000	1,000,000	3,030,000
10	Lower Pecos Valley	113,778,000	65,375,000	--	37,854,000	31,190,000	1,750,000	1,100,000
11	Lower Rio Grande	198,313,000	244,812,000	300,000	54,869,000	1,400,000	--	--
12	Middle Rio Grande	110,199,000	137,667,000	6,870,000	205,235,000	3,750,000	19,150,000	58,807,000
13	Estancia Basin	1,595,000	980,000	135,000,000	3,362,000	1,090,000,570		900,000
14	Rio Chama	19,169,000	20,525,000	1,264,550	2,000,000		101,879,000	2,476,000
15	Socorro/Sierra	12,564,000	500,000	2,600,000	914,100	500,000	1,150,000	140,500
16	Lea County	29,507,000	40,215,000	--	11,945,000	26,587,000	--	--
Total		1,800,500,000	917,005,000	382,520,000	360,459,000	173,461,000	151,635,000	142,698,000

Table 7-6. Summary of Costs by Region for 20 Strategies (Continued).

Strategy		8	9	10	11	12	13	14
Region		Drill New Well	Dam Safety	Water Treatment System (M)	Water Conservation System (M)	Transfer Water Rights	Desalination	Metering
1	Northeast	--	--	290,000	6,500,000	--	--	--
2	San Juan	--	2,150,000	--	--	--	--	60,000
3	Jemez y Sangre	18,165,000	1,853,000	3,270,000	771,000	515,000	--	2,780,000
4	Southwest	6,628,000	--	--	4,562,500	1,250,000	--	260,000
5	Tularosa/Salt Basins	2,190,000	--	1,468,707	36,400,000	--	8,500,000	--
6	Northwest	16,738,000	5,000,000	281,000	--	--	--	142,000
7	Taos	420,000	--	--	--	1,450,000		943,000
8	Mora/San Miguel/Guadalupe	6,134,000	6,532,000	17,414,000	--	--	8,890,000	1,231,000
9	Colfax	2,490,000	21,121,000	350,000	--	4,050,000	--	--
10	Lower Pecos Valley	100,000	20,500,000	10,950,000	--	--	--	4,787,000
11	Lower Rio Grande	6,046,000	--	8,010,000	--	4,520,000	--	695,000
12	Middle Rio Grande	600,000	--	5,300,000	1,450,000	13,464,000	--	--
13	Estancia Basin	825,000	--	--	10,000	--	--	565,000
14	Rio Chama		1,759,000	5,903,000	--	500,000	--	
15	Socorro/Sierra	875,000	--	--	40,000	--	--	630,000
16	Lea County	8,370,000	--	--	33,000	750,000	--	1,300,000
Total		69,581,000	58,915,000	53,237,000	49,766,000	26,499,000	17,390,000	13,392,000

Table 7-6. Summary of Costs by Region for 20 Strategies (Continued).

Strategy		15	16	17	18	19	20
Region		Increase Storage (A)	Regional Water System	Regional Wastewater System	Dam Rehabilitation	Data Collection Hydrologic Studies	Water Planning
1	Northeast	--	--	--	--	69,000	50,000
2	San Juan	--	--	--	--	250,000	30,000
3	Jemez y Sangre	--	10,900,000	10,000,000	--	1,400,000	--
4	Southwest	--	--	--	--	1,300,000	--
5	Tularosa/Salt Basins	--	--	--	--	564,000	65,000
6	Northwest	--	--	--	--	175,000	--
7	Taos	--	--	--	--	290,000	110,000
8	Mora/San Miguel/ Guadalupe	1,000,000	--	--	9,000,000	333,000	100,000
9	Colfax	--	--	--	--	478,000	--
10	Lower Pecos Valley	--	--	--	--	--	--
11	Lower Rio Grande	--	--	--	--	1,742,000	3,345,000
12	Middle Rio Grande	--	--	--	--	200,000	1,520,000
13	Estancia Basin	--	--	--	--	485,000	--
14	Rio Chama	10,000,000	--	--	--	660,000	1,020,000
15	Socorro/Sierra	--	--	--	--	--	150,000
16	Lea County	--	--	--	--	700,000	30,000
Total		11,000,000	10,900,000	10,000,000	9,000,000	8,646,000	6,420,000

Notes:
M = Municipal, A = Agriculture
Note that totals are rounded and may not match exact calculations

7.3 DEVELOPING RECOMMENDATIONS TO THE STATE

While many water supply issues can be addressed by individuals or through collaboration among organizations, some aspects, such as policy changes or enforcement, need to be addressed by a state agency. As part of the planning process for updating the RWPs, the steering committees created recommendations to the state. The recommendations in each of the 16 plans have been compiled for this report. A total of 116 recommendations ranged from requesting improved data collection and groundwater modeling to water planning to adjudication (Table 7-7).

Table 7-7. Recommendations to the State.

Category	Total Recommendations
Data collection/hydrologic studies	17
Water rights	17
Planning	16
Watershed restoration	10
Water quality protection	7
Acequias	5
Planning boundaries	5
Small drinking water systems	5
Wastewater reuse	5
Drought mitigation	4
Instream flow	4
Produced water	3
Conservation	2
Dam safety	2
Importation of water	2
Metering	2
Reservoir operations	2
Stormwater system infrastructure	2
Divert excess water for aquifer storage and recovery	1
Economic development planning	1
Increase precipitation	1
Infrastructure	1
Infrastructure-Resilient to Climate Change	1
Political	1
Total	116

The recommendations involve the jurisdiction of many state and federal agencies, including ISC, OSE, New Mexico Environment Department (NMED), State Land Office, New Mexico Department of Game and Fish, NMBGMR, New Mexico State Forestry, New Mexico Department of Agriculture, United States Bureau of Reclamation, United States Army Corps of Engineers, United States Forest Service, and United States Bureau of Land Management. Most of the recommendations are for funding and others are for regulatory or policy changes, public outreach, development of new programs or enforcement of existing regulations (Table 7-8).

Table 7-8. Summary of the Needs Related to Recommendations to the State.

Need	Total
Funding	59
Regulatory	24
Policy	16
Public Outreach/Stakeholder Involvement	11
Programmatic	3
Enforcement	3

The recommendations have been organized into categories and analyzed for similarities. A summary of these categories and common recommendations are presented as Appendix A.

References

Arrowhead Center. 2013. *Economic base studies*. New Mexico State University. September 2013.

Bawazir, A.S., Z. Samani, M. Bleiweiss, R Skaggs, and T Schmugge. 2009. Using ASTER satellite data to calculate riparian evapotranspiration in the Middle Rio Grande, New Mexico. *International Journal of Remote Sensing* 30(21):5593-5603. November 2009.

Brinegar, H.R., and F.A. Ward. 2009. Basin Impacts of Irrigation Water Conservation Policy. *Ecological Economics* 69(2009):414–426.

Coonrod, J., and D. McDonnell. Undated. Using Remote Sensing and GIS to Compute Evapotranspiration in the Rio Grande Bosque.

<http://proceedings.esri.com/library/userconf/proc01/professional/papers/pap487/p487.htm#_INTRODUCTION>. Accessed May 2014.

Forest Guild. 2008. Managing Forests in the Face of Climate Change: A Summary of New Mexico Forestry and Climate Change Workshop on November 20, 2008 in Albuquerque, New Mexico. December 2008.

Garfin, G., A. Jardine, R. Merideth, M. Black, and S. LeRoy (eds.). 2013. Assessment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assessment. A Report by the Southwest Climate Alliance. Island Press, Washington, DC.

Gori, D., M.S. Cooper, E.S. Soles, M. Stone, R. Morrison, T.F. Turner, D.L. Propst, G. Garfin, M. Switanek, H. Chang, S. Bassett, J. Haney, D. Lyons, M. Horner, C.N. Dahm, J.K. Frey, K. Kindscher, H.A. Walker, and M.T. Bogan. Gila River Flow Needs Assessment. A report by The Nature Conservancy.

Gutzler, D. 2003. Drought in New Mexico: History, causes, and future prospects. pp. 101-105 in Johnson, P., L.A. Land, L.G. Price, and F. Titus. (eds.), Water resources of the lower Pecos region, New Mexico: Science, Policy, and a Look to the Future. Decision-Makers Field Conference 2003, New Mexico Bureau of Geology and Mineral Resources, Socorro, New Mexico.

NM Dam Inventory, 2017... Data Provided to Amy Lewis from the NMOSE via Google Drive Sept 25, 2017.

Hoekstra, J. M., J. L. Molnar, M. Jennings, C. Revenga, M. D. Spalding, T. M. Boucher, J. C. Robertson, T. J. Heibel, with K. Ellison. 2010. The Atlas of Global Conservation: Changes, Challenges, and Opportunities to Make a Difference. Ed. J. L. Molnar. Berkeley: University of California Press.

Hurd, Brian and Julie Coonrod. 2008. Climate Change and its Implications for New Mexico's Water Resources and Economic Opportunities. Technical Report 45, New Mexico State University.

Intergovernmental Panel on Climate Change (IPCC). 2013. Climate Change 2013, The Physical Science Basis. Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY. 1535p.

Interstate Stream Commission (ISC), New Mexico. 1994. Regional Water Planning Handbook.

_____, 2013. Updated Regional Water Planning Handbook: Guidelines to Preparing Updates to New Mexico Regional Water Plans. December 2013.

Land, Lewis. 2016. Overview of Fresh and Brackish Water Quality in New Mexico. New Mexico Bureau of Geology and Mineral Resources Open File Report 583.

Longworth, J.W., J.M. Valdez, M.L. Magnuson, and K. Richard. 2013. *New Mexico water use by categories 2010.* Technical Report 54, New Mexico Office of the State Engineer, October 2013.

New Mexico Environment Department (NMED), 2016. New Mexico's Annual Public Water Systems Compliance Report, 2015. Drinking Water Bureau July 2016.

OSE, 2005. State Engineer Order 161. "In the Matter of the Declaration of the Clayton Underground Water Basin and Extension of the Canadian River Underground Basin." September 23.

_____, 2017. "Water Planning in New Mexico.".

Office of the State Engineer, New Mexico and New Mexico Interstate Stream Commission (OSE and ISC), 2006. The Impact of Climate Change on New Mexico's Water Supply and Ability to Manage Water Resources. July 2006

Palmer, W.C., 1965: *Meteorological Drought*. Research Paper No. 45, US Weather Bureau, Washington, DC.

Schmidt-Petersen, R. 2011. Middle Rio Grande Water Use Constraints and Commitments. Presentation by Rolf Schmidt-Petersen, Rio Grande Basin Manager, New Mexico Interstate Stream Commission.

The Nature Conservancy (TNC), 2010.These data were derived by The Nature Conservancy, and were displayed in a map published in The Atlas of Global Conservation (Hoekstra et al., University of California Press, 2010). More information at http://nature.org/atlas.

Thibault, J., and C. Dahm. 2011. Groundwater level data from the Middle Rio Grande riparian zone (1999-). Dataset available at <http://sev.lternet.edu/node/4256>. Sevilleta Long-Term Ecological Research.

United States Bureau of Reclamation (USBOR). 2011. SECURE Water Act Section 9503(c) – Reclamation climate change and water 2011. Prepared for United States Congress. April 2011.

_____, 2013. USBOR West-wide Climate Risk Assessment: Upper Rio Grande Impact Assessment. Upper Colorado Region, Albuquerque Area Office. December 2013.

United States Census Bureau (Census). 2014. Annual Estimates of the Resident Population: April 1, 2010 to July 1, 2013. American Fact Finder <http://factfinder2.census.gov/faces/nav/jsf/pages/ searchresults.xhtml?refresh=t> Accessed May 2014.

United States Global Change Research Program (USGCRP), 2014. Climate Change Impacts in the United States: 2014 Report. Prepared for the United States Government.

Water Dialogue, 1996) Water Dialogue, 1996. "Future on a Shoestring". Published by the New Mexico Water Dialogue. November 1996.

Williams, A.P., C.D. Allen, C. Millar, T. Swetnam, J. Michaelsen, C.J. Still, and S.W. Leavitt. 2010. Forest Responses to Increasing Aridity and Warmth in Southwestern North America. *Proceedings of the National Academy of Sciences, USA* 107(50):21289-21294.

Williams, A.P., C.D. Allen, A.K. Macalady, D. Griffin, C.A. Woodhouse, D.M. Meko, T.W. Swetnam, S.A. Rauscher, R. Seager, H. D. Grissino-Mayer, J.S. Dean. E. R. Cook, C. Gangodagamage, M. Cai, and N.G. McDowell. 2013. Temperature as a potent driver of regional forest drought stress and tree mortality. Nature Climate Change Vol 3. DOI: 10.1038/NClimate1693. March 2013.

Water Resource Research Institute (WRRI) 2017. New Mexico's Water Balance Model. https://nmwrri.nmsu.edu/category-blocks-swa/#DSWB.

Appendices

Appendix A. Recommendations to the State by Category

Recommendations related to planning include:

1. Seek funding for ongoing regional water planning and regional water plan implementation
2. Provide $1 million per water planning region in state funds for implementation
3. Set up interregional cooperative working groups to address common interests and issues and to identify opportunities for collaboration
4. Present RWP program and project needs to the legislative interim water and agriculture committee.
5. Consider including tribal water use in regional water planning*
6. Integration of water supply and wastewater treatment planning for infrastructure
7. Support for water conservation, source water protection, drought mitigation, and RWP implementation
8. Support drinking water system collaboration efforts and regionalization projects
9. Define goal of sustainable groundwater use for each groundwater basin that is being mined
10. Plans should focus on long-term sustainability and resilience of water resources

Planning boundaries include:

1. Evaluate geographical boundaries of existing water planning regions to identify areas where it may be appropriate to adjust boundaries based on local considerations (e.g., a water system or community that is separated into two planning regions, or watersheds)
2. Consider renaming Region 6 since Northwest New Mexico Water Planning Region does not accurately reflect the geographical boundaries of the region. This region does not include San Juan County, which covers the northwestern corner of the state

*Tribal participation was solicited and encouraged by the state during the regional water planning processes. It was the prerogative of tribes whether to provide water use data to the state.

Recommendations to the state related to data collection/hydrologic studies:

1. Developing and maintain a comprehensive statewide water budget
2. Exploring alternative water sources to identify new supplies through aquifer mapping and exploratory drilling
3. Provide funding to continue data collection, aquifer mapping and water quality monitoring
4. Meter pumping for improved water budget/groundwater modeling analysis
5. Improve groundwater modeling
6. Enforcing regulations for well drillers to report water level data to the OSE
7. Improve understanding of impacts from climate change
8. Improve reservoir loss accounting
9. Develop a database of geohydrology reports

Recommendation related to water rights include:

1. Discussion of water rights about forfeiture of water rights, reductions in water rights diversions within critical management areas, and the ability of farmers to expand their irrigated acreage to use water that is conserved. Some regions have significant “paper rights” that have never been put to beneficial use which presents challenges for planning and managing the water resources
2. Revise the 40-year water planning provision to require longer-term water planning

3. Change subdivision regulations (developed by county governments) to support community water supply and return flows
4. Adjudicate water rights
5. Support policy to protect water rights from loss for non-use when placed in a conservation plan or an acequia water bank
6. Define agricultural water use and what constitutes waste of agricultural water.
7. Enhanced Water Right Administration: Increased enforcement of existing policies, which will require increased staffing and overall capacity at the OSE
8. When considering interbasin transfer applications, the OSE should be mindful of Senate Joint JM 17 (2008) considerations as well as local public welfare statements, criteria, and priorities
9. Educate title companies statewide on the need to file a change-of-ownership for real estate that includes a well
10. Work with the Estancia Basin Water Planning Council on the criteria for deepening wells in the Estancia Basin.
11. Allow flexibility for water banking, leasing, and temporary transfers of water
12. Meter acequias and mutual domestic water associations so that they may receive return flow credits
13. Protect water rights by ensuring proper use of the Water Use Leasing Act (72-6-1 to 72-6-7 NMSA 1978) and the emergency / temporary water permit process (72-5-25 NMSA 1978)
14. Support conjunctive use strategies

Small drinking water systems include:

1. Support for small drinking water systems through capacity, administration, rate analysis, and asset management

Recommendations related to watershed restoration include:

1. Provide resources and dedicated funding for watershed-scale watershed management and restoration and playa lake conservation projects
2. Support education for best management practices to protect watersheds, including catastrophic fire prevention and mitigation and livestock management
3. Develop programs and policies that encourage locally produced small-diameter timber use and support landscape-level forest restoration
4. Encouragement of best management practices for grazing

Recommendations related to water quality protection include:

1. Enforce NMED liquid waste disposal regulations to protect water quality
2. Develop policies that provide for water quality protection in headwater watersheds, rivers, and creeks
3. Increase the budget available to the Monitoring, Assessment, and Standards section of the Surface Water Quality Bureau to allow for more staff to conduct more surface water monitoring around the state
4. Increase funding for the River Stewardship Program. This funding is available on a competitive grant basis from the Surface Water Quality Bureau of NMED for surface water restoration projects. This is on-the-ground funding with no match required
5. Develop policies for oil and gas development for protection of water quality

6. Monitor the proposed expansion of the scope of the Clean Water Act and the potential impact to water management and supplies

Recommendations related to acequias include:

1. Support for acequias through capacity building, administration, financial, audit, governance supports
2. Address anti-donation clauses related to funding for public/private projects (to allow for shared ditch lining) where ditches serve both agricultural associations and public water systems

All other recommendations included:

1. Statewide economic development initiatives that encourage low water use industries and green infrastructure and low impact development policies
2. Support the creation of an agricultural water conservation initiative, which would pay producers to reduce their irrigation demands by funding the implementation of agricultural water conservation strategies
3. Review dam safety regulations for both unnecessary requirements and for areas where additional safety is needed and provide funding and resources to address safety issues
4. Recommend changing the State Constitution to allow for sale of excess water for recharge
5. Work with the other states to revisit the interstate compacts, to add drought provisions
6. Provide resources and follow-up to link and implement state and local drought planning including: Emergency Preparedness, long-term planning, drought contingency, alternative water resource, and ensure that all water providers have a drought contingency plan
7. Exploration of changing subdivision regulations to support community water supply
8. Develop a State policy for importation and transfers of water; the State should consider statutory and administrative measures to expedite transfers, protect water rights, and monitor compliance
9. Develop and implement a statewide policy and program for weather modification initiatives to increase precipitation as supported by scientific study and previous projects implemented in New Mexico
10. Support capacity for COGs to address large-scale issues (infrastructure)
11. Clarify the definition of beneficial use and the use of water rights for instream flow purposes. Exploration of instream flow opportunities (legal protection for beneficial use and compatibility with acequias)
12. Require metering and reporting on all wells to improve estimates of actual water use
13. Support state and local control and management of water resources, in response to attempts to federalize water management
14. Evaluate mechanisms that affect the market for produced water. Provide incentives for use of produced water
15. Coordinate with federal agencies to explore the possibility of planning dam release schedules for downstream users to minimize negative impacts and maximize benefits to local acequias
16. Reduce state water losses: evaporative losses from reservoirs and conveyance channels are significant and should be addressed
17. Establish flood control districts where none exist to provide flood control projects with revenue from contracts, levy ad valorem taxes, or newly issued bonds to help prepare communities for high-intensity storm events
18. Develop water disaster recovery programs, including flood preparation and mitigation
19. Include wastewater planning and reuse as part of future regional water planning efforts
20. Support policies that promote water reuse and efforts to advance treatment technologies (reducing costs)
21. Modify NMED Regulations: current water quality standards for use in injection for aquifer storage, discharge to the Pecos River, or for direct reuse are too stringent and make reuse difficult and expensive

Appendix B. Water Supply, Demand, and Gap Methodology

B.1. ADMINISTRATIVE WATER SUPPLY METHODOLOGY

The method used to estimate the available supply, referred to as the administrative water supply in the Handbook, is based on withdrawals of water as reported in the *New Mexico Water Use by Categories* report (Longworth et al., 2013), which provide a measure of supply that considers both physical supply and legal restrictions (i.e., the water is physically available, and its use is in compliance with water rights policies). Therefore, this estimate provides a reasonable approximation of the amount of water that is available for use by each region. Considering the actual use as a measure of supply allows for a more accurate measure of available water, because it discounts physical supplies that may be present in a region but are required by legal or policy restrictions to be conveyed downstream for use. The administrative water supply was developed as a tool to provide an overview of water supply that incorporates both physical and legal supplies to be used for broad state planning purposes. It is not intended to replace or negate the need for more detailed water budgets, models, and other analyses to inform specific projects or local planning decisions.

For regions such as the Tularosa-Sacramento-Salt Basins planning region, where the aquifers are being depleted, the administrative water supply may not be sustainable in the future. In these cases, the future available supply was estimated as follows:

Non-stream connected groundwater basins with available OSE administrative models were used to predict the water level declines in the year 2060 based on estimated groundwater diversions. These declines were compared to the available water column to assess the potential impact on future pumping. The predicted drawdown in 2060 from a model cell in a heavily stressed area was selected and compared to the available water column in existing wells to calculate the percentage of wells impacted by the drawdown. This percentage of impacted wells was assumed to reflect a percentage reduction in the available supply.

Another method to predict the future decline of the saturated thickness and thus available supply is to use existing wells with water level hydrographs and compare the predicted decline with the available water column in existing wells:

- Using the average rate of water level decline calculated from United States Geological Survey (USGS) monitor wells within the non-stream connected groundwater and assuming that this rate will continue, the water level decline to 2060 was predicted.
- The percentage of impacted wells was estimated by comparing the predicted drawdown to the available water column in existing wells, and the percentage of impacted wells was assumed to represent the reduction in supply by 2060.

By assuming that the percentage of impacted wells results in an equal impact on water supply, the estimated supply in 2060 is reduced proportionally in each of the Underground Water Basins.

Both of these approaches represent an approximation of the impact on existing wells by 2060. Factors that may affect the accuracy of these predictions include:

- The water columns may not represent the available supply because some existing wells could possibly be drilled deeper.
- The shallowest wells that are most impacted may not proportionally represent the distribution of pumping (the deeper wells most likely pump more than the shallow wells).
- New wells could be drilled in other parts of the aquifer, although doing so would require a water right permit.

B.2 DROUGHT SUPPLY METHODOLOGY

An estimate of supply during future droughts was developed for each region, by adjusting the 2010 withdrawal data based on physical supplies available during historical droughts. One method to review long-term variations in climate conditions is by using drought indices. A drought index consists of a ranking system derived from the assimilation of data—including rainfall, snowpack, streamflow, and other water supply indicators—for a given region. The Palmer Drought Severity Index (PDSI) was created by W.C. Palmer (1965) to measure variations in the moisture supply and is calculated using precipitation and temperature data as well as the available water content of the soil. Because it provides a standard measure that allows comparisons among different locations and months, this index is widely used to assess the weather during any time relative to historical conditions. The PDSI classifications for dry to wet periods are provided in Table B-1.

Table B-1. Palmer Drought Severity Index Classifications

PDSI Classification	Description
+ 4.00 or more	Extremely wet
+3.00 to +3.99	Very wet
+2.00 to +2.99	Moderately wet
+1.00 to +1.99	Slightly wet
+0.50 to +0.99	Incipient wet spell
+0.49 to –0.49	Near normal
–0.50 to –0.99	Incipient dry spell
–1.00 to –1.99	Mild drought
–2.00 to –2.99	Moderate drought
–3.00 to –3.99	Severe drought
–4.00 or less	Extreme drought

There are considerable limitations when using the PDSI, as it may not describe rainfall and runoff that varies between locations within a climate division and may also lag by several months in indicating emerging droughts. Also, the PDSI does not consider groundwater or reservoir storage, which can affect the availability of water supplies during drought conditions. However, even with its limitations, many states incorporate the PDSI into their drought monitoring systems; it also provides a useful indication of long-term relative variations in drought conditions, because PDSI records are available for more than 100 years.

The PDSI is calculated for climate divisions throughout the United States. For the 8 climate divisions present in New Mexico, the PDSI classifications for 2010 were either near normal (5 climate divisions) or incipient wet spell (3 climate divisions). Given that the water use data for 2010 represent a 'near normal' to 'slightly wetter than normal' year, it cannot be assumed that this supply will be available in all years; it is important to also consider potential water supplies during drought periods. The locations of New Mexico Climate Divisions are shown in Figure B-1.

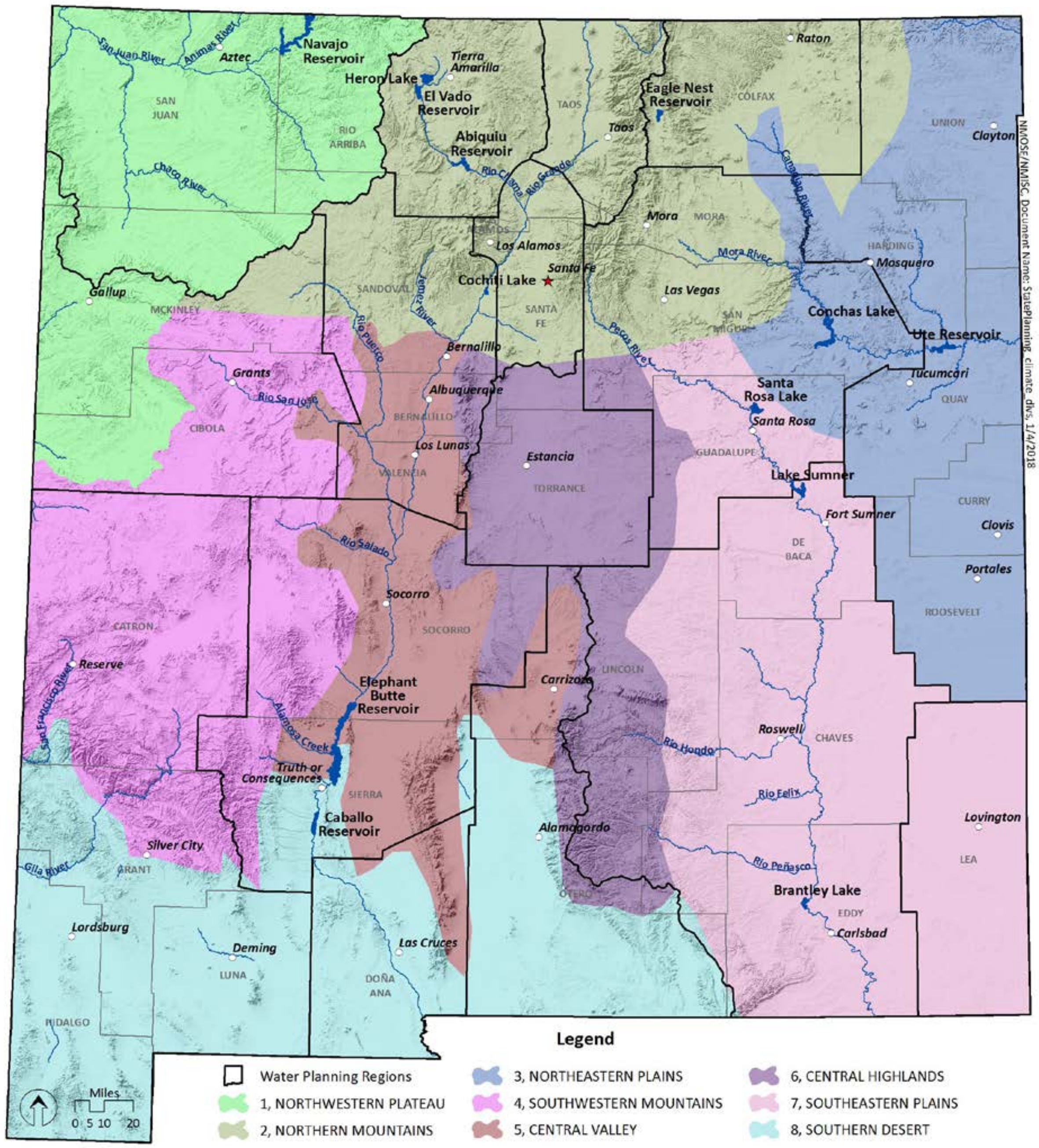


Figure B-7. Climate Divisions in New Mexico.

There is no established method or single correct way of quantifying a drought supply given the complexity associated with varying levels of drought and constantly fluctuating water supplies. To provide an estimate of drought supplies for regional as well as statewide water planning, the state has developed and applied a consistent method for surface water/stream-connected aquifers and for groundwater supplies. The method adopted for surface water/stream-connected aquifers is described below:

- The drought adjustment is applied only to the portion of the administrative water supply that derives from surface water, as it is assumed that groundwater supplies will be available during drought due to the relatively stable thicknesses of groundwater aquifers that are continuously recharged through their connection to streams. While individual wells may be depleted due to long-term drought, this drought adjustment does not include an evaluation of diminished groundwater supplies.
- The minimum annual yield for key stream gages on mainstem drainages was compared to the 2010 yield, and the gage with the lowest ratio of minimum annual yield to the 2010 yield was selected.
- The 2010 administrative surface water supply for the region was then multiplied by that lowest ratio to provide an estimate of the surface water supply adjusted for the maximum drought year of record.

Though the adjustment is based on the minimum year of streamflow recorded to date, it is possible that drought supplies could be even lower in the future. Additionally, water supplies downstream of reservoirs may be mitigated by reservoir releases in early drought phases, while longer-term droughts can have potentially greater consequences. This approach does not evaluate either the mitigating influences of reservoir storage during the early phases of a drought, when storage is available, or for the potential development of new groundwater supplies. Also, in some parts of the state's larger planning regions, the surface water irrigators are far removed from developed groundwater sources. Thus, drought conditions may result in a much larger reduction than a normal year of water supplies in those areas. Nonetheless, the adjusted drought supply does provide a rough estimate of supply that might be available during a year of severe to extreme drought.

In non-stream-connected (or closed) basins, the administrative water supply was adjusted to consider the potential long-term drought impacts on groundwater. To predict the potential impact by 2060 of a 20-year drought, existing groundwater models were used, where available, to estimate the vulnerability of closed basins within a planning region during a prolonged drought. The following method was adopted to estimate drought supplies for non-stream-connected aquifers:

- The drought adjustment was applied only to the portion of the administrative water supply that derives water from the mined aquifer.
- In basins for which OSE has an administrative model, the simulation period was from 2010 to 2060 as described above, with no recharge from 2020 to 2040.
- For a conservative approximation, the drawdown predicted during the drought period was derived from a model cell in a heavily stressed area at the end of the simulation period (2060) to represent the water column that will be lost due to drought and pumping. For those basins where either no model is available, or where model results were not available, a drought correction of 12% was used, based on the average of the modeled drawdown from all the OSE administrative models for other regions of the state.
- This adjusted predicted drawdown is then compared to the median available water column in 2010 to determine the percentage of wells that are impacted by the 20-year drought and continued pumping.

The reduction in supply due to drought is estimated by multiplying the percentage by the 2060 administrative supply.

B.3 SAN JUAN BASIN ADJUSTMENT

The 2013 Handbook (OSE, 2013) describes a common technical approach for analyzing the water supply in each water planning region but recognizes that other methods can be used to account for supply and demand. The RWP updates for 15 water planning regions in New Mexico present an analysis of the administrative water supply for the region using the technical approach described in the 2013 Handbook, as summarized here. However, the plan for the San Juan Basin Water Planning Region does not incorporate the technical approach described in the handbook because it does not adequately address the following:

- The substantial reservoir storage capacity that was developed to allow the water in the San Juan River Basin to be used
- Authorized full development of federal water supply projects (the Animas-La Plata Project, the Navajo-Gallup Water Supply Project, and the Navajo Indian Irrigation Project)
- Actual diversion practices and reservoir operations on the San Juan and Animas rivers
- The water apportionments made to New Mexico by the Colorado River and Upper Colorado River Basin compacts

Because of these circumstances, the long-term amount of water from the San Juan River stream system that is available for use in New Mexico during normal (non-drought) years far exceeds the administrative water supply, as well as the severe drought-adjusted administrative water supply that would be calculated when using the technical approach described in the handbook. The water supply calculation used for the San Juan Basin is described below.

San Juan Basin Normal Water Year Supply

The terms of the 1922 Colorado River Compact include several provisions important to the San Juan Basin region:

- The Upper Colorado River Basin was apportioned the consumptive use of 7.5 million ac-ft/yr from the Colorado River system.
- The states of the Upper Division (New Mexico, Colorado, Utah, and Wyoming) may not cause the flow of the Colorado River at Lee Ferry to be depleted below an aggregate of 75,000,000 ac-ft in any period of 10 consecutive years.

Under the terms of the 1948 Upper Colorado River Basin Compact, New Mexico was apportioned 11.25% of the consumptive use available to the Upper Basin under the Colorado River Compact and remaining after deduction of 50,000 ac-ft apportioned to Arizona. The Secretary of the Interior determined in the 2007 Hydrologic Determination that at least 5.76 million ac-ft/yr, on average, of consumptive use, excluding reservoir evaporation from Lake Powell, Flaming Gorge Reservoir, and the Aspinall Unit reservoirs of the Colorado River Storage Project is available to the Upper Basin. After subtraction of the 50,000 ac-ft that was apportioned to Arizona, New Mexico's share of the Upper Basin yield is at least 642,380 ac-ft/yr of consumptive use, on average, for water development within the state. The amount of diverted water may substantially exceed the amount of water consumptively used. Also, return flows from uses of water diverted from the San Juan or Animas rivers are generally available for diversion to meet water demands for downstream uses.

San Juan Basin Drought Supply

The variability in surface water supply over a multi-year period for a region with a large water supply reservoir is a good indicator of how vulnerable a planning region would be under conditions of drought. There is no established method or single correct way to quantify a drought supply given the complexity associated with varying levels of drought and water supplies that constantly fluctuate.

As a result, the state has adopted the following method to provide an estimate of drought supplies for the San Juan Basin Planning Region:

- The drought adjustment is applied to the 2060 high demand scenario.
- The USGS stream gage on the Animas River (Animas River near Cedar Hill) was selected as a representative gage for the region.
- The ratio of the minimum value derived from the three-year moving average of the mean annual flow to the median value of the mean annual flow for the Animas River near Cedar Hill stream gage was used to provide an estimate of the surface water supply, adjusted for multi-year drought.

For the Animas River near Cedar Hill gage, the minimum value of the three-year moving average is 406,580 ac-ft. The median value of annual flow at the gage is 624,711 ac-ft. The ratio of these two values is 65.1% (406,580/624,711). Based on the region's high scenario demand in year 2060 of 1,122,500 ac-ft, the drought-adjusted water supply is 730,750 ac-ft. This is a rough estimate of what may be available during an extended drought.

B.4 WATER DEMAND PROJECTION METHODS

Projections of future demand in nine categories of water use are based both on demographic and economic trends and on population projections. Consistent methods and assumptions for each category of water use were applied across all planning regions. As discussed in the Handbook (ISC, 2013), many methods can be used to account for supply and demand; however, some tools used to implement these analyses are available only for some segments of New Mexico, and resources to develop them for all regions are not currently available. Therefore, the state developed a simple method that was used consistently across all regions (except for the San Juan Region) to assess project demands for planning purposes. The use of this consistent method allowed for the efficient development of a statewide overview of the balance between supply and demand in both normal and drought conditions. This method allows the state to move forward with planning and funding water projects and programs that will address pressing water issues both for the regions and for the state.

These projections began with 2010 data and were developed in 10-year increments (2020, 2030, 2040, 2050, and 2060). Projections were developed for withdrawals in each of the nine categories included in the *New Mexico Water Use by Categories* report (Longworth et al., 2013).

To assist in bracketing the uncertainty of the projections, low- and high-water demand estimates were developed for each category in which growth is anticipated. These estimates were based on demographic and economic trends as well as population projections, unless specific adjustments were applied based on local conditions, as detailed in the RWPs. The projected growth in population and economic trends affects water demand in eight of the nine water use categories; the reservoir evaporation water use category is not driven by these factors.

The 2010 withdrawals were used as a base from which water demand was projected forward, except in the San Juan Region as noted previously. The assumptions and methods used to develop the demand projections for each water use category follow. Not all of these categories are applicable to every planning region. Issues specific to various planning regions are detailed in each RWP.

Public water supply includes community water systems that rely on surface water and groundwater diversions other than from domestic wells permitted under 72-12-1.1 NMSA 1978 and that consist of common collection, treatment, storage, and distribution facilities operated for the delivery of water to multiple service connections. This definition includes municipalities (which may serve residential, commercial, and industrial water users), mutual domestic water user associations, prisons, residential and mixed-use subdivisions, and mobile home parks.

For regions with anticipated population increases, the increase in projected population (high and low) was multiplied by the per capita use from the *New Mexico Water Use by Categories 2010* report (Longworth et al., 2013) (reduced for conservation as specified below), times the portion of the population that was publicly supplied in 2010 (calculated from Longworth et al., 2013); the resulting value was then added to the 2010 public water supply withdrawal amount. Current surface water withdrawals were not allowed to increase above the 2010 withdrawal amount unless there is a new source of available supply (i.e., water project or settlement). Both high and low projections incorporated conservation for counties (see specific conservation assumptions listed below).

For planning purposes, in counties where a decline in population is anticipated (in either the high or low scenario, or both), it was assumed as a conservative approach that the public water supply would remain constant at 2010 withdrawal levels based on the 2010 administrative water supply (the water is physically available for withdrawal, and its use is in compliance with water rights policies). Likewise, in regions where the population growth is initially positive but later shows a decline, the water demand projection was kept at the higher rate for the remainder of the planning period.

The ***domestic (self-supplied)*** category includes self-supplied residences with well permits issued by the OSE under 72-12-1.1 NMSA 1978 (Longworth et al., 2013). Such residences may be single-family or multi-family dwellings. High and low projections were calculated as the 2010 domestic withdrawal amount plus a value determined by multiplying the projected change in population (high and low) times the domestic self-supplied per capita use from the *New Mexico Water Use by Categories 2010* report (Longworth et al., 2013) times the calculated proportion of the population that was self-supplied in 2010 (calculated from Longworth et al., 2013). In counties where the high and/or low projected growth rate is negative, the projection was set equal to the 2010 domestic withdrawal amount. This allows for the continuing use of existing domestic wells, which is anticipated, even when there are population declines in a county. In regions where the population growth is initially positive but later shows a decline, the water demand projection was kept at the higher level for the remainder of the planning period, based on the assumption that domestic wells will continue to be used, even if there are later population declines.

The ***irrigated agriculture*** category includes all withdrawals of water for the irrigation of crops grown on farms, ranches, and wildlife refuges (Longworth et al., 2013). To understand trends in the agricultural sector, interviews were held with farmers, farm agency employees, and others with extensive knowledge of agriculture practices and trends in each planning region and in multiple counties in the larger regions. Additionally, the New Mexico agriculture census data for 2007 and 2012 were reviewed and provided helpful agricultural data such as principal crops, irrigated acreage, farm size, farm subsidies, and age of farmers (USDA NASS, 2014). Comparison of the two data sets shows a downward trend in the agricultural sector across New Mexico. This decline was in all likelihood related at least in part to the lack of precipitation in 2012: in most of New Mexico 2007 was a near normal precipitation year (ranging from mild drought to incipient wet spell across the state), while in 2012 the PDSI for all New Mexico climate divisions indicated extreme to severe drought conditions. Based on the interviews, economic factors are also thought to be a cause of the decline.

In much of the state, recent drought and recession are thought to be driving a decline in agricultural production. However, that does not necessarily indicate that there is less demand for water. In areas where irrigation is supplied by surface water, there are frequent supply limitations, with many ditches having no or limited supply later in the season. This results in large fluctuations in agricultural water use and productivity from year to year. Though long-term drought may occur at some point, it is also likely that drought years will be interspersed with wetter years, and renewed agricultural activity is likely as a result. With infrastructure and water rights in place, there is a demand for water if it becomes available.

In regions that use surface water for agriculture withdrawals, the 2010 administrative water supply used as the starting point for the projections reflects a near normal water year for the region. For 2020 through 2060 projections, therefore, it was generally assumed that the surface water demand is equal to the 2010 administrative water supply for both the high and low scenarios. Even if some farmers cease operations or plant less acreage, the water is expected to be used elsewhere due to surface water shortages. Conversely, if increased agricultural activity is anticipated, water demand in this sector was still projected to stay at 2010 administrative water supply levels unless there is a new source of available supply (i.e., water project or settlement).

In areas where 10% or more of groundwater withdrawals are for agriculture and there are projected declines in agricultural acreage, the low projection assumes that there will be a reduced demand in this sector. The amount of projected decline is based on interviews with individuals knowledgeable about the agricultural economy in each county as detailed in the RWP updates. Even in areas where the data indicate a decline in the agricultural economy, the high projection assumes that overall water demand will remain at the 2010 administrative water supply levels, since water rights have economic value and will continue to be used.

The ***livestock*** category includes water used to raise livestock, maintain self-supplied livestock facilities, and support on-farm processing of poultry and dairy products (Longworth et al., 2013). High and low projections for the percentage growth or declines in the livestock sector were developed based on interviews with ranchers, farm agency employees, and others with extensive knowledge of livestock trends in each county (Section 6.2). The growth or decline rates were then multiplied by the 2010 water use to calculate future water demand.

The ***commercial (self-supplied)*** category includes self-supplied businesses (e.g., motels, restaurants, recreational resorts, and campgrounds) and public and private institutions (e.g., public and private schools and hospitals) involved in the trade of goods or provision of services (Longworth et al., 2013). This category pertains only to commercial enterprises that supply their own water; commercial businesses that receive water through a public water system are not included. To develop the commercial self-supplied projections, it was assumed that commercial development is proportional to other growth, and the high and low projections were calculated as the 2010 commercial water use multiplied by projected high and low population growth rates. In regions where the growth rate is negative, both high and low projections were assumed to stay at the 2010 administrative supply water level, based on water rights having economic value. In regions where population growth is initially positive but later shows a decline, the water demand projections will remain at higher levels for the remainder of the planning period, again based on the administrative water supply and the value of water rights. This method was modified in some regions to consider specific information regarding plans for large commercial development or increased use by existing commercial water users.

The ***industrial (self-supplied)*** category includes self-supplied water used by enterprises that process raw materials or manufacture durable or nondurable goods and water used for the construction of highways, subdivisions, and other construction projects (Longworth et al., 2013). To collect information on factors affecting potential future water demand, economists conducted interviews with industrial users and used information from the New Mexico Department of Workforce Solutions to determine if growth is expected in this sector. Based on these interviews and information, high and low scenarios were developed to reflect the ranges of possible growth. If water use in this category is low and limited additional demand is expected, then both high and low projections are the same.

The ***mining*** category includes self-supplied enterprises that extract minerals occurring naturally in the earth's crust, including solids (e.g., potash, coal, and smelting ores), liquids (e.g., crude petroleum), and gases (e.g., natural gas). Anticipated changes in water use in this category were based on interviews with individuals involved in or knowledgeable about the mining sector. If water use in this category is low and limited additional demand is expected, then both high and low projections are the same.

The ***power*** category includes all self-supplied power generating facilities and water used in conjunction with coal-mining operations that are directly associated with a power generating facility that owns and/or operates the coal mines. Anticipated changes in water use in this category were based on interviews with individuals involved in or knowledgeable about the power sector. If water use in this category is low and limited additional demand is expected, then both the high and low projections are the same.

Reservoir evaporation includes estimates of open water evaporation from man-made reservoirs with a storage capacity of approximately 5,000 ac-ft or more. The amount of reservoir evaporation is dependent on the surface area of the reservoir as well as the rate of evaporation. Evaporation rates are partially dependent on temperature and humidity; that is, when it is hotter and drier, evaporation rates increase. Surface areas of reservoirs are variable, and during extreme drought years, the low surface areas contribute to lower total evaporation, even though the rate of evaporation may be high.

The projections of reservoir evaporation for each region were based on evaporation rates reported in the *Upper Rio Grande Impact Assessment* (USBOR, 2013), which evaluated potential climate change impacts in New Mexico. This report predicted considerable uncertainty, but some increase in evaporation rates and lower evaporation totals overall due to predicted greater drought frequency and resultant lower reservoir surface areas. Although it is possible that total evaporation will be lower in drought years, since the projections are to be compared to 2010 use, assuming lower reservoir evaporation would give a false impression of excess water. Thus, the low projection assumes 2010 evaporation amounts. For the high projection, the same surface areas as 2010 were assumed, but higher evaporation rates, derived from the *Upper Rio Grande Impact Assessment* (USBOR, 2013), were used to reflect potentially warmer temperatures. The high scenario projected using this approach represents a year in which there is a normal amount of water in storage, but the evaporation rates have increased due to increasing temperatures.

In reality the fluctuations in reservoir evaporation are expected to be much greater than the high/low range projected using this method. To evaluate the balance between supply and demand, the projections are being compared to the administrative water supply, including reservoir evaporation. It is important to not show an unrealistic scenario of excess available water. Therefore, the full range starting with potentially very low reservoir surface areas was not included in the projections.

B.5 WATER CONSERVATION ASSUMPTIONS IN THE WATER DEMAND PROJECTIONS

To develop demand projections for the regions, some simplifying assumptions regarding conservation have been made. These assumptions were made only for the purpose of developing an overview of the future supply-demand balance in the regions and are not intended to guide policy regarding conservation for individual water users. The approach to considering conservation in each category of water use for developing water demand projections is discussed below.

Public water supply. Public water suppliers that have large per capita usage have a greater potential for conservation than those that are already using water more efficiently. Through a cooperative effort with seven public water suppliers, the OSE developed a gpcd calculator to be used statewide, thereby standardizing the methods for calculating populations, defining categories of use, and analyzing use within these categories. The gpcd calculator was used to arrive at the per capita uses for public water systems in each region and were provided to assist the regional steering committees in considering specific conservation measures.

The system-wide per capita usage for each water supplier includes uses such as golf courses, parks, and commercial enterprises that are supplied by the system. Hence there can be large variability among the systems. For purposes of developing projections, a county-wide per capita rate was calculated as the total public supply use in the county divided by the total county population (or portion of the county within a region), excluding those served by domestic wells. For future projections, a consistent method was used statewide which assumes that conservation would reduce future per capita use in each county by the following amounts:

- For current average per capita use greater than 300 gpcd: assume a reduction in future per capita use to 180 gpcd.
- For current average per capita use between 200 and 300 gpcd: assume a reduction in future per capita use to 150 gpcd.
- For current average per capita use between 130 and 200 gpcd: assume a reduction in future per capita use to 130 gpcd.
- For current average per capita use less than 130 gpcd: no reduction in future per capita use is assumed.

Self-supplied domestic. Homeowners with private wells can achieve water savings through household conservation measures. These wells may not be metered, and current water use estimates were developed based on a relatively low per capita use assumption (Longworth et al., 2013). Therefore, no additional conservation savings were assumed in developing the water demand projections. For purposes of developing projections, a county-wide per capita rate was calculated as the total self-supplied domestic use in the county divided by the total county population (or portion of the county within the region), excluding those served by a public water system.

Irrigated agriculture. As the largest water use in the state, conservation in this sector may be the most beneficial. However, when considering the potential for improved efficiency in agricultural irrigation systems, it is important to consider how potential conservation measures may affect the region's water supply.

Withdrawals in both surface and groundwater irrigation systems include both consumptive and non-consumptive uses and incidental losses:

- Consumptive use occurs when water is permanently removed from the system due to crop evapotranspiration (i.e., evaporation and transpiration). Evapotranspiration is determined by factors that include crop and soil type, climate and growing season, on-farm management, and irrigation practices.
- Non-consumptive use occurs when water is temporarily removed from the stream system for conveyance requirements and is returned to the surface or groundwater system from which it was withdrawn.
- Incidental losses from irrigation are irrecoverable losses due to seepage and evapotranspiration during conveyance that are not directly attributable to crop consumptive use.
- Seepage losses occur when water leaks through the conveyance channel or below the root zone after application to the field and is either lost to the atmosphere or remains bound in the soil column.
- Evapotranspiration occurs as a result of (1) evaporation during water conveyance in canals or with some irrigation methods (e.g., flood, spray irrigation) and (2) transpiration by ditch-side vegetation.

Some agricultural water use efficiency improvements (commonly referred to as agricultural water conservation) reduce the amount of water diverted but may not reduce depletions or may even have the effect of increasing consumptive use per acre on farms (Brinegar and Ward, 2009; Ward and Pulido-Velazquez, 2008). These efforts can result in economic benefits, such as increased crop yield, but may have the adverse effect of reducing return flows and, therefore, the timing and availability of downstream water supply. For example, methods such as canal lining or piping may result in the reduction of seepage losses associated with conveyance, but that seepage will no longer provide return flow to other users. Other techniques, such as drip irrigation and center pivots, may reduce the amount of water diverted, but if the water saved from such reductions is applied to on-farm crop demands, the timing and availability of water supplies for downstream uses will be reduced.

Due to the complexities in agricultural irrigation efficiency, no quantitative estimates of savings are included in the projections. However, the regions were encouraged to explore strategies for agricultural conservation, especially those that result in consumptive use savings through changes in crop type or fallowing of land while concentrating limited supplies for greater economic value on smaller parcels.

Self-supplied commercial, industrial, livestock, mining, and power. Conservation programs can be applicable to these sectors, but since uses are expected to be relatively low in the commercial, livestock and power categories within the region, no additional conservation savings are assumed in the water demand projections in the Regional Water Plans. As a more significant user, the mining sector is encouraged to explore conservation opportunities. However, no quantitative estimates of potential conservation savings are available at this time.

Reservoir evaporation. No water conservation assumptions were applied to the reservoir evaporation category.

REFERENCES

Brinegar, H.R., and F.A. Ward. 2009. Basin Impacts of Irrigation Water Conservation Policy. Ecological Economics 69(2009):414–426.

Longworth, J.W., J.M. Valdez, M.L. Magnuson, and K. Richard. 2013. New Mexico water use by categories 2010. Technical Report 54, New Mexico Office of the State Engineer, October 2013. Available at <http://www.ose.state.nm.us/Conservation/PDF/NM%20Water%20¬Use%20-by%20Categories%20Tech.%20Report%2054.pdf>.

United States Bureau of Reclamation (USBR), 2013. USBOR West-wide Climate Risk Assessment: Upper Rio Grande Impact Assessment. Upper Colorado Region, Albuquerque Area Office. December 2013. Available at http://www.usbr.gov/WaterSMART/wcra/docs/urgia/¬URGIAMainReport.pdf

Ward, F.A., and M. Pulido-Velazquez. 2008. Water Conservation in Irrigation Can Increase Water Use. *Proceedings of the National Academy of Sciences* 105(47):18215–18220.

USDA NASS, 2014. https://www.nass.usda.gov/Publications/Ag_Statistics/2014/Ag%20Stats%202014_Complete%20Publication.pdf

Appendix C. Addressing the Supply and Demand Gap

A summary of the projects, programs and policies for closing the supply and demand gap is provided here, first focused on PPPs that reduce demand and then those that increase the supply.

C.1 Reducing Demand through Water Conservation across All Sectors of Water Use

Water conservation is often a cost-effective and easily implementable measure that a region may use to help balance supplies with demands. The State of New Mexico is committed to water conservation programs that encourage wise use of limited water resources. The Water Use and Conservation Bureau of the OSE developed the New Mexico Water Conservation Planning Guide for Public Water Suppliers. When evaluating water rights transfers or Water Development Plans (also known as 40-year Water Plans) that hold water rights for future use, the OSE considers whether adequate conservation measures are in place.

To develop demand projections for the region, some simplifying assumptions regarding conservation were made for the RWPs. These assumptions were made only for the purpose of developing an overview of the future supply-demand balance in the region and are not intended to guide policy regarding conservation for individual water users. The approach to considering conservation in each category of water use for developing water demand projections is discussed below.

C.1.1 Public Water Use Sector: Actions to Reduce Demand

Public water suppliers that have large per capita usage have a greater potential for conservation than those that are already using water more efficiently. Longworth et al., 2013 reports the GPCD for public water systems and the average by county, presented in Figure C-1. (See section A for about Public Water Supply information and assumptions used in the RWPs.)

As explained in Appendix B, water conservation was already factored into the future demand, but not the existing population. Thus, only the future additional population added to a region was assumed to implement conservation measures. This is a reasonable assumption because newer homes tend to have more water saving fixtures, such as low–flow toilets and faucets. Additional savings can be achieved with existing populations and many communities are pursuing conservation efforts that range from education to tiered rate structures based on water use.

Figure C-2 shows the total potential savings by county within each region if per capita demand is reduced to 130 gpcd (where the average was greater than 130 gpcd). A reduction to 130 gpcd may or may not be realistic if a particular community has government, educational institutions or industries that contribute to the per capita demand. However, the City of Santa Fe, which is the state capital with not only government offices with many employees who commute from outside the City limits, but also a large tourist industry, has reduced per capita demand from 168 GPCD in 1995 to 90 GPCD in 2015 (City of Santa Fe, 2016). If the demand were reduced to 130 gpcd, the total potential savings for the 1.7 million people served by public water systems statewide is 66,000 ac-ft per yr as shown in Table C-1. Some of these potential savings are in regions that do not have a projected gap within the public water system sector.

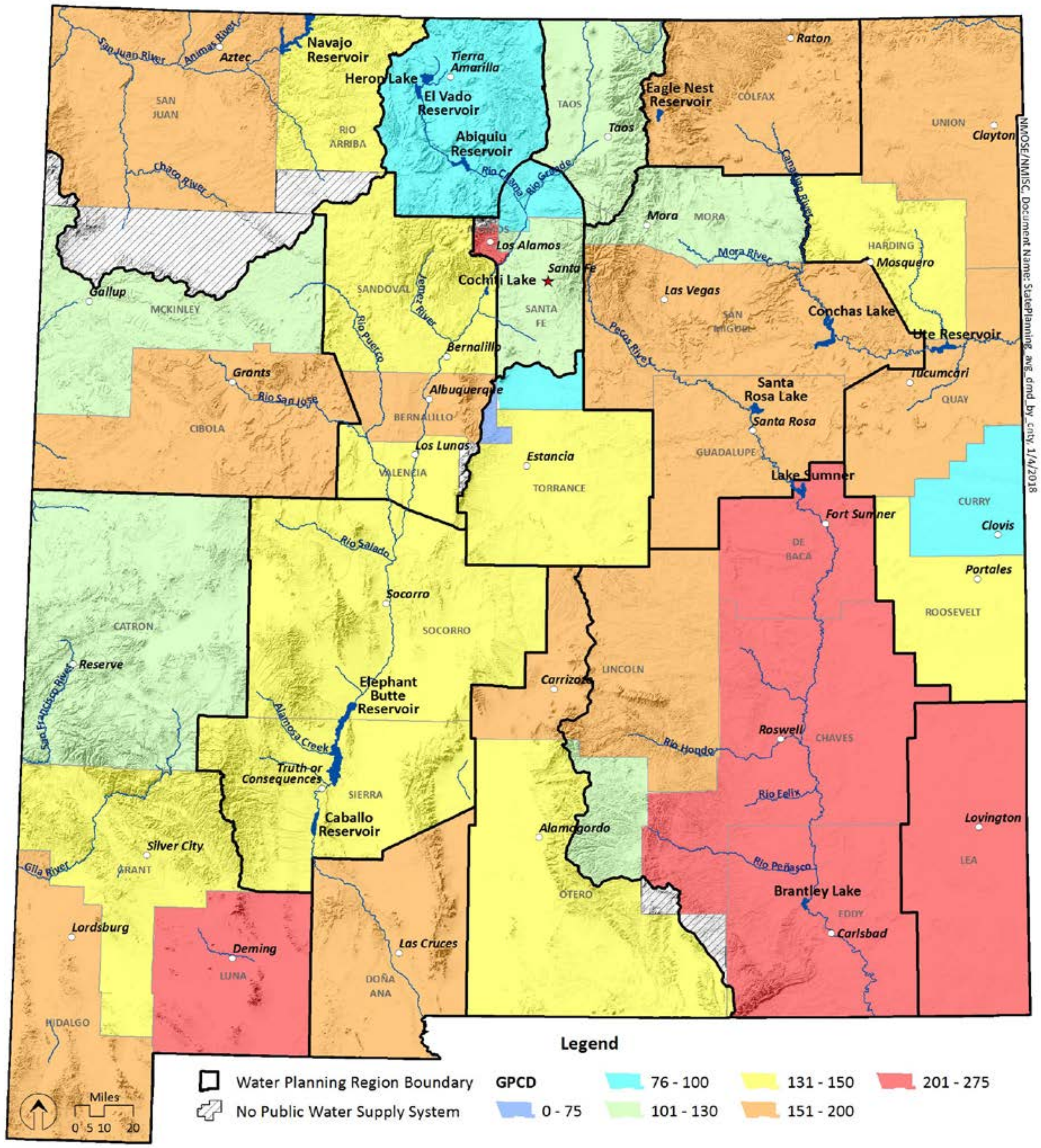


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Figure C-1. Average Per Capita Demand by County and Water Planning Region Serving Public Water Systems.

Table C-1. Potential Water Savings through Conservation Efforts by Public Water Systems.

Region Name	Reg No	County Portion within Region	Average Per Capita per Day on Public Water Systems (gallons)	Population in 2010 served by Public Water Systems	Potential Water Savings Per Capita Reduced to 130 GPCD (ac-ft per year)
Northeast New Mexico	1	Curry	100	6,630	0
	1	Harding	148	418	8
	1	Quay	183	8,304	493
	1	Roosevelt	142	18,276	246
	1	Union	192	2,628	183
San Juan	2	McKinley	0	0	0
	2	Rio Arriba	148	4,050	82
	2	Sandoval	0	0	0
	2	San Juan	162	108,239	3,880
Jemez y Sangre	3	Rio Arriba	87	14,334	0
	3	Sandoval	0	0	0
	3	Santa Fe	102	108,238	0
	3	Los Alamos	202	17,950	1,448
Southwest New Mexico	4	Catron	110	1667	0
	4	Luna	209	17,344	1,535
	4	Grant	141	16,870	208
	4	Hidalgo	164	3,431	131
Tularosa / Salt Basins	5	Chaves	0	0	0
	5	Lincoln	176	1,666	86
	5	Otero	134	56,309	252
Northwest New Mexico	6	McKinley	117	31,599	0
	6	San Juan	0	0	0
	6	Cibola	193	13,654	964
Taos	7	Taos	101	20,178	0
Mora/San Miguel/ Guadalupe	8	Mora	129	3909	0
	8	San Miguel	157	22,099	668
	8	Guadalupe	168	4,248	181
Colfax	9	Colfax	177	13,571	715
Lower Pecos Valley	10	Chavez	266	55,646	8,478
	10	De Baca	207	1,696	146
	10	Eddy	266	52,020	7,925
	10	Lincoln	186	16,772	1,052
	10	Otero (North)	113	2,015	0
	10	Otero (South)	0	0	0
Lower Rio Grande	11	Dona Ana	182	203,401	11,848
Middle Rio Grande	12	Valencia	134	43,659	196
	12	Bernalillo	155	635,124	17,787
	12	Sandoval	141	100,952	1,244
	12	Torrance	0	0	0
Estancia	13	Bernalillo	51	695	0
	13	Santa Fe	80	570	0
	13	Torrance	133	10,942	37
Rio Chama	14	Rio Arriba	76	5580	0
Socorro / Sierra	15	Sierra	147	10,109	193
	15	Socorro	147	13,890	265
Lea County	16	Lea	230	51,352	5,753
Total Population Served by Public Water Systems				1,700,035	
Total Potential Savings (ac-ft/year)					66,004

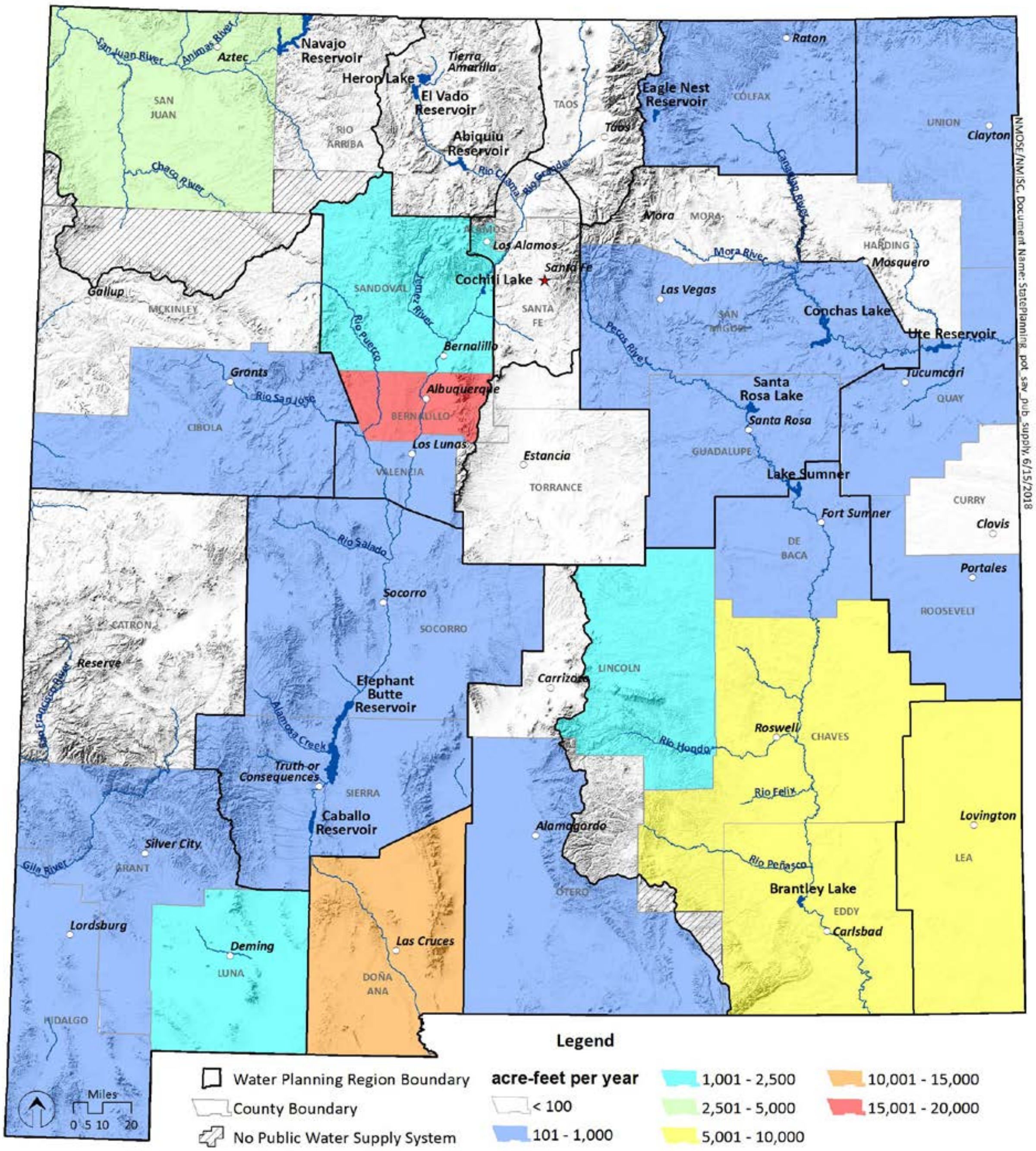

Figure C-2. Total Potential Savings by County if per Capita Demand Served by Public Water Systems is Reduced to 130 GPCD.

Regional Strategies for Public Water Use Sector

Examination of the PPP lists prepared by the regions, show 145 projects for reducing water demand to the community water systems. The projects can be summarized by four types: 1) Water conservation programs, 2) Metering, 3) Water System Infrastructure, and 4) Wastewater Reuse.

1. Water Conservation Programs

- Identified in: 11 out of 16 regions
- Number of PPPs: 50

Water conservation programs by public water systems include a range of strategies from education and incentives to enforcement. Educational programs help residential users understand how to calculate appropriate water use for landscaping, planting low-water use landscape, designing methods of slowing runoff or capturing rainfall. Some of the incentives include rebates for water efficient appliances and tiered rate structures. Enforcement measures include fines for excessive use.

2. Metering

- Identified in: 11 out of 16 regions
- Number of PPPs: 42

Metering water use is an effective method to reduce water waste and it is also a common basis for billing customers. Some public water systems have no fee or only charge a flat fee, resulting in a lack of incentive to conserve water. A total of 42 projects in the PPP lists address metering of water use in 11 out of 16 Regions. Some of the projects involve meter replacement or calibration and some are for installation of new meters.

3. Water System Infrastructure

- Identified in: 5 out of 16 regions
- Number of PPPs: 7

Water system infrastructure projects that reduce water losses will reduce the demand on water systems. Water pipes leading from wells and water treatment systems to residential and commercial customers can leak and waste water. Leaks are often detected through water audits that compare the amount of water produced from wells or diverted from surface water to the amount sold. Each water system will have some “non-revenue” water (usually about 12%, Vickers, 2002), due to flushing of fire hydrants and other losses.

4. Wastewater Reuse

- Identified in: 13 out of 16 regions
- Number of PPPs: 45

The reuse of treated effluent for irrigation of turf and other non-potable uses is widely accepted in New Mexico as a method to reduce the demand of potable water. The water rights surrounding the ownership of treated effluent must be examined for each public system before planning to reuse wastewater and NMED regulations must be met with respect to the level of treatment and potential human exposure. Once these issues are addressed, the replacement of potable water with treated wastewater will reduce the demand on the water system. Conversely, selling treated effluent to other uses outside of the public water system may bring in revenue, but does not reduce the demand on the water system.

C.1.2 Self-Supplied Domestic Users: Actions to Reduce Demand

Homeowners with private wells can achieve water savings through household conservation measures. Domestic wells are generally not metered unless the well serves more than one home or other regulations require metering (County Regulations or other), thus quantifying the actual use and the potential savings is problematic. One study in Santa Fe County (Lewis et al., 2013) examined meter records for 141 domestic wells connected to 291 homes and found that the per capita use averaged 177 gpcd with a median of 112 gpcd. The potential water savings was estimated by determining the water requirements for the existing landscape for the 161 homes served by the 71 metered wells (where the location of the homes could be identified). It was determined that if water efficient irrigation methods were applied without changes to the area of the landscape, a 33% reduction in water demand could be realized. This estimated savings in water conservation translated to 1,872 ac-ft or 0.04 ac-ft per person for self-supplied within Jemez y Sangre Region.

The water use estimates for the RWPs were developed based on a relatively low per capita use assumption and therefore no additional conservation savings were assumed in developing the water demand projections. For purposes of developing projections, a county wide per capita rate was calculated as the total self-supplied domestic use in the county divided by the total county population (or portion of the county within the region), excluding those served by a public water system.

An estimated 295,694 people are self-supplied by domestic wells statewide, or 14% of the population (Longworth et al., 2013). Some conservation programs address management of domestic wells generally, and many projects have already been implemented to restrict drilling of domestic wells within city boundaries or critical management areas, but no projects were identified in the PPP lists for targeting water conservation for self-supplied domestic homes. Some projects are focused on reducing water demand through roof-top harvesting, for example, which could apply to a home on a public water system or domestic well.

C.1.3 Irrigated Agriculture: Actions to Reduce Demand

As the largest water use in the region, conservation in this sector may be beneficial. However, as explained in Appendix B.5, the potential for improved efficiency in agricultural irrigation systems is complicated and it is important to consider how potential conservation measures may affect the region's water supply.

Examination of the PPP lists for actions to reduce water demand within the agricultural water use sector revealed a total of 34 projects in 11 out of 16 regions. The types of projects include water conservation programs, metering, wastewater reuse, and water system infrastructure. Agricultural water conservation programs can include exchange of high water use crops to low water use crops, exploring irrigation timing, methodology, laser leveling fields, metering, lining canals and using treated effluent.

C.1.4 Self-Supplied Commercial, Industrial, Livestock, Mining, And Power Water Use

Conservation programs can be applicable to these sectors, but since uses are very low in these categories within the region, no additional conservation savings are assumed in the water demand projections. Examination of the PPP lists revealed 2 projects in 2 regions that addressed water reuse in industries.

C.1.5 Reservoir Evaporation.

In many parts of New Mexico, reservoir evaporation is one of the highest consumptive water uses. To reduce usage in this category, some regions have considered aquifer storage and recovery to replace some reservoir storage, and it may also be possible in some circumstances to gain some reduction in evaporation by storing more water at higher elevations or constructing deeper reservoirs with less surface area for evaporation. Due to the legal, financial, and other complexities of implementing evaporation reduction techniques, no conservation savings are assumed in developing the reservoir evaporation demand projections for any region.

Examination of the PPP lists revealed 3 projects that address reducing evaporative losses from reservoirs, all of which are in the Lower Pecos Valley planning region. One project involves creating a berm around the shallow portions of lakes to reduce the surface area. Another project suggests storing water at higher elevations to reduce evaporative losses. The third project suggests using leaky reservoirs as recharge locations, not storage locations.

C.2 Develop New Sources of Water Supply

Mapping the horizontal and vertical boundaries of aquifers would greatly assist in identifying the potential of deeper untapped water supplies. Deep brackish water that is not hydrologically connected to existing freshwater supplies could serve as a new water supply, particularly during drought periods, but treatment costs can be high. Using produced water instead of fresh water for drilling and production of oil and gas wells could reduce the demand on fresh water. (In Lea County alone, over 14,000 ac-ft of fresh water per year is used for oil and gas production). New projects such as the Navajo-Gallup Water Supply Project and the Ute Reservoir Pipeline Project can provide additional supply, but legal and economic challenges make such projects difficult. Transfer of water rights from agricultural water use to urban use to meet growing demand in population centers. Importing water from one water planning region or surface water basin or from one state to another. Projects under consideration or discussion include transfers from the Gila River, Rio Grande, Nutt-Hockett, or Salt Basins; reuse of produced water and transfer to another area, or import from the Columbia, Mississippi, or other large river basins in other regions of the United States.

C.2.1. Groundwater

- Identified in: 16 out of 16 regions
- Number of PPPs: 110

110 PPPs were included to improve the understanding of the water resources through monitoring, mapping, modeling, and other studies. While all of these projects will improve the management of the groundwater resources, mapping the horizontal and vertical extent of aquifers would greatly assist the identification of deeper untapped water supplies. 23 of the PPPs are for quantifying the extent and quality of water supplies. The extent of deep brackish water that is not hydrologically connected to existing freshwater supplies could serve as a new water supply, particularly during periods of extended drought.

D.2.2. Produced Water

- Identified in: 3 out of 16 regions
- Number of PPPs: 3

Produced water is water separated during the production of oil and gas. Produced water is generally from highly saline water sources and much of it is disposed of through evaporation or reinjected into the saline aquifers. Fresh water, brackish water and municipal wastewater are often used in drilling and production of oil and gas wells and some produced water is recycled for drilling and production. Operators of oil and gas wells are required by the Oil Conservation Division (OCD) of the New Mexico Energy, Minerals and Natural Resources Department to report the volumes of water, oil and gas produced from each production well and the volume of water injected. The quantities of produced and injected water reported to OCD are compiled in the Petroleum Recovery Research Center (PRRC, 2016) database.

It is important to note that injection wells can be used for disposal of produced water or for enhanced oil recovery (EOR), which can include fracking or water flooding. EOR has occurred for many decades but became much more prolific beginning in 2005 (Graham et al., 2015). Fracking involves a process of injecting sand and guar gum under pressure to open fractures in the geologic formation and then injecting chemicals (usually an acid and surfactants) to remove the injected fluid. Initially, the process required fresh water, but the process has changed in recent years such that highly saline water (up to 150,000 Total Dissolved Solids (TDS)) can be used (Graham et al., 2015). Thus, a single well may show volumes of injected and produced water. **Figure C-3** shows the water inflows and outflows for the oil and gas production process. Graham et al. (2015) explored the potential for utilizing produced water instead of freshwater in the Oil & Gas production process. Graham showed that in Lea County alone, about 14,000 ac-ft of fresh water a year was diverted in 2000 and 2005 for oil and gas production.

In 2015, produced water totaled about 114,700 ac-ft, of which 108,900 ac-ft of was injected, resulting in a net depletion of 5,800 ac-ft (**Table C-2**). The net depletions may represent the total volume that is disposed of through evaporation rather than reinjected.

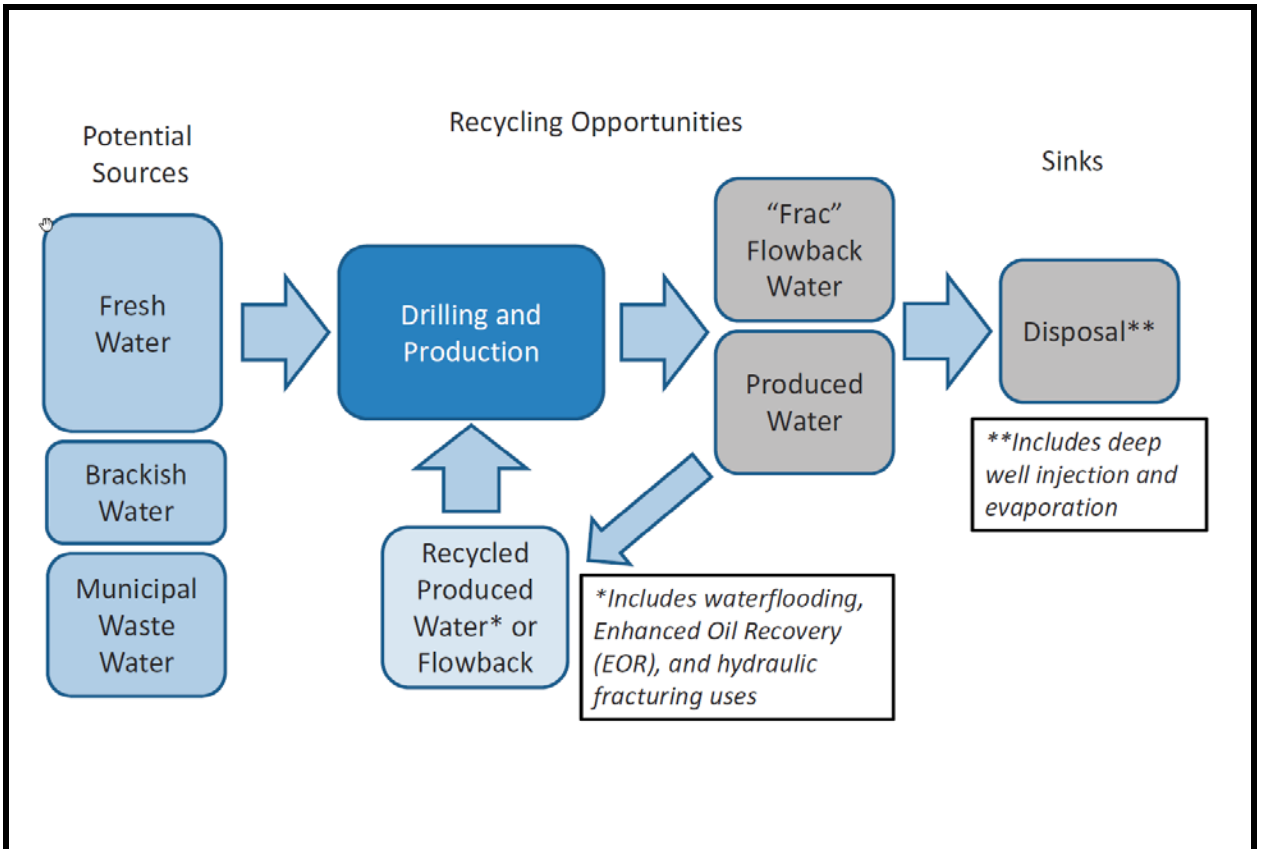

Figure C-3. Recycling Opportunities for Produced Water (Graham et al., 2015).

Table C-2. Injected and Produced Water by County in New Mexico.

COUNTY	Injected Water 2015	Produced Water 2015	Net Water Depleted 2015
	ac-ft/yr	ac-ft/yr	ac-ft/yr
Chaves	1,439	2,712	1,273
Colfax	1,350	1,661	311
Eddy	31,018	35,085	4,067
Harding	3	6	3
Lea	70,891	69,805	(1,086)
McKinley	612	523	(89)
Rio Arriba	400	1,153	753
Roosevelt	227	247	20
San Juan	2,773	3,242	468
Sandoval	167	231	64
Union	9	10	2
TOTAL	108,889	114,675	5,786

There were 3 projects in 3 regions on PPP lists for produced water from oil and gas, all about studying the possibility of using produced water. The Lower Pecos Valley plan suggested that policy changes are needed to make the reuse of produced water more feasible and that NMED regulations need to be re-evaluated to allow lower water quality standards for aquifer storage and recovery and direct Pecos River releases. Produced water research is ongoing in this region and supported by WRRI and the Pecos Valley Water Users Organization.

C.2.3 Desalination

- Identified in: 5 out of 16 regions
- Number of PPPs: 9

In areas with limited fresh water supplies and ample brackish or saline aquifers, such as the Tularosa-Sacramento-Salt Basins, efforts to desalinate the brackish water for potable supply in a cost-effective manner can help increase the water supply to a region. The Brackish Water Work Group under the Governors Drought Task Force and the City of

Alamogordo are leading such an effort. They are also interested in working with the New Mexico Institute of Mining and Technology and Otero County to map freshwater and brackish water.

The New Mexico Desalination Association is working to promote and assist the desalination industry in developing professional and stakeholder knowledge of desalination approaches, technologies and costs. Alamogordo is the largest community in New Mexico with a desalination plant (currently under construction in 2018) and the largest inland desalination plant in the world is located in El Paso Texas, just south of the border with New Mexico. Capital costs vary on the size of the plant, while operation and maintenance costs vary based on the salinity of the water. Lead time to design, permit, build and secure funding for a desalination plant requires many years (18 years for Alamogordo). Some companies offer portable desalination systems for treating up to 1 million gallons per day and could be set up and contracted within a month for emergency operation if the necessary water rights are available and other permitting requirements are obtained (Hightower, 2018).

C.2.4. New Water Projects / Development of New Supply

- Identified in: 14 out of 16 regions
- Number of PPPs: 64

Developing new water projects and developing new sources of supply were presented in the PPP lists. A total of 57 of the PPPs involve drilling new wells in 14 of the regions. In some cases, the drilling of a new well may replace an existing well and only improve the system efficiency, or the new well is tapping into the same aquifer, thus it is not exactly a "new supply". However, if a well is drilled to access new water rights, then the new well does represent the development of a new supply.

New water projects require water rights (and wet water supply). Four significant regional water supply projects will impact the available water supply for public water systems to some of the regions (as shown in Figure C-4) Error! Reference source not found.:

The San Juan-Chama Project, completed in 1976, provides up to 96,200 ac-ft of water per year of a portion of New Mexico's Upper Colorado River Basin Compact allocation to Tribes and Pueblos, Cities of Albuquerque and Santa Fe, multiple communities and the MRGCD in the Rio Grande basin upstream of Elephant Butte Dam. Most of the water supplied by the project is diverted or used for offsets by the various project contractors, but some, such as Los Alamos, have yet to utilize their allocation. SJC water will also be utilized to resolve the Nambe-Tesuque-Pojoaque and Taos Settlements.

Navajo–Gallup Water Supply Project (part of the Northwestern New Mexico Rural Water Projects)The Northwestern New Mexico Rural Water Projects Act (Public Law 111-11, Title X, Subtitle B), which was passed by Congress and signed into law in March 2009, approved the San Juan River Basin in New Mexico Navajo Nation Water Rights Settlement Agreement (San Juan Navajo Water Rights Settlement) and authorized construction of the Navajo-Gallup Water Supply Project (NGWSP) to service municipal and domestic water demands of the Navajo Nation, the Jicarilla Apache Nation, and the City of Gallup. The Act also authorizes funding for rehabilitation of the Hogback and Fruitland irrigation projects on Navajo Reservation lands in the San Juan River valley. A final San Juan Navajo Water Rights Settlement conforming to the provisions of the Act and a related Navajo Reservoir water supply contract for the Navajo Nation were executed in December 2010. In November 2013 the Court in the San Juan River Adjudication entered two significant rulings:

1. A Partial Final Judgment and Decree of the Water Rights of the Navajo Nation (Navajo Decree) defining the rights of the Navajo Nation in New Mexico to divert and use water from the San Juan River, including Navajo Reservoir, and from the Animas River and groundwater

A Supplemental Partial Final Judgment and Decree of the Water Rights of the Navajo Nation (Navajo Supplemental Decree) defining the rights of the Navajo Nation in New Mexico to divert, store, and use waters from ephemeral tributaries to the San Juan River, including in the Chaco River drainage.

The Northwestern New Mexico Rural Water Projects Act also authorized funding of up to $11 million to be appropriated through federal fiscal year 2019 for the repair, rehabilitation, or reconstruction of non-Navajo irrigation diversion and ditch facilities in the San Juan River basin in New Mexico to improve water use efficiency. The application of federal funding for such improvements to irrigation canal distribution systems and on-farm irrigation practices is subject to 50% non-federal cost-sharing.

The Animas-La Plata Project (ALP) was completed by USBOR in 2011. ALP will provide water supplies for municipal, industrial, and domestic uses in Colorado and New Mexico. Lake Nighthorse, the pumped-storage facility for the ALP, was completed and filled by June 2011 with a total storage capacity of 123,500 ac-ft. The reservoir will provide roughly 90,000 ac-ft of active storage to help meet future municipal and domestic water demands of non-Indian water providers in New Mexico and the Navajo Nation, and water users in Colorado.

The Eastern New Mexico Rural Water System (ENMRWS) and the Tucumcari Quay County Regional Water Authority (TQCRWA) projects in eastern New Mexico will serve the communities of Clovis, Cannon Air Force Base, Portales, Elida, Melrose, Grady, Tucumcari, and Logan; and deliver 24,000 ac-ft of surface water from Ute Reservoir. On March 1,1997 the ISC entered into a contractual agreement with the Ute Reservoir Water Commission to provide up to 24,000 ac-ft per year of water from Ute Reservoir. The ENMWUA anticipates completing construction of the ENMRWS project within the next ten years. The Ute Reservoir Water Commission, which was formed by a joint powers agreement (JPA) in 1996 to serve as a viable organization for the planning, development, and acquisition of water from Ute Reservoir, allocated this water to its member entities for municipal and industrial supply as follows:

- City of Clovis (12,292 ac-ft) (including Cannon AFB, which has a long-term lease agreement with the City of Clovis for a portion of the City's reservation)
- Curry County (100 ac-ft)
- Village of Elida (50 ac-ft)
- Village of Grady (75 ac-ft)
- Village of Melrose (250 ac-ft)
- City of Portales (3,333 ac-ft)
- Roosevelt County (100 ac-ft)
- Village of Texico (250 ac-ft)
- Quay County (1,000 ac-ft)
- Tucumcari (6,000 ac-ft)
- Logan (400 ac-ft)
- San Jon (150 ac-ft)

Arizona Water Settlement Act(AWSA)-Gila and San Francisco Rivers

A number of legal ruling and Congressional acts regulate New Mexico's use of water on the Gila/San Francisco River system:

- The 1964 *Arizona v. California* Decree issued by the U.S. Supreme Court effectively limits new or large water development projects in the Gila or San Francisco sub-basins.
- The 1968 Colorado River Basin Project Act allocated an additional 18,000 ac-ft per year of consumptive use to New Mexico for use in the Gila and San Francisco River basins, allowing for a total of approximately 48,000 ac-ft per year of consumptive use. This act also authorized the Central Arizona Project (CAP).
- The 2004 AWSA reduced the 1968 allocation from 18,000 to 14,000 ac-ft per year of annual average consumptive use, resolved the issue of New Mexico's junior priority, and included funding of up to $128 million. The AWSA provides that, "in the operation of the Central Arizona Project, the Secretary shall offer to contract with water users in the State of New Mexico, with the approval of its Interstate Stream Commission, or with the State of New Mexico, through its Interstate Stream Commission, for water from the Gila River, its tributaries and underground water sources in amounts that will permit consumptive use of water in New Mexico of not to exceed an annual average in any period of 10 consecutive years of 14,000 ac-ft, including reservoir evaporation, over and above the consumptive uses provided for by article IV of the decree of the Supreme Court of the United States in *Arizona v. California* (376 U.S. 340). Such increased consumptive uses shall continue only so long as delivery of Colorado River water to downstream Gila River users in Arizona is being accomplished in accordance with the AWSA, in quantities sufficient to replace any diminution of their supply resulting from such diversion from the Gila River, its tributaries and underground water sources. In determining the amount required for this purpose, full consideration shall be given to any differences in the quality of the water involved."

The AWSA also gave New Mexico $66 million to finance a New Mexico Unit or other water utilization project in the Southwest New Mexico Region. Initial funding became available beginning in 2012 and is being paid to the New Mexico Unit Fund in annual increments.

In November 2014, in accordance with the AWSA, the ISC provided notice to the Secretary of the Interior that New Mexico intends to have a New Mexico Unit of the CAP constructed or developed. In 2014 and 2015, the ISC also voted to partially fund additional water-use projects in the region:

- Municipal water conservation: $3 million
- Gila Basin Irrigation Commission diversion structure: $1.25 million
- Catron County Community Ditch Permanent Points of diversion: $500,000
- Deming effluent reuse: $1.75 million
- Pleasanton East-Side Ditch Company ditch improvement: $200,000
- Sunset Canal and New Mexico New Model Canal ditch improvements: $200,000 (in 2016 Sunset Canal renounced its share of the funding and asked that it be transferred to New Model)
- 1892 Luna Irrigation Ditch Association permanent diversion structure: $100,000
- Grant County Regional Water Supply Project: $2.1 million
- The AWSA provides for the designation of a New Mexico CAP Entity to own and hold title to the New Mexico Unit of the CAP. The Entity was designated by the ISC and created through a Joint Powers Agreement among the participating local governments in July 2015.
- The New Mexico CAP Entity is continuing to plan for the development of a New Mexico Unit project, which must be designed to comply with the terms of the AWSA. Environmental and planning studies, including

preparation of an environmental impact statement by the ISC and the USBR, must be completed before construction. The AWSA allows New Mexico to be a joint lead in the NEPA process. Information on the process is available on the New Mexico AWSA website (http://nmawsa.org/). Steering committee support for this project is mixed, with some strong supporters but others in the group voicing strong opposition (refer to Southwest New Mexico Regional Water Plan). Even if no New Mexico CAP Unit is built, up to $66 million of the $128 million may be used for projects that meet a water supply demand in the Southwest New Mexico region.

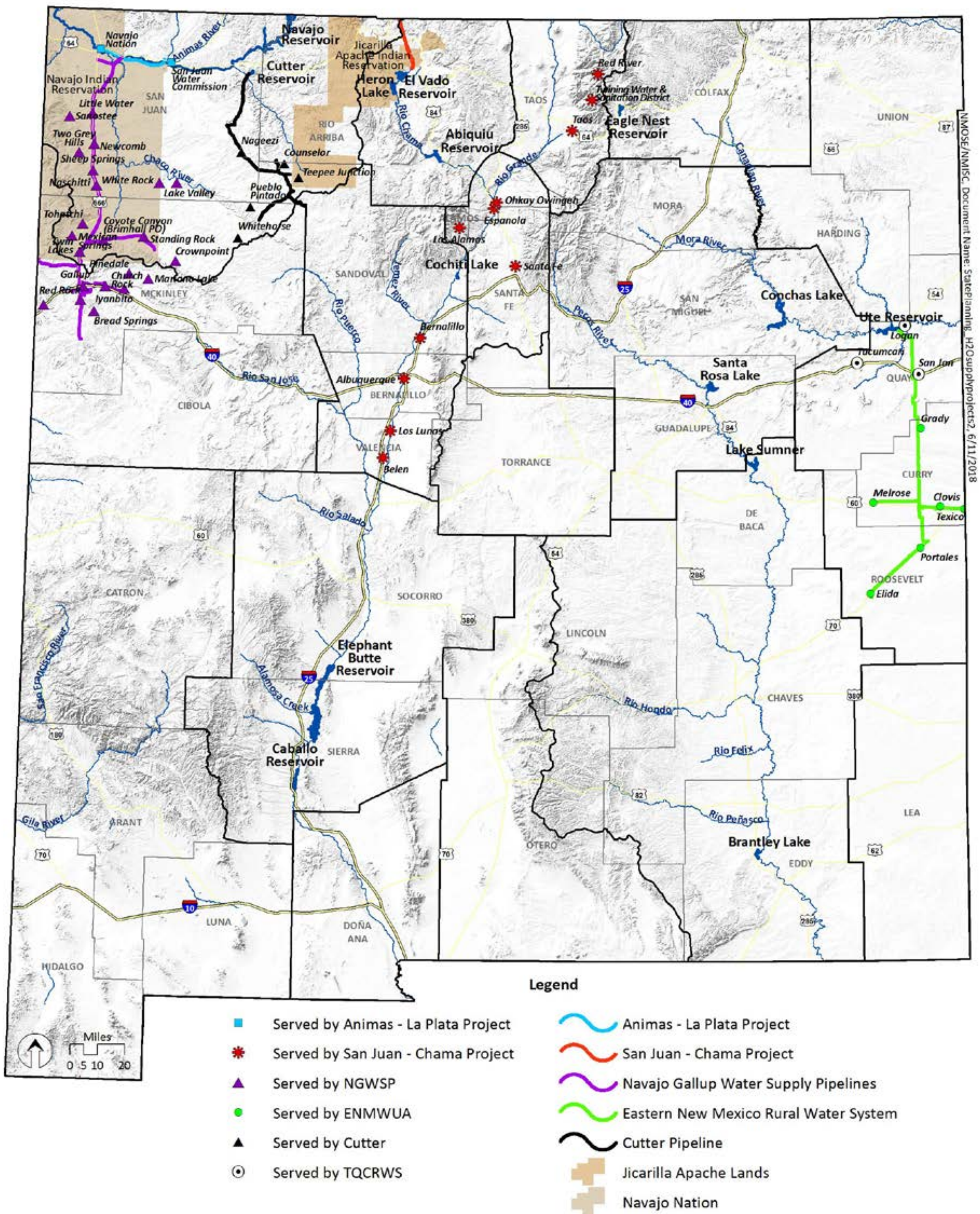

Figure C-4. Water Supply Projects for Public Water Systems in New Mexico.

C.3. Transfer Water Rights

- Identified in: 10 out of 16 regions
- Number of PPPs: 29

Water rights transfers from one purpose of use to another are one mechanism for meeting future demands (at the expense of the transferred-from use). Of the 29 water right transfer projects, programs or policies included in the PPP lists for 10 of the regions, all but 1 project involves the transfer of water rights from agricultural water use to urban use. One project includes purchase of unused mining water rights for agriculture.

C.4. Inter-Basin Transfers

- Identified in: 5 out of 16 regions
- Number of PPPs: 2

Inter-basin transfers involve importing water from outside of the water planning region, or from one groundwater basin or surface water basin to another. A total of 5 projects from 2 water planning regions are in the PPP lists that involve importing water. Region 10, Lower Pecos Region, includes conceptual ideas of exploring for unappropriated water in New Mexico for import to the Lower Pecos Region and considering importing water from major rivers outside of New Mexico. Region 11, Lower Rio Grande Water Planning Region, is interested in importing water from the Gila Project, Nutt-Hockett Basin, and the Salt Basin.

C.5. Shortage Sharing Agreements

- Identified in: 2 out of 16 regions
- Number of PPPs: 2

Shortage sharing agreements between parties on a stream or ditch provide an alternative to priority administration during periods of drought. Two projects on the PPP lists involve developing shortage sharing agreements for drought mitigations.

References

Hightower, Mike. 2018. Letter to Amy Lewis from Mike Hightower of the New Mexico Desalination Association regarding the status of desalination in New Mexico and neighboring states. June 8, 2018.

Lewis, Amy C., Wetherbee Dorshow, and Charlie Nylander, 2013. Water Resource Inventory of the Espanola Basin. Prepared by Santa Fe County September 17, 2013.

Longworth, J.W., J.M. Valdez, M.L. Magnuson, and K. Richard. 2013. *New Mexico water use by categories 2010.* Technical Report 54, New Mexico Office of the State Engineer, October 2013. Available at <http://www.ose.state.nm.us/Conservation/PDF/NM%20Water%20Use%20 by%20Categories%20Tech.%20Report%2054.pdf>.

Graham, Enid J Sullivan, Anne C. Jakle & F. David Martin (2015). Reuse of Oil and Gas Produced Water in South-eastern New Mexico: Resource Assessment, Treatment Processes, and Policy, *Water International*, 40:5-6, 809-823, DOI:10.1080/02508060.2015.1096126

PRRC, 2016. http://octane.nmt.edu/gotech/Petroleum_Data/allwells.aspx. Accessed on 3/15/2016.

Vickers, Amy, 2002. Handbook of Water Use and Conservation: homes, landscapes, businesses, industries, farms. ISBN1-931579-07-5 Water Plow Press. First edition, second printing.