ADVANCING **NEW MEXICO'S** FUTURE:

A Town Hall on Water Planning, Development & Use

BACKGROUND REPORT

- Town hall participants are urged to read this report before the event.
- April 15-16, 2014, Albuquerque, NM

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FOREWORD

Purpose of Report

This background report is intended to help participants prepare for the **New Mexico First** statewide town hall on water policy, April 15-16, 2014. This type of major deliberation is held every two years, on a topic of critical importance. The statewide town hall is New Mexico First's service to the people and policymakers of our state. The event will produce a platform of consensus recommendations. New Mexico First will advance those recommendations for at least 18 months (i.e., two legislative sessions), ensuring that the participants' ideas receive attention statewide.

We believe that the best deliberations are *informed* deliberations. Therefore, all our town halls are preceded by a nonpartisan backgrounder that sets the context.

Note: There are few right or wrong answers to any public policy question, and the problems and opportunities around our state's water are complex. As a result, no brief explanation of the situation – including this report – can hope to cover all the information and opinions available. Our research committee provided their knowledge and expertise, but ultimately the people and policymakers of New Mexico must decide what course our water future will take.

Convener

New Mexico First engages people in important issues facing their state or community. Established in 1986, our public policy organization offers unique town halls and forums that bring together people from all walks of life to develop their best ideas for policymakers and the public. New Mexico First also produces nonpartisan public policy reports on critical issues facing the state. These reports – on topics like water, education, healthcare, the economy, and energy – are available at nmfirst.org.

Our state's two U.S. Senators – Tom Udall and Martin Heinrich – serve as New Mexico First's honorary co-chairs. The organization was co-founded in 1986 by retired U.S. Senators Jeff Bingaman and Pete Domenici.

Pre-Town Hall Input

In the months prior to the town hall, listening sessions were held on water issues in northern and southern New Mexico. We also conducted an online survey to collect suggestions for specific reforms the town hall might address. Those inputs, in addition to the ideas of the research committee below, generated the outline for this report. They also informed the selection of the discussion topics for the upcoming town hall.

Research Committee

New Mexico First staff members Heather W. Balas and Melanie Sanchez Eastwood prepared this report, with extensive consultation from our research committee:

Aron Balok, Pecos Valley Artesian Conservancy District
Tom Blaine, New Mexico Environment Department
Angela Bordegaray, Interstate Stream Commission
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Paula Garcia, New Mexico Acequia Association
Kerry Howe, UNM Center for Water and the Environment
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Laura McCarthy, Nature Conservancy
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Bruce Thomson, University of New Mexico
Pei Xu, New Mexico State University

Some sections of this report were partly drafted by committee members. Such instances are noted throughout the document. Many, many thanks to the committee of hard-working contributors.

ADDITIONAL READERS

We also brought in extra readers when needed. In some cases, they reviewed only the sections related to their areas of expertise.

- Ed Archuleta, University of Texas, El Paso
- Sharon Berman, New Mexico First
- Ron Bohannan, NAIOP
- Beth Bardwell, Audubon NM
- Brian Burnett, Bohannan Huston
- John D'Antonio, U.S. Army Corps of Engineers
- Patricia Dominguez, Office of U.S. Senator Martin Heinrich
- David Dubois, NM State Climatologist
- Bob Feinberg, Watergy Sourcing Group
- Charlotte Pollard, New Mexico First
- Louis W. Rose, Montgomery & Andrews
- Rolf Schmidt-Petersen, NM Interstate Stream Commission
- John Shomaker, John Shomaker and Associates

WHERE DID WE GET OUR INFORMATION?

Throughout this document, we provided as many data sources as possible. We draw from published reports, newspaper and journal articles, first-hand interviews and online resources. We know that policymakers, researchers and students use our reports, so we provide the details you need to research further – and answer your own questions about water policy. Footnotes provide short-references to complete citations in the bibliography.

INTRODUCTION

The last year was a record-breaker for water in New Mexico, and it was not *all* bad news. Yes, we ranked worst in the nation for intensity of drought, but then a deluge of rains delivered a years worth of precipitation in a few weeks. In fact, Albuquerque received more rainfall than in any five-day period since 1929. But then the drought returned, and we underwent the longest winter streak with no precipitation on record (over 40 days). Last year brought 1,064 wildfires. Our water storage reservoirs were at their lowest levels in more than 15 years. Over 72,000 defendants held unsettled water rights (and still do).

Despite that roller coaster of challenges, we found solutions. We are New Mexicans, and we know how to be resilient. We have a rich heritage of being stewards of our natural resources. So, when faced with drought, communities developed water shortage-sharing agreements. Businesses and farmers adjusted their water use. Universities stepped up water research. Albuquerque used the least amount of water in 20 years. And residents of Santa Fe remained number one in the Southwest for using fewest gallons of water per person.

Those were commendable responses, but they were piecemeal, often uncoordinated efforts at solving our water problems. What we need to do is look at New Mexico's water policy in a comprehensive way. Doing this would give our state the opportunity to lead the nation in the adoption and implementation of smart water policies. Most of us already agree on the major goals that would characterize such policies. We need to continue to provide safe and adequate drinking water for homes and businesses. We need to irrigate our crops. We need to protect endangered species in our waterways, manage our watersheds, and address the growing number of wildfires that in some cases devastate our land and rivers but can also lead to natural regeneration. We need to manage our water rights, work out the myriad of disputes over who owns what water, and continue to meet compact obligations to neighboring states. We need to explore new technologies that let us reuse more water and potentially develop new sources. And, as if that isn't enough, we have to find sufficient funds to pay for all that activity.

It is a lot to accomplish for a small population inhabiting one of the largest and most geographically diverse states in the nation.

A first step can be to understand the foundational water policy issues in New Mexico. The following report attempts to provide a primer on the most critical water matters facing New Mexico. Using this information, plus your own knowledge and experiences, we invite the people of this state to put forward their best ideas.

What are the smartest water policies to ensure that New Mexico's future is bright?

Figure 1: New Mexico, Illustrated by River Basin [1]

[1] (NM Office of the State Engineer) This map is of the basins, and does not necessarily align to the boundaries for the interstate compacts.

WATER IN NEW MEXICO

THIS CHAPTER ADDRESSES:

- How much water we use
- Where it comes from
- How we store and manage it
- How much might we have in the future

ADVISORS:

Aron Balok, Pecos Valley Artesian Conservancy District
Adrian Oglesby, Utton Center
Bruce Thomson, UNM College of Engineering
NM Interstate Stream Commission, compacts managers
NM Office of State Engineer (OSE), hydrology bureau

How We Get Our Water

New Mexico uses about 3.8 million acre-feet of water a year.[2] That averages to 3.4 trillion gallons per day. We have a modestly growing population and economy, but we also see a steady decline in overall water use. Perhaps this surprising shift reflects increased conservation, changes in business practices, or other factors. Figure 2 illustrates our water use and population growth since 1995.[3]

Regardless how much water we use, New Mexico is a land-locked state. Thus all our water comes from precipitation (some of it hundreds of years old). New Mexico averages about 13.5 inches of rain per year and receives additional river water that flows down from Colorado.[4] Of that water received each year, an estimated 97 percent evaporates or is transpired by plants.[5] The remaining three percent is what we use to help meet human, economic, legal, environmental and groundwater recharge needs.

We access our water from two sources:

- Surface water (rivers, streams, lakes)
- Groundwater (deep, underground aquifers)

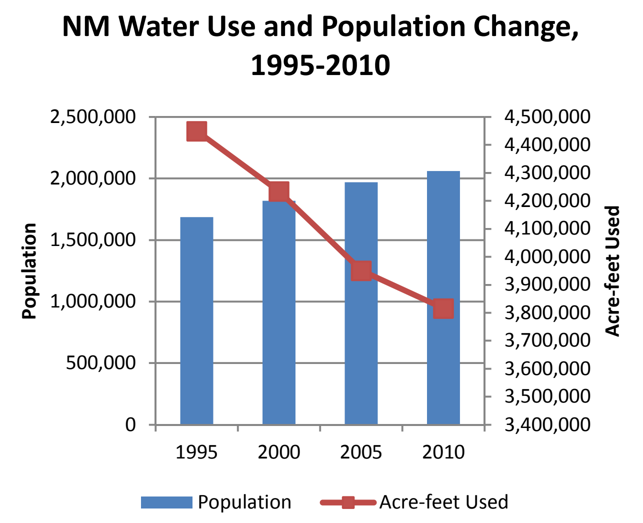

Figure 2: NM Water Use and Population Change, 1995-2010 [6]

WHAT DO WE MEAN BY "WATER USE?"
In this report, the phrase "water use" refers to human withdrawals from a known source (such as a river or aquifer). That water is not necessarily permanently "consumed" since much of it may return to a river or other water source to be used again.

The two sources are indisputably components of the same system. Groundwater contributes to surface water in some circumstances and locations; and surface water recharges groundwater in others. For example, groundwater levels beneath the Rio Grande are far more variable than those in parts of eastern New Mexico, where there are no rivers.

Despite the definite linkage between ground and surface water, they are often counted separately for measurement, policy and planning purposes. They are definitely managed differently.

[2] Calculated from total 2010 water withdrawals. One acre-foot is the amount of water that would cover an acre of land to a depth of one foot, or 325,851 gallons.
[3] Water use by categories is calculated every five years by the OSE. The most recent report includes data through 2010.
[4] (National Ocean and Atmospheric Association)
[5] (New Mexico Bureau of Geology & Mineral Resources)

[6] Compiled by New Mexico First from OSE water use by categories reports from 1995, 2000, 2005, 2010.

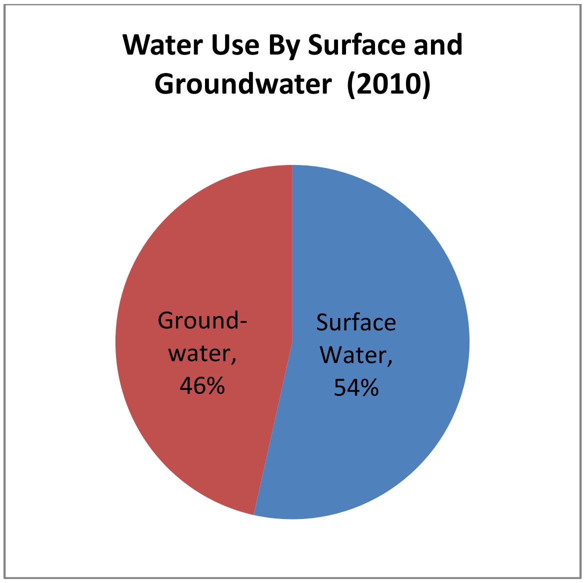

Figure 3: 2010 Withdrawals by Surface and Groundwater [7]

Surface Water

New Mexico surface water comes into our rivers via rain, snow, and downstream flow from other states. That water naturally flows into our six river basins:

- Upper Colorado
- Rio Grande
- Arkansas-White-Red
- Lower Colorado
- Pecos
- Texas Gulf

Located in most of these basins are dams and reservoirs that store and deliver water. **It is not an understatement to say that New Mexico's entire economy and current way of life relies on this heavily regulated and engineered system.** The reservoirs store water for a number of purposes:[8]

- Flood control (normally holding water for a short time)
- Municipal water
- Irrigation
- Power production
- Fish and wildlife benefits
- Recreation
- Sediment control

New Mexico operates a number of small reservoirs and dams, but water managers tend to focus on the large ones. The tables starting on p. 4 present key facts about these reservoirs, including limited information on interstate compact obligations. *(Compacts are explained more on p. 15 and 40.)*

In addition to the operation of the reservoirs, policymakers pay attention to water levels and evaporation losses. Figure 4 shows that all our reservoirs currently hold far less than their storage capacity, and – despite last summer's monsoons – most are still below average levels. (Note: The red line shows average level, not capacity.) Figure 6 shows that our combined water reservoir storage in 2013 was the lowest in at least 15 years. Figure 5 synthesizes data from four OSE "water use by categories" reports over a 15-year timespan. It shows that the amount of water lost to evaporation declined significantly over those several years, from 500,000 acre-feet in 1995 to just over 262,000 in 2010. This decline is primarily caused by the fact that the reservoirs have far less water than in the mid-1990s. Many people focus on Elephant Butte's evaporation. Unlike some reservoirs that are deep with smaller surface areas (such as Heron, El Vado and Navajo), Elephant Butte is comparatively shallow with a large surface area – thus its high levels of evaporation loss.[9]

NEW MEXICO RESERVOIR VOLUMES

	Reservoir	Capacity
1	Navajo	57%
2	Heron	22%
3	El Vado	3%
4	Abiquiu	13%
5	Cochiti	9%
6	Bluewater	10%
7	Elephant Butte	13%
8	Caballo	12%
9	Lake Avalon	58%
10	Brantely	3%
11	Sumner	36%
12	Santa Rosa	22%
13	Costilla	19%
14	Conchas	37%
15	Eagle Nest	26%

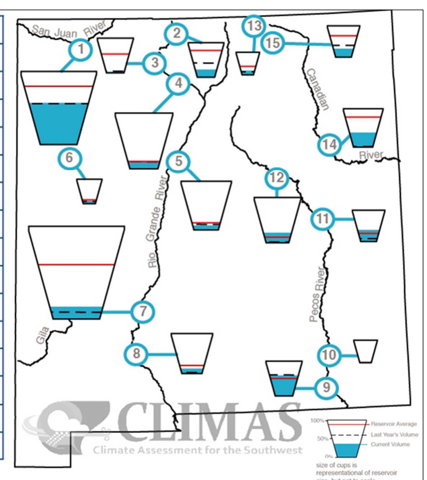

Figure 4: Amount of Water in NM Reservoirs[10]

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[7] (NM Office of State Engineer-Categories, 2010)
[8] (Kelly, 2011)
[9] (Thomson B., 2013)
[10] (The University of Arizona, February 2014)

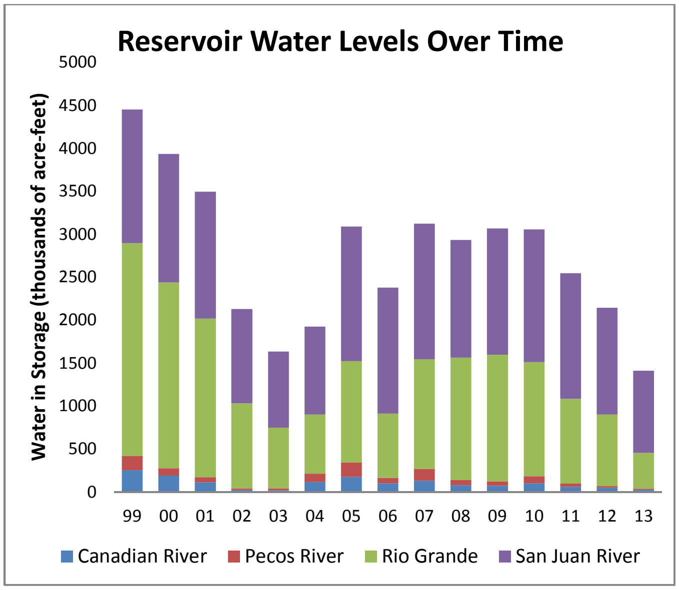


Figure 6: NM Reservoir Water Storage, 1999-2013, (OSE)

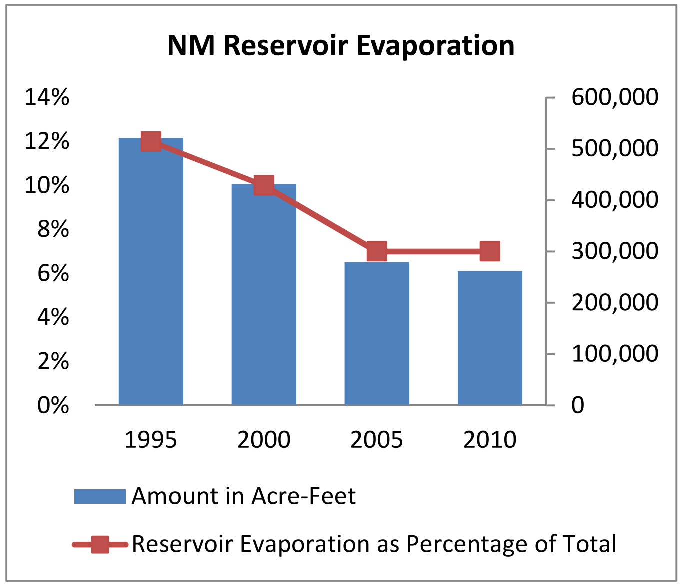


Figure 5: NM Evaporation Levels by Amount and Percentage, 1995-2010, (OSE)

Reservoir Summary

As noted previously, New Mexico's economy and modern way of life is highly dependent on our complex network of reservoirs. The following table illustrates the range of communities and industries that rely on reservoir water.

CANADIAN RIVER BASIN [11]

Reservoir	Capacity in Acre-Feet	Major Purposes	Notes
Eagle Nest Reservoir	78,000	• Irrigation • Domestic water for Raton and Springer • Recreation	• Reservoir was originally built by the Springer ranching family. It was conveyed to the NM Game and Fish Department in 2002 and is now operated by the ISC. • The water is owned by 18 entities.
Ute Reservoir	200,000 (storage) 24,000 (municipal)	• Recreation • Projected future use: municipal water for cities from Tucumcari south to Portales. *(See p. 24 for details.)*	• Built and managed by the ISC. • Storage capacity limited by the Colorado River Compact.
Conchas Reservoir	198,000 (flood) 252,000 (storage)	• Conservation storage and irrigation for the Arch Hurley Conservancy District (also known as the "Tucumcari Project." • Recreation	• Managed by the U.S. Army Corps of Engineers. • Constructed in 1939 as a relief project of the Great Depression. • The lake has been very low in recent years. Spring 2014 is predicted to be the first season in several years when irrigation water is scheduled for release.

[11] (Kelly, 2011)

RIO GRANDE BASIN[12]

Reservoir	Capacity in Acre-Feet	Major Purposes	Notes
Heron Reservoir	401,320	• Municipal, industrial and agricultural water supply in Albuquerque, Santa Fe, and the Middle Rio Grande Conservancy District (MRGCD) • Smaller supplies to Jicarilla Apache, Los Alamos, Espanola, Belen, Los Lunas, Taos, Bernalillo, Red River	• Managed by Bureau of Reclamation as part of the San Juan-Chama (SJC) diversion project. It is only authorized to hold San Juan Chama water, not Rio Grande water. • Water is withdrawn from the San Juan River in Colorado and delivered to the reservoir via a tunnel under the Continental Divide. • Affected by legal conflicts over protection of the Rio Grande silvery minnow.
El Vado Reservoir	198,000	• Irrigation for Middle Rio Grande Conservancy District • Storage for six pueblos • Water for Rio Chama Acequia Association • Power generation for Los Alamos County	• Managed by Bureau of Reclamation. • Subject to rules in the Rio Grande Compact. • Affected by silvery minnow litigation. • Releases water for weekend river rafting when conditions permit.
Abiquiu Reservoir	183,099	• Flood and sediment control • Storage of Albuquerque's SJC water	• Managed by the U.S. Army Corps of Engineers. • Affected by silvery minnow litigation. • Some water managers are interested in Abiquiu because they think its history of flexible storage could be a model for avoiding over-delivery to Texas and reducing evaporation losses at Elephant Butte.
Cochiti Reservoir	50,000 (recreational) 590,000 (flood)	• Flood control for Albuquerque • Recreation	• Managed by the U.S. Army Corps of Engineers. • Located on Pueblo de Cochiti land. • Releases extra storage of water to create "pulse flows" that promote spawning of the silvery minnow.
Elephant Butte Reservoir	2 million	• Principal storage facility for the federal Rio Grande Project and thus New Mexico's delivery obligations to Texas • Water for NM farmers, managed via the Elephant Butte Irrigation District • Recreation	• Built in 1916 after extensive negotiation with Texas and Mexico. • Managed by Bureau of Reclamation. • Estimated evaporation losses about 10 feet annually. When the lake is full, that is about 140,000 acre-feet per year (or twice the annual use of Albuquerque).
Caballo Reservoir	50,000 (target) 350,000 (flood)	• Storage for irrigation, power and flood. • Water delivery to Mexico required by international treaty.	• Managed by Bureau of Reclamation. • Operates in conjunction with Elephant Butte Reservoir.

COLORADO RIVER BASIN [13]

Reservoir	Capacity in Acre-Feet	Major Purposes	Notes
Navajo Reservoir	1,708,600	• Irrigation and municipal purposes • Hydropower for Farmington • Storage of water for the Navajo Indian Irrigation Project • Flood control • Recreation	• Owned and operated by the Bureau of Reclamation. • Subject to the rules of more compacts and federal acts than other lakes in reservoirs in this report. • Subject to the Upper Colorado River Basin Compact, Colorado River Storage Project Act, San Juan-Chama diversion act, and Navajo Indian Irrigation Project.

[12] (Kelly, 2011)
[13] (Kelly, 2011)

PECOS RIVER BASIN

Reservoir	Capacity in Acre-Feet	Major Purposes	Notes
Storrie Lake	22,900	• Irrigation • Municipal water for Las Vegas	• Owned by the Storrie Project Water Users Association. • Used in conjunction with Bradner and Peterson Reservoirs for Las Vegas water.
Santa Rosa	438,364 (flood) 92,236 (storage)	• Water delivery obligations to Texas per the Pecos Compact • Irrigation storage for the Carlsbad Irrigation District • Smaller supplies to farmers in Fort Sumner, Roswell and Artesia	• Managed by the U.S. Army Corps of Engineers. • Santa Rosa, Sumner, Brantley and Avalon reservoirs operated together as a system for the Carlsbad Project. • Water kept in Santa Rosa and Sumner reservoirs to take advantage of lower evaporation losses. • Project affected by the endangered Pecos Bluntnose Shiner fish. • In 1988, Texas sued New Mexico for under-delivery of water, resulting in $14 million in fees.
Sumner	93,828 (flood) 40,398 (storage)		
Brantley	414,466 (flood) 3,866 (irrigation)		
Avalon	4,466 (flood) 3,866 (irrigation)		

Groundwater

Underground aquifers of various sizes and depths exist beneath most of the earth's surface, but the water in them is not always accessible or of sufficient quality for human consumption. The word "aquifer" literally means "carry water," which is exactly what they do; aquifers are geological formations that hold and carry water underground. Across our planet, groundwater held in aquifers is the single largest supply of freshwater available to humans.[14]

As noted previously, New Mexico gets about half of its fresh water from aquifers. We use it for agricultural, municipal, industrial and commercial needs. Some of our aquifers are declining significantly; for others the picture is less clear. They vary because some aquifers quickly recharge (or take in new water), due to their proximity to other water systems like mountain snowmelt, rivers or springs.

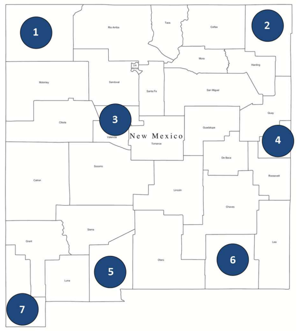
Others, such as the Ogallala Aquifer located under the southwest High Plains, take centuries to recharge.[15] The Ogallala spans eight states and is the world's largest known aquifer. High-volume groundwater withdrawals in parts of the Ogallala caused declines of as much as 234 feet from about 1940 to 2007.[16] In some cases, aquifers can be recharged artificially via injection wells. *(See p. 24 for information on groundwater depletion in eastern New Mexico.)*

The U.S. Geological Survey (USGS) graphs on the following page provide a snapshot of groundwater levels in several different New Mexico counties, over a 60-year period. Long-term water levels have dropped in every aquifer reported. However, the amount of decline varies considerably. For example, aquifers located near river systems (such as in Doña Ana and Eddy County) are more variable. By contrast, aquifers in closed basins (such as Curry County) show a steady decline. The following hydrographs do not necessarily depict the water situation in the entire county or region. When considering changes to groundwater management policies, the graphs illustrate the need to follow water trends closely, recognize regional differences, and potentially avoid "one-size-fits-all" approaches.

[14] (U.S. Geological Survey-Groundwater)
[15] (U.S. Geological Survey-Groundwater)
[16] (U.S. Geological Survey-High Plains)

GROUNDWATER HYDROGRAPHS

These hydrographs were selected from hundreds of wells tracked by USGS. Levels vary, even within counties. Well-selection for this report was based on the number of available years and most measurements taken. (Data for additional wells is posted at usgs.gov.)



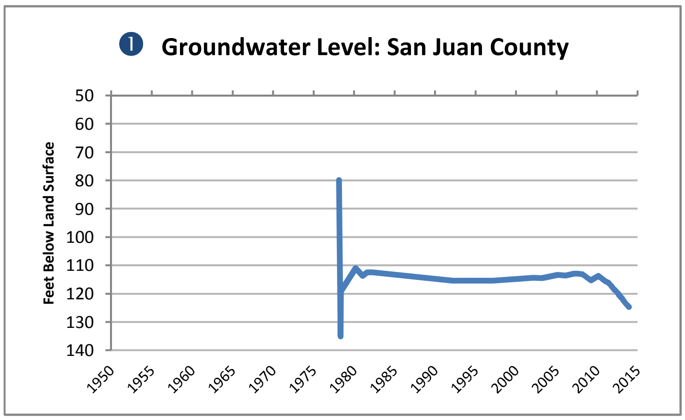


Figure 11: San Juan County Test Well 364750108214701

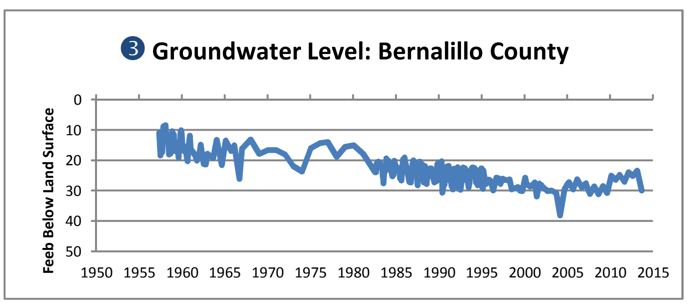


Figure 12: Bernalillo County Test Well 350837106393801

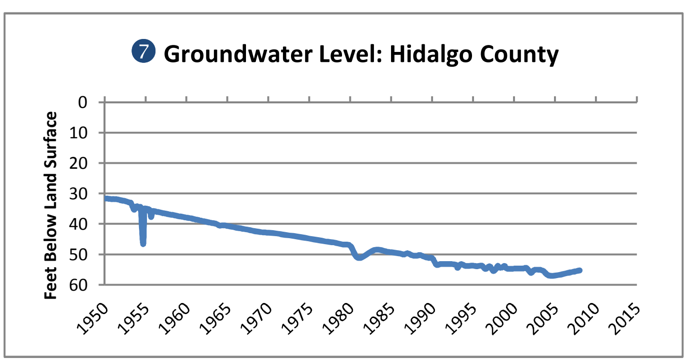


Figure 13: Hidalgo County Test Well 321624108504001

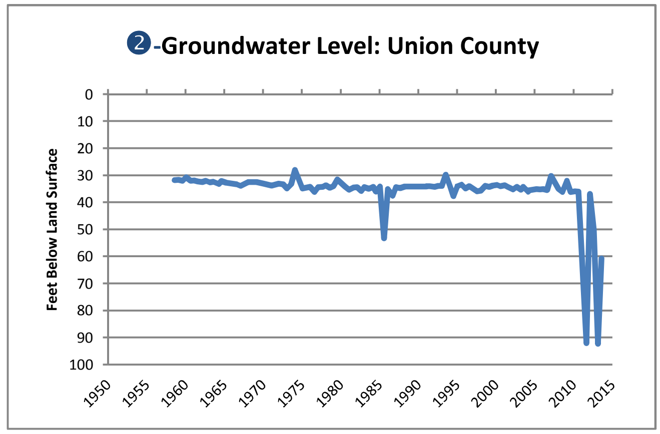


Figure 7: Union County Test Well 364444104000201

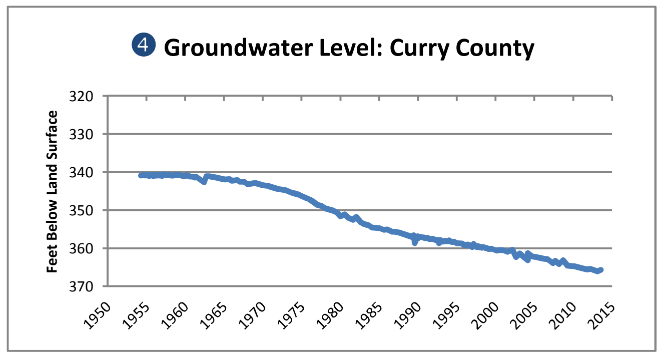


Figure 8: Curry County Test Well 342736103203701

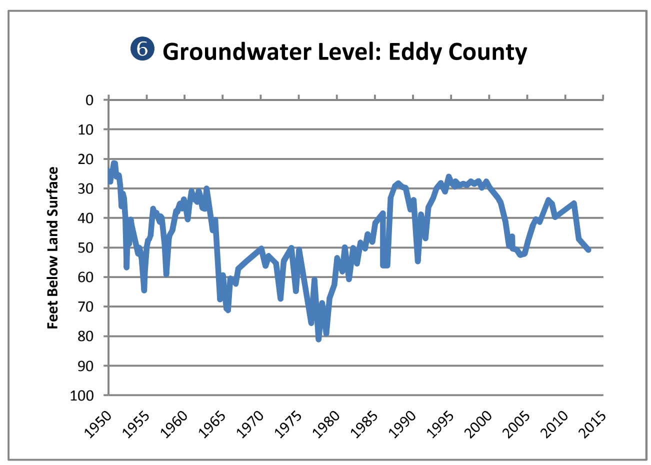


Figure 10: Eddy County Test Well 322238104101801

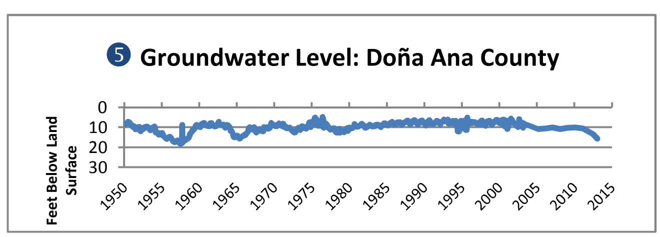


Figure 9: Doña Ana County Test Well 315515106392801

How Much Water Can We Expect in Coming Years?

As if managing all our surface and groundwater were not complicated enough, the variability of our climate makes it very difficult to predict how much water we will have from year to year. When we look at water from the long view, say 1,000 years, we realize that the last several decades of the 20th century were unusually wet.[17] These years were important because they were a time of rapid growth in the west, and the public and water managers came to rely upon this relatively plentiful rainfall. Historical research also shows that one of the wettest periods of the 20th Century was 1912-1921.[18] (The Colorado River Compact was signed in 1922; details on p. 40.)

HISTORICAL PRECIPITATION DATA

Study of historic tree ring data also tells us that major droughts like the one in the 1950's were a regular occurrence in our climate history, and that they were often more severe. This means that the last three years of New Mexico drought, which may have felt extreme to many of us, may not be so abnormal. In the illustration below, the wavy dark blue line shows a moving average of northern New Mexico precipitation throughout nearly a thousand years. The solid colored lines point out the precipitation averages from specific periods of history.

RAINFALL ACROSS A MILLENIUM

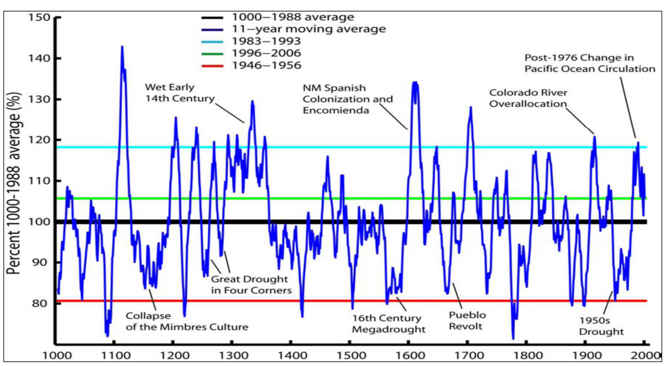


Figure 14: Precipitation Time Series for 1000 Years
(tree ring data; expressed as % departures from the 1,000 year average)[19]

FORECASTS AND CLIMATE

It is not possible to predict weather reliably over periods of decades, years or even months. However, the National Oceanic and Atmospheric Administration (NOAA) releases a seasonal drought outlook that forecasts persistent drought for the southwestern U.S. for the coming season. If this forecast is accurate, 2014 will be fourth year of very dry conditions throughout the state. In addition, researchers who follow the El Niño weather patterns forecast neutral conditions in the Northern Hemisphere through spring 2014, with about a 50% chance of El Niño developing during the summer or fall.[20] Such a development could produce rains at that time. (If New Mexico were to adopt different policies on storm-water storage, such forecasts might warrant advance planning. *See p. 27.)*

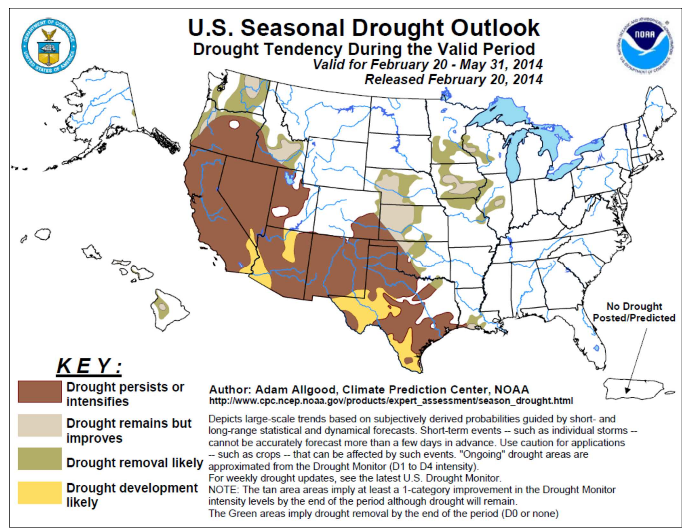


Figure 15: Seasonal Drought Outlook through April 2014 [21]

In addition to natural variability of weather patterns, there is increasing recognition that the some of the earth's climate conditions are trending in negative directions. Whether the change is due to natural causes or human activity is not an issue for this report, but there is sufficient evidence that the climate of the southwestern U.S. has warmed over the past several decades and that this warming is likely to continue for the foreseeable future. This information leads to the question of what the impact of a warmer climate would be on future water availability.

[17] (Gutzler, 2012)
[18] (Oglesby, Drought, 2013)
[19] (Gutzler, 2012)
[20] (International Research Institute for Climate and Society, March 2014)
[21] (National Oceanic and Atmospheric Administration, 2014)

CLIMATE MODELING

The U.S. Bureau of Reclamation attempted to address this question via an extensive modeling study of the Rio Grande watershed. The results do not indicate whether there will be a likely change in precipitation in future decades. They do, however, predict that average temperatures in New Mexico and other Rocky Mountain states will increase by nearly 10°F by 2100. Increased temperatures would result in more water lost to evaporation and transpiration, especially from the winter snow pack. Less snowpack would mean significantly decreased river flows in the Rio Grande, and thus reduced surface water in Albuquerque. The study predicts that river flows to Elephant Butte Reservoir would drop from above 1,000 cubic feet per second (cfs) in the 1950s to 400-500 cfs by the year 2100.[22]

Higher temperatures, coupled with reduced river flows, would create a series of potential challenges for people and policymakers to address:[23]

- A longer growing season and thus potentially increased agricultural demands on existing water resources
- Reduced availability of surface water for irrigated agriculture, potentially resulting in reduced yields and economic losses
- Difficulty in meeting water delivery obligations relied on by Texas and Mexico
- Likely impacts on endangered species such as the Rio Grande Silvery Minnow
- Increased stress on riparian vegetation due to reduced river flows and declining groundwater levels
- Decreased recreational opportunities associated with skiing, fishing, boating, and whitewater rafting
- Increased conflicts over water rights, particularly among users who compete for limited river flows

Policy Considerations on Water Supply

What strategies and policies exist for the effective management of the state's dams and reservoirs? What can or should we do to advance conservation of surface and groundwater? To what degree are we adequately monitoring changes in groundwater levels?

How can New Mexico plan for expected water scarcity? If we have wet seasons – such as a possible El Niño year – what should we do with that water? What, if any, opportunities exist to store excess water when we have it? Are we better off to use the water when it is available? Or should we let it flow and even overflow riverbeds to reseed cottonwood and other riparian vegetation?

[22] (U.S. Bureau of Reclamation, 2013)
[23] (U.S. Bureau of Reclamation, 2013), (Garcia, 2014)

LEGAL MATTERS

THIS SECTION ADDRESSES:

- Water rights in general
- The water rights adjudication process
- Water shortage-sharing agreements
- Active Water Resources Management (AWRM)

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Water Rights

Before drafting this report, New Mexico First collected input via focus groups and surveys on water issues in New Mexico. Several people said our state should just "throw out" the current system of water rights. They argued that it is outdated, prioritizes the needs of individual water rights holders over the larger population, discourages common-sense approaches like shortage-sharing, and that it is expensive for the state to litigate. Others argued that our current system is fair, grounded in history, and fundamentally impossible to change.

Either way, the current system is firmly established in statute. There is no path for undoing over 200 years of water law, nor for taking a legal property right from thousands of owners. Therefore, this report operates under the assumption that improvements in policy or practice would occur within the current water rights system.

Just what does that system entail?

Under our state constitution, all water is owned by the State of New Mexico and the ability to use it is granted in the form of 'water rights.' **A water right is the legal authority to use a specific quantity of water, on a specific time schedule, at a specific place, and for a specific purpose.**[24]

New Mexico water law is historically based. Pueblo Indians used water centuries before statehood, and have an "early priority" date to their water rights. Later, Spanish settlers introduced the acequia system of open-air ditches. It was based on engineering, governance and customs common in 15th century Spain. When New Mexico became a territory, treaties guaranteed that inhabitants' existing property and water rights would be respected. In the years that followed, the policy of "prior appropriation" (described below) was a precedent consistently followed. After New Mexico became a state, this policy remained in law.[25]

PRIOR APPROPRIATION/PRIORITY ADMINISTRATION

Prior appropriation is a foundation of water law in the west, where shortages are common. Under this doctrine, water shortages are not necessarily shared among all water users. Instead, the "first in time is the first in line" for water. Theoretically, each water right is quantified, and the ability to use those amounts is determined by the chronological order in which the water was first put to beneficial use. The people (or entities) who came first are the "senior water rights holders," and thus get top priority to their allocations of water.[26] All who follow are "junior." According to law, after senior holders use their allocation of water, junior users can tap theirs. That said, no one has the legal right to waste water; per the NM Constitution, water must be put to "beneficial use."

In New Mexico, the more senior water rights are typically owned by Native Americans, acequias and farmers. Junior water rights are most often used for municipal, industrial, residential, and recreational uses.

Under this system of water management, water is administered in order of priority, senior to junior (thus the phrase, "priority administration"). Senior users have the right to make a "priority call" to obtain water during periods of shortage. Alternatively, water right owners may enter into sharing agreements or other forms of alternative administration.

[24] (NM Office of State Engineer-Glossary)

[25] (Buynak, 2008)

[26] "Beneficial use" is a purpose through which benefits are derived, such as municipal, irrigation, industrial, power development or recreation.

PRIORITY CALL IN CARLSBAD

Last year, during their worst drought on record, the Carlsbad Irrigation District (CID) voted to issue a "priority call" on water in the Pecos River. The controversial measure had the potential to cut off groundwater pumping for upstream users in Roswell and Artesia, potentially halting water use for those communities' farmers, oil drillers, cities, a local cheese plant and others. Estimated economic impacts of shutting off upstream pumping topped $1 billion.

The water rights of the Carlsbad irrigators are senior to those in Roswell and Artesia, so they had legal priority to call for the water. The CID is part of the landmark 2003 Pecos River Settlement Agreement, which was intended to avoid this type of crisis. However, the intensity of the drought was beyond the parameters of the settlement. The CID's decision to issue the priority call came after three years of drought and the announcement that they would receive one-tenth their normal water allotment. Ultimately, action was delayed a few months by legal issues, and then the late summer monsoons came – providing more than the minimum allotment of water. Unfortunately, the rains came late in the growing season (but will provide a substantial boost for CID irrigation in 2014).

Interestingly, while the intersection between groundwater and surface water exists, it is often slow. Unlike an irrigation ditch, where upstream waters flow down quickly, it can take years before upstream groundwater pumping affects downstream river flows.[27] So, if the priority call had halted upstream pumping, it would not have solved Carlsbad's immediate water needs. Financial compensation for the downstream farmers is one alternative that was raised.

SHORTAGE-SHARING AGREEMENTS

While priority administration is the legal solution, some people refer to it as the "nuclear option" of water law. While the Office of State Engineer (OSE) may need the tools of prior appropriation in some circumstances, there are alternatives. Voluntary shortage-sharing agreements enable water rights owners within a region to work together to meet minimum needs. These agreements can be effective, but they are difficult, time-consuming to develop and often expensive. Agreements can be developed between water rights owners whose rights have been fully adjudicated, or among those waiting for resolution. Fundamentally, shortage-sharing agreements provide an alternative to the "win/loss" structure of senior and junior water rights. They can also be used to address other concerns such as the environment or endangered species. They recognize the reality of multiple water needs by different entities and communities.

For example, in 2013, severe drought prompted water users along the Rio Chama to develop a voluntary, collaborative agreement with rotating irrigation schedules and reduced diversions. The lower Rio Chama is fully adjudicated, so procedures already exist for priority administration in that stretch. The Rio Chama Acequia Association (RCAA) initially considered a priority call, but avoided doing so. A priority call could have resulted in expensive litigation as well as a possible shutdown of acequias and lost crops. The agreement was developed in a series of meetings between the RCAA, OSE, Interstate Stream Commission, and La Asociación de las Acequias Norteñas de Rio Arriba, which is comprised of acequia leaders in the Chama Valley (whose water rights are junior to the RCAA). Many people on the system made sacrifices to avoid priority administration.

Compromises included a rotation schedule, shutting down half the acequias twice a week, and reducing diversions by half at other times. In the end, crops were kept alive, and litigation was avoided. Furthermore, San Juan-Chama diversion water (which flows to Albuquerque and other contracted users) was also protected.[28]

Other regions have worked out similar arrangements:

- The 1996 Rio Jemez shortage-sharing agreement was the first time in New Mexico history that water-users developed a priority process for themselves. The landmark agreement included two pueblos and five acequias. It is renewed regularly, with the most recent agreement endorsed through 2016.[29]
- The 2003 San Juan Basin shortage-sharing agreement addresses drought conditions in the Four Corners area. It includes 10 parties, including two tribal nations, two power utilities, one oil company, one municipality and

[27] (NM Office of State Engineer, 2013)

[28] (New Mexico Water Dialogue, 2013-Fall)

[29] (New Mexico Water Dialogue, 2013-Fall)

four irrigation associations. The agreement guides the use of water, including distributions from Navajo Reservoir, during shortage conditions. Similar agreements were endorsed in subsequent years, with the most recent lasting through 2016.[30]

- The 2013 Lower Rio Grande agreement enables shortage-sharing between farmers and conservation groups protecting habitats for endangered birds and native plants. It enables water to be leased or acquired for habitat from willing water rights holders, locates habitat restoration sites within irrigation district boundaries, and subjects habitat acreage to the same rights and obligations as farmland. [31] (See p. 19.)

Adjudications

With a shortage-sharing agreement, the parties might have all their water rights settled in advance – or they might not. But for a priority administration system to work, people *must* know who owns water rights and in what priority. When the senior and junior water rights are legally settled for an entire stream system or groundwater basin, the system is "fully adjudicated." Unfortunately, large portions of New Mexico's water rights are not adjudicated. There has been progress in recent years, with about two-thirds of the acreage involved in adjudications settled (almost 300,000 acres). However, the unsettled rights include 12 pending adjudications, representing over 72,000 non-Indian defendants plus 18 tribes or pueblos.[32] The oldest of these adjudications was filed in 1966; the most recent in 2005.

Because so many New Mexico water rights are tied up in the legal system, some advocates say we have priority administration system in name only, but not in practice.[33]

WATER RIGHT PROCESS

Part of the reason so many water rights are not adjudicated is because the complete process was not consistently followed, especially in the early decades of the 20th century. Since 1907, the sequence is supposed to be:

1) Apply for a **permit** to appropriate the water.
2) Submit **proof of completion** for the water diversion.
3) Submit proof that the water was put to **beneficial use**.
4) Receive a **license** that includes the amount of beneficial use and the priority date.

Many water right holders only have the permit, not the license. Had all water rights been licensed within the first few years of their inception (with the amount and priority date), we would have far fewer cases to adjudicate. Water rights holders may be reluctant to apply for licenses because it creates a final quantification of their allowed amount. They may not be using their full permitted amount currently, but they want to protect the right to use more water later. Once the beneficial use amount is determined on the license, it is difficult to change. (The same problem occurs for water rights holders before 1907; many have permits but not licenses.)[34]

WHY *DO* ADJUDICATIONS TAKE SO LONG?

For the last decade, lawmakers and water advocates have said that full adjudication is a top priority. Prior to 1940, four adjudications were completed. Since 2000, five more adjudications, representing over 20,000 defendants, were settled. In part, the process takes time because of the sheer number and types of defendants. They include the federal government, tribes, pueblos, irrigation districts, acequias, municipalities, businesses and tens of thousands of individual water rights owners.

There are three main phases in the adjudication process:[35]

1) **Hydrographic survey**: This data collection includes aerial photography, field information, documents or abstracts of water rights, reports, and interviews. This information is used to produce maps and water rights abstracts to form a final report.
2) **Subfile phase**: A "subfile" is essentially all the water rights held by one owner, grouped together. (They are grouped if the rights are geographically close together. But if a farmer holds water rights on opposite sides of a county or in different stream systems, those rights would go in separate subfiles.) The state uses data from the hydrographic survey to present what it believes is the owner's water right (including amount, priority, and location). If the owner agrees, a consent order is filed with the courts. If the owner disagrees, the subfile

[30] (PNM, 2013)
[31] (Bardwell, 2014)
[32] (Utton Transboundary Resources Center-Law, 2011)
[33] (Belin, Bokum, & Titus, 2002)
[34] (Shomaker, 2014)
[35] (Ridgley, 2014)

goes to mediation. In rare instances, when mediation does not work, the matter can go to trial.

3) ***Inter se* phase:** Latin for "among themselves," the *inter se* phase gives defendants a chance to challenge one another's claims. For example, an individual water rights owner might agree with the water allocation in her subfile, but her neighbor might see that settlement as an encroachment on his water rights. Such challenges are hopefully addressed in mediation but can go to trial.

Given that process, one can see why the settlement of water rights in New Mexico will take many more years. The OSE, when fully staffed and budgeted, can employ up to 16 adjudication attorneys. For example, presuming OSE staffing and legal processes remain the same, adjudication of the lower Rio Grande cases could take about 30 years.[36] No adjudication process has been undertaken for the middle Rio Grande. A table later in this section illustrates OSE staffing for each adjudication.

SENATE JOINT MEMORIAL 3 (2009)[37]

In 2009, the New Mexico Senate passed a memorial calling for research and public input on the adjudication process. UNM Law School staff conducted six forums around the state to collect input on improving the water rights settlement process. About 75 people attended. Prior research on other states had produced four specific reforms for consideration.

1. **State Your Claim**: Water rights holders would be required to file a claim form with a state agency describing their right, similar to getting a title for a car. Currently, the State Engineer conducts a hydrographic study and presents the water right for each claimant to accept or dispute.
2. **Licensing First**: Before a formal lawsuit would begin adjudication of an area, the state would be required to issue licenses for all valid water rights in the area.
3. **Get It Done, One at a Time:** Disputed issues related to a particular water right claim or among claimants would be resolved in one proceeding instead of across multiple stages. Generally, the adjudication is completed in phases. This change would enable parts of the *inter se* phase to occur even if all the subfiles in an adjudication are not complete.
4. **All for One and One for All:** Organizations with members (such as acequias associations or irrigation districts) would represent their members in an adjudication rather than the current process where every claimant defends his/her water right individually.

Participants discussed these four concepts, but did not endorse any of them. They were more concerned with fairness and accuracy than with speed in completing the water rights adjudications. A majority were uncomfortable with changes to the process that might reduce individual protections. They were concerned about unintended consequences of changing existing law or practices. They also expressed a perception that the OSE has conflicting responsibilities that may prevent it from being truly neutral.

One reform is being tested on a small scale in the current Animas adjudication in southern New Mexico. The subfile and *inter se* phases are being conducted together. Given that the adjudication consists of only 500 defendants, it presents an opportunity to try out process refinements.

INDIAN WATER RIGHTS [38]

Tribal water issues are discussed throughout this report, since the fundamental challenges for Indian and non-Indian water use are similar. Pueblos and tribal reservations are located throughout New Mexico and within most of the state's watersheds, and thus are part of many regional adjudications. There are 18 tribes and pueblos involved in the 12 major water rights adjudications described previously in this section.

The 2003 State Water Plan called for quantification of tribal water rights, declaring the matter a critical statewide priority. However, the plan does not address the process by which Indian nations, pueblos and tribes formally work with local governments and other entities on water issues.[39]

[36] (Ridgley, 2014)
[37] (UNM Law School-IPL, 2009)
[38] (Bushell, 2012), (Utton Center, 2013)
[39] (Tribal Water Institute, 2013)

SUMMARY: NEW MEXICO WATER RIGHTS CASES

Region	Total Acres	Adjudicated Acres	Percent of Acres Adjudicated	Subfiles	Number of Defendants	Combined OSE Staffing (Number of attorneys, technicians, researchers, contractors)
Northern NM Adjudications	112,435	77,271	69%	29,803	39,241	14
Southern NM Adjudications	127,354	42,794	34%	14,129	18,564	14
Pecos Adjudications	206,816	178,753	86%	5,840	14,484	9
TOTAL	**446,605**	**298,818**	**67%**	**49,768**	**72,289**	**37**

(Office of the State Engineer, adjudication data from 2011, staffing data from 2014.)

The tribes and pueblos have water rights, but those rights do not necessarily translate to adequate water availability. Some tribal communities face serious shortfalls of drinking or irrigation water. Others have enough water, but lack clarity on the quantity or priority level of their water rights.

Adjudications regarding tribal water rights may be conducted in state or federal court, through litigation or settlement. Tribal water cases, such as the San Juan Basin/Navajo Nation settlement, took decades to work out. Another case, the Aamodt Settlement (signed into law in 2010 but not yet approved by the courts), would end 45 years of water disputes involving four pueblos and thousands of non-pueblo residents.

Given the time and expense associated with court and legislative solutions, some tribal leaders are champions of shortage-sharing agreements. Previous examples in this report pointed to engagement by Native American leaders to find solutions between tribal and non-tribal neighbors.

Active Water Resource Management

The Active Water Resource Management (AWRM) initiative was launched in 2004 in response to drought conditions. Authorizing new management tools, AWRM enabled the State Engineer to conduct priority administration of stream systems where the water rights have not been fully adjudicated. The strategy was developed because so many water rights in New Mexico remained unsettled.

When the proposed AWRM framework was published, a number of objections were raised. People were concerned that the initiative gave the State Engineer authority they believed should be held by the courts. Industry associations challenged the new law as unconstitutional, delaying its launch for several years. The state Supreme Court upheld AWRM in November 2012.

Because AWRM is still in early stages of implementation, many questions remain about the approach. Its regulations include measuring and metering, rules and regulations, creation of water districts, appointment of water masters and development of water master manuals. Through ARWM, the OSE can also support voluntary water-sharing agreements.

Stream systems potentially identified for AWRM include the Lower Pecos River, the Lower Rio Grande, the San Juan River, Upper Mimbres, Rio Gallinas, the Nambe-Pojoaque-Tesuque Basin, and the Rio Chama. [40]

Water Rights Transfers and Markets[41]

Because most of New Mexico's water is already appropriated, one of the few ways cities, developers, farmers or environmental organizations can access new water supplies is to buy and transfer water rights. The OSE regulates such transfers. For example, 21,000 acre-feet of middle Rio Grande water was legally transferred between 1982 and 2011, mostly from agriculture to municipalities. High profile water rights transfers include the Berrendo project and the Augustin Plains Ranch project, both of which transferred water to the middle Rio Grande.

[40] (NM Office of the State Engineer-ARWM)
[41] (Oat & Laura, 2013)

Someone who wants to transfer a water right must prove that it is valid, and that the transfer will not impair existing water rights, conservation of water, or public welfare. The process requires hydrologic evaluations.

Advocates of water markets argue that this type of system has not matured in New Mexico. They report legal and political barriers. Water marketing is a complex business, especially in a state where so many water rights are not adjudicated. *(See p. 12.)* Additionally, many of New Mexico's most senior water rights are held by tribes and pueblos. (In 2012, Jicarilla Apache Nation leased some of its San Juan-Chama water rights in a water auction.)

People in agricultural communities have mixed feelings about water rights transfers. Some farmers can become wealthy by selling their water rights. Water rights sold for Albuquerque use are currently estimated at about $20,000 per annually recurring acre-foot, with a higher price in Santa Fe.[42]

However, environmental advocates and those who promote local food systems argue that water transfers should be carefully regulated to consider sustainability of ecosystems and agricultural communities. The concern about permanent water transfers is particularly well known within acequia communities, which have the statutory authority to regulate water transfers out of their respective ditches. Once agricultural land and water leaves production, it will not come back. Some people worry that our society is slowly exporting our ability to feed our state and our country.[43]

Some people instead support water leasing, which lets other parties use the water right temporarily. Many farms already lease their annual water allotments if they are not going to be used that year.

TRANSFERS ACROSS WATER BASINS

Some people also worry about the long-term environmental or cultural implications of transferring water rights from one basin to another. A bill was introduced in the 2014 legislative session to require additional permitting and authorization of inter-basin transfers larger than 1,000 acre-feet. It did not pass but brought attention to the policy question. Opponents of such regulation argue that inter-basin transfers have been taking place in New Mexico for decades. The San Juan-Chama diversion project that provides much of Albuquerque's drinking water is one example.

Water Compacts

Water travels along watersheds, without regard to state lines or international borders. Without clear guidelines, the water might not be shared fairly. Interstate compacts are legal agreements between states on how to share natural resources within specific river systems. Fundamentally, most of them prevent upstream states from using too much water before it flows to downstream states. For example, Colorado cannot use more than its share of water in the Rio Grande before it flows to New Mexico, just as New Mexico cannot empty the river before it flows to Texas and Mexico.

There are eight interstate stream compacts affecting New Mexico. Rules governing them vary considerably, and they influence how much water we use, where we store it and when we can move it. They cannot be changed without consent of the affected state legislatures and U.S. Congress. The table beginning on p. 40 summarizes each compact.

While all eight of the interstate agreements are important, the Upper Colorado and Rio Grande River Compacts stand out because they guide the use of two important water sources. Under the parameters of these compacts, the Colorado and Rio Grande river systems provide an average of about 700,000 acre-feet of water to New Mexico users. Thus, these two compacts draw significant attention. It is through the Upper Colorado River Compact that New Mexico taps the San Juan-Chama diversion project. This project enables water to move over 170 miles, from the Colorado River basin to the Rio Grande Basin. The diversion provides water to Albuquerque and 13 tribal governments, irrigation districts, cities, and towns.

RIO GRANDE COMPACT

As noted above, the Rio Grande Compact attracts significant attention. **(Please first read the compact's description in the Appendix A table, p. 42.)** Under the agreement, New Mexico must deliver a certain amount of water each year to Elephant Butte for delivery to southern New Mexico farmers, Texas and Mexico. In some years, New Mexico has significantly over-delivered (100,000 acre-feet in 2006 and

[42] (Thomson B. , 2013)
[43] (Balok, 2014), (Garcia, 2014)

50,000 in 2013 from the late season rains). Some water managers believe New Mexico needs to capture and store more storm-water, rather than letting it flow down the river. They point out that Colorado rarely over-delivers to New Mexico, but that New Mexico often over-delivers to its downstream neighbors.

John Stomp of the Albuquerque Water Utility Authority calculated that if 30,000 acre-feet of storm-water could have been stored from the 2013 monsoons, that storage could have provided 5,000 acre-feet per year for six years to keep the river flowing well in dry years.[44] Such water could be stored in shallow aquifers. (*See information on Aquifer Storage and Recovery (ASR) strategies, p. 27.)*

Another idea often raised in discussions of the Rio Grande Compact is storing more water in northern New Mexico reservoirs, rather than in Elephant Butte. Evaporation loss is higher in southern New Mexico, because it is hotter.

However, there are definite barriers to implementing these ideas. The Rio Grande Compact contains rules restricting upstream storage if Elephant Butte levels are low. When these rules (called Article VII) are in effect, the state has few options besides letting the water flow to southern New Mexico. *(See Rio Grande Compact notes on p. 42 for details.)* It might be possible to store more water upstream when Article VII is *not* in effect, but such activities would potentially be an OSE water right permitting issue, not a compact management decision.[45]

It is unclear to our research committee members whether the Article VII rules would apply to upstream aquifer storage. This might be a policy option for consideration.

A different idea for maximizing compact water is "water banking," which would allow water rights owners to lease water across state lines to help fulfill compact obligations. Such a solution would require compact managers to agree on a system of credit and debits for managing the leases.[46]

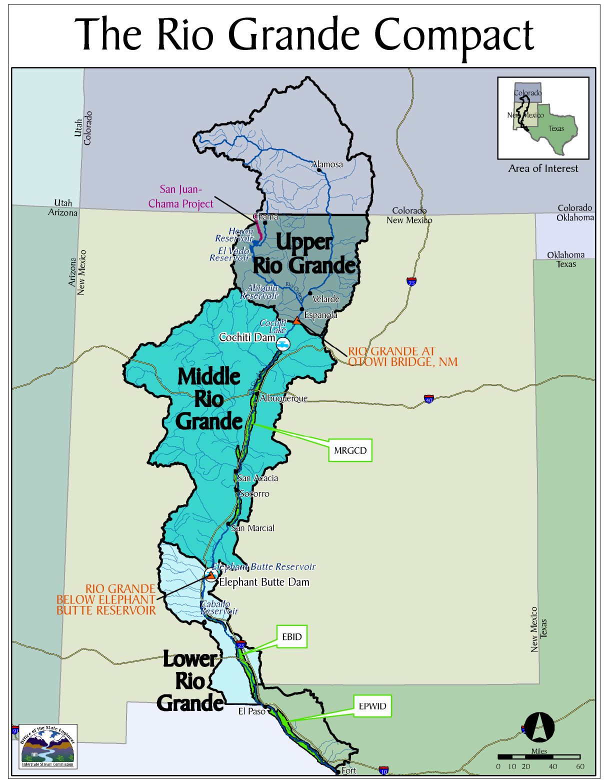

Figure 16: Rio Grande Compact Map

Policy Considerations on Legal Matters

What would enable more of the pending water rights adjudications to be settled? Which is more important, speed and efficiency or due process protections for individuals? To what extent are shortage-sharing agreements a potential alternative to water rights disputes or priority calls? What are the barriers to pursuing these types of agreements?

What would it take to have a water transfer system in New Mexico that is fair, efficient and addresses economic, environmental, and social values? As a water market evolves in New Mexico, how can its framework adapt to future growth or different state needs? How might the system be structured to meet both environmental and economic needs? To what degree would such a market support or undermine the viability of agriculture?

What options exist for New Mexico to import water that is located external to our borders? What are potential drawbacks to such options?

[44] (Stomp, 2014)
[45] (Schmidt-Petersen, 2014)
[46] (Stomp, 2014)

WATERSHEDS AND WATER SUPPLY

THIS SECTION ADDRESSES:

- Watershed challenges and definitions
- Wildfires
- Healthy rivers and environmental flows

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Water Supply and Mountain Fires

Mountain snowpack and high-elevation rains provide essential water supplies for the entire state. These supplies are declining for many reasons, including the drought issues described on p. 8. A related factor is the trend toward larger and more intense wildfires. The burn scars can create an immediate impact on water supplies, bringing ash, debris and sediment in the rivers that feed municipal and agricultural water. Summer wildfires also affect winter snowpack, for reasons explained later in this section.

To be clear, wildfires are not always a bad thing, since they can often enable watersheds to regenerate. However, the frequency, intensity and severity of many recent wildfires are very different from the natural patterns for our mountain forests. For example, New Mexico's ponderosa pine forests thrive best within a regime of frequent but low-intensity fires. The combination of human fire suppression or fire exclusion, accumulated levels of fuel in the forest, and higher summer temperatures are creating infrequent, high-intensity fires in ponderosa pine ecosystems. (Note: one size does not fit all forests with fire policies. The ideal regime for New Mexico's high-elevation spruce forests is different than the ponderosa pines.)[47] Effective mountain watershed management requires policies informed by the best available science and observation.

WATERSHEDS AND BASINS DEFINED

Throughout this report, we describe New Mexico in terms of its "basins." **River basins, groundwater basins and watersheds are all areas of land that drain to a particular water body, such as a lake, stream, river or aquifer.**[48] Sometimes the terms are used interchangeably, but watersheds generally describe a smaller area of land that drains to a smaller stream system. There are many smaller watersheds within a basin. For example, the Chama River valley and the Rio Puerco valley are watersheds within the Rio Grande basin.

FIRE IMPACTS ON WATER QUALITY[49]

When large fires burn out of control, they affect water quality for downstream users. For example, streams flowed with dark grey water for months after the 2011 Los Conchas Fire. Weeks after the fire was out, summer rains sent more soil, ash, and charcoal into the rivers and streams. This type of contaminated water affects fish, plants and wildlife – and definitely humans. Debris and ash in the rivers and streams from the Los Conchas fire prompted Santa Fe to shut down a large diversion facility. In response to the same fire, Albuquerque curtailed its use of Rio Grande water to reduce the level of ash entering its treatment facility. The city had to shift to groundwater pumping for part of the summer and early fall.

NUMBER OF NEW MEXICO WILDFIRES[50]

Year	# NM Wildfires	#of Acres Burned
2013	1,064	221,9541
2012	1,028	372,497
2011	1,873	1,089,769
2010	998	233,056
2009	1,278	421,481
5-Year Total	**5,177**	**4,336,344**

[47] (National Wildfire Coordinating Group, 2003)

[48] (USGS)
[49] (NM EPSCoR and New Mexico First, 2012)
[50] (National Interagency Fire Center)

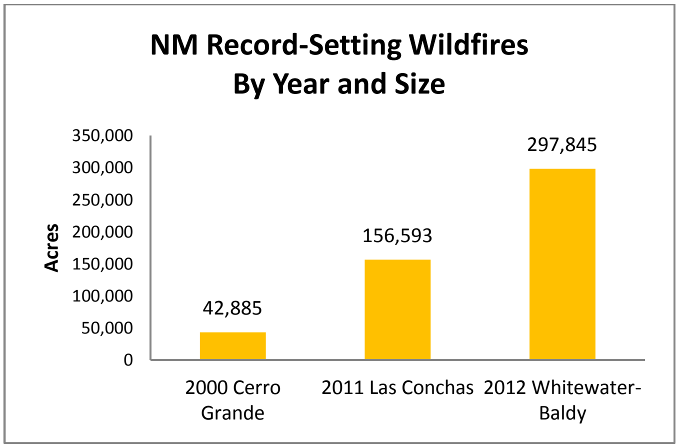

Figure 17: Record-Setting Wildfires in New Mexico[51]

MOUNTAIN SNOWPACK

The damage described above comes, in part, from dense forests with more trees than the landscape would naturally support. In winter months, those dense forests create a different challenge. The canopy of branches capture the snow as it falls, preventing it from eventually melting into the ground. Research at New Mexico's Valles Caldera National Preserve found that as much as 50 percent of snow that falls in such dense forests sublimates.[52] Sublimation is much like evaporation; the moisture in the snow turns to water vapor in the air.

If the snow turns to vapor, it does not create snowpack for spring runoffs. And, as noted previously in this report, snowpack is essential to statewide water supply for people and farms. Mountain snowpack is the natural reservoir that supplies an estimated 75 percent of freshwater in the western U.S.[53]

As a result, forest managers who want to maximize the water produced by a mountain watershed may consider tree-thinning or controlled burns as a strategy. However, over-thinning or large-scale burns can also be counter-productive. Without any trees to provide shade, the snow lacks protection from the sun and it evaporates or melts too early. We rely on a solid snowpack that melts slowly in the spring – when the water is needed by nature and humans. Charred forests not only lack trees to provide shade for the snow, but their bits of ash make the snow dirty, less reflective, and quicker to melt – thus slowing or preventing accumulation of snowpack.[54]

Taken together, these two sets of research seem to indicate that forest managers want to strike the balance of thinning some trees, but not too many. One source recommends tree canopy densities between 25 and 45 percent.[55] Forest and watershed managers must also make informed decisions about the type of trees to cut. There are 9.4 million acres of national forest lands in New Mexico, plus privately owned forested lands.[56] Some researchers believe we need to increase thinning efforts ten-fold.[57]

A previous New Mexico town hall developed an entire slate of recommendations on this topic. Among other suggestions, it called for the creation of comprehensive water source protection plans in the state's mountain forests – focusing on both surface and ground water. The event also called for extensive public education on wildfires, including potential benefits of controlled burns as well as the impact of forest management on public water supplies and the economy.[58]

That said, some organizations oppose tree-thinning. For example, the Center for Biological Diversity argues that some thinning can produce loss of habitat for creatures, remove old-growth trees, or lead to soil erosion.

Endangered Species Act

The Endangered Species Act (ESA) is a major guiding law that plays a huge role in watershed management and water supply planning. Administered by the U.S. Fish and Wildlife Service, the ESA seeks to protect and recover imperiled species and the ecosystems upon which they depend. There are 31 animals and 13 plants on the endangered species list for New Mexico.

[51] (Balice, Bennett, & Wright, 2004) (U.S. Forest Service, 2013) (U.S. Forest Service, 2013)
[52] (Parmenter, 2009)
[53] (U.S. Geological Survey-Snow)
[54] (Gleason, Nolin, & Roth, 2013)
[55] (Parmenter, 2009)
[56] (Western States Data. 2007)
[57] (Racher 2013)
[58] (NM EPSCoR and New Mexico First, 2012)

Environmental Flows

The beginning of this section addressed how forest density and wildfires can impact the water and wildlife in rivers and streams. Human development also impacts river flow and, in some cases, leaves some watersheds with little or no water flowing in rivers and streams. The term "environmental flows" is a concept that aims to calibrate the timing, amount and quality of water flowing in a river or stream system to sustain the plant, animal, and human life that relies on that system. It is implemented in various ways in different states. The concept does not call for turning back the clock on human uses of water, but it urges water managers to find a balance that meets the minimum needs of a flowing stream system.[59]

LEGAL HISTORY

Historically, the idea of "beneficial use" of water was largely limited to what was good for people. Water was diverted from natural sources for human benefit. When advocates became concerned about rivers drying up, some organizations wanted the State Engineer to provide legal protection for in-stream flows (i.e., leaving water in rivers for environmental purposes). This practice was not supported by state policy until a 1998 opinion by then Attorney General Tom Udall. The opinion indicated that New Mexico law does allow the State Engineer to afford protection to in-stream flows for recreational, fish, wildlife, or ecological purposes. Essentially, the opinion supported the notion that in-stream flows can be a "beneficial use" of water.[60]

In 2005, a law passed creating New Mexico's Strategic Water Reserve. Modeled on the federal Strategic Petroleum Reserve, this fund supports publicly held water rights for keeping the state's rivers flowing to meet the needs of endangered species and fulfillment of interstate compact obligations to other states.[61] *(See p. 15 and 40 for information on interstate compacts.)*

[59] (UNM Law School-Env, 2010)
[60] (Opinion of Attorney General Tom Udall, 1998)
[61] (Think New Mexico)

EXAMPLES OF ENVIRONMENTAL FLOW ACTIVITIES

In 2007, Texas passed a comprehensive environmental flow law and standards for each river basin.[62] Similarly, Colorado created environmental flow policies, in part because of perceived economic development and tourism benefits.[63]

In New Mexico, there is not one over-arching law, but a number of efforts are underway. Examples include:

- Santa Fe set aside 1,000 acre-feet of water in wet and average years for Santa Fe River flows. This amount equals about one tenth of the city's current water demand. The city also set up a Santa Fe River Fund to which residents can donate through their water bill.
- In 2013, Governor Susana Martinez announced support for the New Mexico River Stewardship Initiative, calling for improvement in the quality of the state's waterways. The project was awarded $2.3 million in the 2014 legislative session.
- Minimum flow levels are maintained in parts of the Rio Grande, San Juan and Pecos rivers to support spawning and habitat of the endangered silvery minnow. The biological opinion that guides policies related to silvery minnow habitat is currently under review.
- For years, New Mexico has attempted to reduce the numbers of salt cedar and other non-native, deep - rooted plants along river banks, in order to reduce the amount of water they consume. This strategy is another approach to improving in-stream flows.

It appears to the research committee that the overall goals of environmental flow policies are widely supported. However, some water advocates point to the need to look at the issue broadly – not place undue focus on a specific species, individual habitat, or specific human need. They point out that there are many types of life – human and environment – that rely on water in our rivers.[64]

For example, an estimated $150 million has been spent in New Mexico on legal and other costs associated with saving the silvery minnow.[65] Some environmental advocates argue that such dollars would be better spent protecting the

[62] (UNM Law School-Env, 2010)
[63] (Oglesby, Utton Center, 2014)
[64] (Chavez, 2014), (Coalition of Six Middle Rio Grande Pueblos, 2013), (Oglesby, Utton Center, 2014)
[65] (Bryan, 2013)

ecosystem as a whole, rather than zeroing in one this specific fish; others say that federal, state and private investments are absolutely warranted for this unique species.[66]

Policy Considerations on Watersheds

Is New Mexico currently doing enough to advance healthy watersheds? To what extent are state, federal, tribal and local entities integrating their watershed management practices?

What, if any, additional policies should be considered regarding environmental flows? What are the pros and cons of focusing on protection of specific species versus overall ecosystems? To what extent can we preserve native ecosystems in the face of potential long-term drought and the increasing presence of invasive species?

What about wildfire policies? What options exist for the establishment of storage facilities that help manage flood runoff, especially in burned areas? Should we thin our forests? If so, how could a small-budget state like New Mexico begin to thin over nine million acres of forested land? Should our state allow more logging or other commercial activities, and if so, under what parameters?

[66] (Oglesby, Utton Center, 2014)

HUMAN USES OF WATER

THIS SECTION ADDRESSES:
- Breakdown of uses of water by category
- Agricultural uses of water and conservation options
- Public/municipal water supply and conservation
- Mining and energy

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How Do We Use Our Water?

The New Mexico Office of the State Engineer (OSE) tabulates water withdrawals in nine categories:

1. Irrigated agriculture
2. Public water supply
3. Reservoir evaporation
4. Self-supplied commercial
5. Self-supplied domestic (domestic wells)
6. Self-supplied industrial
7. Self-supplied livestock
8. Self-supplied mining
9. Self-supplied power

What does "self-supplied" mean? Water users are self-supplied if they have their own water source, and thus do not buy it from a local utility. For example, if a company has its own wells, its water use falls under "self-supplied commercial." But, if it purchases its water from its local water utility, it falls under "public water supply."

As the following chart illustrates, agriculture taps the largest share of New Mexico's water by far. Public water supply, which includes residential and business use within municipal water systems, totals eight percent. The third highest use of water is evaporation from reservoirs, at seven percent. This type of evaporation – unlike that which might occur naturally in rivers – is counted as a "withdrawal" since human engineering systems put the water in the reservoirs. All other uses, including power generation, mining, oil and gas, commercial businesses, and domestic wells combine to five percent of the state's total water use.

As noted previously, all references to water use refer to it being withdrawn from a surface or groundwater source. Much of the water returns to that source and is thus not truly consumed.

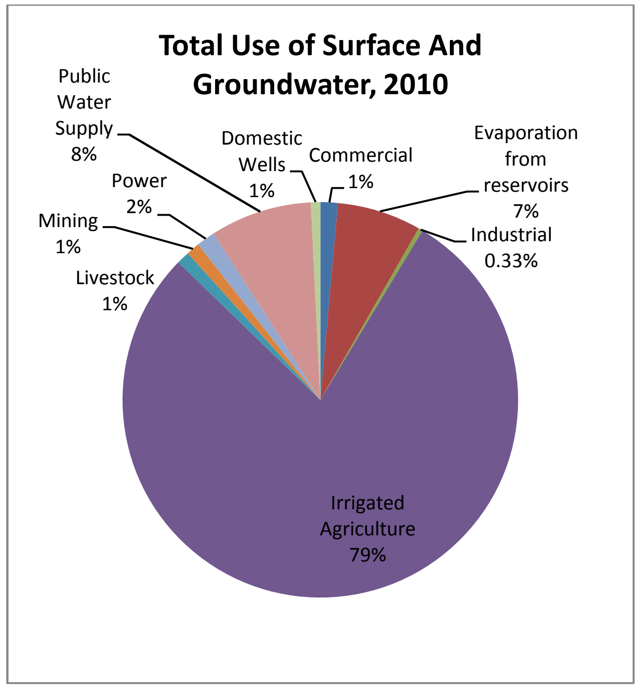


Figure 18: Total Use of Surface and Groundwater by Category, 2010 [67]

ECONOMY AND WATER

Almost all the human uses of water in Figure 18 relate, in one way or another, to the state's economy. Many people instinctively assume that a growing economy leads to increased water use. That is certainly correct in some cases. However, that idea has not born true in New Mexico. Our state's economy grew 85 percent in the last 19 years. During that same period, total water use declined by 14 percent. The remainder of this chapter looks at water policy issues associated with different economic industries.

[67] (NM Office of State Engineer-Categories, 2010)

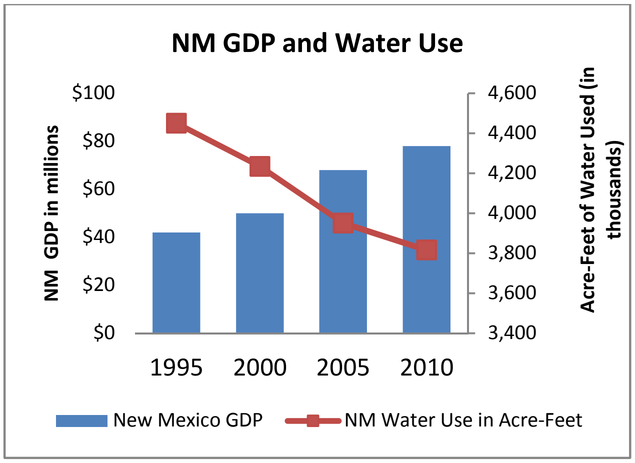


Figure 19: NM's State Total Gross Domestic Product and Water Use, 1995-2010, (OSE)

Agriculture

As noted, the agricultural industry accounts for an estimated 80 percent of New Mexico's total water withdrawals.[68] Much of that water returns to rivers or other water sources and is re-used downstream. As a portion of the state total, agriculture's percentage increased slightly in recent decades (from 75 percent in 1995). However, the actual volume of water used by the industry steadily declined, from 3.4 million acre-feet in 1995 to 3 million acre-feet in 2010.[69] That decline may be due to changes in irrigation technology, farming practices, amount of acreage in production, or other factors.

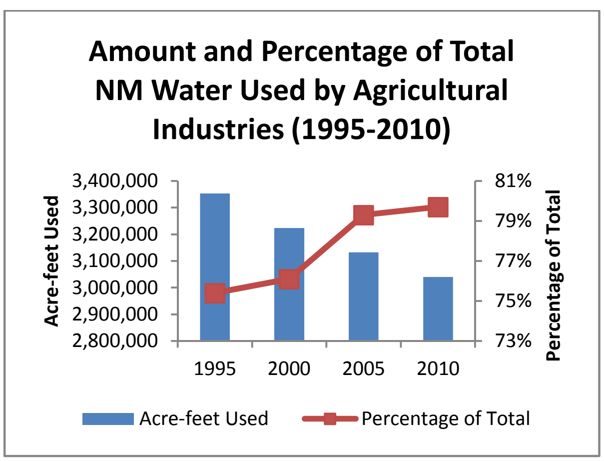
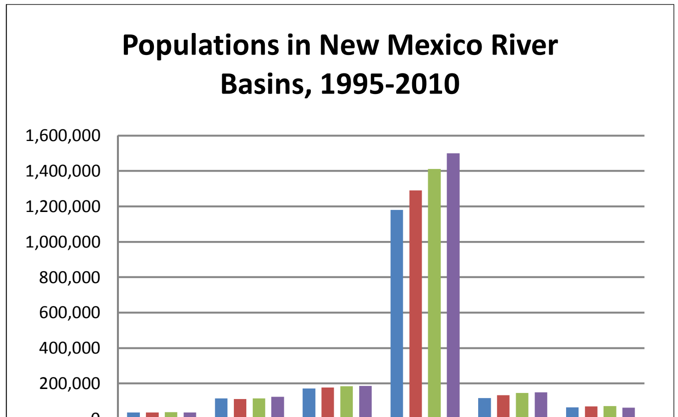


Figure 20: Amount and Percentage of Total NM Water Used by Agricultural Industries (1995-2010), (OSE)

[68] (NM Office of State Engineer-Categories, 2010, p. 35)
[69] (NM Office of State Engineer-Categories,1995, 2000, 2005, 2010) As noted previously, this report is published every five years, beginning in 1995. Data through 2015 will likely be released in 2017.

FUTURE AND ECONOMIC IMPACT OF AGRICULTURE IN NEW MEXICO

An analysis of the state's 16 regional plans found that the most common solution to predicted water shortfalls was moving water from agriculture to other uses.[70] Figure 21 shows that the population of New Mexico (and, presumably, future demand for water) is growing the fastest in the central Rio Grande Basin where Albuquerque, Santa Fe, Rio Rancho and Las Cruces are located. Half of the state's 33 counties experienced population decline in the last five years, almost all of them rural. In addition, some farmers are choosing to sell their water rights to meet public water supply needs. *(See p. 14.)* These realities prompt some water advocates to quietly predict a long-term decline in the agricultural industry.



	Arkansas -White-Red	Texas Gulf	Pecos River	Rio Grande	Upper Colorado	Lower Colorado
1995	35,727	116,001	171,973	1,180,696	117,922	64,158
2000	36,357	111,601	177,173	1,290,353	133,287	70,270
2005	37,726	114,674	184,374	1,412,323	146,597	72,659
2010	35,812	125,121	185,300	1,500,696	149,431	62,819

Figure 21: Populations in New Mexico River Basins, 1995-2010, (OSE)
(See p. 1 for basin map.)

At the same time, the agricultural industry in our state is indisputably growing. Unlike much of the rest of the nation, the number of New Mexico farms, young farmers, and minority farmers *increased* in recent years. The number of young farmers and ranchers (under age 34) rose 47 percent in the last five years. The number of Hispanic-operated farms jumped 45 percent to almost 9,400. With over 24,000 farms, New Mexico has about 43 million acres in

[70] (Albuquerque Journal, 2013)

farmland.[71] Total agricultural net income increased more than a third in the last five years. [72]

Consequently, according to one study, agriculture in New Mexico translates into about $10.6 billion a year, over 50,000 jobs, and nine percent of the state's economy. That percentage includes the direct effect of the sale and processing of agricultural products. It also includes the indirect effects of farmers and ranchers buying goods and services from local industries, and the induced effect of those people and businesses re-spending the income they received from the farmers and ranchers. Dairy products made up over 35 percent of agricultural cash receipts in 2012 (more than all food crops combined).[73]

BUY LOCAL

Researchers point out that the agricultural industry could play a larger role in the state economy, create more jobs, and increase the in-state benefits of its water use if consumers would purchase more food from local growers. Many environmental advocates also champion the cause, pointing to energy savings when fewer foods are trucked or flown across the globe. Our state currently imports more than $4 billion in food products each year. One study calculated that if New Mexicans bought 15 percent of their food directly from local farmers and ranchers, incomes would increase by over $370 million. For every dollar that goes to New Mexico farmers and ranchers, an estimated 95 cents is re-spent in the local community.[74]

AFFECT OF DROUGHT ON FARMERS

While it may be growing, the agricultural industry definitely has its ups and downs. It is highly vulnerable to drought. The 2013 drought led to loss of crop production, fallowed farmland, decreased crop yield and increased groundwater pumping. Farmers reliant on surface water for their irrigation were particularly affected by the dry weather. The 2013 irrigation season in the lower Rio Grande Basin was the shortest on record.[75]

Livestock producers in New Mexico faired no better last year. Ranchers faced higher feed costs because rangelands could not support the animals. They hauled water, saw worsening range conditions, reduced soil moisture and decreased herd sizes.[76] Hundreds of cattle were sold at auction. In response to these drought conditions, the entire New Mexico congressional delegation, including both U.S. Senators and the three U.S. Representatives, jointly announced that 27 counties qualified for emergency loan assistance.

WATER CONSERVATION IN AGRICULTURE

Because their livelihoods rely on water, many farmers and ranchers strongly support water conservation efforts. Changes in technology enable them to use less water than in previous decades. For example, high plains farmers rely on groundwater pumping. Many who previously used overhead sprinklers now deploy systems that are positioned a few feet or less above the crop, significantly reducing evaporative losses.

Farmers who rely on surface irrigation turn to different solutions, such as lining ditches with concrete, covering canals, and converting to alternative irrigation methods instead of flooding fields. Not all these changes are universally favored, however. When acequias are lined in concrete, less water seeps into the ground to support nearby vegetation or aquifer recharge. If the goal of the ditches is to deliver water to farms, concrete linings are good public policy. But if the goal is also to support the surrounding cottonwood trees and vegetation near the ditch-banks, concrete lining poses a problem. Research conducted in northern New Mexico found that 16 percent of the acequia flow seeped out of the ditchbed and supported vegetation habitat along the ditch as well as groundwater recharge.[77]

The answer partly depends on region and culture. Irrigators on acequias and community ditches, which are smaller in acreage, are less likely to consider seepage "lost water" since it hydrates the entire floodplain. By contrast, many irrigators in arid southern New Mexico are more likely favor systems that maximize water delivery to crops.

[71] The amount of irrigated acreage is 872,664 acres. (NM OSE, 2010)
[72] (NM Department of Agriculture)
[73] (Crawford, Diemer, & Patrick, 2014) (These figures are based on direct, indirect, and induced agricultural income. The U.S. Department of Commerce calculates the agricultural sector of the NM economy at just under $1.5 million, but it only counts cash receipts.)
[74] (Crawford, Diemer, & Patrick, 2014)
[75] (NM Interstate Stream Commission-Review, 2013)
[76] (NM Interstate Stream Commission-Review, 2013)
[77] (Fernald, Baker, & Guldan, 2006)

Switching to drip systems, microjet spray, or border flood systems are highly effective conservation strategies for surface and groundwater irrigators.[78] However, farmers may be reluctant to make the costly transition to alternative irrigation systems if they have enough water rights to flood their fields. Some say these expensive conversions ask farmers to shoulder the expense of New Mexico's water delivery obligations to Texas.

Additionally, some researchers and farmers do not favor drip irrigation systems because of concerns about increased salinity in the soils. They favor flood irrigation because it flushes more of the salts from the soil and enables more water to seep into shallow aquifers.

CONCERNS

In addition to concerns about the volume of water used in agriculture, the dairy industry in particular has been connected with groundwater contamination in the past. The industry is regulated in an effort to prevent future issues.

POLICY CONSIDERATIONS FOR AGRICULTURE

What are the best ways to encourage water conservation among the different types of agriculture throughout New Mexico? Does it make sense to set concrete conservation targets, and rally the industry around them? How can the industry plan for a future that may have considerably less water than in previous decades? What can be done for or with the agricultural community to advance water rights settlements? To what extent do shortage-sharing agreements *(see p. 11)* make sense for agricultural communities? What are the challenges? To what extent should farmers be encouraged or discouraged from selling off water rights from agricultural use? *(See p. 14.)*

UTE PIPELINE PROJECT[79]

Decades of groundwater pumping of the Ogallala Aquifer in eastern New Mexico and west Texas have led to significant water supply problems for the largely agricultural communities of Roosevelt and Curry counties. Annual withdrawals in the area are estimated at 249,000 acre-feet, while groundwater recharge is about 40,000 acre-feet. At that rate, the Ogallala should be a reliable water source in the area for only about ten more years.

Roughly 70,000 people live in the region, including residents of Clovis, Portales, Cannon Air Force Base and several smaller farming communities. Agriculture is a major economic engine in the region, which includes several dairies, a cheese plant, peanut farming and processing, and ranching.

Part of the solution is the planned the Ute Pipeline Project, a 151-mile system to deliver 24,000 acre-feet of water a year from Ute Reservoir near the town of Logan. Water delivery from the reservoir has been planned for the Portales/Clovis area since the lake was built in 1962. The reservoir is included in the Canadian River Interstate Compact described on p. 40.

Published cost estimates for the pipeline range from $436 to $550 million. The federal government is expected to pay 75 percent, state government 15 percent, and the local water users the remaining 10 percent.

Construction is underway on an intake station at Ute Lake. Local residents oppose the project, concerned about property values and dropping reservoir levels. Legal injunctions against the pipeline were filed by the Village of Logan, but construction is moving forward.

The pipeline should take about 20 years to complete. In the interim, community leaders plan to buy water rights from area landowners to meet municipal supply needs. *(See p. 4 for additional information on New Mexico's system of reservoirs.)*

[78] (Fernald S. , 2013)

[79] (Quay County Sun, 2013)

Public/Municipal Water Supply

In New Mexico, a combination of municipal water utilities, rural water systems, and mutual domestic water associations provide water to most residences and businesses. These entities provide water for the population centers around the state and are an essential element of the economy now and into the future. The customer base includes single-family homes, industry, commercial businesses, schools and universities, parks and athletic fields and many other types of uses. Together they make up "public water supply." Their use has declined somewhat between 1995 and 2010, while the percentage of total has remained about the same. The state's largest municipal water supplier, Albuquerque Bernalillo Water Utility Authority, reported record-breaking conservation rates in 2013, so it is likely that the downward trend in public water use may continue beyond the dates available in the following chart.

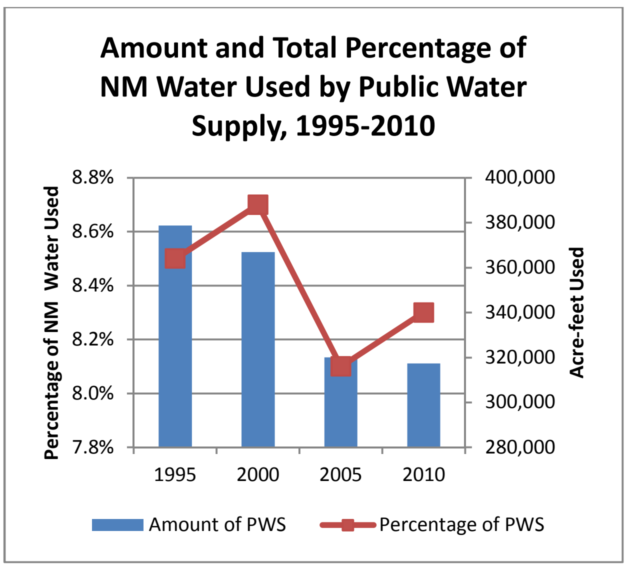


Figure 22: Amount and Total Percentage of NM Water Used by Public Water Supply, 1995-2010, (OSE)

INFRASTRUCTURE

One way to optimize existing water supplies is to repair and maintain leaky infrastructure. Every day in the United States over six billion gallons of pumped water fails to reach a billed customer. Much of this water is lost due to leakage from over 250,000 water main ruptures that occur every year.[80]

[80] (AWWA, 2009)

New Mexico has 650 public water systems, large and small, many of them with aging pipes, inadequate capacity, or limited ability to comply with federal clean water policies.[81] For example, water systems in three New Mexico towns were audited in 2009: Las Vegas, Rio Rancho, and Ruidoso. The audit used criteria developed by the American Water Works Association. "Real water losses" were defined as:

- Leakage on service meters/lines and leaks in homes
- Leakage and overflows at storage tank sites
- Leakage on transmission and distribution mains

The following table illustrates results of the audits.[82]

WATER LOSS AUDITS-2009

City	Volume of Water Supplied	Volume of Real Losses From Leaks	Losses as Percentage of Total
Ruidoso	586 million gallons	102 million gallons	17%
Las Vegas	792 million gallons	210 million gallons	27%
Rio Rancho	4,352 million gallons	596 million gallons	14%

The challenges in the table above are not isolated. The Gila Conservation District applied for funds to repair aging municipal infrastructure and install leak detections systems in southwestern New Mexico.[83] The highly publicized 2013 water shortages in Magdalena and Vaughn were not caused by drought but by a neglect of wells (in Magdalena) and a rusting transmission line (in Vaughn). These rural water systems face unique challenges. Commented one reviewer on the American Society of Civil Engineers (ASCE) recent infrastructure report card, "We heard story after story of water systems that are held together with duct tape and bailing wire."[84]

When capital funds are made available for new systems, some communities lack the resources or knowledge to maintain them, so the new systems do not last as long as

[81] (NM Interstate Stream Commission-Review, 2013)
[82] (NM Office of the State Engineer, 2010)
[83] (NM Office of the State Engineer)
[84] (Thomson B. , 2012)

they should. Small municipalities may be able to improve their infrastructure with a one-time government grant or loan, but they often lack the dollars to perform regular repairs and upkeep. *(See p. 37 on capital outlay and government investments.)* One solution could be to create a small water system maintenance group within the New Mexico Environment Department or through the Rural Water Users Association, with dedicated staff who travel and provide maintenance services.[85]

ASCE NEW MEXICO INFRASTRUCTURE REPORT CARD-2012

Category	Grade	Details
Drinking Water	C-	Many of New Mexico's potable water systems are deteriorating due to the age of the systems.
Flood Control	D+	The condition of flood control infrastructure in New Mexico varies widely. On balance, 77% of jurisdictional flood control dams are considered deficient or not in satisfactory condition.
Wastewater	C	Treating wastewater was not, until recent years, a priority in most New Mexico municipalities.

REUSING WATER

Another important water resource strategy is to reuse and recycle water. Reuse was previously considered the option of last resort, but public opinion and policies are changing. Reuse can extend water supplies, but it requires additional infrastructure and more sophisticated systems. Throughout the nation, cities and regions apply treated wastewater to a number of uses. Reuse does not reduce the amount of water used by a community, but instead matches the quality of the water with the need. For example, public parks do not need potable water and therefore non-potable wastewater can be substituted. There are at least three major approaches:

1) **Indirect reuse** of treated wastewater is common and somewhat invisible. Water is used in a community, treated in a wastewater treatment plant and then discharged to the environment. Once in the environment, it can be used again, either by the same community or one downstream. For example, Albuquerque's cleaned wastewater goes into the Rio Grande, where it reflows into acequias or to southern New Mexico farmers, or even to Texas to meet our compact obligations. Use by a downstream community is known as unplanned, or *de facto*, reuse.
2) **"Purple pipe" direct water reuse** (also called "non-potable reuse") is fairly common throughout the Southwest. Non-potable reclaimed water is distributed in purple pipes to clearly signify that it has not been treated to drinking water standards. The Albuquerque Bernalillo Water Utility Authority has two large reuse projects that deploy treated municipal and industrial wastewater to irrigate golf courses, playgrounds, ball fields and road medians. A number of smaller communities in New Mexico follow the same practice. Some rural communities, such as Tularosa, provide treated wastewater to farmers for irrigation.
3) **Potable direct water reuse** is far less common. Sometimes cynically referred to as "toilet to tap," this type of system introduces highly purified reused water into the drinking water system. Unlike indirect reuse described above, this treated water does not pass through an environmental barrier (such as a river or ground seepage) before it returns to the drinking water supply. Big Springs, Texas is one of the first cities to use such a system. A similar facility has been designed for Cloudcroft, NM; it should become operational by the end of the year. The practice requires expensive and energy-intensive advanced treatment technologies. It also requires considerable public education so that people are not troubled about drinking the water.

Wastewater can also be used for industrial purposes, such as power generation. For example, the majority of water used at the Palo Verde Nuclear Generating Facility near Phoenix is wastewater. This facility is a source for electricity in New Mexico, through the Albuquerque-based utility PNM.

[85] (Stomp, 2014)

MUTUAL DOMESTIC WATER CONSUMER ASSOCIATIONS

There are approximately 250 Mutual Domestic Water Consumers Associations throughout rural communities in New Mexico. Commonly called "mutual domestics," these local entities are run by an elected board of three or more members. They construct and operate water supply, reuse, storm drainage and wastewater facilities in their communities.

Since 2005, a significant number of mutual domestics located in rural communities collaborated and formed distinct regional entities. They hold a number of shared goals, including:

- Developing a team of professionals to promote and maintain sound water and wastewater management practices
- Complying with water reporting requirements
- Protecting regional assets and water rights
- Maintaining infrastructure
- Providing affordable rates to customers
- Informing the public on water issues

These regional collaborations enable small utilities to operate more efficiently, combine resources and share staff.

FUTURE PUBLIC WATER SUPPLY

Conservation, re-use, and infrastructure repairs are all important strategies to maximize public water supplies. In addition, many municipal and other water suppliers also focus on future sources of additional water. Some people say that communities must have the ability to move water from one part of the state to another in order to meet the growing needs. Examples include the San Juan-Chama diversion project or the planned Ute pipeline. However, these types of inter-basin water transfers concern some avocates. (*See p. 15 for information on inter-basin transfers and p. 24 for Ute pipeline details.)*

Another option for future supplies is Aquifer Storage and Recovery (ASR) projects. This approach enables municipalities to store excess water in underground aquifers for later use. The storage is engineered through detention ponds or recharge wells that deliberately add water to shallow aquifers.[86] Water stored in aquifers instead of reservoirs does not evaporate. However, it has the drawback of being more difficult to measure and manage.

Aquifer storage and recovery strategies are not deployed much in New Mexico, but Arizona, Nevada and California use ASR extensively. Albuquerque has conducted some small-scale infiltrations projects.[87]

POLICY CONSIDERATIONS FOR PUBLIC WATER SUPPLY

To what degree can or should communities explore different re-use options? What are the barriers? To what degree would public perception drive policy? What about conservation targets; do specific goals motivate people to reduce water use?

To what extent should New Mexico explore the viability of aquifer storage and recovery? How can other infrastructure needs be met? And once new infrastructure is installed, how do we make sure communities can maintain it so the capital investment does not have to repeated? What role should consumer water rates play in financing infrastructure needs?

To what degree do the mutual domestics have the funding and professional support they need to be effective? Can or should more mutual domestics be encouraged to form regional entities?

Mining and Energy

Mining, including oil and gas, used an estimated 41,559 acre-feet of water withdrawals (or one percent of total water use) in 2010. Most of that water was used in metal and potash mines. Within the mining category, the oil and gas industry used about 2,244 acre-feet.[88]

That figure – like all the water use numbers in this report – reflects the amount of freshwater used. Oil and gas drilling utilizes considerably more brackish (or non-potable) water in its drilling process. This water comes up with the production process and, unless reused by the industry, is re-injected 9,000 to 12,000 feet below the surface. This non-potable "produced water" is the focus of interest as a

[86] (American Groundwater Trust)
[87] (Stomp, 2014)
[88] (NM Office of State Engineer-Categories, 2010)

potential new water source. There are pros and cons to the practice. (*See p. 29 for more information.)*

Historically, the biggest water concerns about the extractive industries are not the amount of water used but rather the potential for groundwater contamination. Consequently, these industries are highly regulated and monitored by state agencies.

Domestic Wells

New Mexico households that are not served by a water utility have domestic wells. The OSE estimates that these wells withdrew a combined total of 28,952 acre-feet in 2010, or less than one percent of total water use in New Mexico. (This estimate is difficult to substantiate since most of the domestic wells have no meters.)

There are roughly 160,000 domestic wells in New Mexico. Some water advocates are concerned that the cumulative affect of domestic wells near river systems reduces shallow aquifer levels that in turn reduce river flows. *(See p. 18 on environmental flows.)* Another concern with domestic wells is water quality. Increased metering and monitoring are potential solutions, but they would also bring increased costs and regulation.

BRACKISH AND PRODUCED WATER

THIS SECTION ADDRESSES:

- Explanation of brackish water and produced water
- Summary of opportunities and limitations
- Information on Texas activities
- Desalination process overview

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Low Quality Water

The previous section described the myriad of major human uses of water in New Mexico. Given all those needs, many people believe our state will need to pursue new types of water, in addition to improving conservation. Consequently, researchers and policymakers actively seek additional options. Potential "new" sources of water might include:

- Increased reuse of municipal water (discussed in the previous chapter, see p. 26)
- Clean up of brackish water in deep aquifers
- Clean up of "produced water" (water pumped for oil and gas extraction)

All of these sources are considered "low quality water." The public and policymakers are increasingly interested in technology solutions that make low quality water potable. A 2009 New Mexico statute granted the Office of the State Engineer (OSE) authority to regulate and grant permits for brackish water in many deep-water aquifers, if the water is for public supply. (Previously, these extremely deep aquifers were less subject to OSE regulation.)

Brackish Water

Significant portions of the state have brackish water deep below the surface. Essentially, water is "brackish" if it has too much salt. Salinity is measured as the concentration of total dissolved solids (TDS) in water. (The measure is also called "parts per million" or ppm.) Federal regulations recommend – but do not require – that public water supplies have a TDS of less than 500 milligrams per liter (mg/L). This is a national voluntary standard, and there are a number of New Mexico and Texas communities where the native groundwater cannot meet this target. The state of Texas sets a standard of 1,000 TDS.[89]

Definitions vary some, but a general rule of thumb is:

- Brackish water: TDS of 1,000-10,000 mg/L (or ppm)
- Saline: TDS of 10,000-35,000 mg/L (or ppm)
- Seawater: TDS of greater than 35,000 mg/L (or ppm)

There is an estimated 15 billion acre-feet of brackish water in New Mexico.[90] For several years, Figure 23 has circulated among researchers and advocates in New Mexico. It shows the quality of the state's groundwater. From that map, it would appear that the state has plenty of water, as long as we clean it up. However, most water is located in deep aquifers with low "hydraulic conductivity." This means the rock formation of the aquifers does not transmit water effectively. Furthermore, when compared with freshwater aquifers on which New Mexico currently relies, many of the brackish aquifers have a small amount of water that can be released by pumping.[91] Bottom line: there *is* accessible brackish water beneath much of the state's surface, but not as much as people might think if the map were their primary data source.

The salinity of New Mexico's brackish water is highly varied, ranging from 1,100 TDS (near potable) to 160,000 TDS (essentially impossible to use). Additional research would be required to identify the best locations for pilot projects, but experts believe that brackish water at the edges of the five major basins is likely to have the lowest TDS.[92]

[89] (Archuleta, 2013)
[90] (Bohannan & Feinburg, 2013)
[91] (Thomson B. , 2013)
[92] (Bohannan & Feinburg, 2013)

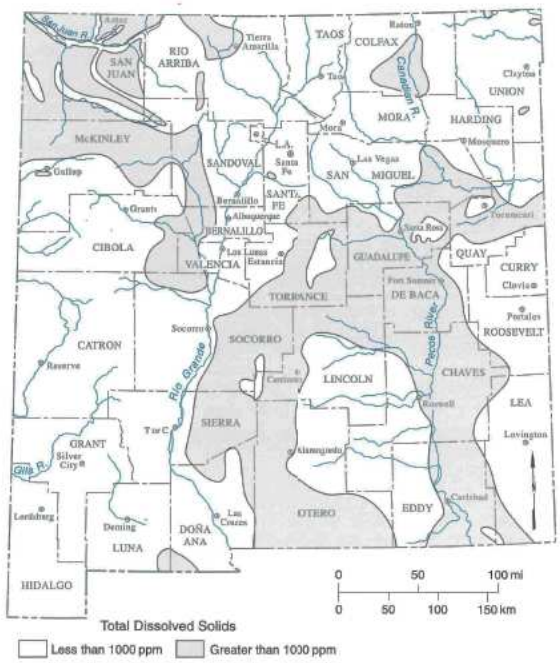

FIGURE 7—Quality of ground water in New Mexico (modified from New Mexico State Engineer Office, 1967).

Figure 23: Map of Fresh and Brackish Water Aquifers

A number of projects were proposed or begun in New Mexico to harvest and clean brackish groundwater. Some include:

- A desalination system is being built in Cloudcroft, NM as part of a project that also includes wastewater reuse. The desalination portion may become operational in 2015.
- The Bureau of Reclamation operated a pilot desal system for Gallup, NM to recover wastewater for potable supply. It is now closed.
- Two proposals were made in the late 1990s by water developers who hoped to extract brackish water from the Estancia Basin in central New Mexico and pipe it to Santa Fe. The projects were not approved.
- A Roswell, NM desalination facility started operation in 1963, but it is now closed. It was a U.S. Department of Interior research project.

ALAMOGORDO: HUB OF DESALINATION

The city of Alamogordo is currently building a desalination plant to diversify water supply for its region. Among other financial sources, the project received about $2.6 million last year from the New Mexico Finance Authority. The projected total cost is $20 million. The city plans to pipe brackish water from north of Tularosa, remove the salt and apply the cleaned water to municipal use.[93]

The permanent location for the city's plant will be near the federally operated Brackish Groundwater National Desalination Research Facility. Established by Congress, the federal facility has two main goals: 1) Understand the environmental impacts of desalination, and develop approaches to minimize these impacts relative to other water supply alternatives. 2) Develop approaches to lower the financial costs of desalination so that it is an attractive option relative to other alternatives in locations where traditional sources of water are inadequate.

CONCERNS ABOUT RELYING ON BRACKISH WATER

The research underway in Alamogordo holds promise. Experts warn, however, that sustainability of the groundwater source must be considered.[94] Many of these types of aquifers contain very old water that is not recharged from surface sources. Thus, once the water is pumped from isolated aquifers it may never be replenished. A sustainable water resource "contributes to objectives of society now and in the future while maintaining ecological, environmental, and hydrological integrity."[95] In New Mexico, many deep-water aquifers are not being replenished and are therefore not a truly sustainable source. However, some brackish aquifers are geologically situated so they do recharge. It is possible that this factor might influence the locations for any future desalination facilities.

Some researchers also worry that over pumping of deep saline aquifers may cause land subsidence (i.e., sink holes or other downward motion of the land surface) which could compromise the foundation of structures.[96] However, other

[93] (Alamogordo Daily News, 2013)
[94] (Thomson B. , 2013)
[95] (ASCE 1998)
[96] (Thomson B. , 2013)

researchers take the position that use of brackish aquifers – even if not permanently sustainable – extends the life of the freshwater aquifers on which we currently rely.[97]

Desalination Process

Desalination involves removal of dissolved constituents from water. There are two major types of desalination technologies in common use: membrane and distillation. Distillation is commonly used in the Middle East for seawater desalination. The United States is more likely to use membrane processes, such as reverse osmosis (RO).[98] At its most basic, this technology pumps unclean water through a semi-permeable membrane, pressuring cleaner water through to the other side. The salt or other substances become a brine wastewater. The clean water has 90 percent of impurities removed, and can be put to a new purpose.

BRINE DISPOSAL

While coastal facilities can release wastewater in the sea, inland desalination requires deep injection wells or evaporation ponds to dispose of the brine water. The location of these wells or ponds must be carefully monitored to ensure that existing potable groundwater is not contaminated. Although the arid southwest might seem an ideal location for evaporation ponds, experience with wastewater sludge drying beds has shown that they do not work well. A design study for a large-scale desalination plant in Phoenix found that 10 square miles of evaporation ponds would be required, costing $410 million. (This cost would have been nearly the same as a 184-mile pipeline through Mexico to send the brine water to the Gulf of California.)[99] Deep well injection is the more common approach.

DESALINATION IN TEXAS

The El Paso Water Utility operates the world's largest inland desalination facility, the $91 million Kay Bailey Hutchison Desalination Plant. It produces up to 27.5 million gallons of drinking water per day. It starts with brackish water that is about 3,000 TDS, treats it to about 600 TDS for drinking water supplies, and pipes the brine wastewater 22 miles to deep injection wells for disposal.[100] The facility supplies an average of 4 percent of the utility's annual water needs, but on hot summer days, it produces 25-30 percent of the region's water. The facility helps the utility meet peak demand and diversify supply during droughts or other crises. The plant is part of a 50-year water plan.

The planning process was extensive, with USGS hydrologic modeling, exchanges of well data with Mexico, plus extensive research to determine the quantity of brackish water available and the direction of its flow. High energy costs are a challenge. Part of the desalination costs are paid by the consumer. The utility increased rates 6 percent to pay for the plant.[101]

There are multiple desalination efforts underway in Texas. An analysis of them produced these cost estimates: [102]

- Capital cost range from $2.03 to $3.91 per thousand gallons of installed capacity.
- Operation and maintenance costs range from $.53 to $1.16 per thousand gallons of water produced.
- Production cost of water ranges from $1.09 to $2.40 per thousand gallons or $357 to $782 per acre-foot.

[97] (Carroll, 2013)

[98] Reverse osmosis is not the only desalination process for brackish water, but it is the most used at this time. Other technologies include, but are not limited to, advanced oxidation and ozone/biofiltration.

[99] (Thomson & Howe, 2009)

[100] (Hutchison, 2009)

[101] (Archuleta, 2013)

[102] (Texas Water Development Board, 2012)

ENERGY AND COSTS

Desalination of brackish water is considerably more energy intensive than pumping existing freshwater, but less energy intensive than treating ocean water. Public discussions of desalination often include the assertion that future technologies will solve the problems of high energy demand. Research by the National Academy of Sciences does not support this prediction. The study found that current membrane technology is approaching fundamental limits of energy efficiency and that further improvements may only result in 5 to 10 percent reduction in the annual desalination costs. However, the study also found that other costs, such as construction and related capital costs of desalination, will likely come down because of economies of scale.[103]

SANDOVAL COUNTY

In 2007, Sandoval County conducted a pilot project to research a deep saline aquifer west of Rio Rancho. The project offered potential for a 100-year supply of 50,000 acre-feet a year.[104] In 2008, the Atrisco Oil and Gas Corporation announced its discovery of a deep saline aquifer in western Bernalillo and Sandoval counties. Subsequent research determined that the brackish water was very salty, about four times the salinity of the water being purified in El Paso at its desalination plant. Research also determined that the underlying geology of Sandoval County is not suitable for deep well disposal of brine wastewater. Land intensive evaporation ponds would be required. This research does not mean the water cannot be used; but it would be expensive. The cost to produce drinking water from the Sandoval County saline aquifer was projected at $8 per thousand gallons.[105]

[103] (NRC, 2008)
[104] (Sandoval Signpost, 2007)
[105] (Inter Inc., WHPacific, 2008)

Produced Water

When oil or gas is extracted, significant amounts of brackish water comes up too. Most wells generate far more of this "produced water" than they do oil.[106] Unless the water is reused by the industry, this produced water is generally disposed of through deep injection wells that put the water back in the ground at depths of approximately 9,000-12,000 feet.

To prevent groundwater contamination, these wells have authorized "injection zones." Federal and state guidelines protect freshwater and prevent it from being mixed with produced water.[107]

The United States pumps an estimated 21 billion barrels of produced water a year.[108] New Mexico is one of the top oil and gas producing states (sixth in the nation).[109] The most active wells are located in the Permian Basin of southeast New Mexico and the San Juan Basin of northwest New Mexico. In 2012, over 767 million barrels of produced water were pumped back underground via injection wells.

AMOUNT OF PRODUCED WATER REINJECTED ANNUALLY

	Southeast (Permian Basin)		Northwest (San Juan Basin)	
	Water Injected, in Acre-Feet	Average Water Quality	Water Injected, in Acre-Feet	Average Water Quality
2008	86,353	TDS 69,300-83,100 mg/L	5,888	TDS 15,900-34,100 mg/L
2009	82,149		4,577	
2010	86,918		5,284	
2011	84,051		4,680	
2012	94,195		4,474	

There are three ways some of this water could be reused:

- Agricultural purposes
- Municipal needs
- Water needs of the oil and gas drilling process itself, thus reducing the industry's use of freshwater

[106] (Produced Water Society, 2010)
[107] (NM Energy, Minerals and Natural Resources Department, Oil Conservation Division, 2005)
[108] (Clark & Veil, 2009)
[109] (USA Today, 2013)

There are significant limitations, however. The TDS levels for produced water in New Mexico vary considerably. Some levels are so high that the produced water would be very difficult and expensive to treat. Researchers do not know what percentage of the state's produced water could be treated for municipal or agricultural use. If appropriate locations were identified, different technology could be deployed. Some options clean the water at the well site. Water would be transferred via pipeline to its destination, probably municipal or agricultural locations.

A Society of Petroleum Engineers report addressed the issue this way: "Because the idea of using produced water as an alternative drinking water supply is still in its infancy and the quality of produced water varies greatly from location to location, little is known about the feasibility of potable reuse and the level of treatment needed. However, much can be learned from the reuse of other alternative water sources such as domestic wastewater, the reuse of which has grown rapidly in the past two decades."[110]

RE-USE IN THE INDUSTRY

A more common way to reuse produced water is to repurpose it for future oil and gas drilling operations. The industry must use water (though not necessarily freshwater) to drill and complete new wells, and to plug older non-producing wells. When a company is able to reuse produced water from a functioning oil well for these purposes, the company uses far less freshwater. As technology improves, industry leaders expect that this practice will further expand. The Oil Conservation Commission is considering changing existing rules for the management and storage of produced water so that more of it can be repurposed. Experts agree that any rule changes must ensure that produced water must be stored safely and thus not create risk for groundwater contamination.[111]

Policy Considerations on Brackish Water

How can New Mexico gather information to understand the economic and technical viability of reusing brackish/produced water? How can we best leverage the research capabilities of the national laboratories and state universities? What information is needed regarding potential environmental risks to soils, plants and groundwater? How would practical matters, such as pipelines to move the water, be handled and financed?

Experts agree that brackish water as a source is not permanently sustainable. They worry that we will become reliant on another water source that will eventually be depleted. Others argue that diversifying water sources can reduce the amount of water drawn from freshwater aquifers, improving their ability to recharge. These advocates also argue that cleaned brackish water will enter the water system and naturally replenish existing aquifers. How should decision-makers balance these questions of sustainability versus diversification?

Legal and regulatory issues are additional policy considerations. The question of who owns rights to "new" water must be clarified. To what degree does the OSE have authority over brackish water, particularly for waters without an obvious hydrologic connection to surface water sources? Some advocates recommend consideration of new policies, such as establishing two levels of water rights or regulating brackish liquid as a mineral instead of water.[112] What are the merits and drawbacks of such options?

[110] (Society of Petroleum Engineers, 2011)
[111] (Cravens, 2014)

[112] Feinberg/ Mr. Ron Bohannan <rrb@tierrawestllc.com>

WATER AND CAPITAL PLANNING

THIS SECTION ADDRESSES:
- History of water planning in New Mexico
- Regional water plans
- State water plan
- Capital planning

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Value of Planning

There is one recurring idea that is reflected in every chapter of this report: no resource is more important to New Mexico's future than water. However, it is difficult to plan for that future given annual changes to our water supply. We cannot predict how much rain or snow we might receive in a given year, but we can reasonably predict likely population and economic needs. We can also set plans to address environmental concerns, such as watershed management or endangered species protection.

New Mexico has a responsibility to address all these priorities, while adhering to legal obligations. Participants at both the listening sessions New Mexico First held prior to the town hall championed the need for organized, integrated and updated water plans. They recognized, however, that water planning does not follow a straight path, but is instead a creative process that necessarily considers all perspectives and competing interests.[113]

New Mexico currently has a state-level plan as well as a series of regional ones.

Regional Planning

New Mexico is divided into 16 water planning regions. Beginning in the late 1990s, each region completed its own plan, based on its own unique needs and resources. The plans addressed water supply and demand, water quality, legal issues and other elements. The regional plans provided a strong foundation for improving water management in New Mexico. They improved local and state government coordination, clarified community priorities, engaged the public in water issues, and – perhaps most important – required regions to quantify any gaps between available water and projected demand. The plans helped each region determine if it was 'living within its means' regarding water.

That said, several of the plans are over a decade old. They are largely impossible to integrate into the state water plan because they did not use the same methodology for quantifying water supply and demand. Policymakers understandably want to add up the water needs in the 16 plans for a statewide total, but that is not possibly under the current structure.

In 2013, the New Mexico Legislature provided funding to the Interstate Stream Commission (ISC) to begin updating state and regional water plans. This was the first legislative appropriation for water planning in five years. The legislation authorized a smaller appropriation in 2014. Presuming funding is identified, the ISC hopes to update all 16 regional water plans, and integrate them into an updated state water plan.

REGIONAL PLANNING LAW [114]
New Mexico law simply states:

- The future water needs of New Mexico can best be met by allowing each region of the state to plan for its water future.
- The state can assist regions in planning future water use by implementing a state appropriation program to ensure an adequate supply of water for each region, as reflected in each region's water use plan.
- The ISC is the appropriate agency to implement such a program.

The law also provides parameters for ISC funding of regional planning efforts.

[113] (Bordegaray, 2014)

[114] (NM Statute 72-14-43 and 72-14-44, 1987)

NEW APPROACH TO REGIONAL PLANS

The ISC, with advice from stakeholder groups including the New Mexico Water Dialogue, recently released a new handbook with detailed guidelines for updating the regional plans. The approach builds on what worked well with the first round of plans, while making some key changes: [115]

- The groups will focus more on identifying water projects, policies and funding needs in their areas, in a way that more closely aligns to the Water Trust Board funding process.
- All plans will follow a common water supply and demand methodology, and the ISC will provide that data for a 40-year planning horizon for each region. The method will be based on the OSE's existing "Water Uses by Category" reporting system.
- The ISC will also provide data on legal issues, population projections and economic forecasts, so that each region can estimate future water use.
- Regions will be given an opportunity to provide comments and suggestions to the baseline data provided by the ISC.
- The planning groups in each region will include all the key water stakeholders in that area. A detailed list of required entities is provided in the new handbook, thus ensuring that no essential interests are left out.

While many people see the proposed changes as valuable, others are concerned. Some people worry that the common data methodology coming from the ISC will result in a "top-down" process.[116] Some people who worked on the first round of regional plans have a sense of ownership of the data they already produced. "They were close to it, and it brought them together as a region," said state water planner Angela Bordegaray, interviewed for this report. "Plus, the new process is so new, people are understandably worried."

A different concern, voiced by some water advocates, is that the new regional planning process does not take into account climate change. However, ISC leadership indicated that resources are unavailable to deal with climate change projections this time.[117]

MAKING THE MOST OF THE NEW REGIONAL PLANS[118]

As the regions begin work, some advocates offer suggestions.

- Increase communication between neighboring regions on their planning processes and implementation.
- Use scenario planning to reflect uncertainty and variable conditions.
- Place greater emphasis on drought planning, water delivery constraints, environmental impacts and energy.
- Provide ongoing funding for regional planning processes, enabling regular updates.

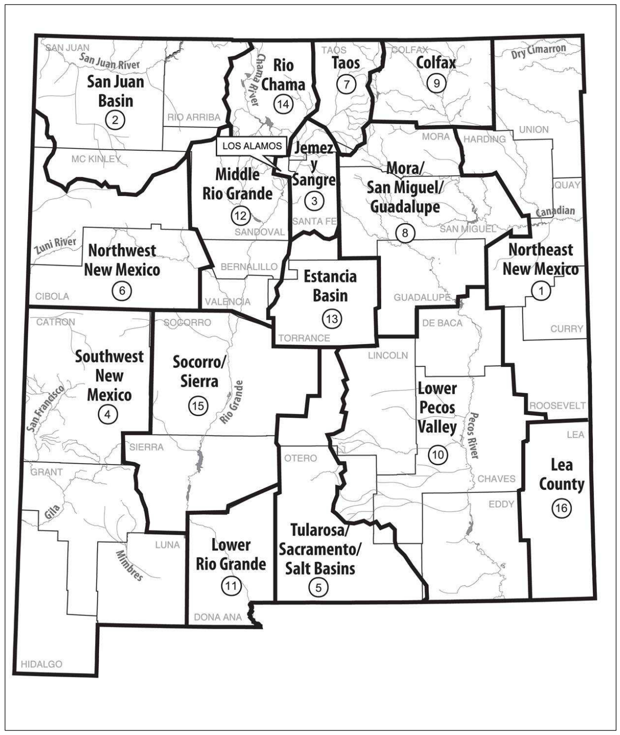

Figure 24: Map of NM's 16 Water Planning Regions

[115] (NM Interstate Stream Commission-Regional, 2013), (Bordegaray, 2014), (NM Interstate Stream Commission-Handbook, 2013)
[116] (Fleck J.-P. , 2013)
[117] (Fleck J.-P. , 2013)

[118] (Utton Transboundary Resources Center-Planning, 2013)

REGIONAL PLAN BOUNDARIES

In our state, regional water planning boundaries were self-defined in the late 80s and early 90s, using a combination of hydrologic and political factors. Some regions comprise one county, others up to five, and a few include partial counties. Because the regional plans are being updated, some people believe the boundaries should be redrawn – perhaps by river basin (like Colorado, Oklahoma or Wyoming), or by county (like Texas), or to align with New Mexico's Council of Governments boundaries. A case could be made for any number of structures, but the ISC made the decision to stick with the existing boundaries for the current round of updates. Redrawing from scratch would require additional resources, since each region would lose the ability to build on their first plan. That said, if any existing regions want to voluntarily merge before updating their water plans, the ISC is willing consider such proposals.[119]

State Planning

New Mexico's state water plan was developed in 2003, after the legislature passed a law requiring it. The statute set out an ambitious set of goals for the plan, including:[120]

- Inventories of quantity and quality of water supply under a range of conditions
- Inventories of population and water demand projections
- Water budgets for the state, as well as major river basins and aquifers
- Strategies for water conservation, reuse and recycling
- Drought management plans
- River and watershed restoration
- Protection of culture, environment, and economy
- Provisions for efficient transfers of water
- Coordination among all levels of government
- Integration of regional plans into the state water plan
- Identification of water infrastructure needs
- Promotion of research collaborations to develop new water technology and management policies
- Review of the plan at least every five years

To meet those goals, the ISC undertook a large-scale public involvement campaign, engaging thousands of New Mexicans. The resulting 80-page plan identified fundamental statewide priorities but, given limited time and funding, did not fulfill all the legislative goals.[121] As noted above, it proved impossible to integrate the regional plans into the state plan because the lack of common methodology. This issue will be corrected in the next round of updates.

Challenges to Effective Planning

Water planning in New Mexico is complicated for a number of reasons. Our state's terrain is considerably more varied than our western neighbors (with mountain, high plains and desert). Consequently, from a hydrological standpoint, water is managed differently throughout the state.

We are also home to 21 tribes and pueblos, each with water rights. And, as noted before, over 71,000 defendants await resolution to pending water rights adjudications.[122]

Another challenge is resources. We are not a wealthy state. New Mexico funds and staffs water planning at considerably lower levels than our neighbors. Wyoming, for example, allocated $3.7 million for the development of seven regional water plans, followed by $500,000 per year for ongoing planning and updates. Wyoming also employs five water planners. Colorado spends about $1 million annually for regional planning.[123] Our wealthiest neighbor, Texas, spent $21 million to develop 16 regional water plans and $15 million on its state plan – plus annual appropriations for updates and maintenance. The table later in this section illustrates New Mexico's funding levels.[124]

[119] (Bordegaray, 2014)
[120] (NM Statute 72-14-3.1, 2003)
[121] (Utton Transboundary Resources Center-Planning, 2013)
[122] (Bordegaray, 2014)
[123] (NM Interstate Stream Commission-Western, 2009)
[124] (Utton Transboundary Resources Center-Planning, 2013)

STATE FUNDING FOR NEW MEXICO WATER PLANNING

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014
Funding amount	$55,000	$55,000	$55,000	$300,000 for state water planning update	$0	$0	$0	$400,000	$275,000
Number of water planners	1	1	1	2	2	1	1	1	1

HISTORY OF NEW MEXICO FIRST AND PLANNING[125]

- **1988 water town hall:** The event called for regional water planning to improve collaboration between state and local governments. (Outcome: Legislation on regional planning had passed in 1987. Some regions began official work after the 1988 town hall. The ISC released its first planning handbook in 1994.)
- **2002 water town hall:** The event called for the creation of the state water plan, integrating regional plans, with recurring funding to maintain them. (Outcome: Legislation creating the state plan passed in 2003.)
- **2003 water planning town hall:** Conducted as a follow-up to the 2002 event, and in partnership with ISC, this town hall informed the first state water plan.
- **2007 regional public forums**: This project collected input via hearings in Las Cruces, Roswell, Farmington, Albuquerque and Las Vegas. The resulting report informed the five-year review of the state water plan.
- **2012 "centennial" town hall:** The event called for an update of state and regional plans to develop a long-range, statewide water strategy for New Mexico's surface and ground water. (Outcome: Funding was approved in 2013 to begin updating the 16 regional plans.)

NOTE: New Mexico First is one of many organizations that has championed water planning over the years.

POLICY CONSIDERATIONS FOR WATER PLANNING

Multiple entities recommended that future long-range planning be integrated across multiple issues, including land use, economic development and energy.[126] What prevents such integration from occurring currently? How might collaboration occur across regions?

As the new regional planning groups begin, many people believe that ample time for the regions to offer input on the ISC's new water supply and demand analyses is essential. What activities, conducted now, would increase the likelihood of success for the new regional approach?

New Mexico law on regional water planning is quite broad, leaving room for interpretation. What are the potential benefits or drawbacks for clarifying the legislation?

Water Funding and Capital Planning

This report illustrates a wide array of water investment options. Those needs might include repairing dams and reservoirs, maintaining rural water systems, watershed management, researching new water technologies, or facilitating state and regional water planning. Our state must not only prioritize what to do, but also how to fund it. Public-private partnerships are one strategy, but New Mexico currently leans more heavily on government financing options.

The New Mexico Legislative Finance Committee (LFC) recently published an evaluation indicating that the state has access to millions of dollars in unused water infrastructure funds. In addition, the state has seven programs that fund water projects, but their efforts are not directly coordinated. Water project funding is also not necessarily aligned with the state and regional water plans.[127]

One reason the federal funds go unused is because state policies discourage the use of available loan money, favoring state grants instead. As a result, these loan funding sources are underutilized and in some cases money is returned to Washington.

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[125] (New Mexico First-Lifeblood, 1988), (New Mexico First-Water, 2002), (New Mexico First-State Plan, 2003), (New Mexico First-Regionals, 2007), (New Mexico First-Centennial, 2012)

[126] (Governor's Blue Ribbon Water Task Force, 2010), (New Mexico First-Energy, 2009), (New Mexico First-Strategic, 1996)

[127] (NM Legislative Finance Committee, 2013)

New Mexico spends six times more state money on water project grants than our neighboring states combined. Most states fund water projects from revolving loan programs, which are intended to be self-perpetuating. It is likely that local and county governments favor our current system, since grants are preferred to long-term loans. However, the Water Trust Fund is projected to be depleted within 19 years.[128]

A few immediate solutions offered by the LFC include:

- Tap New Mexico's capital outlay funds when state or federal loan and grant programs cannot be used.
- Establish a single application process for all water infrastructure projects.
- Centralize the funding decision-making process, ensuring collaboration among all state funding programs.

CAPITAL OUTLAY

Many of these efforts fall under the broad category of "capital outlay," which refers to funds used to build, improve or equip physical property that will be utilized by the public. In New Mexico, state-funded capital outlay is authorized by the Legislature and generally is one-time (non-recurring) money. The overall issues of capital outlay reform are significant, and could be the subject of their own report. They include not just water, but also public schools, roadways, parks, libraries or even fire trucks.

2014 Legislative Funding

New Mexico's legislature and governor prioritized water infrastructure projects during the 2014 legislative session. The capital outlay bill included $89 million toward critical water infrastructure projects throughout the state. It included funding for the repair of watersheds damaged by fires and floods, as well as repairs of selected dams. Resources to improve access to clean drinking water was approved for more than 20 communities including Santa Cruz, Gabaldon and Algodones.

Additional items included:

- Funding to help small towns, including Magdalena, Maxwell, and Vaughn, prevent water supply emergencies
- An appropriation for the River Stewards Initiative, advancing healthy and vibrant river ecosystems
- Funding for the desalination facility in Alamogordo
- Upgrading critical water and wastewater treatment systems in dozens of communities

NM Water Trust Board

The 2001 Legislature enacted the Water Project Finance Act which created the Water Project Fund in the New Mexico Finance Authority (NMFA) and charged the NMFA with the administration of the fund and the Water Trust Board. The Water Trust Board is a diverse 16-member board that recommends to the Legislature projects to be funded through the Water Project Fund.

The Water Trust Board recommends funding within five project categories: (1) water conservation or reuse, (2) flood prevention, (3) endangered species act collaborative efforts, (4) water storage, conveyance and delivery infrastructure improvements, and (5) watershed restoration and management initiatives. Since its creation, the WTB has recommended more than $228 million of funding for 221 projects statewide.

The Water Trust Board was also tasked, in collaboration with the OSE and the ISC, with preparing and implementing a comprehensive State Water Plan.

See p. 44 for a list of additional funding programs in New Mexico.

[128] (NM Legislative Finance Committee, 2013)

Conclusion

By now it is clear that the issues affecting New Mexico's water policies are complex and value-laden. The choices we make today as a state have the potential to bring enormous impacts for our future economy, environment, and way of life. As you read through the report, you probably found your own opinions reflected in some places and not others. That is expected and will stimulate interesting discussions during the town hall. In New Mexico First town halls, the goal is to bring together a wide spectrum of people, with different opinions and points of view, and to help the group find the invisible consensus. We choose to unify New Mexicans by finding and focusing on the common ground.

APPENDICES

Appendix A: Interstate Water Compact Summary

Interstate Compact[129]	Summary	Annual Amount NM Receives or is Authorized to Use	Annual Amount NM Delivers to Others	Notes
Animas-La Plata Project Compact	The Animas-La Plata Project Compact between NM and CO governs the allocation and administration of waters stored and delivered by the U.S. Bureau of Reclamation's ALP Project. The compact was ratified in 1969 in anticipation of construction of the ALP Project, which was completed in 2011. The ALP Project developed a portion of the waters in the Animas River, which rises in the western San Juan Mountains of southwest Colorado and flows south to join the San Juan River in NM near Farmington. The compact ensures that NM's share of ALP Project water enjoys the same priority and validity (within CO) as CO's share. It essentially prevents junior users in CO from appropriating NM's share of ALP Project water.	Average annual depletion: **13,520 acre-feet** (See notes on the entities that share this water.)	Not applicable.	The ALP Project consists primarily of a reservoir (Lake Nighthorse), which stores water near Durango. The Navajo Nation, San Juan Water Commission and La Plata Conservancy District have contracts with the U.S. Bureau of Reclamation for use of the water.
Canadian River Compact	Approved in 1952, this compact between NM, OK and TX regulates the use of waters in the Canadian River. In NM, the river runs in the northeastern corner of NM before flowing into TX. Under the compact, NM has unrestricted use of waters originating in the drainage basin of the Canadian River above Conchas Dam. The state also has unrestricted use of basin waters below Conchas Dam, provided that the state does not store more than 200,000 acre-feet in reservoirs below Conchas.	Not available. While NM uses water authorized under this compact, the state does not report depletion amounts.	Not applicable.	The Canadian River Compact does not require river gaging. While a number of gages exist on the Canadian River, a larger number would be needed to conduct a depletion analysis. Gages cost between $12,000 and $20,000 each to operate per year.
Colorado and Upper Colorado River Compacts	The Colorado River Compact, signed in 1922, is an agreement between seven western states on allocation and use of water in the Colorado Basin. (While the main Colorado River does not run through NM, its tributary, the San Juan River, does.) The basin is divided into two portions (upper and lower). There is a dam at Lee Ferry in northern AZ that essentially divides water between upper and lower basins. The compact prevents the upper basin states (NM, CO, UT and WY) from causing the flow at Lee Ferry to be depleted below 75 million acre-feet in any ten year period. This requirement ensures that water is available for lower basin. If that	Average amount allowed: 640,000 acre-feet Average amount used: **400,000 acre-feet**	There are not specific delivery targets, just a requirement that NM not deplete more than our share	While it is possible that the water supply associated with this compact could vary in the future, it has been historically consistent because of long-term storage at Navajo Reservoir. About 105,000 acre-feet a year of

[129] Each compact is different, so slightly different types of data are available for each one. This table is an attempt to make it as consistent as possible, but variations exist based on the nature of the agreements and the type of monitoring performed.

Interstate Compact[129]	Summary	Annual Amount NM Receives or is Authorized to Use	Annual Amount NM Delivers to Others	Notes
	target is not met, upper states would have to curtail their water use. (This has never happened). In 1948, a separate compact was signed between the upper basin states (NM, AZ, CO, UT and WY). It provided additional clarity on the division of water between those states. The upper basin compact allows NM to consume 11.25% of the combined allocation of the five upper states.			NM's allocation is diverted for the San Juan-Chama Project, which provides water for Santa Fe, Albuquerque and other users.
Colorado Riv. Compact (lower basin)	As noted above, most of NM's Colorado River Compact water comes from the upper basin. Within the lower basin, NM is allowed consume water from the Gila and Zuni basins. Amounts vary based on precipitation.	Estimated averages: Gila: **33,000 acre-feet** Zuni: **5,000 acre-feet**		
Costilla Creek Compact	The Costilla Creek Compact governs a small interstate stream that originates in the mountains north of Taos, flows into CO, then returns to NM. Except in very wet years, the creek rarely reaches the Rio Grande. Approximately 9,500 acres are irrigated. Originally signed in 1944, the compact was renegotiated slightly In 1963 to allow the transfer of water between Colorado ditches. The 1963 Costilla Creek Compact apportions river flow water as well as that stored in the Costilla Reservoir. It allocates 64% of reservoir water to NM and 36% to CO. Since 2002, the Costilla Creek system is administered under a daily accounting spreadsheet and operations manual. Water users submit daily orders for water and an employed "water master" posts orders and delivery amounts each day.	Average annual amount used: **15,000 acre-feet** (or about 60% of the total consumptive water allowed)	Delivery data not available. CO is apportioned about 40% of the compact water.	The discrepancies between water orders and deliveries average less than 2% in most years, which is considered remarkably accurate in a natural river system.
La Plata River Compact	The La Plata River begins in southwestern CO. Exiting the mountains near Hesperus, CO, the river flows south into NM before entering the San Juan River at Farmington. Settlers began diverting water from the La Plata in the late 1800s. Controversies developed early because of the river's tendency to run dry or nearly dry by mid or late summer. In 1922, CO and NM signed the La Plata River Compact. It requires CO to deliver to NM, between February 15 and December 1, an average daily flow equal to half the average daily flow at Hesperus on the preceding day. There are a couple of exceptions: CO is never required to deliver an average daily flow greater than 100 cubic feet per second; CO is not required to deliver more water than is needed for beneficial use in NM.	Average annual amount received at CO state line: **20,000 acre-feet**	Not applicable.	In most recent years, CO has failed to fully meet its obligations to NM on over half the days it is in effect. CO has difficulty getting water to NM once the flows at Hesperus drop to around 20 cubic feet per second or less.

Interstate Compact[129]	Summary	Annual Amount NM Receives or is Authorized to Use	Annual Amount NM Delivers to Others	Notes
Pecos River Compact	In 1948, following decades of controversy, NM and TX signed the Pecos River Compact, which apportions the river's water between the two states. The river begins near the village of Pecos (northeast of Santa Fe), flows south through Carlsbad and into TX. The compact is based on the human and environmental conditions of 1947. New Mexico water delivery obligation to TX is calculated annually using complex a formula approved by the U.S. Supreme Court and contained in the Pecos River Master Manual. The calculations rely on numerous stream gages and weather stations, and delivery obligations are determined as a three-year running average amount. Very generally, NM's annual water delivery obligation to TX is roughly half the sum of Sumner Dam releases and tributary flood inflows from Sumner Dam to the TX state line.	Not applicable. The river initiates in NM. Depletion is not calculated under this compact.	Annual obligation in acre-feet: Highest: 171,800 acre-feet (1988) Lowest: 31,700 acre-feet (1964) **Average: 77,900**	The accumulated overage of water deliveries to TX, as of 2012, equals 102,000 acre-feet. There are advantages to having credits with TX. Once credits reach 150,000 acre-feet, OSE can release some of its own purchased water rights for NM users.
Rio Grande Compact[130]	Adopted in 1939, the Rio Grande Compact apportions river water between CO, NM, TX and Mexico. The compact requires CO to deliver surface water to NM at the state line, and New Mexico delivers surface water to Elephant Butte Reservoir. Water released from Elephant Butte is targeted to downstream users in southern NM, TX, and Mexico. The compact divides the basin in upper, middle, and lower regions. The middle region has a specified delivery. The actual volume of water to be delivered to and from NM vary from year to year and depends on hydrologic conditions in the Rio Grande Basin. Because of that variability, the compact contains a system of credits and debits. The states of CO and NM can build up credits (like a savings account), so prepare for drier years. (NM's target is 50,000 acre-feet of accrued credit.) In addition, the compact contains a number of provisions that restrict water operations in the upper and middle regions when Elephant Butte is low. (See notes.)	Amount CO is obligated to deliver to NM: High: 816,100 acre-feet (1941) Low: -46,400 acre-feet (2002) **Average: 293,000 acre-feet** Average amount over/under their obligation: -2,700 acre-feet	Amount NM is obligated to deliver to Elephant Butte: High: 2,319,000 acre-feet (1941) Low: 145,200 (2002) **Average: 591,600 acre-feet** Average amount over/under our obligation: 16,700 acre-feet	• Provisions in the compact (Articles VI and VII) restrict storage of water at several upstream reservoirs if Elephant Butte levels are low. These provisions also affect NM's ability to control or manage evaporation loss when the reservoir is low. • NM can cumulatively under-deliver to Elephant Butte Reservoir up to 200,000 acre-feet without violating the compact. • Texas filed suit in 2013 over compact deliveries. The issues have not yet been litigated.

[130] See additional information on the Rio Grande Compact on p. 15.

Appendix B: Government Entities Addressing Water

There are many government entities that address water issues and policy. Some of them follow.

NM Acequia Commission
http://www.nmacequiacommission.state.nm.us/
The New Mexico Acequia Commission advises the governor, the New Mexico Interstate Stream Commission and the U.S. Army Corps of Engineers on what criteria should be used to determine priorities for rehabilitating acequias.

NM Department of Agriculture
http://www.nmda.nmsu.edu/
NMDA promotes food protection, a uniform and fair market place, and global marketing and economic development; supports beneficial use of natural resources; and works cooperatively with public and private sector entities.

NM Department of Game and Fish
http://www.wildlife.state.nm.us
The New Mexico Department of Game and Fish seeks to conserve, regulate, propagate and protect the wildlife and fish within the state of New Mexico.

NM Energy, Minerals and Natural Resources Department
http://www.emnrd.state.nm.us
ENMRD oversees five divisions, Energy Conservation and Management, State Forestry, Mining and Minerals, Oil Conservation and State Parks. Although each division has a unique focus, they all address water policy issues via their main objectives.

NM Environment Department
http://www.nmenv.state.nm.us/nav_water.html
NMED is responsible for overseeing water infrastructure systems and water quality issues throughout the state. NMED has many programs that focus on protecting the quality of our waters and assuring safe and effective infrastructure for delivering clean water to our communities.

NM Finance Authority
http://www.nmfa.net/financing/water-programs/water-trust-board/
The 2001 Legislature enacted the Water Project Finance Act which created the Water Project Fund in the New Mexico Finance Authority and charged the NMFA with administration of the Fund and the Water Trust Board.

NM Governor's Drought Task Force
http://www.nmdrought.state.nm.us
New Mexico Drought Task Force is led by the State Engineer to examine ways the state can prepare for and mitigate the problems that occur in New Mexico due to persistent drought conditions.

NM Interstate Stream Commission
http://www.ose.state.nm.us/
The Interstate Stream Commission is charged with separate duties including protecting New Mexico’s right to water under eight interstate stream Basins, ensuring the state complies with each of those Basins, as well as water planning.

NM Office of the State Engineer
http://www.ose.state.nm.us/
The Office of the State Engineer is charged with administering the state's water resources. The State Engineer has power over the supervision, measurement, appropriation, and distribution of all surface and groundwater in New Mexico, including streams and rivers that cross state boundaries.

NM Soil and Water Conservation Districts
http://www.nmda.nmsu.edu/apr/soil-and-water-conservation-districts/
Soil and water conservation districts are independent subdivisions of state government made up of local landowners and residents to conserve and develop the natural resources of the state, provide for flood control, and preserve wildlife.

NM Water Quality Control Commission
http://www.nmenv.state.nm.us/wqcc/
The commission is the state water pollution control agency for this state for all purposes of the federal Clean Water Act and the wellhead protection and sole source aquifer programs of the federal Safe Drinking Water Act.

NM Water Trust Board
http://www.nmfa.net/governance/water-trust-board/
See p. 38.

Appendix C: New Mexico Water Infrastructure Funding Programs

Agency	Fund	Type	Eligibility	Criteria
New Mexico Finance Authority	Water Trust Board (WTB)	Grant/Loan combination depending on system affordability.	Municipalities, counties, irrigation and conservancy districts, acequias, Indian nations, tribes or pueblos	Five types of projects (1) water conservation or reuse, (2) flood prevention, (3) Endangered Species Act collaborative efforts, (4) water storage, conveyance and delivery infrastructure improvements, and (5) watershed restoration and management initiatives.
	Local Government Planning Grants	Grant $50K-$100K	Local government	Need based program based on rates and median household income.
	Public Project Revolving Loan Fund (PPRF)	Loan	State and local public projects	Finance infrastructure projects and capital equipment purchases.
	Drinking Water State Revolving Loan Fund (DWSRLF)	Grant/Loan Forgiveness	Public Water Systems must first be placed on the State's Fundable Priority List by the New Mexico Environment Department (NMED)	Finance cost of repair and replacement of drinking water infrastructure, maintain or achieve compliance with the federal Safe Drinking Water Act (SDWA) requirements, and protect drinking water quality and public health.
NM Environment Department	Rural Infrastructure Program (RIP)	Low cost loans Maximum loan per entity is $2 Million/fiscal year	Municipalities that serve population of less than 20,000, and Counties with population less than 200,000	Construction or modification of water supply, wastewater, and solid water facilities.
	Special Appropriation Program	Grants	Municipalities, counties, special districts, Indian tribes, and water and/or wastewater mutual domestic associations	Appropriation for construction of community water supplies, wastewater facilities and other environmentally related projects.

Appendix D: Glossary

(Most of the following definitions were taken from the OSE's glossary of water terms.)

Acre-Foot: A common measurement tool for water management. The amount of water to cover one acre to the depth of one foot, or 325,851 gallons of water.

Appropriation: The right to take water from a natural stream or aquifer for beneficial use at a specified rate of flow, either for immediate use or to store for later use. (See also Prior Appropriation, Riparian Rights and Water Right.)

Aquifer: A geologic formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs.

Artificial Recharge: The addition of water to the ground water reservoir by man's activities, such as irrigation or induced infiltration from streams or wells.

Bank Storage: Water absorbed and stored in the banks of a stream, lake, or reservoir when the stage rises above the water table in the bank formations and stays there for an appreciable length of time. Bank storage may be returned in whole or in part as seepage back to the water body when the level of the surface water returns to a lower stage.

Beneficial Use of Water: The use of water by man for any purpose which benefits are derived, such as domestic, municipal, irrigation, livestock, industrial, power development, and recreation. Under the New Mexico constitution beneficial use is the basis, the measure and the limit of the right to use water; therefore, beneficial use of public water diverted or impounded by manmade works is an essential element in the development of a water right.

Closed Basin: A basin is considered closed with respect to surface flow if its topography prevents the occurrence of visible outflow. It is closed hydrologically if neither surface nor underground outflow can occur.

Compact: A formal agreement between states concerning the use of water in a river or stream that flows across state boundaries.

Consumptive Use: Water removed from a surface or groundwater source that is not returned as discharged water. For example, the water used by a crop is consumed, but the water that flows through the irrigation system back to a river is not.

Continental Divide: An imaginary boundary line that runs north to south through the Rocky Mountains, separating rivers that flow west to the Pacific Ocean from those that flow south and east toward the Gulf of Mexico and the Atlantic Ocean.

Declared Underground Water Basin: An area of the state proclaimed by the State Engineer to be underlain by a ground water source having reasonably ascertainable boundaries. By such proclamation the State Engineer assumes jurisdiction over the appropriation and use of groundwater from the source. The entire state is now covered by declared basins.

Depletion: That part of a withdrawal that has been evaporated, transpired, incorporated into crops or products, consumed by man or livestock, or otherwise removed.

Diversion: A turning aside or alteration of the natural course of a flow of water, normally considered physically to leave the natural channel. It can also include pumping from a well.

Domestic Water Use: Water for normal household purposes, such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets, and watering lawns, gardens and livestock supplied from a domestic source. Also called residential water use. The water can be obtained from a public supply or be self-supplied.

Drainage Basin: A part of the surface of the earth that is occupied by a drainage system, which consists of a surface stream or body of impounded surface water together with all tributary surface streams and bodies of impounded surface water.

Drip Irrigation: See Irrigation.

Drought: A long period of below-average precipitation.

Dryland Farming: Practice of crop production without irrigation in semiarid regions.

Effluent: The water leaving a water or wastewater treatment plant.

Flood Irrigation: See Irrigation.

Flood Plain: Land bordering a stream. The land was built up of sediment from overflow of the stream and is still subject to flooding when the stream is at flood stage.

Freshwater: Water that contains less than 1,000 mg/L (milligrams per liter) of dissolved solids; generally, more than 500 mg/L is considered undesirable for drinking and many industrial uses.

Groundwater: Generally, all subsurface water as distinct from surface water; specifically, that part of the subsurface water in the saturated zone (a zone in which all voids, large and small, ideally are filled with water under pressure equal to or greater than atmospheric).

Groundwater Recharge: The addition of water to the zone of saturation. Infiltration of precipitation and its movement to the water table is one form of natural recharge.

Harvested Water: Precipitation or irrigation runoff collected, stored, and available for reuse for irrigation purposes.

Hydroelectric Power: Electric energy generated by means of a power generator coupled to a turbine through which water passes.

Hydrograph: A graph showing the stage, flow, velocity, or other property of water with respect to the passage of time. Hydrographs of wells show the changes in water levels during the period of observation.

Hydrologic Cycle: The movement of water from the atmosphere to the Earth and back. The three stages are precipitation, runoff or infiltration, and evaporation.

Imported water: Water that has originated from one hydrologic region and is transferred to another hydrologic region. *(Water Reuse Association)*

Irrigation: Generally, the controlled application of water to arable lands to supply water requirements of crops not satisfied by rainfall. (See also Irrigation water use.) Some examples include::

- *Center-pivot*: Automated sprinkler irrigation achieved by rotating the sprinkler pipe or boom, supplying water to the sprinkler heads or nozzles, as a radius from the center of the circular field to be irrigated. The pipe is supported above the crop by towers at fixed spacings and propelled by pneumatic, mechanical, hydraulic, or electric power on wheels or skids in fixed circular paths at uniform angular speeds. Water, which is delivered to the center or pivot point of the system, is applied at a uniform rate by progressive increase of nozzle size from the pivot point of the system to the end of the line. The depth of water applied is determined by the rate of travel of the system. Single units are ordinarily about 1,250 to 1,300 feet long and irrigate about a 130-acre circular area.

- *Drip*: An irrigation system in which water is applied directly to the root zone of plants by means of applicators (orifices, emitters, porous tubing, perforated pipe, and so forth) operated under low pressure. The applicators can be placed on or below the surface of the ground or can be suspended from supports.
- *Flood*: The application of irrigation water where the entire surface of the soil is covered by ponded water.

Junior Water Rights: Water rights that were obtained more recently and therefore are junior in priority to older or more senior rights.

Mayordomo: Executive Officer or ditch boss of the community ditch or acequia.

mg/L: Concentrations of constituents in water are usually reported in units of milligrams per liter or mg/L. In freshwater, 1 mg/L equals one part per million (ppm) so it is also common for concentrations to be reported in ppm.

Potable Water: Water that is safe and palatable for human consumption.

Prior Appropriation: The water law doctrine that confers priority to use water from natural streams based upon when the water rights were acquired. Water rights in Colorado and other western states are confirmed by court decree; holders of senior rights have first claim to withdraw water over holders who have filed later claims. (See also Water Right, Riparian Rights, Priority and Appropriation)

Priority Call: A demand that upstream water rights with more recent (junior) priority dates than the calling right cease diverting; the exercise of a senior water right holder in "calling" for his or her water rights, requiring junior water right holders to allow water to pass to the senior right holder.

Recharge: The addition of water to an aquifer by infiltration, either directly into the aquifer or indirectly by way of another rock formation. Recharge may be natural, as when precipitation infiltrates to the water table, or artificial, as when water is injected through wells or spread over permeable surfaces for the purpose of recharging an aquifer.

Recoverable Ground Water: The amount of water which may be physically and economically withdrawn from the ground water reservoir.

Reservoir: A body of water used to collect and store water, or a tank or cistern used to store potable water.

Return Flow: The part of a diverted flow which is not consumptively used and which returns to a water body.

Reuse: To use again; recycle; to intercept, either directly or by exchange, water that would otherwise return to the stream system, for subsequent beneficial use. (See also Potable, Non-Potable.)

Reverse Osmosis: A water treatment technique that forces water through a dense membrane to remove impurities.

Riparian Vegetation: Vegetation growing on banks of a waterway, such as a river, stream, or other body of surface water.

River master: See water master

Runoff: Water not absorbed by soil or landscape to which it is applied. Runoff occurs when water is applied too quickly (application rate exceeds infiltration rate), particularly if there is a severe slope. Storm water runoff is created by natural precipitation rather than human-caused or applied water use. The part of the precipitation that appears in surface streams.

Senior Water Rights: Have earlier priority date and claimants who hold them have a higher priority to divert water from a stream or water body than those with more junior rights. However, in times of scarcity, when there is not enough water to meet demand in a basin, those who need water for domestic and livestock use have first right to water, regardless of one's priority date.

System Loss: An amount of water, expressed as a percentage, lost to leaks, seepage and unauthorized use.

Total Dissolved Solids (TDS): An aggregate of carbonates, bicarbonates, chlorides, sulfates, phosphates, nitrates, etc., of calcium, magnesium, manganese, sodium, potassium, and other cations which form salts. High TDS concentrations exert varying degrees of osmotic pressures and often become lethal to the biological inhabitants of an aquatic environment. The common and synonymously used term for TDS is "salt".

Transpiration: Process by which water is absorbed by plants, usually through the roots. The residual water vapor is emitted into the atmosphere from the plant surface. (See also Evaporation; Evapotranspiration.)

Tributary: A stream or river that flows into a larger one.

Wastewater: Water that contains dissolved or suspended solids as a result of human use.

Water Budget: An accounting of the inflow to, outflow from, and storage changes of water in a hydrologic unit.

Water Exports: Artificial transfer (pipe, canals) of water to one region or subregion from another.

Water Main (or Distribution Main): A 12-inch or smaller diameter pipe along public streets or appropriate rights-of-way used for distributing water to individual customers.

Water Master: One who actively administer the distribution of water from stream systems on a daily basis. The State Engineer has the authority to create special water districts and hire Water Masters as the State Engineer determines is necessary for the administration of water rights. Water Masters serve an important function for the Office of the State Engineer because they ensure that water is distributed fairly.

Water Right: Legal rights to use a specific quantity of water, on a specific time schedule, at a specific place, and for a specific purpose.

Watershed: A region of land that drains to a body of water such as a river or a lake. Rain or snow that falls in that watershed eventually flows to that water body. It may travel overland as surface water or flow underground as groundwater.

Withdrawal: Water removed from the ground or diverted from a surface water source for use.

Xeriscape: Landscaping concept that requires less water on vegetation that is suited to soils and climate. The term was developed by Denver Water in 1981. It is derived from the Greek word Xeros, meaning dry.

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