5. Water Supply

This section provides an overview of the water supply in the San Juan Basin Water Planning Region, including climate conditions (Section 5.1), surface water and groundwater resources (Sections 5.2 and 5.3), water quality (Section 5.4), and the administrative water supply used for planning purposes in this regional water plan update (Section 5.5). Additional quantitative assessment of water supplies is included in Section 7, Identified Gaps between Supply and Demand.

The Updated Regional Water Planning Handbook (NMISC, 2013) specifies that each of the 16 regional water plans briefly summarize water supply information from the previously accepted plan and provide key new or revised information that has become available since submittal of the accepted regional water plan. The information in this section regarding surface and groundwater supply and water quality is thus drawn largely from the 2003 RWP (San Juan Water Commission, 2003) and, where appropriate, updated with more recent information and data from a number of sources, as referenced throughout this section.

Currently some of the key updates and issues regarding water supplies in the San Juan Basin region are:

- In 2006 the Bureau of Reclamation (USBR) completed a Final Environmental Impact Statement and Record of Decision (ROD) on operations of Navajo Reservoir on the San Juan River that provide for either operating the reservoir to meet Navajo Reservoir water supply contract deliveries and the San Juan River Basin Recovery Implementation Program’s (SJRBRIP’s) flow recommendations for the San Juan River below Farmington, or providing a suitable alternative to the flow recommendations depending upon hydrologic conditions. Operating the reservoir in accordance with the ROD and the SJRBRIP’s flow recommendations helps to provide Endangered Species Act (ESA) compliance for federal water development and water management activities in the San Juan River basin.

- Surface water supplies the majority of water uses in the San Juan Basin region, making the region vulnerable to shortages during times of extreme or extended drought when reservoir storage might be exhausted. In response to extreme drought in 2002, the major water users from the San Juan River in New Mexico, beginning in 2003, developed recommendations for annual river operations and administration within New Mexico that include maximum diversion rates or amounts for each of the major water users or associated uses and provisions for sharing water supply shortages. The latest agreement
on such recommendations covers the period 2013 through 2016. There is no similar shortage sharing agreement on the Animas River, which is a challenge for operations and water users during times of drought. On La Plata River, diversions are administered by priority, and by July of each year, streamflow is typically insufficient to meet diversion demands. Similarly, there are insufficient streamflows in the Chaco River drainage and insufficient reservoir storage to adequately irrigate historical Navajo Reservation farmlands in and near the Chuska Mountains or elsewhere in the drainage.

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

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

- The USBR completed the Animas-La Plata Project (ALP) as authorized by the Colorado Ute Settlement Act Amendments of 2000 (Public Law 106-554, Title III), which will provide water supplies for municipal, industrial, and domestic uses in Colorado and New Mexico. Lake Nighthorse, the pumped-storage facility for the ALP, was completed and
filled in June 2011, and will provide up to 123,500 acre-feet per year (ac-ft/yr) of storage to help meet future municipal and domestic water demands of non-Indian water providers in New Mexico, the Navajo Nation, and water users in Colorado. In March 2009, the ALP water contractors executed an Intergovernmental Agreement that among other things forms a project operations and maintenance organization and provides principles for the operation of the ALP. The project operations and maintenance organization subsequently entered into an agreement with the USBR to transfer operation, maintenance, and replacement responsibilities to the project participants.

- Several actions regarding transfers of water rights related to municipalities in the region have occurred since completion of the 2003 RWP:
  - In March 2005 the State of New Mexico, the City of Farmington, and the Navajo Nation entered into an Agreement regarding terms of a Consent Order to describe elements of certain of the City’s rights to divert and use waters of the San Juan River stream system that derive from State Engineer File No. 2995 or from the Echo Ditch Decree of 1949, including rights decreed to the City and rights pursuant to several permits associated with transfers of water rights from decreed irrigation uses to municipal use.
  - In May 2013 the State of New Mexico and the City of Aztec entered into an Agreement regarding the City’s water rights, including quantification of its rights to divert and use waters of the Animas River that derive from State Engineer File No. 2801 or from rights decreed to it by the Echo Ditch Decree.
  - Also in May 2013, the State of New Mexico and the City of Bloomfield entered into an Agreement setting forth conditions for the review and acceptance of transfers to City municipal use of specific irrigation rights.

- In February 2013 the State Engineer and the State of New Mexico entered into agreements with the San Juan Water Commission (SJWC) and the La Plata Conservancy District (LPCD) for settlement of pending litigation and other disputes concerning water rights in which:
  - Water appropriated pursuant to State Engineer File No. 2883 for the ALP that is not needed for the ALP as authorized and constructed under the Colorado Ute Settlement Act Amendments of 2000 was allocated to the SJWC, the LPCD, and the Navajo Nation based on previous ALP allocations to them that were not fully included in the ALP as now constructed, subject to the use of these additional allocations being administered as junior in priority to the ALP.
  - The State Engineer agreed that return flow plans for quantifying return flow credits for the administration of diversions for municipal, industrial or domestic uses made
pursuant to the ALP or these additional water allocations under File No. 2883 will be based on measured return flows, including directly measured wastewater discharges to the San Juan or Animas rivers and indirectly measured return flows to these rivers calculated using a water budget method acceptable to the State Engineer. In September 2015 the State Engineer determined a specific method and standards for such return flow plans and determined that the same method and standards would also apply to certain other water rights held by the SJWC or its member entities.

- The USBR, in cooperation with the seven Colorado River basin states, completed the *Colorado River Basin Water Supply and Demand Study* in 2012. This study evaluated water supply and demand throughout the Colorado River basin—including possible increases in demands for Colorado River basin water in adjoining areas that use water exported from the basin—through the year 2060, reservoir system reliability for meeting water demands in the basin, and opportunities for system operations, demand reductions, and water supply augmentation projects to meet the projected gap in supply and demand. Other than the operation of Navajo Reservoir to meet the SJRBRIP’s flow recommendations, the study did not evaluate water administration in the San Juan River Basin in New Mexico or potential shortages to meet water demands in New Mexico. The study also did not assess how deficiencies in deliveries from the Upper Basin to the Lower Basin at Lee Ferry under the Colorado River Compact, if any, might affect water uses in New Mexico.

- Substantive issues related to administration of interstate compacts need to be resolved, including:
  
  - Quantification of the Upper Basin’s obligation to deliver water in the Colorado River at Lee Ferry for purposes of Mexican Treaty deliveries under Article III(c) of the Colorado River Compact, including determination of extraordinary drought.
  
  - Development of (1) the method for accounting consumptive uses in the Upper Basin pursuant to Article VI of the Upper Colorado River Basin Compact and (2) procedures for implementing any water use curtailments in the Upper Basin pursuant to Article IV of the Upper Colorado River Basin Compact.
  
  - Resolution of New Mexico’s issues with Colorado’s performance in making water deliveries at the Colorado-New Mexico state line, as required by Article II.2 of the La Plata River Compact, during the summer and fall months after the snowmelt runoff period ends.
  
  - Administration of ALP operations at the Durango Pumping Plant, including plant bypasses of project water for direct delivery to New Mexico, and at Lake Nighthorse consistent with the ALP Project Compact.
• The Northwestern New Mexico Rural Water Projects Act approved the San Juan Navajo Water Rights Settlement with certain deadlines to be substantially met in order for the settlement to become effective and with certain associated funding authorizations that will require congressional appropriations.

  △ The United States must fund and complete rehabilitation of the Fruitland Irrigation Project by the end of 2016 and of the Hogback Irrigation Project by the end of 2019, at a total estimated cost of $23 million (indexed to 2004 dollars).

  △ By the end of 2019, the United States must appropriate a total of $50 million to the Navajo Nation Water Resources Development Trust Fund and a total of $30 million (indexed to 2008 dollars) for conjunctive use groundwater wells in the San Juan River basin to supplement the surface water deliveries of the NGWSP to rural communities of the Navajo Nation.

  △ Construction of all NGWSP facilities must be completed by the end of 2024, at a total estimated cost of $870 million (indexed to 2007 dollars).

• Due to the large amount of forested land within and upstream of the region, coupled with the recent drought conditions, the threat of wildfire and subsequent sedimentation impacts on streams and reservoirs remains a key planning issue. Continued and expanded efforts to reduce catastrophic fire risk through forest management, as well as additional information on the quantitative benefits of various management techniques, are needed. In particular, quantification of the effectiveness of riparian vegetation removal, upland conifer thinning, and other water salvage methods need further study to support well-informed decisions. Most of the forested land upstream from substantial storage reservoirs and water uses in New Mexico is in Colorado, and most of the usable streamflow in the San Juan River through New Mexico originates in Colorado.

• There is concern about the potential for hydraulic fracturing for oil and gas extraction to contaminate local water resources due to improperly managed surface or casing operations.

• There are several small rural drinking water systems within the region. These small systems face challenges in financing infrastructure maintenance and upgrades and complying with water quality monitoring and training standards. The maintenance, upgrades, training, operation, and monitoring that is required to ensure delivery of water that meets drinking water quality standards is a financial and logistical challenge for these small systems.

• Water quality in the San Juan and Animas River continues to be a source of concern within the region. A recent study analyzed samples collected from four sites on the San
San Juan and Animas rivers in San Juan County and one at the Colorado-New Mexico border. Results from two years of data found human feces bacteria was the most common bacterium (SJSWCD et al., 2015).

- Sedimentation within the San Juan River basin continues to be a challenge for water suppliers. During rain and flood events, ephemeral tributaries such as Canon Largo may contribute substantial amounts of sediments into the rivers.

- In 2007 the USBR completed a Hydrologic Determination of Water Availability from Navajo Reservoir and the Upper Colorado River Basin for Use in New Mexico (USBR, 2007). The Hydrologic Determination was made for the purpose of contracting for water from the Navajo Reservoir water supply for the Navajo Nation's uses in New Mexico under the NGWSP as required by Section 11(a) of Public 87-483. Based on the Hydrologic Determination, depletions from the flow of the Colorado River at Lee Ferry by the Upper Basin states can be reasonably allowed to rise to an annual average of 5.76 million (M) acre-feet excluding evaporation from Colorado River Storage Project (CRSP) storage unit reservoirs other than Navajo Reservoir. As part of the Hydrologic Determination, New Mexico’s Upper Basin allocation was determined to be at least 642,380 ac-ft/yr excluding the State’s share of reservoir evaporation from CRSP storage unit reservoirs (Lake Powell, Flaming Gorge Reservoir, and the Aspinall Unit). In 2006 the Upper Colorado River Commission (UCRC) approved a resolution stating that while it disagrees with some of the assumptions contained in a draft of the Hydrologic Determination, the UCRC does not object to a finding that the yield available for development by the Upper Basin is at least 5.76M ac-ft/yr, excluding reservoir evaporation at Lake Powell, Flaming Gorge Reservoir, and the Aspinall Unit reservoirs of the CRSP (UCRC, 2006).

5.1 Summary of Climate Conditions

The 2003 RWP (SJWC, 2003) included an analysis of historical temperature and precipitation in the region. This section provides an updated summary of temperature, precipitation, snowpack conditions, and drought indices pertinent to the region (Section 5.1.1). Studies relevant to climate change and its potential impacts to water resources in New Mexico and the San Juan Basin region are discussed in Section 5.1.2.

5.1.1 Temperature, Precipitation, and Drought Indices

Table 5-1 lists the periods of record for weather stations in the San Juan River basin in San Juan, Rio Arriba, and McKinley counties, and it identifies two stations (Dulce and Otis) that were used for detailed analysis of weather trends in the region. These two stations were selected based on location, how well they represented conditions in their respective counties, and completeness of their historical records. In addition to the climate stations, data available from two snow course
or snowpack telemetry (SNOTEL) stations were used to document snowfall in the Chuska Mountains in the southwestern part of the region (Table 5-1). The locations of the climate stations for which additional data were analyzed are shown in Figure 5-1.

Long-term minimum, maximum, and average temperatures for the Dulce and Otis weather stations are detailed in Table 5-2, and average summer and winter temperatures for each station for each year of record are shown on Figure 5-2.

The average precipitation distribution across the entire region is shown on Figure 5-3, and Table 5-2 lists the minimum, maximum, and long-term average annual precipitation (rainfall and snowfall) at Dulce and Otis. The long-term averages do not reflect the considerable variability of precipitation, which creates a direct challenge for water supply planning. The variability in total annual precipitation for the two selected climate stations is shown in Figure 5-4 and is also reflected in the snow data and drought indices discussed below. Monthly variability in precipitation and resulting streamflow also may affect the availability of water at times when water is most needed for agriculture or other uses.

The Natural Resources Conservation Service (NRCS) operates two snow course stations in the planning region (in the Chuska Mountains in southwestern San Juan County [Figure 5-1]), at which snow depth and snow water equivalent data have been collected (Figure 5-5) (NRCS, 2014a).

- Hidden Valley snow course station
- Missionary Spring snow course station

The snow water equivalent is the amount of water, reported in inches, within the snowpack, or the amount of water that would result if the snowpack were instantly melted (NRCS, 2014b). The end of season snowpack is a good indicator of the runoff that will be available to meet water supply needs. A summary of the early April (generally measured within a week of April 1) snow depth and snow water equivalent information at the two stations is provided on Figure 5-5. The snowpack at these two stations is an indicator only of the runoff that might be available to meet water supply needs on the Navajo Reservation that are supplied from runoff in the Chuska Mountains. It is not an indicator of runoff from the San Juan Mountains in Colorado into the San Juan, Animas, or La Plata rivers.

Another way to review long-term variations in climate conditions is through drought indices. A drought index consists of a ranking system derived from the assimilation of data—including rainfall, snowpack, streamflow, and other water supply indicators—for a given region. The Palmer Drought Severity Index (PDSI) was created by W.C. Palmer (1965) to measure the variations in the moisture supply and is calculated using precipitation and temperature data as well as the available water content of the soil. Because it provides a standard measure that
allows comparisons among different locations and months, the index is widely used to assess the weather during any time period relative to historical conditions. The PDSI classifications for dry to wet periods are provided in Table 5-3.

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

The PDSI is calculated for climate divisions throughout the United States. All four counties in the planning region fall primarily within New Mexico Climate Division 1 (the Northwestern Plateau Climate Division); small portions of the southeastern and eastern edges of the region, in McKinley, Sandoval, and Rio Arriba counties, fall within Division 2 (the Northern Mountains Climate Division) (Figure 5-1). Figure 5-6 shows the long-term PDSI for these two regions. Of interest are the large variations from year to year in both divisions, which are similar in pattern though not necessarily in magnitude.

The chronological history of drought, as illustrated by the PDSI, indicates that the most severe droughts in the last century occurred in the early 1900s, the 1950s, the early 2000s, and in recent years (2011 to 2013) (Figures 5-6a and 5-6b).

The likelihood of drought conditions developing in New Mexico is influenced by several weather patterns:

- **El Niño/La Niña:** El Niño and La Niña are characterized by a periodic warming and cooling, respectively, of sea surface temperatures across the central and east-central equatorial Pacific. Years in which El Niño is present are more likely to be wetter than average in New Mexico, and years with La Niña conditions are more likely to be drier than average, particularly during the cool seasons of winter and spring. This is not the case for Colorado as there is little to no correlation between a strong El Niño and above average snowpack in the Upper Animas, San Juan, or La Plata basins, which head in the San Juan Mountains of southwest Colorado.

- **The Pacific Decadal Oscillation (PDO):** The PDO is a multi-decadal pattern of climate variability caused by shifting sea surface temperatures between the eastern and western Pacific Ocean that cycle approximately every 20 to 30 years. Warm phases of the PDO (shown as positive numbers on the PDO index) correspond to El Niño-like temperature and precipitation anomalies (i.e., wetter than average), while cool phases of the PDO
(shown as negative numbers on the PDO index) correspond to La Niña-like climate patterns (drier than average). It is believed that since 1999 the planning region has been in the cool phase of the PDO.

- **The Atlantic Multidecadal Oscillation (AMO):** The AMO refers to variations in surface temperatures of the Atlantic Ocean which, similarly to the PDO, cycle on a multi-decade frequency. The pairing of a cool phase of the PDO with the warm phase of the AMO is typical of drought in the southwestern United States (McCabe et al., 2004; Stewart, 2009). The AMO has been in a warm phase since 1995. It is possible that the AMO may be shifting to a cool phase but the data are not yet conclusive.

- **The North American Monsoon** is characterized by a shift in wind patterns in summer, which occurs as Mexico and the southwest U.S. warm under intense solar heating. As this happens, the flow reverses from dryland areas to moist ocean areas. Low-level moisture is transported into the region primarily from the Gulf of California and eastern Pacific. Upper-level moisture is transported into the region from the Gulf of Mexico by easterly winds aloft. Once the forests of the Sierra Madre Occidental green up from the initial monsoon rains, evaporation and plant transpiration can add additional moisture to the atmosphere that will then flow into the region. If the Southern Plains of the U.S. are unusually wet and green during the early summer months, that area can also serve as a moisture source. This combination causes a distinct rainy season over large portions of western North America (NWS, 2015).

### 5.1.2 Recent Climate Studies

New Mexico’s climate has historically exhibited a high range of variability. Periods of extended drought interspersed with relatively short-term, wetter periods are common. Historical periods of high temperature and low precipitation have resulted in high demands for irrigation water and higher open water evaporation and riparian evapotranspiration. In addition to natural climatic cycles (i.e., el Niño/la Niña, PDO, AMO [Section 5.1.1]) that affect precipitation patterns in the southwestern United States, there has been considerable recent research on potential climate change scenarios and their impact on the Southwest and New Mexico in particular.

The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) that was released in September 2013 states, “Warming of the climate system is unequivocal, and since the 1950s many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased” (IPCC, 2013). Atmospheric concentrations of greenhouse gases are rising so quickly that all current climate models project significant warming trends over continental areas in the 21st century.
In the United States, regional assessments conducted by the U.S. Global Change Research Program (USGCRP) have found that temperatures in the southwestern United States have increased markedly in recent decades. Since the 1950s, the region has been hotter than any comparably long period in at least 600 years. Temperatures are predicted to continue to increase, and serious water supply challenges are expected. Water supplies are projected to become increasingly scarce, calling for trade-offs among competing uses and potentially leading to conflict (USGCRP, 2009). Most of the major river systems of the southwestern U.S. are expected to experience reductions in streamflow and other limitations to water availability (Garfin et al., 2013).

Although there is consensus among climate scientists that global temperatures are warming, there is considerable uncertainty regarding the specific spatial and temporal impacts that can be expected. To assess climate trends in New Mexico, the NMOSE and NMISC (2006) conducted a study of observed climate conditions over the past century and found that observed wintertime average temperatures had increased statewide by about 1.5°F since the 1950s. A number of other studies predict temperature increases in New Mexico from 5° to 10°F by the end of the century (Forest Guild, 2008; Hurd and Coonrod, 2008; USBR, 2011). Predictions of annual precipitation are subject to greater uncertainty “given poor representation of the North American monsoon processes in most climate models” (NMOSE/NMISC, 2006).

Recent studies in Colorado indicate that warmer temperatures are expected to increase sublimation from snowpack and increase evapotranspiration (Lukas et al., 2014). In the San Juan Basin planning region streamflow is expected to decrease as a result, though there is considerable variability in modeled predictions.

Based on these studies, the effects of climate change that are likely to occur in the planning region include (NMOSE/NMISC, 2006):

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

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

To minimize the impact of these changes, it is imperative that New Mexico plan for dealing with variable water supplies, including focusing on drought planning and being prepared to maximize storage from extreme precipitation events while minimizing their adverse impacts.

5.2 Surface Water Resources

Surface water supplies approximately 99 percent of the water currently diverted in the San Juan Basin Water Planning Region, with its primary uses being for irrigated agriculture, power, and public water supply. Most of the drinking water in the region comes from surface water. The Cities of Farmington and Aztec and several other domestic water providers divert water from the Animas River. The City of Bloomfield and other domestic water providers divert water from the San Juan River. The Navajo Tribal Utility Authority (NTUA) may divert water for municipal and domestic purposes from the San Juan River near Shiprock or from the Animas River through the City of Farmington’s water diversion, treatment, and distribution system to which Navajo Nation pipelines are connected.

The dominant waterways and tributaries flowing in the region are the San Juan River and its tributaries the Animas River, Canon Largo, Chaco River, and La Plata River. Major surface drainages (including both perennial and intermittent streams) and watersheds in the planning region are shown on Figure 5-7. When evaluating surface water information, it is important to note that streamflow does not necessarily represent available supply, as water storage in Navajo Reservoir and other reservoirs has been developed to allow water demands under relatively junior water rights to be met during periods of extreme low flows in the San Juan and Animas rivers. The administrative water supply discussed in Section 5.5 is intended to represent supply considering both physical and legal limitations. The information provided in this section is intended to illustrate the variability and magnitude of streamflow, and particularly the relative magnitude of streamflow in recent years.
Tributary flow is not monitored in every subwatershed in the planning region. However, streamflow data are collected by the USGS and various cooperating agencies at stream gage sites in the planning region. Table 5-4a lists the locations and periods of record for data collected at stream gages in the region, as well as the drainage area and estimated irrigated acreage for surface water diversions upstream of the station. Table 5-4b provides the minimum, median, and maximum annual yield for all gages that have 10 or more years of record. In addition to the large variability in annual yield, streamflow also varies from month to month within a year, and monthly variability or short-term storms can have flooding impacts, even when annual yields are low. Table 5-5 provides monthly summary statistics for each of the stations with 10 or more years of record. Most of the streamflow in the San Juan basin in New Mexico is a result of snowmelt runoff during the March to June period.

For this water planning update, five stream gages, shown on Figure 5-7, were analyzed in more detail. These stations were chosen because of their locations in the hydrologic system, completeness of record, and representativeness as key sources of supply. Figure 5-8 shows the minimum and median annual water yield for these gages. Figures 5-9a through 5-9c show the annual water yield from the beginning of the period of record through 2013 for the five gages. As shown in these figures, streamflow varies greatly from year to year, with the highest-flow years supplying many times more water than the drier years. Figures 5-9a through 5-9c illustrate that streamflow in most years since 2000 has been below average.

Several lakes and reservoirs are present in the planning region (Figure 5-7). Table 5-6 summarizes the characteristics of the larger lakes and reservoirs (i.e., storage capacity greater than 5,000 acre-feet, as reported in the NMOSE Water Use by Categories report [Longworth et al., 2013]).

- As indicated on Table 5-6, Navajo Reservoir on the San Juan River, constructed in 1963, is operated by the USBR and is the main storage facility for surface water in the area, with a capacity of 1.7M acre-feet. The Navajo Reservoir water supply is contracted for uses by the Navajo Nation under the Navajo Indian Irrigation Project (NIIP) and the NGWSP, and for uses by the Jicarilla Apache Nation, which include Jicarilla uses under the NGWSP in addition to currently subcontracted uses for the Public Service Company of New Mexico (PNM) at the San Juan Generating Station (SJGS) and the City of Gallup under the NGWSP.

- Morgan Lake, with a capacity of about 42,800 acre-feet, is filled by diversions from the San Juan River and is operated by the Arizona Public Service Company (APSCo ) to store water for use in the generation of thermal electric power at the Four Corners Power Plant (FCPP).
Farmington Lake, with a capacity of under 6,900 acre-feet, is filled by diversions from the Animas River and is the principal water storage facility of the City of Farmington.

In addition, Lake Nighthorse in Colorado is the ALP storage facility from which ALP diversion demands in New Mexico can be met when the available natural flow in the Animas River is not sufficient to meet these demands.

In addition to the reservoirs shown in Table 5-6, several smaller lakes and reservoirs are present in the region; information on these smaller reservoirs was included in the 2003 RWP (SJWC, 2003).

The NMOSE conducts periodic inspections of non-federal dams in New Mexico to assess dam safety issues. Dams that equal or exceed 25 feet in height that impound 15 acre-feet of storage or dams that equal or exceed 6 feet in height and impound at least 50 acre-feet of storage are under the jurisdiction of the State Engineer. These non-federal dams are ranked as being in good, fair, poor, or unsatisfactory condition. Dams with unsatisfactory conditions are those that require immediate or remedial action. Dams identified in recent inspections as being deficient, with high or significant hazard potential, are summarized in Table 5-7.

There are three dams with high hazard potential (Farmington Lake Dam, Jackson Lake Dam, and Thirtieth Street Dam). The high hazard potential is related to dams where failure would likely result in loss of human life needed maintenance, seepage, woody vegetation, and a lack of design information.

Several San Juan Stream Improvement projects were implemented in the river reaches below the Navajo Dam between 2005 and 2011 to improve flows and habitat for fish (Float ‘n Fish, 2015).

### 5.3 Groundwater Resources

Groundwater accounted for only about 1 percent of all water diversions in the year 2010 (Longworth et al., 2013). Even though it is a small portion of the water supply, the 2003 RWP (SJWC, 2003) indicated a need to develop backup groundwater supplies in some locations to provide a buffer for potential drought conditions.

#### 5.3.1 Regional Hydrogeology

The geology that controls groundwater occurrence and movement within the planning region was described in the 2003 RWP (SJWC, 2003), based on studies by Phillips et al. (1984), Stone et al. (1983), Kernodle (1996), and Levinge et al. (1996). A map illustrating the surface geology of the planning region, derived from a geologic map of the entire state of New Mexico by the New Mexico Bureau of Geology & Mineral Resources (2003), is included as Figure 5-10a. The Colorado Plateau is the only physiographic region to exist within the planning region (Hawley, 1986). Two important characteristics of the hydrogeologic system in the San Juan Basin are
horizontal flow through aquifer sandstones and, to a smaller extent, vertical flow through the intercalated shale aquitards (Dam, 1995; Kernodle, 1996; Levings et al., 1996; Lorenz and Cooper, 2003).

5.3.2 Aquifer Conditions

As reported in the 2003 RWP (SJWC 2003), the Ojo Alamo Sandstone is the aquifer with the highest potential to supply adequate groundwater for use by the metropolitan areas along the San Juan River. This aquifer produced a median flow rate of 12 gallons per minute (gpm) in 19 wells that were tested. Further aquifer characteristics have been discussed in the 2003 RWP (SJWC, 2003).

The Morrison Formation is another major aquifer in the San Juan Structural Basin. It is a non-Marine sandstone, mudstone, shale, with some limestone from the Jurassic age. It is also a source of uranium. This aquifer has a median production flow rate of 30 gpm, based on the review of 83 wells; further discussion is provided in the accepted water plan (San Juan Water Commission, 2003).

In order to evaluate changes in water levels over time, the USGS monitors groundwater wells throughout New Mexico (Figure 5-11). Hydrographs illustrating groundwater levels versus time, as compiled by the USGS (2014b), were selected for five monitor wells with longer periods of record and are shown on Figure 5-12. These hydrographs indicate that water levels are decreasing in some wells and increasing in others. It is important for individual groundwater users to monitor their water levels in relation to the entire water column available, but declining water levels in not a regional issue in the San Juan Basin.

Recharge of the aquifers in the San Juan Structural Basin generally occurs in the topographically high outcroppings along the basin margin. Discharge occurs generally in the low elevations within the basin, specifically to the San Juan River in the northwest portion of the region. Because much of the groundwater is confined, precipitation must fall on the outcrop of the geologic unit and then travel downgradient to the saturated aquifer level for recharge to occur; therefore, groundwater recharge from precipitation is minimal. A 1996 USGS modeling study used a steady-state flow model to estimate recharge in the San Juan Structural Basin (Kernodle, 1996). The model indicates that the recharge rate ranges between 0.1 and 0.8 inch per year. According to the 2003 RWP (SJWC, 2003), the average recharge rate is 0.14 inch per year or about 1 percent of the yearly precipitation.

With groundwater providing only 1 percent of the water supply, there are no major well fields in the region.
5.4 Water Quality Assessment

Assurance of ability to meet future water demands requires not only water in sufficient quantity, but also water that is of sufficient quality for the intended use. This section summarizes the water quality assessment that was provided in the accepted regional water plan and updates it to reflect new studies of surface and groundwater quality and current databases of contaminant sources. The identified water quality concerns should be a consideration in the selection of potential projects, programs, and policies to address the region’s water resource issues.

Surface water quality in the San Juan Basin Water Planning Region is evaluated through periodic monitoring and comparison of sample results to pertinent water quality standards. Several reaches of the San Juan, La Plata, and Animas rivers, as well as several lakes, have been listed on the 2012-2014 New Mexico 303(d) list (NMED, 2014a). This list is prepared by NMED to comply with Section 303(d) of the federal Clean Water Act, which requires each state to identify surface waters within its boundaries that are not meeting or not expected to meet water quality standards.

Section 303(d) further requires the states to prioritize their listed waters for development of total maximum daily load (TMDL) management plans, which document the amount of a pollutant a waterbody can assimilate without violating a state water quality standard and allocates that load capacity to known point sources and nonpoint sources at a given flow. Figure 5-13 shows the locations of lakes and stream reaches with impaired water quality; Table 5-8 provides details of impairment for those reaches. Specific pollutants identified include E. coli, temperature, sediment/turbidity, nutrients, biological indicators, phosphorus, selenium, dissolved oxygen, and mercury in fish tissue.

In evaluating the impacts of the 303(d) list on the regional water planning process, it is important to consider the nature of water quality impairment and its effect on potential use. Problems such as stream bottom deposits and turbidity will not necessarily make the water unusable for irrigation or even for domestic water supply (if the water is treated prior to use). However, the presence of the impaired reaches illustrates the degradation that can occur in the water supply, and some of these impairments can be very disruptive to a healthy aquatic community.

Specific sources that have the potential to impact either surface or groundwater quality in the future are discussed below. Sources of contamination are considered as one of two types: (1) point sources (Section 5.4.1), if they originate from a single location, or (2) nonpoint sources (Section 5.4.2), if they originate over a more widespread or unspecified location. Information on both types of sources is provided below.
5.4.1 Point Sources

Point source discharges to surface water must comply with the Clean Water Act and the New Mexico Water Quality Standards (20 NMAC 6.4.1) by obtaining a National Pollutant Discharge and Elimination System (NPDES) permit to discharge. NPDES-permitted discharges in the planning region are summarized in Table 5-9 and shown on Figure 5-14. Many of the discharges are wastewater treatment plants but there are also three coal mine discharge permits.

The NMED Ground Water Bureau regulates facilities with wastewater discharges that have a potential to impact groundwater quality. These facilities must comply with the New Mexico Water Quality Act (NMSA 1978, §§ 74-6-1 through 74-6-17) and the New Mexico Water Quality Control Commission (NMWQCC) regulations (NMWQCC, 2002) and obtain approval of a discharge plan, which provides for measures needed to prevent and detect groundwater contamination. A variety of facilities fall under the discharge plan requirements, including mines, sewage dischargers, dairies, food processors, sludge and septage disposal facilities, and other industries. The NMWQCC regulations contain requirements for cleanup of any groundwater contamination detected under discharge plan monitoring requirements. Until such cleanup is complete, these facilities may impact the availability of water supplies of sufficient quality for intended uses. Details indicating the status, waste type, and treatment for individual discharge plans can be obtained from the NMED Ground Water Bureau website (http://www.nmenv.state.nm.us/gwb/). A summary list of current discharge plans in the planning region is provided in Table 5-10; their locations are shown in Figure 5-14.

The region contains one site, the Lee Acres Landfill, listed by the U.S. EPA (2014) as a Superfund site (Table 5-11).

Leaking underground storage tank (UST) sites present a potential threat to groundwater, and the NMED maintains a database of registered USTs. Many of the facilities included in the NMED UST database are not leaking, and even leaking USTs may not necessarily have resulted in groundwater contamination or water supply well impacts. These USTs could, however, potentially impact groundwater quality in and near the population centers in the future. UST sites in the San Juan Basin region are identified on Figure 5-14. Many of the UST sites listed in the NMED database require no further action and are not likely to pose a water quality threat. Sites that are being investigated or cleaned up by the state or a responsible party, as identified on Table 5-12, should be monitored for their potential impact on water resources. Additional details regarding any groundwater impacts and the status of site investigation and cleanup efforts for individual sites can be obtained from the NMED database, which is accessible on the NMED website (http://www.nmenv.state.nm.us/ust/ustbttop.html).

Landfills used for disposal of municipal and industrial solid waste can contain a variety of potential contaminants that may impact groundwater quality. Landfills operated since 1989 are
regulated under the New Mexico Solid Waste Management Regulations. Many small landfills throughout New Mexico, including landfills in the planning region, closed before the 1989 regulatory enactment to avoid more stringent final closure requirements. Other landfills have closed as new solid waste regulations became effective in 1991 and 1995. Within the planning region, there are two closed and one operating landfills (Table 5-13, Figure 5-14).

5.4.2 Nonpoint Sources

Nonpoint sources of pollutants that are concerns for surface water quality in the planning region include wildfires, grazing, agriculture, recreation, hydromodification, streambank destabilization/modification, removal of riparian vegetation, road and highway maintenance, silvicultural activities, land disposal, resource extraction, road runoff, septic tanks, and natural and unknown sources (Table 5-8).

One approach to addressing nonpoint source pollution is through Watershed Based Planning or other watershed restoration initiatives that seek to restore riparian health and to address sources of contamination. Nonpoint source projects completed in the past few years include:

- Microbial source tracking within the San Juan watershed to identify sources of bacteria and nutrient pollution in the Animas and San Juan rivers
- Watershed planning for the Animas River, namely to reduce pollutant loads in the watershed
- The La Plata river riparian restoration which is designed to increase capacity in the floodplain and maintain water levels for wildlife
- Sediment reduction in the Largo Canyon under the Carrizo Watershed Cooperative Conservation Partnership Initiative
- Management of the invasion of woody vegetation along river corridors, a project with the U.S. Forest Service
- Restoration projects identified by the San Juan Soil & Water Conservation District as needed in the San Juan, La Plata, Carrizo, and Animas watersheds
- The San Juan Basin Watershed Management Plan (SJBWMP) (San Juan Watershed Group, 2005), completed in 2005

Though there is little groundwater use in the region, groundwater contamination due to septic tanks may be a concern in areas with shallow water tables (NMWQCC, 2002), contributing increased concentrations of:
- Total dissolved solids (TDS)
- Iron, manganese, and sulfides (anoxic contamination)
- Nitrate
- Potentially toxic organic chemicals
- Bacteria, viruses, and parasites (microbiological contamination)

Because septic systems are generally spread out over rural areas, they are considered a nonpoint source. Collectively, septic tanks and other on-site domestic wastewater disposal systems constitute the single largest known source of groundwater contamination in New Mexico (NMWQCC, 2002), with many of these occurrences in areas with shallow water tables.

Another potential nonpoint source concern in the San Juan Basin region is water quality contamination from produced water. A 2006 study that evaluated geology and water chemistry from oil and gas wells in the region illustrated the high density of active wells (Simpson, 2006). Careful management of surface and downhole operations is important for water quality protection. The report indicated that four modeled formations—the Fruitland, Pictured Cliffs, Mesa Verde, and Dakota—all had high TDS levels. The occurrence of high TDS is largely a natural phenomenon, but is important to consider if additional groundwater use is considered. The report indicated that costs for hauling produced water to common treatment sites could be reduced with on-site treatment.

Salinity is also a nonpoint source issue in the San Juan Basin. The United States must comply with streamflow salinity standards for the Colorado River set by Minute 242 of the 1944 Mexican Water Treaty. The Colorado River Basin Salinity Control Forum assists in the evaluation and implementation of federal salinity-control measures upstream of Imperial Dam in Arizona that are meant to offset the impacts of water development on salinity of the Colorado River. The Forum also develops recommended salinity standards for the Colorado River system, and the New Mexico Water Quality Control Commission (NMWQCC) has adopted the salinity standards recommended by the Forum for the San Juan River and its tributaries within New Mexico.

### 5.5 Available Water Supply

The *Updated Regional Water Planning Handbook* (NMISC, 2013) describes a technical platform for analyzing the water supply in each water planning region, but recognizes that other methods can be used to account for supply and demand. The regional water plan updates for other water planning regions in New Mexico present an analysis of the administrative water supply for the region using the technical platform described in the handbook, which is intended to represent supply considering both physical and legal limitations based on estimates of recent diversion amounts. However, this plan for the San Juan Basin Water Planning Region does not
incorporate the technical platform described in the handbook because it does not adequately address the following:

- The substantial reservoir storage capacity that was developed to allow the water in the San Juan River Basin to be used
- Authorized full development of federal water supply projects
- Actual diversion practices and reservoir operations on the San Juan and Animas rivers
- The water apportionments made to New Mexico by the Colorado River and Upper Colorado River Basin compacts

Because of these circumstances, the long-term amount of water from the San Juan River stream system that is available for use in New Mexico in normal (non-drought) years far exceeds the estimates of administrative water supply and severe drought-corrected administrative water supply that would be calculated using the technical platform described in the handbook.

5.5.1 Normal Year Water Supply

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

- The Upper Basin was apportioned the consumptive use of 7.5M acre-feet of water per year from the Colorado River system.
- The states of the Upper Division (New Mexico, Colorado, Utah, and Wyoming) will not cause the flow of the Colorado River at Lee Ferry to be depleted below an aggregate of 75,000,000 acre-feet in any period of ten consecutive years.
- The states of the Upper Division shall deliver at Lee Ferry additional water to supply one-half of any deficiency in the amount of surplus water available for delivery to Mexico under the 1944 Mexican Water Treaty.

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

5.5.2 Drought Supply

The variability in surface water supply over a multi-year period for a region with a large water supply reservoir is a good indicator of how vulnerable a planning region is to drought. There is no established method or single correct way of quantifying a drought supply given the complexity associated with varying levels of drought and constantly fluctuating water supplies. For purposes of having an estimate of drought supplies for the San Juan Basin Planning Region, the state has adopted the following method:

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

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