CHAPTER 3
AFFECTED ENVIRONMENT

INTRODUCTION

This chapter describes the setting of the planning area and the current condition of the environment by resource. This information provides the basis for evaluating potential changes in land management under each alternative.

CLIMATE

The climate of the planning area is classified as arid Continental, characterized by cool, dry winters and warm dry summers. The large distance from any source of oceanic moisture creates a climate of abundant sunshine and large diurnal variations in temperature.

Due to its location in the Southern Rocky Mountains, wintertime Pacific storm systems borne by westerly winds lose much of their moisture prior to passing through the region. The peak precipitation season occurs during late summer and early fall, when moisture moves into the region from the Gulf of Mexico in association with the western extension of the Bermuda High. Data from the New Mexico State University Agricultural Science Center at Farmington from 1978 through 2000 are used to characterize the planning area climate (WRCC 2001). However, the more mountainous and elevated portions of the project region experience wetter and colder conditions than those that occur at Farmington.

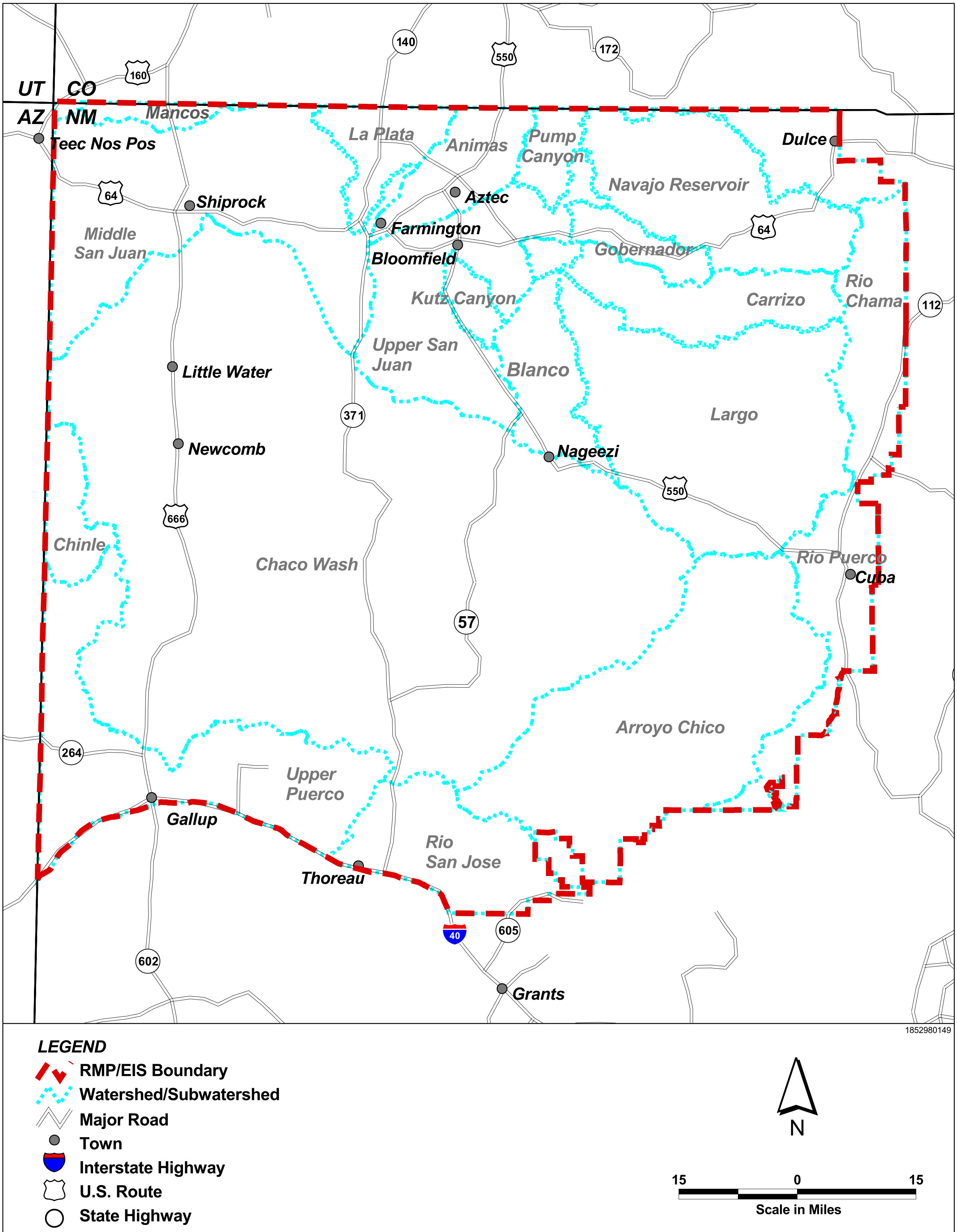
The annual precipitation at Farmington is 8.8 inches. The driest and wettest months are June and August, when 0.3 and 1.2 inches of rain occur, respectively. The average high and low temperatures at Farmington in August are 90 and 59 degrees Fahrenheit (° F), respectively. The January average high and low temperatures are 42 and 19° F.

The large-scale winds within the region tend to prevail from the southwest and westerly directions during the daytime hours for much of the year. However, local wind conditions can vary substantially from this general pattern throughout the planning area, due to the effects of topography channeling and mountain-valley circulations. For example, data collected at the New Mexico Air Quality Bureau (NMAQB) Bloomfield air quality monitoring station shows a high frequency of easterly and westerly winds (NMAQB 1997). This is due to the presence of the east-west aligned San Juan River Valley, which forces winds up the valley during daytime heating and down the valley at night, as cold air drains down this topographic depression. Additionally, winds at this station prevail from the north in association with nighttime drainage winds that flow down the localized sloping terrain at this site.

TOPOGRAPHY AND WATERSHEDS

Extremes in topographic relief exist in the planning area, including areas of broad mesas interspersed with many deep canyons with steep canyon walls, dry washes, entrenched narrow valleys, and alluvial fans and floodplains, extending on both sides of the Continental Divide. Elevations range from approximately 4,800 feet, where the San Juan River flows into Utah, to approximately 9,400 feet in the Chuska Mountains, 8,800 feet near the Jicarilla Apache land, and 7,300 feet near Cuba on the eastern side of the Continental Divide.

The planning area has been divided into watersheds for characterizing topography, soils, vegetation, and water resources. The watersheds were generated based on the Hydrologic Units (4th level) delineated by the USGS, with some subwatersheds further subdivided as necessary to correspond to the management units used by FFO staff in managing natural resources. **Map 3-1** shows the location and extent of the watersheds and subwatersheds delineated in the planning area. In the text, the term "watershed" is used to apply to the smallest named unit and could refer to either a watershed or subwatershed.



Map 3-1: Watersheds and Subwatersheds in the Planning Area

A list of the watershed names, acreage, average slopes, existing wells, road density, and surface disturbance due to roads and wells in each watershed is shown in **Table 3-1**.

Table 3-1. Watersheds in the Planning Area

Watershed Name	Acres	Acres Disturbed	Existing Wells	Percent Disturbed (roads, wells)	Road Density (mi/mi^2)[1]
Animas	144,584	8,668	1,751	6.0	4.2
Arroyo Chico	782,484	4,912	0	0.6	1.1
Blanco	163,658	5,100	1,041	3.1	2.1
Carrizo	208,825	8,361	1,834	4.0	2.4
Chaco Wash	2,918,965	28,999	30	1.0	1.7
Chinle	92,926	1,228	0	1.3	2.3
Gobernador	71,251	3,202	753	4.5	2.3
Kutz Canyon	41,398	2,262	525	5.5	2.9
La Plata	114,841	3,612	687	3.1	2.4
Largo	723,415	24,667	4,783	3.4	2.5
Mancos	38,028	378	0	1.0	1.8
Middle San Juan	673,450	10,084	600	1.5	2.2
Navajo Reservoir	378,389	7,951	1,334	2.1	1.8
Pump Canyon	61,964	2,493	581	4.0	2.1
Rio Chama	218,452	2,199	52	1.0	1.6
Rio Puerco	234,490	1,838	1	0.8	1.4
Rio San Jose	254,614	3,263	1	1.3	2.3
Upper Puerco	525,711	6,696	3	1.3	2.2
Upper San Juan	657,318	24,978	3,853	3.8	3.5

Source: Derived from USGS digital elevation data and USEPA stream data.
Note: (1) mi/mi^2 = miles per square miles.

Sediment yield is an indicator of the stability of a watershed and the effect surface disturbance would have on water quality. Using a GIS tool called Soil-Water Analysis Tool (SWAT), developed by the Natural Resources Conservation Service (Arnold et al. 2000), sediment yield was calculated for three watersheds in the planning area that represent a range of land uses and surface disturbance. Sediment yield was generated using the current BLM roads coverage. The coverage does not include all of the access roads to individual oil and gas well pads, so actual road density and sediment yield values in the high production oil and gas areas are somewhat higher than calculated, but estimates provide a reasonable basis for evaluating the potential increase in sediment yield as a result of increased surface disturbance if additional wells and roads are installed.

Chaco Wash watershed was selected to represent the part of the planning area with little oil and gas activity and with a lower road density. It is fairly homogenous in land use, mainly rangeland. The Chaco Wash watershed contains 30 wells, and a road density of 1.7 miles per square mile. Approximately 1 percent of its area has surface disturbance due to well pads and roads. The average sediment yield from this watershed is estimated at 5.8 tons/acre/year.

The Pump Canyon watershed was selected to represent an area with urban land uses, agriculture, and oil and gas development. It contains 581 wells and 2.1 miles per square mile of roads. Approximately 4 percent of its area has surface disturbance due to well pads and roads. The average sediment yield from this watershed is estimated at 35.2 tons/acre/year.

The Largo watershed was selected to represent a high intensity oil and gas development area that is mainly woodland and rangeland and extends onto USFS land. It contains 4,783 wells and 2.5 miles per square mile of roads. Approximately 3.4 percent of its area has surface disturbance due to well pads and roads. It is likely that the road density of this watershed is higher, due to the large number of wells, but based on current GIS data the average sediment yield is estimated at 2.1 tons/acre/year.

GEOLOGY AND MINERALS

Physiography and General Geology

Although most of northwestern New Mexico is in the Colorado Plateau, the San Juan Basin is the dominant feature of the planning area. The San Juan Basin is an asymmetrical syncline that extends from northwestern New Mexico into southwestern Colorado. Roughly circular in shape, it is approximately 200 miles long (north to south) and 130 miles wide, including its Colorado portion. The San Juan Basin covers approximately 15,000 to 25,000 square miles. The surficial geology of the San Juan Basin consists primarily of Quaternary to Cretaceous-aged alluvium (unconsolidated silts, sands, clays, and gravels), sandstones, siltstones, shales, limestones, conglomerates, and coal.

The central part of the San Juan Basin is a dissected plateau, gently dipping to the west. Stream erosion has formed deep, steep-sided canyons. Nearly all of the formations in the San Juan Basin can be observed on the surface because of the geologic structure and topographic relief.

Structural Characteristics

The San Juan Basin is bordered on the west by the Defiance Uplift and the Chuska Mountains, on the north by the San Juan dome, on the south by the Chaco slope and the Zuni Uplift, and on the east by the Nacimiento uplift (BLM 2000d) (**Figure 3-1**). The Hogback monocline separates the San Juan Basin to the east from the Four Corners Platform, a structural divide that forms the northwestern border of the San Juan Basin. The Hogback monocline is a horseshoe-shaped feature that rims the San Juan Basin on the northwest and north sides, with a maximum elevational rise of 700 feet above the surrounding area. Its strata dip at moderate angles to the east, southeast, and south. The western flank of the San Juan Basin merges with the eastern edge of the Defiance Uplift of northeastern Arizona. There are no sharp structural boundaries in the southern and southwestern parts of the San Juan Basin. Basement rock outcrops, including the eroded cores of the Zuni, Jemez, and Nacimiento uplifts, form the edge of the San Juan Basin to the south and east.

Cretaceous formations were downwarped into the San Juan Basin during the late Cretaceous until the early Tertiary Laramide tectonic event. By the end of the Laramide uplift, Cretaceous rocks reached their maximum depth of burial, and the San Juan Basin achieved its current structural configuration (**Figure 3-2**). Subsequent regional heating enhanced the thermal maturation of deeply buried organic matter to a level that generated gas in the center of the San Juan Basin and oil at the San Juan Basin margins (Engler et al. 2001). Although there are some anticlinal structures on the margins of the San Juan Basin, hydrocarbons in the San Juan Basin developed in stratigraphic traps.

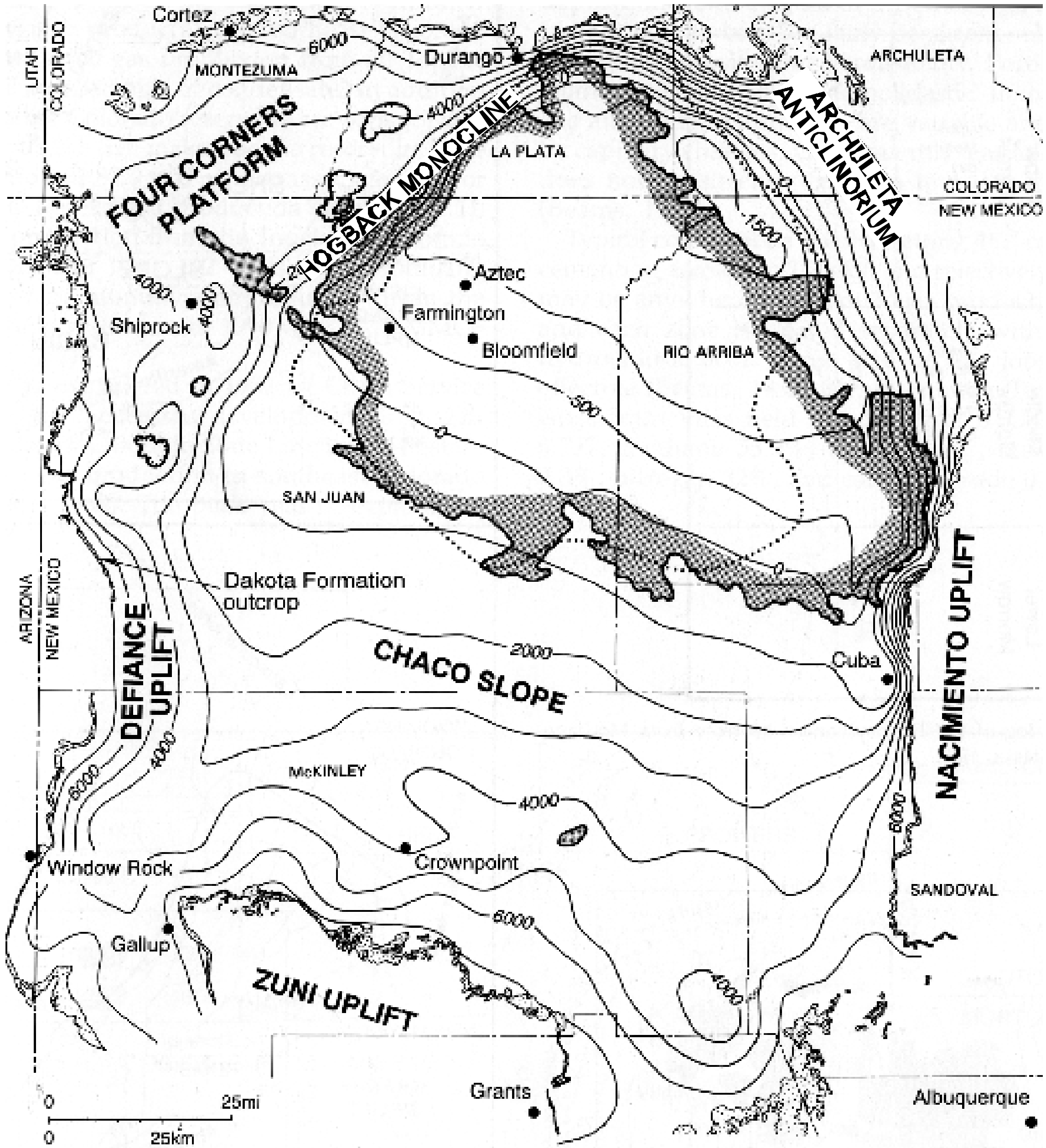


Figure 3-1. Plan View of the San Juan Basin Showing Structural Features

Source: Engler et al. 2001.

Era	System		Formation		Thickness	Production
CENOZOIC	TERTIARY		San Jose Formation		2500 ft.	Gas
			Nacimiento Formation		500-1300 ft.	Gas
			Ojo Alamo Sandstone		250 ft.	Gas
MESOZOIC	CRETACEOUS		Kirtland Shale	Farmington Sandstone	1500 ft.	Gas/Oil
			Fruitland Formation		500 ft.	Gas
			Pictured Cliffs Sandstone		250 ft.	Gas
			Lewis Shale	Huerfanito Bentonite	500-1900 ft.	Gas
		Mesaverde Group	Cliff House Sandstone		0-800 ft.	Gas
		Mesaverde Group	Menefee Formation		350-2200 ft.	Gas
		Mesaverde Group	Point Lookout Formation		100-300 ft.	Gas
		Mancos Shale	Upper Mancos Shale/Tocito Sandstone		2300-2500 ft.	Gas/Oil
		Mancos Shale	Gallup Sandstone/Carlile Shale			Gas/Oil
		Mancos Shale	Greenhorn Limestone			
		Mancos Shale	Graneros Shale			
			Dakota Sandstone		150-200 ft.	Gas/Oil
	JURASSIC		Morrison Formation		400-900 ft.	
			Wanakah Formation	Todilto Limestone	50-200 ft.	
			Entrada Sandstone		100-300 ft.	Oil
	TRIASSIC		Chinle Formation		500-1600 ft.	
PALEOZOIC	PERMIAN		Cutler Formation		1500-2500 ft.	
	PENNSYLVANIAN	Hermosa Formation	Honaker Trail Formation			
		Hermosa Formation	Paradox Formation		200-3000 ft.	Gas?
		Hermosa Formation	Pinkerton Trail Formation			
			Molas Formation		0-100 ft.	
	MISSISSIPPIAN		Leadville Limestone		0-165 ft.	
	DEVONIAN		Elbert Formation		0-325 ft.	
	CAMBRIAN		Ignacio Quartzite		0-100 ft.	
			PRECAMBRIAN			

Figure 3-2. Geologic Time Column of the San Juan Basin

Source: Engler et al. 2001.

Formations dip gently to a low point in the northeastern part of the San Juan Basin (Engler et al. 2001). Dips within the central Basin are generally less than 4 degrees. Dips in the southern flank of the San Juan Basin average approximately 1-1/2 degrees. Around the San Juan Basin's edge in the vicinity of the Hogback monocline, dips are typically 10 to 40 degrees and have been measured up to 60 degrees at the monocline. The change in dip from the monocline to the central portion of the San Juan Basin, locally termed the "flexure" or "hingeline," is abrupt.

Stratigraphy

A cross-sectional view of the San Juan Basin displays the asymmetrical layering of sedimentary rocks that range in age from Cambrian to Quaternary, underlain by Precambrian rocks (**Figure 3-3**). The stratigraphy of the San Juan Basin resulted from inundation by epicontinental seas between periods of major uplift. Depositional environments of the various rock units include deep marine, shoreline, continental, and fluvial. The San Juan Basin was an active seaway connecting the central New Mexico Sea with the Paradox Basin in Utah during most of pre-Permian time. The first downwarping of the San Juan Basin occurred during Pennsylvanian-Permian time as a southeastern depression of the Paradox Basin. Clastic sediments were deposited over a weathered limestone terrace in the resulting sea. The Triassic-Jurassic interval was mainly one of emergence resulting in the deposition of wind-blown sands. Subsequent major downwarping in the Cretaceous resulted in the accumulation of a thick section of sandstone and shales, starting with the Dakota Formation. The Laramide uplift in the late Cretaceous ended the transgression of marine waters. In the Tertiary, the San Juan Mountains to the north and the southern tip of the Rocky Mountains began to erode, supplying the Tertiary sediments that fill the San Juan Basin.

The lithologic units in the San Juan Basin range in age from Cambrian to Quaternary. The lithology of the San Juan Basin includes mainly shales and sandstones of varying grain size but also includes coals, some carbonates, and igneous rocks. Sedimentary rocks display an aggregate thickness of over 14,000 feet near the Colorado-New Mexico state line. The elevation of the top of the Precambrian basement rocks is more than 7,500 feet below sea level at the deepest part of the San Juan Basin. Formations representing the Permian period through the Pennsylvanian period consist mainly of shales and sandstones. The Cretaceous-age rocks represent 6,000 feet of sandstones, siltstones, shales, and coals (Landes 1970).

Primary Hydrocarbon Reservoirs

The predominant hydrocarbon reservoirs of the San Juan Basin are all Cretaceous. These include the Fruitland Formation, Pictured Cliffs Sandstone, Mesa Verde Group, and Dakota Sandstone. These formations contain both source rocks and natural reservoirs for oil and gas. Slow decomposition of plant and animal material within the source rocks resulted in hydrocarbon deposits.

Going down the stratigraphic column in northwestern New Mexico, the first major primary hydrocarbon reservoir is the Fruitland Coal. The Fruitland Formation overlies and interfingers with the Pictured Cliffs Sandstone. The interfingering is due to minor local transgression and regression of the Cretaceous shoreline. The Fruitland Formation consists of coastal swamp, alluvial, and lacustrine deposits that accumulated inland of the prograding and aggrading shoreline deposits of the Picture Cliffs Sandstone. The Fruitland Formation is composed of interbedded sandstones, siltstones, shale, carbonaceous shales, and coal, and contains the coal resources that produce coalbed methane (CBM) as well as mineable coal (Landes 1970).

The Pictured Cliffs Sandstone is a gas reservoir consisting of a shoreline sandstone composed of an upper medium to thick-bedded ledge-forming sandstone and a lower thick, very fine-grained sandstone with interbedded shales and siltstone.

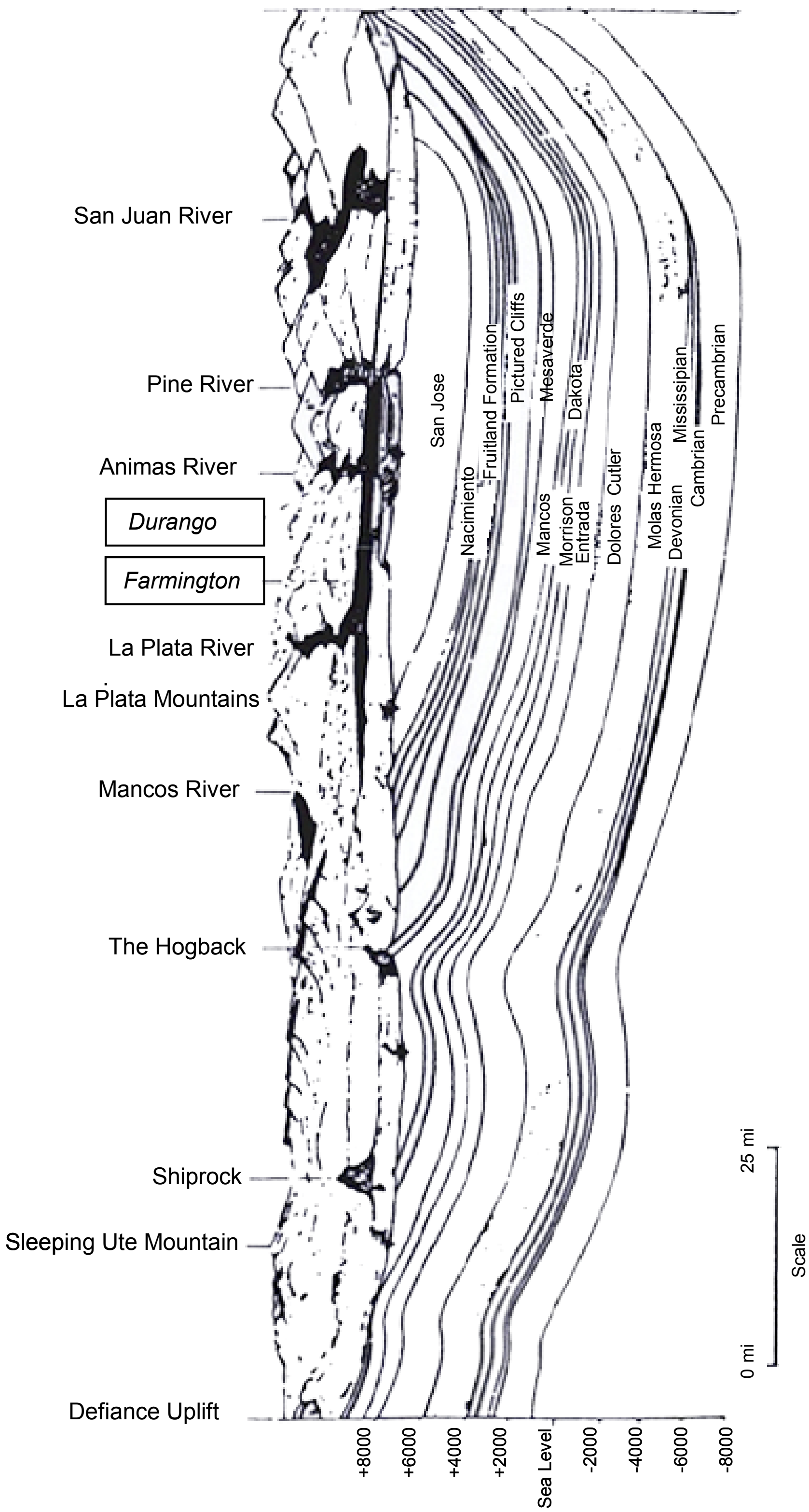


Figure 3-3. Cross-Section of the San Juan Basin

Source: Engler et al. 2001.

The Mesaverde Group is a series of gas reservoirs that represents a single regression and transgression cycle of the epicontinental Cretaceous sea. These are not blanket sands but are discontinuous shoreline deposits. The main gas-producing sandstones are the Cliff House at the top of the group and the Point Lookout at the bottom.

The Dakota Sandstone is a gas reservoir consisting of a transgressive sequence composed of sandstone, shale, minor conglomerates, and coal. The upper sandstones in the Dakota represent shoreline and offshore marine sand deposits.

Minerals

Oil and Gas Resources

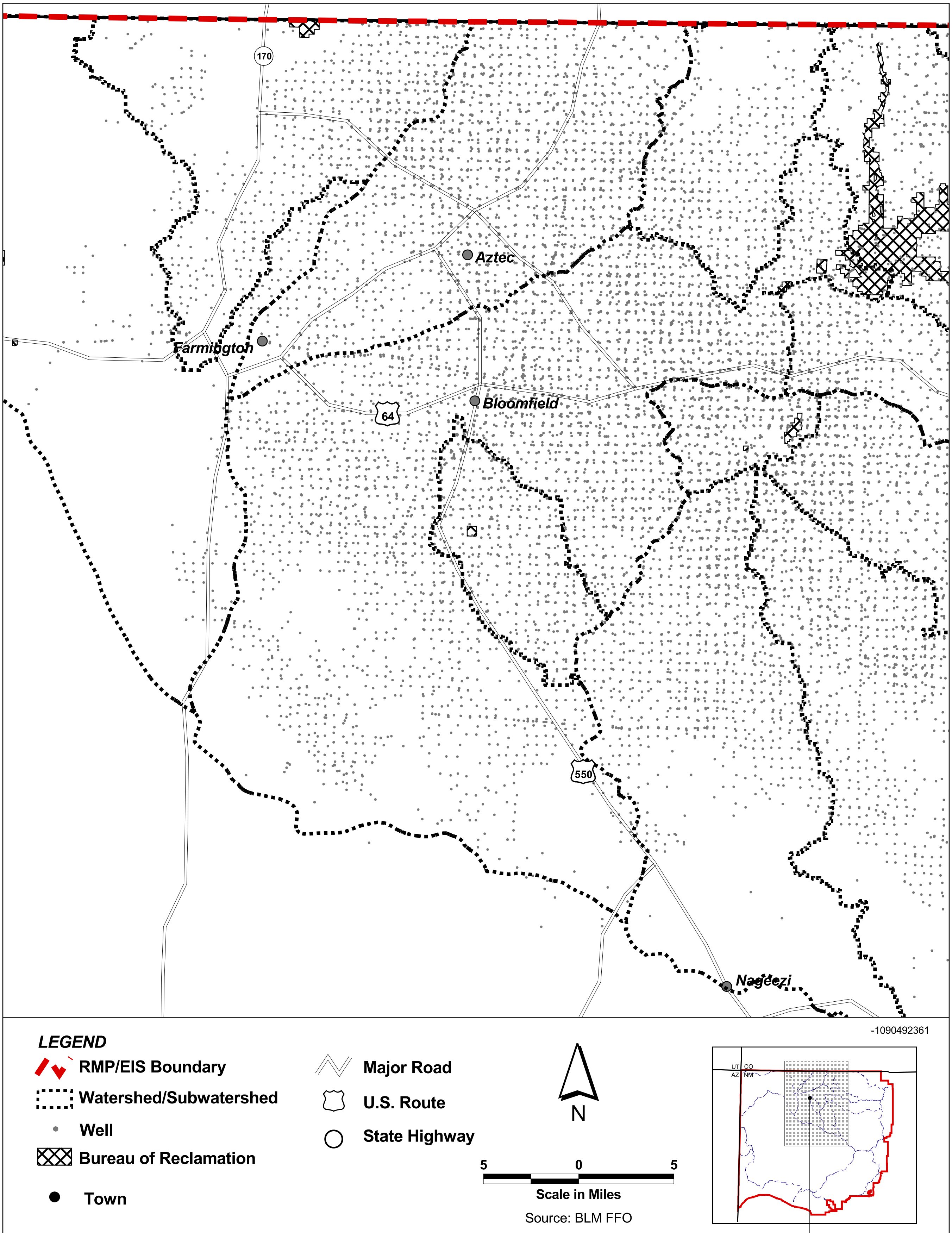
Hydrocarbon production in the planning area consists primarily of natural gas production, CBM production, and a small amount of oil/condensate production. The natural gas production rate from the entire San Juan Basin is approximately 4.0 billion cubic feet per day (Bcfd), as of July 2000 (Engler at al. 2001). The Fruitland Coal, Pictured Cliffs, Mesaverde, and Dakota formations are the primary natural gas-producing formations in the San Juan Basin, although the Fruitland Sand and Chacra also produce notable amounts of natural gas. These formations range in age from 60 to 300 million years before the present time (Tertiary to Pennsylvanian ages).

Conventional (non-coalbed methane) hydrocarbon development began during the 1940s. Natural gas production significantly increased as a result of CBM production from the Fruitland Coal in the late 1980s. Approximately 50 percent of the natural gas produced from wells in the San Juan Basin originates from CBM wells (BLM 1999a). Oil and condensate are produced primarily from the Mancos Shale/Gallup formations; however, condensate is also produced in association with natural gas from the Mesaverde and Dakota.

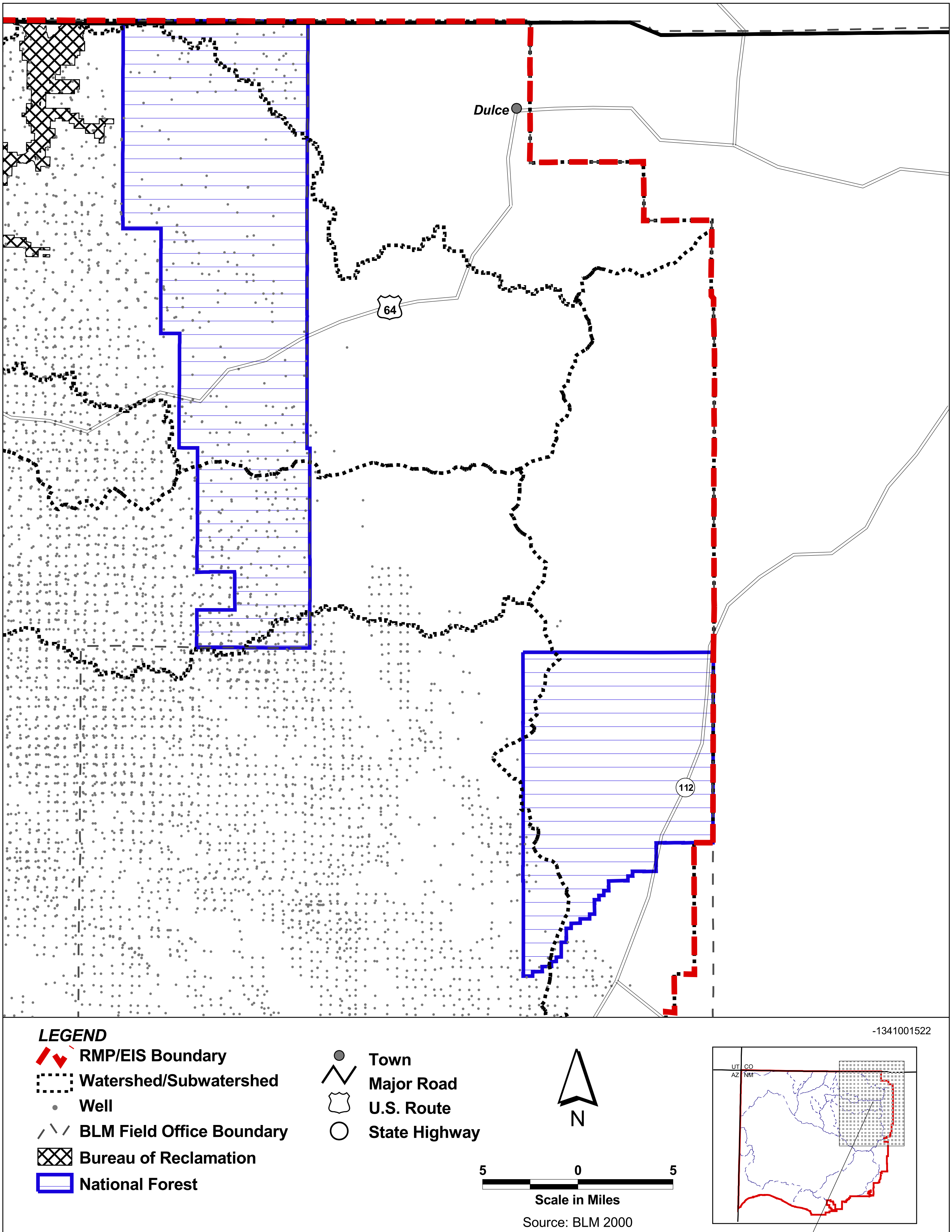
Of the 1.6 trillion standard cubic feet (Tscf) of gas produced in New Mexico in 1997, almost 1.1 trillion (about two-thirds) was from the planning area. Production increased slightly by 2000. San Juan County is the largest natural gas producing county in the state, producing between about 650 and 700 billion cubic feet (million thousand cubic feet [Mcf]) annually. McKinley County produces little natural gas, and Sandoval County produces less than 1 percent of the state's total. The planning area is much less important for its oil production, producing only 5 percent of the state's oil in 1997. The state produced 73.7 million barrels (bbls) of oil in 1997, of which 3.7 million bbls were from the planning area. In 2000, the state produced slightly less oil at 69.8 million bbls, and the planning area has a similar decline, producing on 4.4 percent, or less than 3.1 million bbls, in 2000. San Juan and Rio Arriba County are the primary producing counties in the planning area.

There are approximately 18,000 active wells in the New Mexico portion of the San Juan Basin. **Map 3-2** and **Map 3-3** show the locations of existing wells in the planning area. As of 1999, approximately 15,600 active wells produced from the six gas-bearing formations listed above. The life of a well in the planning area can extend as long as 50 years. Reservoir pressures necessitate the use of compressors in order to produce the gas. The planning area currently contains compressor stations with a capacity of approximately 168,000 horsepower (HP). The amount of oil and gas activity has generated a significant backlog of well pads waiting for field review and approval by the FFO. These locations cannot be considered "reclaimed" until that approval is granted.

The Fruitland Coal is a coal gas formation produced at 320 acre spacing per well. However, there are pilot projects underway that allow production from 160 acres per well in order to assess the feasibility of down-spacing in some areas of the San Juan Basin. The FFO operates under a BLM mandate to produce coal gas prior to mining for coal. As of 1999, there were approximately 2,250 wells that produce from the Fruitland Coal. Approximately 2,500 wells have been completed to the Fruitland Coal to date. The Fruitland Coal formation is also mined for coal and produced by well for methane gas.



Map 3-2: Oil and Gas Wells in the Western Part of the Planning Area



Map 3-3: Oil and Gas Wells in the Eastern Part of the Planning Area

If coal is mined prior to extraction of the associated methane gas, methane is released into the atmosphere. FFO policy prioritizes extraction of CBM over mining of coal. Currently, surface and underground coal mining is limited to the western portion of the FFO.

The Pictured Cliffs produces natural gas from wells spaced at 160 acres per well. There are approximately 4,000 wells that currently produce from this formation. Approximately 5,800 wells have produced from the Pictured Cliffs to date. Currently, approximately 15 percent of wells completed in this formation are dual completions or are commingled, usually with the Mesaverde or Dakota.

The Mesaverde Group produces natural gas from wells spaced at 320 acres per well, with optional infill development allowed on an 80-acre per well basis. There were 4,750 wells actively producing from the Mesaverde in July 2000. Approximately 5,300 wells in total have been completed to the Mesaverde in the San Juan Basin. Approximately 25 percent of recent Mesaverde completions are commingled or dual completions.

The Dakota produces natural gas from wells spaced at 160 acres per well. Recent studies indicate that some areas of the San Juan Basin could be approved for 80-acre infill development in the future. There were approximately 3,900 wells producing from the Dakota in 1999. Approximately 5,200 wells in total have produced from the Dakota. The RFD predicts 6,846 additional Dakota 80-acre locations within the 20-year period of analysis. Production from the Dakota can be commingled with production from the Mesaverde.

The ability to commingle gas produced from different formations and to complete more than one formation within the same wellbore (dual completion) allows operators maximize production from a single well pad. Gas produced from the Mesaverde and Dakota can be commingled either downhole or at the surface. Gas produced from the Pictured Cliffs and the Fruitland Sand can be commingled either downhole or at the surface. Other formations in the San Juan Basin that produce or have the potential to produce natural gas include Tertiary sands, the Farmington, the Fruitland Sand, the Chacra, the Lewis Shale, the Mancos Shale/Gallup Sandstone, the Entrada, and Pennsylvanian deposits.

Historical data gathered by the BLM indicates that approximately 46 percent of the total number of locations in the San Juan Basin are constructed on well pads that already exist. The remaining 54 percent of new locations are drilled on virgin sites.

Coal

The planning area contains large deposits of low sulfur Cretaceous coal concentrated in and mined mainly from the lower part of the Fruitland Formation in the FFO area. The FFO area contains approximately 7.5 billion tons of strippable coal, 3.8 billion tons of which are in the Fruitland Formation (BLM 1987a, b). The coal seams strike direction is northwest to southeast with a gentle dip to the east at 60 to 80 feet per mile. Due to compaction, deposition, and other geologic activity, the coal seams split and merge with minor bends where the coal has been warped (BLM 1998c).

The Fruitland Formation coal has been divided into the Fruitland, Bisti, and Star Lake fields. The San Juan and La Plata mines on FFO land, in addition to the Navajo mine on Navajo land, are extracting from the Fruitland Formation and serve the two power plants in the Four Corners region. The San Juan mine is developing underground mining to expand its supply, as approved in an RMP Amendment in 1998 (BLM 1998c). East of the Navajo Reservation on FFO land are the Bisti and Star Lake coal fields also in the Fruitland Formation. There has been renewed interest in coal tracts in the Star Lake area that could result in future coal lease applications being filed (Hill and Associates 2000).

The other major sources of coal in the planning area are the Mesaverde Group, Menefee Formation, extending from Durango, Colorado to south of Gallup, New Mexico, and east past Grants, New Mexico. This coal is thinner and higher in sulfur (Hill and Associates 2000).

Three strip mines, San Juan, McKinley, and La Plata, are within the FFO boundaries, from which approximately 8 million tons are mined annually. The competitive coal lease tracts, PRLA tracts, and Coal Belt SMA remain available as established in the 1988 RMP. The 1998 RMP amendment (BLM 1998c) established that 80 to 110 million tons of coal would be made available for extraction by deep mining on a lease adjacent to the San Juan strip mine. The locations of the Coal Belt SMA, PRLAs, and competitive Coal Lease Areas are shown on Map 2-4.

Salable Minerals

Salable minerals include common materials such as sand, gravel, rock, and fill material. Most of the salable materials contracted is sand and gravel. The sand and gravel is mostly located on mesa tops that consists of remnants of the Quaternary stream cut terrace. The rock and stone materials are fragments of the weathered Ojo Alamo Sandstone and Farmington Sandstone Member.

There are 33 active permitted operations listed in **Table 3-2**. In addition, there are small quarry locations (less than the 5 acres) associated with oil and gas well sites and used to supply gravel to surface access roads.

Table 3-2. Locations of Permitted Quarries in FFO Area

Current Permitted Areas					
Township	**Range**	**Section**	**Division**	**Material**	**Acreage**
15N	17W	18	N1/2	Fill material	320
17N	13W	24	N1/2	Fill material	320
18N	12W	23	NESE	Fill material	40
20N	5W	36	SESW	Fill material	40
19N	6W	10	E1/2NE	Humate	80
19N	5W	7	NW	Humate	160
19N	5W	9	SENE	Humate	40
19N	5W	9	SESW	Red dog	40
32N	10W	29	W1/2NE	Sand and gravel	80
31N	10W	30	S1/2SW	Sand and gravel	80
31N	10W	30	NWSW	Sand and gravel	40
30N	11W	3	SESE	Sand and gravel	40
30N	11W	10	NENE	Sand and gravel	40
29N	10W	18	SENE	Sand and gravel	40
29N	10W	17	N1/2SE	Sand and gravel	80
29N	10W	15	E1/2SW	Sand and gravel	80
29N	10W	14	E1/2	Sand and gravel	320
29N	10W	15	W1/2	Sand and gravel	320
29N	9W	9	SW	Sand and gravel	160
29N	9W	9	S1/2NW	Sand and gravel	80
30N	15W	35	SESE	Sand and gravel	40
32N	13W	15	NENE	Stone	40

Current Permitted Areas					
Township	Range	Section	Division	Material	Acreage
32N	13W	14	NWNW	Stone	40
30N	12W	4	NESWNE	Fill material	10
30N	12W	11	NWSE	Sand and gravel	40
29N	13W	19	N1/2	Sand and gravel	320
29N	13W	20	W1/2SE	Sand and gravel	80
29N	12W	17	E1/2NE	Sand and gravel	80
29N	12W	14	NWNE	Sand and gravel	40
29N	12W	14	SWNE	Sand and gravel	40
29N	12W	13	NW	Sand and gravel	160
29N	12W	23	E1/2	Sand and gravel	320
29N	12W	24	W1/2	Sand and gravel	320

Source: BLM FFO.

Locatable Minerals

The primary locatable mineral in the FFO is uranium, which is found in the southern portion of the area around Ambrosia Lake and Church Rock in the Jurassic Morrison Formation and associated Rocks. A few claims have been staked in the northern portion of the FFO for metallic minerals, but these claims have little, if any, impact on the program.

Although the uranium industry is depressed, companies continue to file annual assessment work and rental fees to maintain mining claims in good standing.

The Locatable Program also includes Use and Occupancy under the Mining Laws. The purpose of the Use and Occupancy Regulations is to manage the use and occupancy of the public lands for the development of locatable mineral deposits by limiting such use or occupancy to that which is reasonably incident. A few cases dealing with Use and Occupancy have been determined to be unauthorized uses.

SOILS

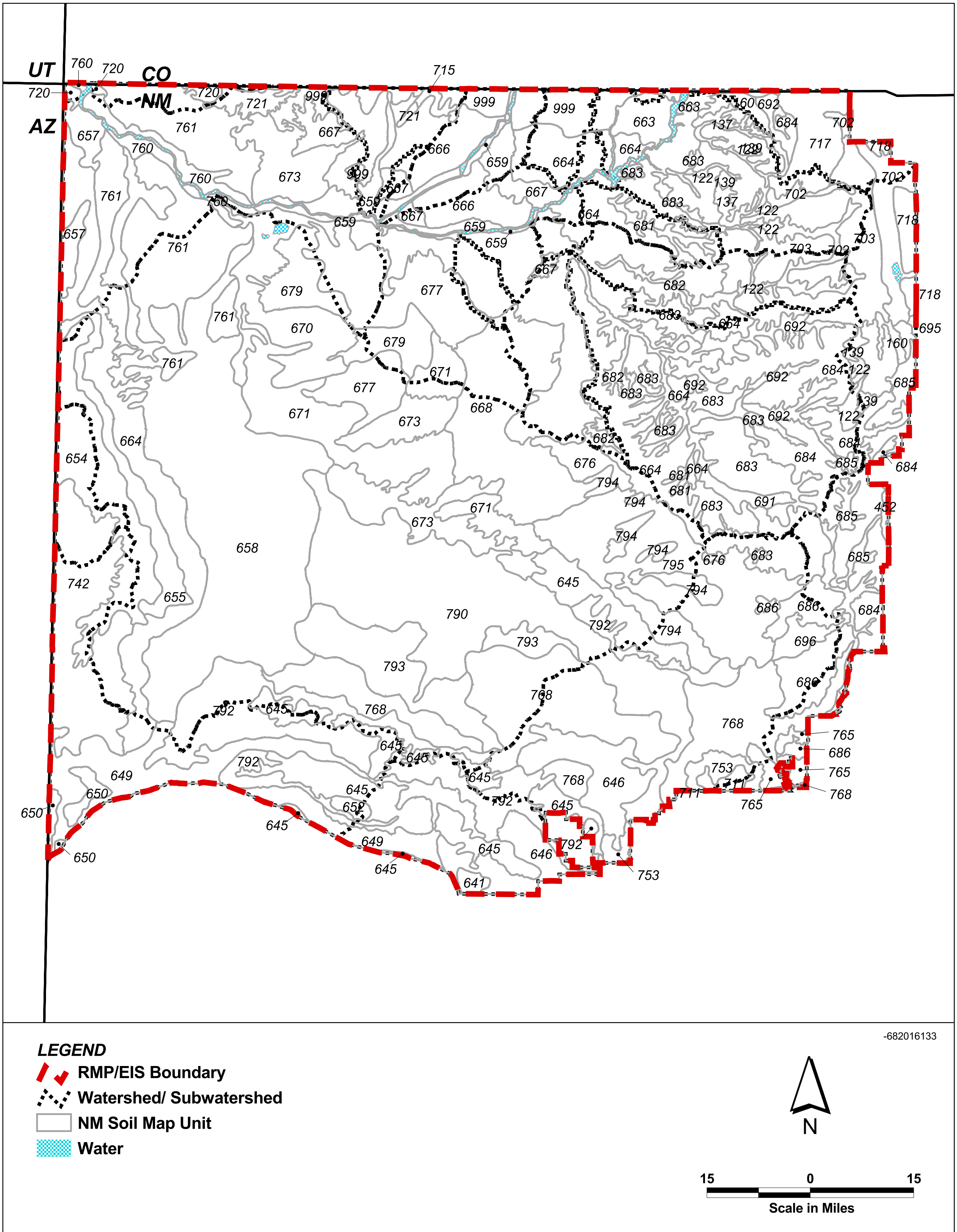
The characteristics and distribution of soil types in the planning area affect the use and management of the land and the quality of surface water, air, forage, and tree growth. Soil characteristics are important to consider when siting construction activities, such as oil and gas well development, road building, and maintenance. They are also important considerations when planning recreation activities, including OHV access and trail development, rangeland improvements, timber stand improvements, protection of surface water quality through minimizing erosion, and surface stabilization.

Nonpoint source pollution is an identified problem in the planning area that is directly associated with soil stability. Efforts to reduce nonpoint source pollution through implementation of erosion controls and management practices are an important part of BLM's land management activities. Some of these management practices are implemented through special stipulations that are attached to the APD for oil and gas. Others are incorporated into management prescriptions applied within OHV Management Units or SDAs. No existing program measures the effectiveness of these soil conservation practices or BMPs in terms of soil prevented from moving offsite or the amount of sedimentation that is deposited into a waterway. The FFO has begun collecting field data to compare with the results from the Water Erosion Prediction Project, developed by the U.S. Department of Agriculture, Agricultural Research Service, a simulation model to predict soil erosion by water within a watershed and sediment delivery to a stream. Data on the rates of erosion from disturbed and undisturbed areas, available beginning in 2003, will be used to evaluate the success of BMPs and to predict potential impacts from land use activities.

Biological soil crusts are an important factor affecting soil erosion and sedimentation in arid regions such as the San Juan Basin, where the crusts are predominantly composed of cyanobacteria. These crusts affect soil stability, water infiltration, and plant germination and growth. Where biological soil crusts are intact and healthy, there is less soil erosion from wind or water, better moisture-holding capacity, and fewer opportunities for exotic weeds to become established. Because the crust-forming organisms are concentrated in the top 1 to 4 millimeters of soil, they are easily damaged by surface activities such as vehicle travel, trampling by humans or livestock, or fire, and are slow to recover (USDI 2001a). Soil crusts are affected by a variety of factors including soil texture, topography, and chemical composition. The type and integrity of soil crusts in the planning area cannot be determined from the soil map unit information, but must be determined through site-specific evaluations in the field. As a general rule, however, it is best for soil health to keep surface disruption and compression to a minimum, especially in otherwise highly erodible areas. The soils data for the planning area were derived from the State Soil Geographic Database (STATSGO) (NRCS 1991) from the Natural Resources Conservation Service. Soil maps for STATSGO are compiled by generalizing more detailed county soil survey maps. Where more detailed soil survey maps are not available, as for McKinley County, data on geology, topography, vegetation, and climate are assembled with satellite imagery, and the probable classification and extent of soils in similar areas are determined. Each map unit on a STATSGO map is plotted on a map scale of 1:250,000 and contains up to 21 components for which there are attribute data. The soil map units and attribute data described in this section are grouped by watershed and by characteristics relevant to the decisions and activities under the jurisdiction of the land managing agencies.

There are 66 different soil map units in the planning area, each having distinctive patterns of soils, topography, and drainage and named for the dominant soils in the unit. These 66 map units represent over 2,700 more detailed soil map units at the county soil survey level of study. These soil map units are shown in **Map 3-4** overlaid by the watershed boundaries and are listed by map unit symbol and name in **Table 3-3**.

The following sections provide information on each of the watersheds concerning the limitations of soils for specified uses addresses common uses in the planning area. These limitations are based on the soil properties and qualities that are used as predictors of soil behavior and for classification and mapping of soils (NRCS 1997). The soil interpretation ratings listed for each watershed include restrictions for uses related to construction and recreation activities, such as roadfill, paths and trails, camp areas, buildings, embankments, and shallow excavations, and some of the main reasons that the restrictions are included. The limitation ratings are described as slight, moderate, and severe.



Map 3-4: Soil Map Units in the Planning Area

Table 3-3. Soil Map Unit Symbols and Names in the Planning Area

Map Unit Symbol	Map Unit Name
NM122	Typic Haplustalfs-Fluventic Ustochrepts
NM132	Typic Haplustalfs-Eutric Glossoboralfs-Rock Outcrop
NM134	Vertic Haplustalfs-Typic Haplustalfs
NM137	Typic Haplustalfs-Eutric Glossoboralfs-Rock Outcrop
NM139	Typic Haplustalfs-Typic Eutroboralfs
NM160	Typic Eutroboralfs
NM161	Typic Eutroboralfs
NM176	Eutric Glossoboralfs-Typic Paleboralfs
NM349	Typic Ustorthents-Eutric Glossoboralfs-Rock Outcrop
NM441	Fluventic Ustochrepts-Aquic Ustifluvents
NM452	Typic Dystrochrepts-Dystric Cryochrepts-Rock Outcrop
NM471	Cumulic Cryoborolls-Aquic Cryoborolls-Histic Cryaquolls
NM641	Viuda-Penistaja-Rock Outcrop
NM645	Laporte-Rock Outcrop-Vessilla
NM646	Penistaja-Sparank-San Mateo
NM649	Flugle-Rock Outcrop-Catman
NM650	Rock Outcrop-Nogal-Pinitos
NM652	Cinnadale-Valnor-Techado
NM654	Stout-Hesperus-Kiln
NM655	Royosa-Telescope
NM657	Nakai-Monue-Blackston
NM658	Kimbeto-Denazar-Farb
NM659	Fruitland-Turley-Garland
NM663	Oelop-Buckle-Rock Outcrop
NM664	Rock Outcrop-Travessilla-Weska
NM666	Badland-Saido-Blancot
NM667	Badland-Persayo-Farb
NM668	Doak-Sheppard-Shiprock
NM670	Badland-Sheppard-Monierco
NM671	Sheppard-Huerfano-Notal
NM673	Badland-Rock Outcrop-Riverwash
NM676	Badland-Fruitland-Blancot
NM677	Shiprock-Avalon-Sheppard

Map Unit Symbol	Map Unit Name
NM679	Doak-Uffens-Sheppard
NM681	Gobernador-Orlie-Sparham
NM682	Sparank-Pinavetes-San Mateo
NM683	Penistaja-Sedale-Menefee
NM684	Menefee-Pinitos-Badland
NM685	Sparham-Elpedro-Nalivag
NM686	Pinitos-Royosa
NM691	Lybrook-Tsosie
NM692	Nalivag-Ruson
NM695	Elpedro-Peney-Ransect
NM696	Berryman-Menefee-Calendar
NM702	Roques-Capillo-Carrick
NM703	Roques-Carrick
NM711	Cebolleta-Charo-Rock Outcrop
NM715	Panitchen-Yenlo-Dominguez Variant
NM716	Shalona-Sedillo-Mikim
NM717	Goldvale-Valto-Hesperus
NM718	Ruko-Morapos-Goldvale
NM720	Claysprings-Myton Family-Uzona
NM721	Witt-Rizno-Ruinpoint
NM742	Augustine-Telescope-Royosa
NM753	Sandoval-Poley-Orejas
NM760	Cudei-Badland-Tocito
NM761	Littlehat-Persayo-Awet
NM765	Querencia-Sandoval-Sparank
NM768	Rock Outcrop-Zia-Sandoval
NM790	Sheppard-Fajada-Sparank
NM792	Mion-Rock Outcrop-Atarque
NM793	Doak-Kiki
NM794	Doakum-Betonnie
NM795	Blancot-Councelor-Tsosie
NM999	Dulce-Travessilla-Rock Outcrop

Source: NRCS 1991.

Following the sections on soil limiting factors in individual watersheds, there is a series of tables that summarize the soil characteristics of the watersheds relative to erodibility, and permeability Three of the watersheds, Chinle, Mancos, and Upper Puerco, are almost entirely on tribal land and are not discussed any further in the narrative. However, their soil characteristics are included in the summary tables. In general, prime farmland is determined by soils that have an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, an acceptable level of acidity or alkalinity, an acceptable content of salt or sodium, and few or no rocks. Its soils are permeable to water and air, not excessively eroded or saturated with water for long periods of time, and either does not flood frequently during the growing season or is protected from flooding (NRCS 1997). Several watersheds have some soils meeting the definitions of prime farmland, all of which must be irrigated to produce high quality crops.

Animas Watershed

The Animas watershed is located in the north central part of the planning area. Components in mapping units NM716 and NM999 contain prime farmland soils, if irrigated, in approximately 10 percent of this watershed. Approximately 65 percent of the Animas watershed is severely limited for construction of roads, small buildings, trails, other shallow excavations, and camp areas primarily due to restrictions such as shallow depth to rock and steep slopes. Smaller areas are limited for these uses due to shrink-swell potential and low soil strength. Construction of embankments is limited in a small portion of the watershed due to thin soils and a high potential of piping through the embankments.

Arroyo Chico Watershed

The Arroyo Chico watershed is located in the southeastern quadrant of the planning area on the east side of the Continental Divide. There are no prime farmland soils in this watershed. Approximately half of the Arroyo Chico watershed is severely limited for construction of roads, small buildings, trails, and camp areas primarily due to restrictions such as shallow depth to rock and steep slopes. Smaller areas are limited for these uses due to shrink-swell potential and low soil strength. Moderate limitations for these uses are attributed to frost action, slope, and low strength. Construction of embankments is limited in 10 to 30 percent of the watershed due to thin soils, seepage, and a high potential of piping through the embankments. Shallow excavations are severely limited in at least half of the watershed due to slope, depth to rock, and caving of cutbanks.

Blanco Watershed

The Blanco watershed is located entirely on BLM land in the center of the FFO administrative area. There are no prime farmland soils in this watershed. Approximately 70 percent of the Blanco watershed is severely limited for construction of roads, small buildings, trails, and camp areas primarily due to shallow depth to rock and steep slopes. Smaller areas are limited for these uses due to shrink-swell potential, low soil strength, and flooding. Moderate limitations for these uses are attributed to shrink-swell potential and, in the case of camp areas and trails, erosion and dusty conditions. Construction of embankments is limited in 25 percent of the watershed due piping through the embankments and difficulty with compaction. Shallow excavations are severely limited in most of the watershed due to slope and depth to rock.

Carrizo Watershed

The Carrizo watershed is located in the northeastern quadrant of the planning area, on BLM, USFS, and Jicarilla Apache land. There are no prime farmland soils in this watershed. Approximately 40 to 50 percent of the Carrizo watershed is severely limited for construction of roads, small buildings, trails, and camp areas primarily due to low strength, shrink-swell potential, shallow depth to rock, and steep slopes. Smaller areas are severely limited for these uses due to flooding. Moderate limitations for these uses are attributed to slow percolation and thin soils. Construction of embankments is limited in a small portion of the watershed due to piping through the embankments; moderate limitations occur in half of the watershed due to soils that are difficult to compact. Shallow excavations are severely limited in most of the watershed due to slope, depth to rock, and caving cutbanks. Moderate limitations on shallow excavations occur in many areas due to clayey soils.

Chaco Wash Watershed

The Chaco Wash watershed is by far the largest watershed in the planning area, almost 3 million acres, and takes up most of the west central part of the planning area, primarily on BLM and Navajo allotment and tribal trust land. Less than 1 percent of the watershed has prime farmland soils, in map unit NM760, if they are irrigated. Approximately 20 to 35 percent of the Chaco Wash watershed is severely limited for construction of roads, small buildings, trails, and camp areas primarily due to low strength, shallow depth to rock, and steep slopes. Smaller areas are severely limited for these uses due to shrink-swell potential. Construction of embankments is limited in 25 to 50 percent of the watershed due to high sodium content, seepage, or piping. Shallow excavations are severely limited in 30 percent of the watershed due to slope, depth to rock, and caving cutbanks.

Gobernador Watershed

The Gobernador watershed is located in the northeast quarter of the planning area, mostly on BLM land. There are no prime farmland soils in this watershed. Approximately two-thirds of the Gobernador watershed is severely limited for construction of roads, small buildings, trails, and camp areas primarily due to slow percolation, steep slopes, shallow depth to rock, and shrink-swell potential. Construction of embankments is severely limited in approximately one-fourth of the watershed in areas where the soil salinity is highest. Shallow excavations are severely limited in approximately two-thirds of the watershed due mainly to the depth to rock and slope, and moderately limited in other areas due to clayey soils.

Kutz Canyon Watershed

The Kutz Canyon watershed is located in the north central part of the planning area, mostly on BLM land. There are no prime farmland soils in this watershed. Most of the Kutz Canyon watershed is severely limited for construction of roads, small buildings, trails, and camp areas primarily due to steep slopes and shallow depth to rock. Construction of embankments is moderately limited in only 5 percent of the watershed due to the likelihood of piping; the rest of the watershed is not limited for construction of embankments. Shallow excavations are severely limited in most of the watershed due mainly to the depth to rock and slope.

La Plata Watershed

The La Plata watershed is located in the north central part of the planning area, mostly on BLM land, and extends into Colorado. The soils described here are only for the New Mexico portion, which is within the planning area. Over 11 percent of the watershed contains prime farmland soils, within map units NM715, NM 721, and NM999. Just over half of the La Plata watershed is severely limited for construction of roads, small buildings, trails, and camp areas, primarily due to steep slopes and shallow depth to rock. Construction of embankments is severely limited in about 20 percent of the watershed due to the likelihood of piping and a small percentage due to excess salt. Shallow excavations are severely limited in over half of the watershed due mainly to the depth to rock and slope, and the potential for caving cutbanks in approximately 5 percent of the watershed.

Largo Watershed

The Largo watershed is relatively large and located in the northeast quarter of the planning area. It has two sections, connected by a small area and includes mainly BLM and Jicarilla Apache land. There are no prime farmland soils in this watershed. Just over half of the Largo watershed is severely limited for construction of roads, small buildings, trails, and camp areas primarily due to steep slopes, shallow depth to rock, and low strength. A smaller portion of the watershed is severely limited due to excess sodium in the soils, shrink swell potential, flooding, and erosion; there are moderate limitations in other parts of the watershed due to slow percolation, low strength, and slope. Construction of embankments is limited in about 20 percent of the watershed due to the likelihood of piping, thin soils, difficulty with compaction, and a small percentage due to excess salt or sodium. Shallow excavations are severely limited in over half of the watershed due mainly to the depth to rock and slope.

Middle San Juan Watershed

The Middle San Juan watershed is located in the northwest corner of the planning area and includes mainly Navajo and Ute Mountain land, except for the eastern portion on BLM land. Prime farmland soils occur on approximately 7 percent of the watershed, within map units NM721, NM760, and NM999, if they are irrigated. Approximately one-third of the Middle San Juan watershed is severely limited for construction of roads, small buildings, trails, and camp areas primarily due to steep slopes, excess salt and sodium, and erodibility. Construction of embankments is limited in about 30 percent of the watershed due to excess salt and sodium, the likelihood of piping, and stones. Shallow excavations are severely or moderately limited in two-thirds of the watershed due mainly to the depth to rock and slope, and a lesser percentage Navajo Reservoir Watershed

Navajo Reservoir Watershed

The Navajo Reservoir watershed is located in the northeast quarter of the planning area and includes mainly USBR, BLM, and USFS land, except for the eastern portion on Jicarilla Apache land. Prime farmland soils occur on approximately 3 percent of the watershed, within map units NM717 and NM999, if they are irrigated. Over half of the Navajo Reservoir watershed is severely limited for construction of roads, small buildings, trails, and camp areas primarily due to low strength and shrink-swell potential, with 20 to 30 percent severely limited due to steep slopes, depth to rock, and erodibility. Moderate limitations exist on 25 percent of the watershed for construction of camp areas due to slow percolation. Construction of embankments is moderately limited in up to half of the watershed due to difficulty in compaction, thin soils, and the likelihood of piping. Shallow excavations are severely or moderately limited in 25 percent of the watershed due mainly to the depth to rock, slope, and the possibility of caving cutbanks.

Pump Canyon Watershed

The Pump Canyon watershed is located in the northeast quarter of the planning area, just west of the Navajo Reservoir watershed, and includes mainly BLM land. Prime farmland soils occur on over 18 percent of the watershed, within map unit NM999, if they are irrigated. Over half of the Pump Canyon watershed is severely limited for construction of roads, small buildings, trails, camp areas, and shallow excavations due to steep slopes and depth to rock. No limitations are listed for construction of embankments.

Rio Chama

The Rio Chama watershed is located in the far northeast of the planning area and is east of the Continental Divide. It includes mainly USFS and Jicarilla Apache land. Prime farmland soils occur on just over 1 percent of the watershed, within map unit NM718, if they are irrigated. From 70 to 90 percent of the Rio Chama watershed is severely limited for construction of roads, mainly due to low soil strength and shrink-swell potential. Construction of small buildings, trails, and camp areas are severely limited primarily due to steep slopes, erodibility, and the potential for flooding in 15 to 30 percent of the watershed. Moderate limitations exist on 15 to 30 percent of the watershed for these uses due to mainly to slow percolation, high clay content, and slope. Construction of embankments is moderately limited in two-thirds of the watershed due to difficulty in compaction and thin soils. Shallow excavations are severely or moderately limited in 2 to 40 percent of the watershed due mainly to the depth to rock, slope, flooding, and the possibility of caving cutbanks.

Rio Puerco Watershed

The Rio Puerco watershed is located in the far southeast of the planning area and is east of the Continental Divide. It includes mainly BLM, USFS, and Navajo trust and allotment land. There are no prime farmland soils in the watershed. The most common severe limitations on construction of roads, small buildings, trails, and camp areas, in half of the watershed, are shallow depth to rock, steep slopes, and low soil strength. Severe limitations for these uses are limited in approximately 20 percent of the watershed due to the likelihood of flooding, erodibility, and shrink-swell potential. Moderate limitations for these uses occur in 15 to 25 percent of the watershed, primarily due to frost action, steep slopes, and high clay content. Construction of embankments has moderate to severe limitations in up to one-third of the watershed due to difficulty in compaction, piping, large stones, and thin soils. Shallow excavations are severely limited in half of the watershed due mainly to the depth to rock and slope.

Rio San Jose Watershed

The Rio San Jose watershed is located in the far south central part of the planning area and is east of the Continental Divide. It includes mainly BLM and Navajo trust and allotment land. There are no prime farmland soils in this watershed. The most common severe limitations on construction of roads, small buildings, trails, and camp areas, in half of the watershed, are shallow depth to rock and steep slopes. Severe limitations for these uses are limited in approximately 25 percent of the watershed due to the low soil strength and shrink-swell potential. Moderate limitations for these uses occur in 25 percent of the watershed, primarily due to steep slopes, frost action, and shrink-swell potential. Construction of embankments are severely limited in half of the watershed due to piping and thin soils. Shallow excavations are severely limited in half of the watershed mainly due to the depth to rock and slope.

Upper San Juan Watershed

The Upper San Juan watershed is located in the far northeast of the planning area and includes mainly USFS and Jicarilla Apache land. Prime farmland soils occur within map units NM717, NM718, and NM999, on approximately 2 percent of the watershed. The most common severe limitations on construction of roads, small buildings, trails, and camp areas, in almost half of the watershed, are shallow depth to rock, steep slopes, and low soil strength. Severe limitations for these uses are limited in approximately 20 percent of the watershed due to the erodibility and shrink-swell potential. Moderate limitations for these uses occur in another 10 to 20 percent of the watershed, primarily due to shrink-swell potential, dusty conditions, and slow percolation. Construction of embankments have moderate to severe limitations in up to 20 percent of the watershed due to difficulty in compaction, piping, seepage, large stones, and thin soils. Shallow excavations are severely limited in up to 40 percent of the watershed due mainly to the depth to rock, high clay content, caving cutbanks, and slope.

Summary Tables Comparing Soils Characteristics between Watersheds

Tables 3-4 and 3-5 summarize various soils characteristics by watershed. All soil properties quantified in the tables below were derived by determining the properties of each soil map unit, then using the amount of each map unit within each watershed to determine a weighted number for that property. For example, a soil map unit that is highly erodible but is present in 5 percent of the Animas watershed would be weighted less than a soil with a medium erosion rate that occurs in 30 percent of the watershed, resulting in a medium erosion classification for the entire watershed. These classifications can be used to consider planning on a watershed level, but for site-specific planning, more detailed evaluations would be needed.

Table 3-4 indicates the potential for water and wind erosion. Erosion ratings are grouped into categories low, medium, and high for water and wind erosion and are based on the erosion factors listed for each soil map unit. These factors are used to describe the erodibility of the bare soil without taking into account vegetative cover, slope, or management.

Table 3-4. Potential for Water and Wind Erosion in Each Watershed

Watershed	Water Erosion			Wind Erosion		
	Low	Medium	High	Low	Medium	High
Animas		100%		14%	86%	
Arroyo Chico	12%	86%	2%	48%	52%	
Blanco		100%		29%	71%	
Carrizo		59%	41%	15%	85%	
Chaco Wash	16%	79%	5%	72%	23%	5%
Chinle		100%		100%		
Gobernador		94%	6%	27%	73%	
Kutz Canyon		100%		13%	87%	
La Plata	1%	99%		21%	78%	1%
Largo		88%	12%	33%	67%	
Mancos	23%	8%	69%	74%	6%	20%
Middle San Juan	20%	50%	30%	58%	29%	11%
Navajo Reservoir		60%	40%	5%	81%	14%
Pump Canyon		100%			100%	
Rio Chama	3%	58%	39%	1%	94%	5%
Rio Puerco	4%	95%	1%	27%	73%	
Rio San Jose	53%	47%		46%	54%	
Upper Puerco	34%	66%		59%	41%	
Upper San Juan		91%	9%	40%	59%	1%

Source: NRCS 1991.

Table 3-5 indicates the soil permeability of each watershed. Soil permeability is the quality of the soil that enables water or air to move through it. It is described for each soil mapping unit as an infiltration rate that ranges from slow through rapid in this planning area. It can be used to evaluate the potential for spills, especially hazardous materials, to infiltrate the soil and possibly affect the groundwater. It also can be used as an indicator of the success of the establishment of seedings and the need for irrigation to ensure growth. It affects the amount of surface water runoff during rainfall.

Table 3-5. Soil Permeability Rates in Each Watershed

Watershed	Slow to Moderately Slow[1]	Moderately Slow to Moderate	Moderate to Moderately Rapid	Moderately Rapid to Rapid	Rapid
Animas			100%		
Arroyo Chico		18%	35%	40%	7%
Blanco			71%	29%	
Carrizo		42%	51%	7%	
Chaco Wash	5%	6%	25%	60%	4%
Chinle			52%		48%
Gobernador		30%	70%		
Kutz Canyon			87%	13%	
La Plata	1%		99%		
Largo		27%	67%	6%	
Mancos		20%	80%		
Middle San Juan	11%	1%	66%	21%	1%
Navajo Reservoir		25%	75%		
Pump Canyon			100%		
Rio Chama		73%	25%	2%	
Rio Puerco		54%	30%		16%
Rio San Jose		49%	4%	47%	
Upper Puerco		34%	13%	28%	25%
Upper San Juan		12%	52%	36%	

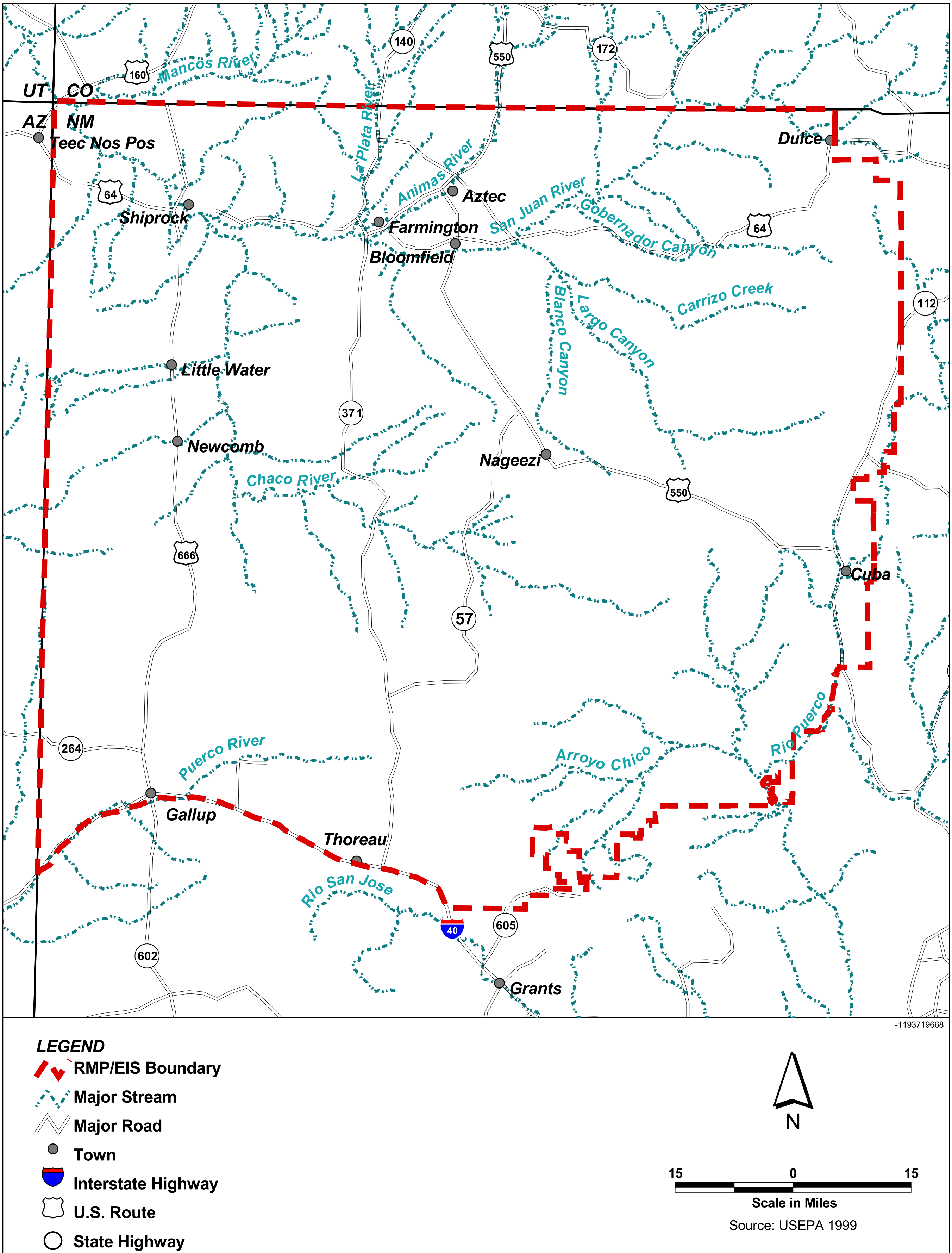
Source: NRCS 1991.

WATER RESOURCES

Water resources include surface water and groundwater. This section discusses surface water quality and quantity, groundwater quality and quantity, and waters of the U.S. Surface waters include lakes, rivers and streams and are important for a variety of reasons, including economic, ecological, recreational, and human health. Groundwater comprises the subsurface hydrologic resources of the physical environment and is an essential resource.

Surface Water

The New Mexico Water Quality Control Commission (NMWQCC) recognizes eleven distinct hydrologic basins within the state. Portions of the planning area lie within three of these regional hydrologic systems (NMWQCC 2001). The largest area is within the San Juan River basin, followed by the Upper Rio Grande basin and the Middle Rio Grande basin. The major streams are shown in **Map 3-5**.



Map 3-5: Major Streams in the Planning Area

The San Juan River is a major tributary to the Colorado River. Arising on the western slope of the Continental Divide in southwestern Colorado, the San Juan River flows from the San Juan Mountains north of Pagosa Springs, Colorado and enters northwestern New Mexico through the Navajo Reservoir in Rio Arriba County the west of the Jicarilla Apache Reservation and the Carson National Forest. The course of the San Juan River turns westward for approximately 140 miles through New Mexico before returning to Colorado in the four-corners area. The San Juan River then continues west through southern Utah to its confluence with the Colorado River. The San Juan River basin encompasses lands in four New Mexico counties: all of San Juan County, most of the northern half of McKinley and the western half of Rio Arriba Counties, and a small portion of Sandoval County. Parts of the Navajo and Jicarilla Apache reservations are within the basin. In this basin, the USBR operates Navajo Dam and Reservoir for water conservation, storage, flood control, and to supply irrigation water for the Navajo Nation's use on the Navajo Indian Irrigation Project.

The Upper Rio Grande basin extends over portions of seven counties, including Rio Arriba, Taos, Santa Fe, Los Alamos, Sandoval, Mora, and San Miguel. It is bounded on the north by the Colorado state line and extends south to the Angostura Diversion Works just above the confluence of the Rio Grande and Jemez River. The eastern boundary of the section runs along the major ridge line of the Sangre de Cristo Mountains, while the western boundary follows the Continental Divide through Rio Arriba County, then southeast through Sandoval County to the San Felipe Pueblo.

The Rio Grande bisects the north central portion of New Mexico from north to south for a distance of about 143 miles. The river is fed by several tributaries including the Rio Chama.

The Middle Rio Grande basin covers parts of nine counties, including Rio Arriba, McKinley, Sandoval and Bernalillo. Most of the surface water in the Middle Rio Grande is supplied by runoff and stream flow from the Upper Rio Grande. Exceptions are perennial tributaries in the Jemez Mountains, which contribute to the Jemez River and its principal tributary, the Guadalupe River, as well as the upper reaches of the Rio Puerco and its principal tributary, the Rio San Jose.

Surface Water Quantity

The principal perennial surface water drainages within the planning area include the San Juan River, the Animas River, La Plata River, and the Rio Grande. **Table 3-6** identifies all those watersheds that lie within the planning area and the hydrologic unit code (HUC) associated with each watershed. The table also indicates the number and miles of streams (both perennial and ephemeral) within each HUC. Each hydrologic unit is identified by a unique HUC consisting of two to eight digits based on four levels of classification in the hydrologic unit system. The Upper San Juan hydrologic unit includes the subwatersheds of Pump Canyon, Navajo Reservoir, Kutz Canyon, and Gobernador. The Blanco Canyon hydrologic unit includes the subwatersheds of Blanco, Largo, and Carrizo. The Middle San Juan hydrologic unit includes the La Plata subwatershed.

The San Juan River headwaters are on the Continental Divide north of Pagosa Springs, Colorado, and it flows westward through the planning area. The headwaters of a number of perennial tributaries to the San Juan River in New Mexico rise in southern Colorado. The major perennial tributaries include the Animas and the La Plata Rivers. Other major tributaries that rise in the southern portion of the San Juan Basin include Canyon Largo, Gallegos Canyon, and the Chaco River, which are all ephemeral streams.

Table 3-6. Streams within Watersheds in the Planning Area

Watershed Name	Hydrologic Unit Code	Streams in HUC[1]	Perennial/ Ephemeral (miles)[a]
Rio Puerco	13020204	15	2284/80.9
Arroyo Chico	13020205	12	1223.5/43
Rio San Jose	13020207	10	2697.8/149.7
Gobernador Kutz Canyon Navajo Reservoir Pump Canyon Upper San Juan	14080101	25	3368/1062.9
Blanco Canyon Carrizo Largo	14080103	5	1739.2/52.6
Animas	14080104	24	1323.9/744.1
La Plata Middle San Juan	14080105	21	2348.8/318.3
Chaco Wash	14080106	21	5567.2/199
Mancos	14080107	15	1010.3/216.3
Lower San Juan	14080201	15	1249.8/214.2
Chinle	14080204	18	3582.7/663.1
Upper Puerco	15020006	5	1836.5/84.4

Source: USEPA 2001c.
Note: (1) Not all streams/miles are within the planning area but they may be affected by it.

The southeastern portion of the planning area is drained by tributaries to the Rio Puerco, which ultimately flows to the Rio Grande. The two major stream systems draining southeast from the Continental Divide are Arroyo Chico and Rio San Jose. Both are also ephemeral streams.

The Puerco River (which is different from the Rio Puerco) headwaters are on the Continental Divide just north of Hosta Butte. This ephemeral stream drains southwest into the Little Colorado River at Holbrook, Arizona.

Streamflow in ephemeral channels is only in response to storm events. Differences in rainfall patterns cause streamflow to be extremely variable. Approximately one-half of the annual precipitation occurs from July through October, generally in the form of localized, short-duration, high-intensity thunderstorms. These storms may create large flows, which are commonly of limited duration and extent. Most of the stream gages within the planning area are concentrated along the perennial streams with very little information being gathered on small ephemeral streams in the southern portion of the planning area.

The type of soil and amount and type of vegetation have a major effect on the amount of precipitation that becomes surface runoff.

Surface Water Quality

Availability of water quality data, like streamflow data, is largely limited to the perennial streams in the northern part of the planning area. The water quality of the perennial streams varies from upstream to downstream and is strongly influenced by the type of rock and soils with which the water has been in contact. In their upper reaches, the perennial streams have relatively low concentrations of dissolved solids. In their middle and lower reaches, the streams contain progressively more magnesium, calcium, sodium, and sulfate concentrations. Water quality also varies according to flow conditions. Generally there are higher concentrations of ions at lower flow conditions. **Table 3-7** describes parameters of concern within each major watershed within the planning area as well as the likely sources of impairment on the stream. The table also indicates which designated uses are not being fully supported in the watersheds, identified by the state in compliance with the CWA.

Table 3-7. Impaired Water Quality by Watershed

River and Watershed Name[1]	Hydrologic Unit Code	Parameters Of Concern	Likely Sources of Impairment
Rio Puerco	13020204	Thermal modification Stream bottom deposits	Agricultural activities, rangeland activities, road maintenance, runoff, riparian vegetation removal, hydromodification.
Rio San Jose	13020207	Thermal modification Total phosphorus pH Stream bottom deposits	Agricultural activities, rangeland activities, hydromodification, riparian vegetation removal, streambank destabilization.
Upper San Juan	14080101	Sediment Mercury Benthic pathogens Turbidity Stream bottom deposits	Atmospheric deposition; resource extraction; petroleum activities; urban runoff; storm sewers; hydromodification; riparian vegetation removal; streambank destabilization; agricultural activities; rangeland activities.
Animas	14080104	Mercury Stream bottom deposits	Atmospheric deposition; resource extraction; petroleum activities; urban runoff; storm sewers; hydromodification; riparian vegetation removal; streambank destabilization; agricultural activities; rangeland activities.
Middle San Juan	14080105	Mercury Nutrients Stream bottom deposits	Atmospheric deposition; resource extraction; petroleum activities; urban runoff; storm sewers; hydromodification; riparian vegetation removal; streambank destabilization; agricultural activities; rangeland activities.
Lower San Juan	14080201	None in New Mexico.	

Source: USEPA 2001c.
Note: (1) Not all streams/miles are within the planning area but may be affected by it.

Quality data for the ephemeral runoff south of the San Juan River are limited to only a few observations at sampling stations associated with the USGS coal hydrology program. Ephemeral flows are generally very poor quality water due to the highly erosive and saline nature of the soils, sparse vegetative cover, and rapid runoff conditions that are characteristic of the area. Surface runoff in the area usually contains greater than 10,000 milligrams per liter (mg/L) of suspended sediment and greater than 1,000 mg/L of dissolved solids. Produced water from gas wells is occasionally used during road construction.

Salinity control is a significant issue in the Colorado River Basin. Available data on salinity contribution from the FFO Area are limited, but existing information from the La Plata and Chaco Rivers does provide evidence that moderately saline water (1,000 to 2,000 mg/L dissolved solids) is predominant within these basins.

Groundwater

The planning area is underlain by sandstone aquifers and unconsolidated sand and gravel aquifers. The Colorado Plateaus Aquifers are sandstone while the Rio Grande Aquifer system is unconsolidated sand and gravel. The primary Colorado Plateaus Aquifers that underlie the planning area are the Unita-Animas Aquifer, which underlies the vast majority of the San Juan Basin, and the Mesaverde aquifer (USGS 2001a).

The Unita-Animas aquifer is composed primarily of Lower Tertiary rocks in the San Juan Basin. It consists of the San Jose Formation, the underlying Animas Formation and its lateral equivalent, the Nacimiento Formation, and the Ojo Alamo Sandstone. The San Jose Formation is the uppermost significant bedrock formation in the San Juan Basin and primarily consists of permeable, coarse, arkosic sandstone interlayered with mudstone. The Animas and Nacimiento Formations and the Ojo Alamo Sandstone consist primarily of permeable conglomerate and medium to very coarse sandstone interlayered with relatively impermeable shale and mudstone. The thickness of the Unita-Animas aquifer generally increases toward the central part of each basin. In the northeastern part of the San Juan Basin, the maximum thickness of the aquifer is about 3,500 feet (USGS 2001a).

Aquifers that have demonstrated 100 gallons per minute (gpm) potential for properly constructed wells include the San Andres-Glorieta system, the Entrada Sandstone, the Morrison Formation, the Gallup Sandstone, the Ojo Alamo Sandstone, the Nacimiento Formation and the San Jose Formation.

The Mesaverde aquifer comprises water-yielding units in the Upper Cretaceous Mesaverde Group, it equivalents, and some adjacent Tertiary and Upper Cretaceous formations. The Mesaverde aquifer is at or near land surface in extensive areas of the Colorado Plateaus and underlies the Unita-Animas aquifer (USGS 2001a). The aquifer is of regional importance in the San Juan Basin. Some of the rocks that form the Mesaverde aquifer contain coal beds, some of which have been mined for at least a century. The hydrologic effects of mining have been of increasing concern in the areas underlain by the aquifer. In the San Juan Basin, the Mesaverde aquifer consists of sandstone, coal, siltstone, and shale of the Mesaverde Group. The formations of the Mesaverde Group interweave extensively with the Mancos Shale and, to a lesser extent, with the Lewis Shale. The Point Lookout Sandstone is the most aerially extensive of the Mesaverde Group formations in the San Juan Basin. The Mesaverde aquifer has a maximum thickness of about 4,500 feet in the southern part of the basin (USGS 2001a).

The unconsolidated sand and gravel basin-fill aquifers of the Rio Grande Aquifer system are present in intermountain basins between mountains and tablelands in northern New Mexico. The Rio Grande Rift is the principal geologic feature of the area. The rift affected the configuration of the bounding highlands, which in turn has affected precipitation, runoff, groundwater recharge, source material of the basin fill, aquifer characteristics, and water quality. The rift is a northward-trending series of interconnected, downfaulted and rotated blocks located between uplifted blocks to the east and west. Various block shave been displaced downward thousands of feet, and most of the rift has been filled with alluvium and volcanic rock. The thickness of the basin fill in unknown in most areas but is estimated to be as much as 30,000 feet in the San Luis Valley and about 20,000 feet near Albuquerque (USGS 2001b).

Groundwater Quantity

Groundwater is available nearly everywhere in the planning area. Although many aquifers are known to yield water to wells somewhere in the basin, most yields are low (less than 20 gpm) (BLM 1987b). The better aquifers are found in sandstone units of Jurassic, Cretaceous, and Tertiary age. Quaternary alluvium deposits filling stream channels are also capable of yielding sufficient quantities of water for local use.

Groundwater recharge to the Unita-Animas aquifer generally occurs in the areas of higher altitude along the margins of each basin. Groundwater is discharged mainly to streams, springs, and by transpiration from vegetation growing along stream valleys. In the San Juan Basin, water recharges the Unita-Animas aquifer in the higher altitude areas that nearly encircle the basin. Groundwater generally flows toward the San Juan River and its tributaries where it is discharged to streamflow, to the alluvium that locally is present in the valleys, or to evapotranspiration (USGS 2001a).

Water generally recharges the Mesa Verde aquifer in upland areas that receive more precipitation than lower altitude areas. The available data in the San Juan Basin indicates that recharge occurs in the area of the Zuni Uplift, Chuska Mountains, and in northern Sandoval County (USGS 2001a). Groundwater discharges from the aquifer directly to streams, springs, and seeps, by upward movement through confining layers and into overlying aquifers, or by withdrawal from wells. The natural discharge areas generally are along streams and rivers such as the San Juan River and the Chaco River and their tributaries (USGS 2001a).

Groundwater recharge to the Rio Grande aquifer system primarily originates as precipitation in the mountainous areas that surround the basins. Runoff from snowmelt or rainfall enters the basins and generally flows for short distances across permeable alluvial fans before the water percolates downward through streambeds of evaporates. Most of the precipitation that falls in the valleys is lost to evaporation and transpiration, with little water percolating to a sufficient depth to recharge the aquifers (USGS 2001b).

Groundwater Quality

The quality of groundwater in the San Juan Basin generally ranges from fair to poor. In most places the total dissolved solids (TDS) content exceeds 1,000 mg/L, and can range from 500 to 4,000 mg/L (BLM 1987b, USGS 2001a). The Unita-Animas Basin contains fresh to moderately saline water. Dissolved solids concentrations generally increase along the groundwater flow path in the San Juan Basin. The water is hard to very hard with actual chemical composition depending on location of withdrawal and the producing aquifer. Calcium or sodium is usually the predominant cation, and bicarbonate or sulfate the predominant anion (BLM 1987b).

The quality of the Mesa Verde aquifer is extremely variable. In general, areas of the aquifer that are recharged by infiltration from precipitation or surface water sources contain relatively fresh water. Sparse data indicate that the dissolved solids concentration ranges from about 1,000 to 4,000 mg/L in the San Juan Basin.

The composition and TDS concentration of water in the Rio Grande aquifer system are affected by the quality of the water that enters the aquifer, the type and solubility of minerals present in the basin fill, and the quantity of water lost by evaporation and transpiration. Soluble minerals present in the rocks of the mountains adjacent to the basins affect the quality of the water draining from the mountains, which, in turn, affects the quality of the recharge entering the aquifers. Water in the aquifer system is of varied chemical composition, in part because of the varied geology of the nearby mountains. Surface water in the Rio Grande in the reach from the headwaters to Albuquerque generally has a small TDS concentration and contains a preponderance of calcium, bicarbonate, and sulfate ions.

UPLAND VEGETATION

Public lands in San Juan, McKinley, Rio Arriba, and Sandoval Counties support a diversity of upland and riparian plant communities. These plant communities or vegetation types are controlled in large part by site-specific topography, soil type, and climatic conditions. The planning area contains five major vegetation units, as well as the non-native cover type represented by urban/agricultural areas, shown in **Map 3-6** (Dick-Peddie 1993).

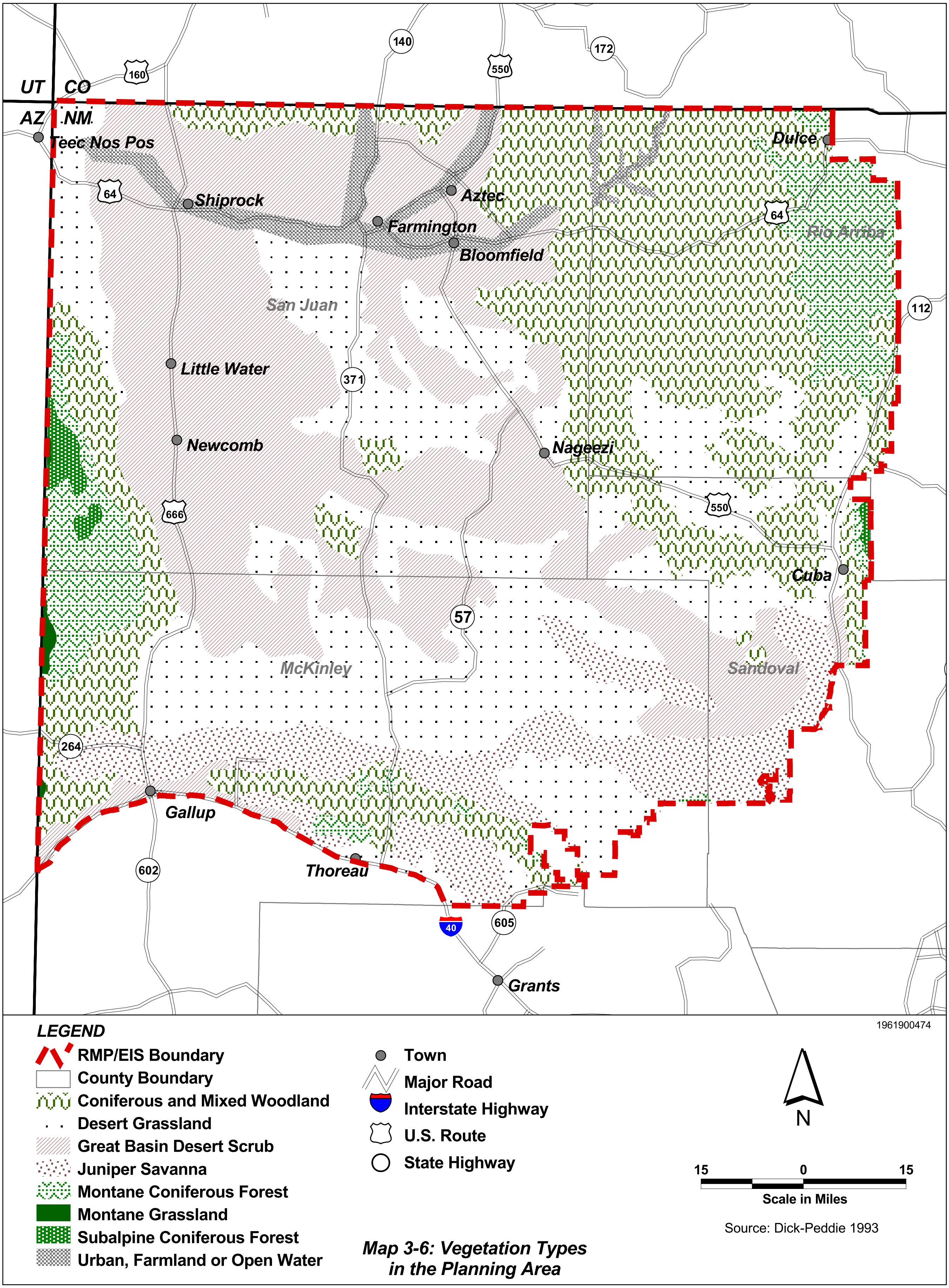
An estimated 223,600 acres of desert grasslands are found within FFO boundaries, 65,500 acres are on AFO land, and 11,800 acres on USFS land (**Table 3-8**). There are large tracts of desert grassland vegetation throughout the central portion of the planning area. Blue grama (*Bouteloua gracilis*), galleta (*Hilaria jamesii*), and dropseeds (*Sporobolus sp.*) are common. Broom snakeweed (*Gutierrezia sarothrae*) occurs in most areas along with scattered big sagebrush (*Artemisia tridentata*) and one-seed juniper (*Juniperus monosperma*) on ridges and rocky areas (BLM 1988).

Table 3-8. Acres of Plant Community Types

Plant Community Type	BLM		USFS	USBR	Total
	FFO[1]	AFO[1]			
Desert Grassland	223,600	65,500	11,800	0	300,900
Great Basin Desert Scrub	435,500	74,700	200	0	510,400
Juniper Savannah	56,500	136,000	0	0	192,500
Piñon-Juniper Woodland	633,400	90,700	191,700	12,900	928,700
Ponderosa Pine Forest	2,300	5,600	43,300	0	51,200
Subalpine Montane Grassland	300	0	0	0	300
Subalpine Coniferous Forest	0	0	6,700	0	6,700
Urban, Farmland, or Open Water	47,000	0	0	17,600	64,600
Total	**1,398,600**	**372,500**	**253,700**	**30,500**	**2,055,300**

Source: GIS data based on Dick-Peddie 1993 (acreage is not comprehensive due to course resolution and rounding).
Note: (1) Acreage reflects all land ownership within BLM administrative boundaries.

The Great Basin Desert Scrub plant community covers approximately 435,000 acres within FFO boundaries, 75,000 acres within AFO boundaries, and 200 acres on USFS land and dominates the landscape in the northwestern portion of the planning area. The major shrub species in this type are big sagebrush, shadscale (*Atriplex confertifolia*), greasewood (*Sarcobatus vermiculatus*), and fourwing saltbush (*Atriplex canescens*). Big sagebrush has increased dramatically over the past 125 years. Most areas now dominated by big sagebrush in New Mexico were grassland or savannah in the middle of the last century (Dick-Peddie 1993). Within Great Basin Desert Scrub, big sagebrush usually occurs at higher elevations than the saltbush communities. Other sagebrush species found with big sagebrush are black sage (*Artemisia arbuscula*) and Bigelow sage (*A. bigelovii*). Other shrub species found with saltbush include winterfat (*Ceratoides lanata*), rabbitbrush (*Chrysothamnus sp.*), and Nuttal's saltbush (*Atriplex nuttallii*). Widespread grasses in this vegetation type include alkali sacaton (*Sporobolus airoides*), western wheatgrass (*Agropyron smithii*), Indian ricegrass (*Oryzopsis hymenoides*), and blue grama (Dick-Peddie 1993).



Map 3-6: Vegetation Types in the Planning Area

The Juniper Savannah plant community lies primarily in a band along the southern boundary of the planning area, and covers approximately 56,000 acres within FFO boundaries and 136,000 acres within AFO boundaries. This vegetation type occurs between the conifer woodlands and grasslands and has been expanding during this century due mainly to human activities, such as livestock grazing and fire suppression. This type consists of widely scattered low trees interspersed in grasslands. One-seed juniper and Utah juniper (*Juniperus osteosperma*) are typical, as are big sagebrush, Bigelow sagebrush, and shadscale. Blue grama, galleta, Indian ricegrass, and sideoats grama (*Bouteloua curtipendula*) are common grass species (Dick-Peddie 1993).

The Piñon-Juniper Woodland plant community type occurs primarily in the northeastern portion of the planning area and along the southern boundary. It covers an estimated 633,000 acres within FFO boundaries, 91,000 acres within AFO boundaries, 192,000 acres on USFS land, and 13,000 acres on USBR land. Trees in these woodlands can form a dense canopy or be fairly open. Dense stands generally occur above 6,600 feet in elevation and the dominant tree species are piñon (*Pinus edulis*), Utah juniper, Gambel's oak (*Quercus gambellii*), and true mountain mahogany (*Cercocarpus montanus*), with occasional stringers of ponderosa pine (*Pinus ponderosa*). Common ground cover species are mutton grass (*Poa fendleriana*), western wheatgrass (*Agropyron smithii*), buckwheat (*Eriogonum sp.*), and penstemon (*Penstemon sp.*) (BLM 1997). More open stands are located on drier sites below 6,600 feet elevation where piñon, Utah juniper, big sagebrush and antelope bitterbush (*Purshia tridentata*) are common. Blue grama and galleta are the principal grass species. Relatively large stands of big sagebrush can occur within the open woodlands (BLM 1997).

The Ponderosa Pine Forest occurs principally on USFS land along the eastern boundary of the planning area, although there is a small amount on FFO land. There are an estimated 2,300 acres within FFO boundaries, 5,600 acres within AFO boundaries, and 43,300 acres on USFS land. This forest occurs on BLM land primarily in deep canyons on north and east facing slopes. Common tree species are ponderosa pine, piñon, and Douglas fir (*Pseudotsuga menziesii*). The shrub component is dominated by antelope bitterbush, true mountain mahogany, and Gambel's oak with grass cover dominated by mutton grass and western wheatgrass. On the Jicarilla Ranger District and the Cuba Ranger District, this vegetation type occurs in scattered locations in deep canyons on north and east facing slopes. Dominant plant species at these locations are similar to those found on BLM lands.

The subalpine montane grasslands is represented by approximately 300 acres within FFO boundaries located on the very western side of the planning area along the New Mexico Arizona border. These grasslands are commonly found above 8,900 feet and up to 11,500 feet on relatively smooth terrain of southwestern exposures with slopes ranging from 20 to 50 percent (Dick-Peddie 1993). Dominant grasses in this vegetation unit include fescue (*Festuca* sp.), oatgrass (*Danthonia* sp.), tuft-hair grass (*Deschampsia* sp.), Junegrass (*Koeleria* sp.), bluegrass (*Poa* sp.), and muhly (*Muhlenbergia* sp.). Areas of heavy grazing experience vegetation community shifts from Thurber and Arizonia Fescue (*Festuca thurberi* and *F. arizonica* respectively), oatgrass and Junegrass to Kentucky bluegrass (*Poa pratensis*) (Dick-Peddie 1993). Restoration to a pre-grazing state of native vegetation occurs within 2 to 4 years if adequate recovery is allowed (Dick-Peddie 1993).

The subalpine coniferous forest unit occurs along the eastern boundary of the planning area with an estimated 6,700 acres of USFS land on the Santa Fe National Forest. The vegetation unit is characterized by elevations of approximately 9,500 feet to timberline, approximately 12,000 feet (Dick-Peddie 1993). Common flora include Englemann spruce

(*Picea englemanii*), Douglas-fir, Juniper species, Corkbark fir (*Abies lasiocarpa*), currants (*Ribes* sp.), fringed brome (*Bromus ciliatus*), mountain trisetum (*Trisetum spicatum*), and bluegrass (Dick-Peddie 1993). Vegetation communities vary among different alpine regions due to elevation and moisture differences.

The urban, farmland, and open water unit includes federal, state and private lands in the northern tier of the planning area. This vegetation unit represents the non-native land cover according to Dick-Peddie (1993). Open water areas are permanently inundated in surface water, such as the Navajo Reservoir. Irrigated cropland represents the farmland located adjacent to the San Juan, Animas, La Plata, and Los Piñas Rivers in this vegetation unit. Urban areas are concentrated in the tri-cities area (Aztec, Bloomfield, and Farmington).

Invasive Weeds

Invasive plants are found in the San Juan Basin, particularly in areas disturbed by surface activities. These plants displace native plant communities and degrade wildlife habitat. A total of 212 invasive and poisonous weeds have been identified on FFO land (Heil and White 2000). **Table 3-9** lists the invasive and non-native species of concern in the planning area and the current management classes for each species. The following management classes provide information on the current status of each species in the planning area and the priority for treatment:

- Class A: Non-native plants that have a limited distribution within or have not yet invaded the state. Some are found on public lands within the planning area, and preventing and eliminating infestations of these weeds has the highest priorities in the BLM management plan.
- Class B: Non-native plants that are presently limited to a particular part of the planning area. The management priorities are to contain them within their current areas and prevent new infestations.
- Class C: Non-native plants that are widespread throughout much of the public land within the planning area. Long-term programs of management and suppression are encouraged.

Table 3-9. 2001 Invasive and Non-Native Plant Species of Concern within the Planning Area

Common Name	Scientific Name	Class
African rue	*Peganum harmala*	A
Black henbane	*Hyoscyamus niger*	B
Bull thistle	*Cirsium vulgare*	C
Camelthorn	*Alhagi maurorum*	A
Canada thistle	*Cirsium arvense*	B
Dalmatian toadflax	*Linaria dalmatica*	A
Diffuse knapweed	*Centaurea diffusa*	A
Dyers weed	*Isatis tinctoria*	A
Hoary cress	*Cardaria draba*	C
Houndstongue	*Cynoglossum officinale*	A
Jointed goatgrass	*Aegilops cylindrica*	B
Leafy spurge	*Euphorbia esula*	B
Malta starthistle	*Centaurea solstitialis*	A
Musk thistle	*Carduus nutans*	C

Common Name	Scientific Name	Class
Onionweed	*Asphodelus fistulosus*	A
Purple loosestrife	*Lythrum salicaria*	A
Russian knapweed	*Centaurea repens*	C
Russian olive	*Elaeagnus angustifolia*	C
Saltcedar	*Tamarix spp.*	C
Scotch thistle	*Onopordum acanthium*	B
Spotted knapweed	*Centaurea maculosa*	A
Tall whitetop	*Lepidium latifolium*	A
Woolyleaf bursage	*Ambrosia grayi*	A
Yellow starthistle	*Centaurea solstitialis*	A
Yellow toadflax	*Linaria vulgaris*	A

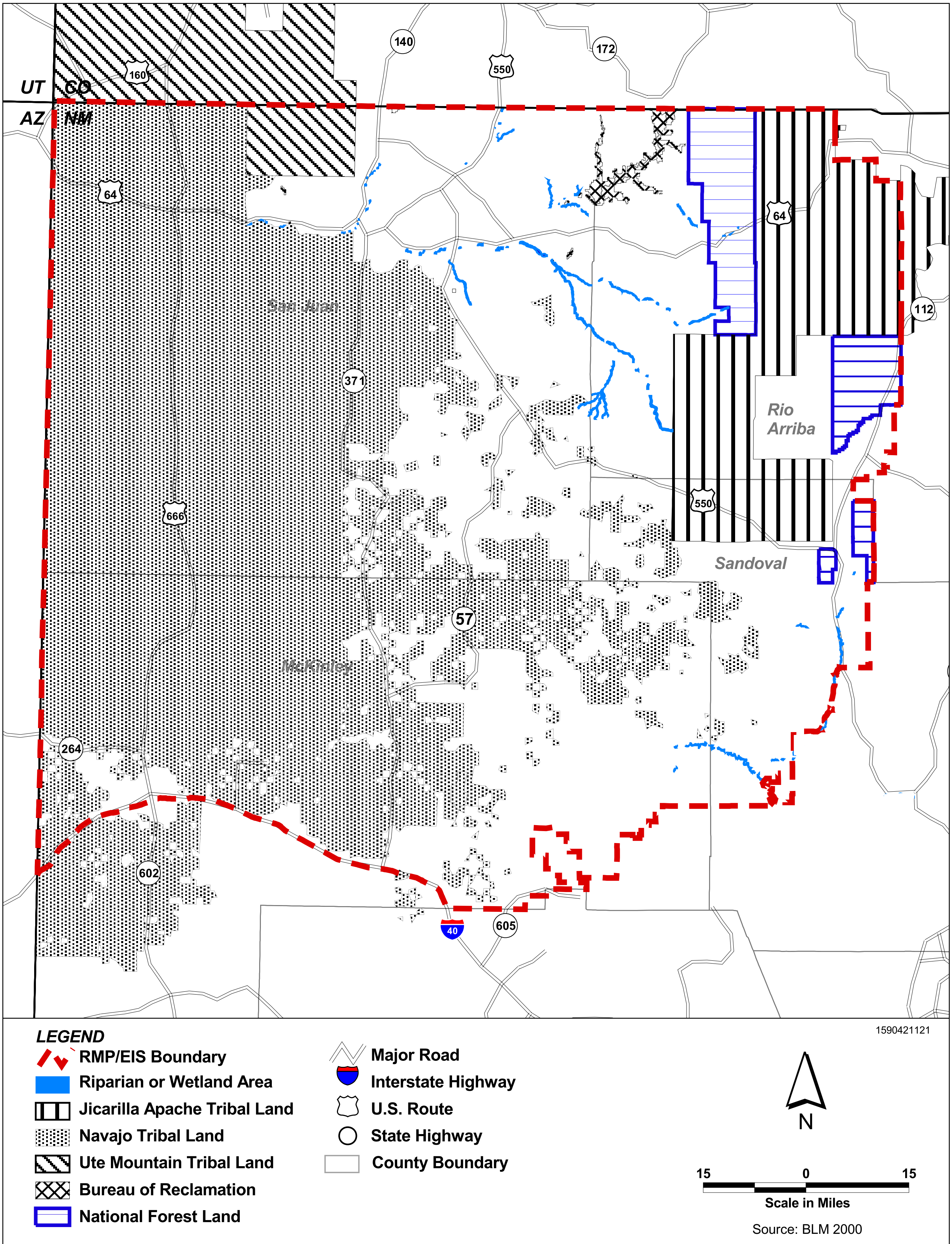
Source: BLM FFO.

RIPARIAN AREAS AND WETLANDS

Riparian areas are defined by the BLM as "a form of wetland transition between permanently saturated wetlands and upland areas. These areas exhibit vegetation or physical characteristics reflective of permanent surface or subsurface water influence. Lands along, adjacent to, or contiguous with perennially and intermittent flowing rivers and streams, glacial potholes, and the shores of lakes and reservoirs with stable water levels are typical riparian areas" (Leonard et al. 1992). Wetlands are regulated by the U.S. Army Corps of Engineers (USACE) and defined as "those areas inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (US Army 1987).

Seventy riparian areas in 35 river tracts and along portions of nine ephemeral stream reaches were identified on FFO land as shown in **Map 3-7** (BLM 2000b). Subsequently, 13 additional tracts along ephemeral drainages were identified. Riparian areas associated with the river tracts comprise 471 acres along 20 miles of river adjacent to the Animas, San Juan, and La Plata Rivers and Pump Canyon Creek (**Table 3-10**) (BLM 2000b). An estimated 1,042 acres of riparian vegetation occurs along an estimated 109 miles of ephemeral streams including Blanco Reach, Carrizo Canyon, Ditch Canyon, Gobernador Canyon, Kutz Canyon, La Jara Canyon, Largo Canyon, Palluche Canyon, and Simon Canyon (BLM 2000b). Wetlands include the 25 acres Carrizo Oxbow wetland identified in BLM (2000b) and the more recently identified 10 acre Desert Hills wetland. Common plant species in riparian areas on FFO land are cottonwoods (*Populus spp.*), willows (*Salix spp.*), saltcedar (*Tamarix spp.*), Russian olive (*Elaeagnus angustifolia*), sedges (*Carex spp.*), rushes (*Juncus spp.*), reed canarygrass (*Phalaris arundinacea*), cattails (*Typha spp.*), bulrushes (*Scirpus spp.*), alkali sacaton, galletagrass, Indian rice-grass, sagebrush, greasewood, and four-wing saltbush (BLM 2000b).

Twenty riparian areas occur along 21 miles of the Rio Puerco, 18 miles of Arroyo Chico, and 3 miles of other ephemeral drainages, for a total of about 42 miles on AFO land (see Table 3-10). There are a total of 1,169 acres of riparian habitat along these drainages, with 601 acres along Arroyo Chico and 523 acres along Rio Puerco. Most of the native cottonwoods and willows have disappeared from these riparian areas and the invasive saltcedar and Russian olive are common in some areas.



Map 3-7: Riparian Areas on BLM Land in the Planning Area

Table 3-10. Riparian Areas on Farmington and Albuquerque BLM Land in the Planning Area

Riparian Areas (number of segments)	Length (miles)	Size (acres)	Rating[1]
Farmington BLM Riparian Areas			
Animas River (3)	1	26	2 FAR (downward) and 1 PFC
San Juan River (18)	11	314	7 FAR (3 upward, 1 downward, 3 static) and 11 PFC
La Plata River (10)	3	68	8 FAR (no trend data) and 2 PFC
Pump Canyon (4)	5	63	3 FAR (no trend data) and 1 PFC
Blanco Reach (1)	1	[2]	FAR (static)
Carrizo Canyon (8)	23	15	4 FAR (3 upward, 1 static) and 4 NF
Ditch Canyon (1)	4	13	FAR (static)
Gobernador Canyon (2)	4	30	2 FAR (upward)
Kutz Canyon (2)	6	55	2 FAR (1 downward, 1 static)
La Jara Canyon (4)	5	18	4 NF
Largo Canyon (10)	37	677	7 FAR (4 upward, 3 static) and 3 NF
Palluche Canyon (5)	19	32	2 FAR (1 upward, 1 downward) and 3 NF
Simon Canyon (1)	1	4	NF
La Fragua (1)	0.6	13	PFC
La Jara Reach #5 (1)	1.3	29	PFC
Pump Canyon #5 (1)	0.5	30	PFC
Desert Hills Overflow (1)	0.5	10	PFC
Desert Hills Wetland (1)	[2]	10	PFC
Cutter Canyon (1)	1	10	PFC
Tapicito Reach #1 (1)	1	30	FAR (static)
Tapicito Reach #2 (1)	1	40	NF
Largo Canyon Reach #11 (1)	0.25	5	FAR (static)
La Plata River Reach #11 (1)	0.25	5	FAR (static)
Bancos Canyon (1)	1	5	FAR (downward)
Cabresto Canyon (1)	0.75	5	FAR (upward)
McDermott Wash (1)	1	6	FAR (downward)
Total	**129**	**1,513**	

Riparian Areas (number of segments)	Length (miles)	Size (acres)	Rating[1]
Albuquerque BLM Riparian Areas			
Rito Leche (1)	1	10	PFC
Senorito Canyon (1)	2	35	PFC
Wilson Canyon[3] (1)	2	77	FAR (upward)
Two Bridges[3] (1)	2	30	No trend data
Coal Creek[3] (1)	4	100	FAR (upward)
Cerros Colorados[3] (4)	2	43	4 FAR (static)
Cachulie[3] (1)	2	26	FAR (downward)
San Luis Community[3] (1)	1	22	FAR (downward)
Lost Valley[3] (1)	4	103	FAR (upward)
Cabezon Community[3] (4)	2	45	4 FAR (upward)
Arroyo Chico (3)	18	601	2 FAR (1 upward, 1 downward) and 1 NF
Guadalupe Community[3] (1)	2	77	NF
Chijuilla Spring	NA[4]	<1	No trend data
Dry Spring	NA	<1	No trend data
Elk Spring	NA	<1	No trend data
Mesa Portales Spring	NA	<1	No trend data
Mesa Chirato Spring	NA	<1	No trend data
Total	**42**	**1,169**	

Source: BLM 2000b, c.

Notes: (1) FAR = functioning at risk, PFC = proper functioning condition, NF = non-functional, upward = upward trend in condition, downward = downward trend in condition, static = no apparent trend in condition.

(2) Size and/or length not provided.

(3) Riparian areas along Rio Puerco.

(4) NA = not applicable

Upland plants, such as rabbitbrush, have moved into some of the riparian areas. However, native vegetation is evident and increasing in some areas due to the exclusion of livestock or limitations on grazing. Vegetation in these areas typically grows in zones from wetter to dryer, starting with sedges and rushes common in the wettest zone and willows, grasses, saltcedar, rabbitbrush, and salt grass growing in progressively dryer areas. A few scattered remnant cottonwoods are present (BLM 2000c).

Proper-functioning condition (PFC) surveys were first conducted on FFO lands in 1994. During 1994, surveys took place on 3 tracts of the San Juan River, 9 tracts of the La Plata River, and the BLM portions of Largo Canyon, Carrizo Canyon, Palluche Canyon, La Jara Canyon, Gobernador Canyon, Kutz canyon, Pump Canyon Ditch Canyon, Blanco Canyon, and Simon Canyon. Of the river tracts, 2 were rated as PFC, 3 were rated as functioning at risk (FAR) with an upward trend, 6 were rated as FAR with no apparent trend, and 1 was rated as non-functional (NF). Of the intermittent and ephemeral systems, 1 was rated as PFC, 10 were rated as FAR with an upward trend, 6 were rated as FAR with no apparent trend, 2 were rated as FAR with downward trend, and 15 were rated NF. All of the remaining riparian reaches were surveyed in 1998. These riparian areas consisted of 25 perennial reaches and 1 wetland. The results of the 1998 surveys were 13 reaches rated as PFC, 4 reaches rated as FAR with an upward trend, 2 reaches rated as FAR with no apparent trend, 3 reaches rated as FAR with a downward trend, on 1 reach rated as NF.

Follow-up PFC surveys were conducted since 1998 on some of the reaches with the following results: 7 reaches showed no change, 1 reach that was rated as FAR with no apparent trend was changed to FAR with a downward trend, 3 reaches that were rated FAR with no apparent trend were changed to FAR with an upward trend, and 5 reaches that were rated as NF were changed to a rating of FAR. The early results of PFC reassessment show some improving conditions.

The 1994 and 1998 PFC surveys revealed that significant portions of riparian areas were in less than PFC. FFO staff began a process to evaluate the cause and effects of management techniques in relationship to riparian conditions. Management actions implemented as a result of the evaluation process include a decision in 1998 to defer all designated riparian areas from summer grazing, the development of an EIS for Riparian and Aquatic Habitat Management in the Farmington Field Office (BLM 2000b), and the development of a riparian monitoring plan.

The FFO riparian management plan is dynamic and, as indicated above, additional riparian areas have been added since the completion of the Riparian Habitat Management Plan (BLM 2000b) (Table 3-10). If other drainages are found that meet the BLM definition of riparian areas, they will also be added. On AFO land within the planning area, three riparian sites (21 percent) are PFC and eight (57 percent) are FAR, with four showing an upward trend, three a downward trend, and one with no apparent trend. Two (14 percent) riparian sites are NF, and one (7 percent) was not categorized (BLM 2000c).

FISHERIES AND WILDLIFE

This section addresses wildlife species within the planning area, except for special status species, which are addressed in the next section.

Fisheries

The FFO area administers a small amount of fisheries habitat on small, generally isolated tracts of public land mostly along the San Juan River. Some of this land, on the San Juan upstream from Archuleta, New Mexico, provides good habitat for rainbow trout (*Oncorhynchus mykiss*). Further downstream, the water temperature rises and the river bottom is covered with mostly mud as opposed to the gravel/cobble substrate upstream. The general absence of a substrate (gravel/cobble) suitable for the production of macro-invertebrates precludes the establishment of any significant trout populations in the area downstream from Archuleta. However, native species such as the flannelmouth (*Catostomus latipinnis*) and bluehead (*C. discobolus*) suckers are abundant in this area.

The State of New Mexico classifies the Navajo Reservoir as both a cold water and a warm water fishery (USBR 1999). The reservoir also carries a “Class 1” supporting “warm aquatic life” by the State of Colorado (USBR 1999). Kokanee salmon (*Oncorhynchus nerka*), rainbow trout, brown trout (*Salmo trutla*), and northern pike (*Esox lucius*) comprise the primary cold water game fish species in the reservoir. Warm water game fish species include smallmouth bass (*Micropterus dolomieui*), largemouth bass (*M. salmoides*), bluegill (*Lepomis macrochirus*), white and black crappie (*Pomoxis annularis* and *P. nigromaculatus*), channel catfish (*Ictalurus punctatus*), and black bullhead (*Ameriurus melas*). Roundtail chub (*Gila robusta*), Bluehead sucker, and Flannelmouth sucker are nongame species of concern (USBR 1999).

Stocking efforts from the Colorado Department of Wildlife and the New Mexico Department of Game and Fish supports Kokanee salmon populations in the reservoir.

Rainbow trout levels are attributed to NMDGF stocking efforts while brown trout and northern pike populations are supported through migrations from adjacent tributaries. The warm water fishery of the Navajo Reservoir is sustained through natural reproduction.

Fish harvesting patterns fluctuate temporally due to accompanying species patterns. Restrictions are implemented for kokanee salmon during the fall and in the spring for trout and other fishes to protect specific spawning behaviors.

Wildlife

The FFO strives to maintain a biologically diverse complement of endemic wildlife species. As a consequence of this, a variety of monitoring and survey efforts are undertaken each year. Generally, the focus of these efforts has been upon those species with a special status designation (i.e., threatened, endangered, or sensitive, or game animals such as mule deer, elk, antelope, and wild turkey). However, in recent years, non-game species (primarily avian) have received more attention.

In 1999, the FFO initiated a monitoring program to assess the status of avian species utilizing the key habitat types common to the FFO area. This monitoring effort consisted of conducting point count surveys during the spring breeding period and again during the winter in the following habitat types: piñon-juniper; ponderosa pine/piñon pine/Gambel's oak; riparian (cottonwood, willow, saltcedar); Wyoming big sagebrush/grass (untreated); and Wyoming big sagebrush/grass (treated). A synthesis of the bird species and numbers of individuals detected in all habitat types by year is provided in Appendix O, Table O-1. The results of these surveys are generally consistent with the trends reported in the breeding bird surveys conducted by the USFWS and with the information presented in the Partners in Flight (PIF) Draft Land Bird Conservation Plan for the State of New Mexico. It is the intention of the FFO to continue, and if funding allows, expand the monitoring of avian species. Data collection of this magnitude will also enable the FFO to more effectively meet its obligations under the provisions of the Migratory Bird Treaty Act and as emphasized by EO 13186 of January 10, 2001.

The PIF Bird Conservation Plan identifies a number of bird species within the Colorado Plateau physiographic region as "priority" species. A number of the highest priority species have been detected in the FFO area. Representatives in this group include sage sparrow, mountain bluebird, loggerhead shrike, and gray vireo. Other species that occur in the FFO area and which PIF has identified in New Mexico as having a high percentage (over 10 percent) of their U.S. population include the piñon jay and western bluebird. Table O-2 in Appendix O summarizes regional breeding bird survey information for priority species for which PIF suggests that New Mexico land managers have a "high level of responsibility" to maintain or increase the current populations. The FFO will consider PIF's recommendations in its future management actions.

One of the earliest non-game species inventories was in the Chaco strippable coal belt where 175 vertebrate species were detected (Albee 1982). Species lists are on file in the FFO.

Waterfowl habitat within the planning area is limited to stock ponds, sumps, a few acres of wetlands in Carrizo and Pump Canyons, and scattered parcels of public land along the San Juan, Animas, and La Plata Rivers. Potholes enclosed by a fence to exclude livestock have been constructed in the Largo Canyon drainage for the purpose of providing waterfowl nesting habitat. Mallards (*Anas platyrhynchos*), American widgeon (*Anas americana*), green wing teal (*Anas crecca*), common merganser (*Mergus merganser*), American coot (*Fulica americana*), common goldeneye (*Bucephala clangula*), and cinnamon teal (*Anas cyanoptera*) are species typically encountered on the water impoundments and rivers. Canada geese (*Branta canadensis*) are abundant on the San Juan and Animas Rivers and the lands adjacent to them.

There are several species of upland game birds found on public lands in the planning area. Gambel's quail (*Callipepla gambelii*) are common in many of the drainages that are well vegetated while scaled quail (*Callipepla squamata*) tend to be more prevalent on drier sage/grass sites in the southern portion of the field office area. Scattered tracts of public land adjacent to private agricultural lands support small numbers of ring-necked pheasants (*Phasianus colchicus*). Merriam's wild turkey (*Meleagris gallopavo*) are found year-long in the ponderosa and piñon-juniper/Gambel's oak habitat types found in the Laguna Seca Mesa SMA, and seasonally in the Rattlesnake Canyon wildlife management area.

The FFO has inventoried and monitored golden eagles (*Aquila chysaetos*), ferruginous hawks (*Buteo regalis*), and prairie falcons (*Falco mexicanus*) since 1981 (Hawks Aloft 1998, 1999a, b, c, and FFO files). Abundance and nesting success has fluctuated probably due to weather conditions and cyclic prey abundance, but populations of ferruginous hawk and golden eagle have remained relatively stable. Owls recorded during Mexican spotted owl surveys included the long-eared owl (*Asio otus*), northern saw-whet owl (*Aegolius acadicus*), flammulated owl (*Otus flammeolus*), and great-horned owl (*Bubo virginianus*) (BLM 1995d). Detailed raptor surveys have not been conducted on AFO land, although species such as the golden eagle and prairie falcon are known breeders (Silva 2001). The northern goshawk (*Accipiter gentilis*), Cooper's hawk (*A. cooperii*), and red-tailed hawk (*Buteo jamaicensis*) are known to nest on the Jicarilla and Cuba Ranger District land (USFS 2000).

A two-year bat survey on FFO land resulted in the detection of 14 species, with the most common species determined to be the California myotis (*Myotis californicum*), long-legged myotis (*M. volans*), big brown bat (*Eptesicus fuscus*), and long-eared myotis (*M. evotis*) (Gannon 1997, 1998a). Bat surveys were also conducted in the Jicarilla Ranger District in 1998 with nine species comprising 251 individuals captured. The big brown bat, long-eared bat, pallid bat (*Antrozous pallidus*), and fringed myotis (*Myotis thysanodes*) were the most common species identified in these surveys (Gannon 1998b). It is expected that these species also occur in appropriate habitat on the Santa Fe National Forest and the AFO land.

The piñon-juniper and Great Basin Desert Scrub plant communities in the northeastern part of the planning area provide habitat for herds of wintering and resident populations of mule deer (*Odocoileus hemionus*) and elk (*Cervus elaphus*). Most of the National Forest land within the project boundary is managed as year-long big game and critical wintering habitat. Much of the AFO land consists of the Piñon-Juniper Woodland vegetation type and supports a low population of mule deer and elk. Elk are most common in the riparian habitat along the Rio Puerco (Silva 2001).

Mule deer and elk are found most often on FFO land north of US 550, and are much less common south of the highway due to the lack of suitable habitat (BLM 1988). Deer and elk population density on FFO land varies by location and time of year. In most years, a large influx of migratory mule deer and a lesser number of elk takes place during the winter. Most of these animals are found on FFO land near the Colorado/New Mexico state line and adjacent to National Forest and Jicarilla Apache reservation lands. Much of this habitat on FFO land is considered critical winter range. TLs currently in place in the Laguna Seca Mesa SMA and other winter habitat provide some protection against disruptions in their habitat when fawning or calving is occurring. Resident deer density is much lower than winter population levels as determined from browse studies and helicopter surveys conducted each year. Aerial surveys conducted on some of the big game subunits on FFO land are summarized in Table 2 in SAIC 2002a.

Several small populations of pronghorn antelope (*Antilocapra americana*) reside in the area north and east of US 550 near Angel Peak and Ensenada Mesa. There are also remnants of a once thriving population of antelope in the Twin Mounds area. The numbers of these animals have been declining over the past 10 years. Studies are currently in progress to determine the cause of this decline. Preliminary indications are that the cause may be attributable to factors such as habitat quality and predation (Hanson 2001). It has been documented that antelope disperse widely over Ensenada Mesa when fawning. Traffic and other human activities can cause does to leave their fawns, leaving them vulnerable to predators. When human disruptions are limited in the habitat during the first 10 days to 2 weeks of a fawn's life, it can remain under cover until it is strong enough to travel with the herd, greatly improving its chances for survival (Hanson 2002). About 100 antelope were released on AFO land in and near the planning area a few years ago but most of these have disappeared, leaving only an occasional pronghorn antelope to be seen (Silva 2001).

Mountain lion (*Felis concolor*) and black bear (*Ursus americanus*) are also considered big game animals that occur in the planning area. The mountain lion population in the FFO area appears to be doing well as indicated by the NMDGF harvest quota for the 2001-2002 season for Game Management Units 2 and 7, which is set at 11 lions. Reports of black bear in the FFO area are infrequent and there is no open hunting season.

HMPs have been developed for some of the wildlife management areas such as Rattlesnake Canyon and Crow Mesa. These areas are managed for big game and other wildlife on FFO land (BLM 1997, 1999b). These areas are characterized by deep canyons, piñon-juniper woodlands with stringers of ponderosa pine, and areas dominated by big sagebrush. The objectives of these HMPs are to increase the year-round resident mule deer and elk populations, contribute to the stabilization of the watersheds, and improve the existing biological diversity. Actions planned for the HMP areas include improving the quantity and quality of forage, water, and protective cover for deer and elk, and increasing ground cover to reduce soil erosion (BLM 1997, 1999b). The condition of wildlife habitats are affected by the multiple uses of the land, including mineral extraction, livestock grazing, recreation activities, and fire management.

SPECIAL STATUS SPECIES

Special status species include federally listed and proposed species, federal candidate species, and state listed species. Other sensitive species considered include BLM sensitive species, and federal species of concern. Information regarding these species are presented in summary tables in this section and more detailed species descriptions appear in SAIC 2002a and the biological assessment associated with this EIS.

Federally Listed and Proposed Species

The FFO manages habitats for species listed by the USFWS as endangered, threatened, or proposed under the authority of the ESA of 1973, as amended. Currently, there are five endangered, three threatened, and one proposed species that occur, or have the potential to occur on lands managed by FFO (**Table 3-11**). In addition, the USFWS has designated portions of FFO lands as critical habitat for the Mexican spotted owl and the Colorado pikeminnow.

A detailed analysis of the listed and proposed species is developed in the Biological Assessment (BA) for this RMP Revision. The BA contains the species ecology, the affected habitat description, and analysis of the effects of the actions authorized by the FFO, the cumulative impacts of authorized actions, and the determination of the effect of the implementation of the RMP Revision on each species. It also describes FFO efforts to implement recovery plans for listed species. It also describes efforts to implement recovery plans for listed species.

Table 3-11. Federally Listed, Proposed, and Candidate Species and Critical Habitat that Occur or Potentially Occur in the Planning Area

Species	Status[1]	Comments
Knowlton's cactus *Pediocactus knowltonii*	E	Endemic to New Mexico on rolling gravel hills in the piñon-juniper/sagebrush plant community. Entire wild population is fenced and protected from disturbances.
Mesa Verde cactus *Sclerocactus mesae-verdae*	T	Found in soils derived from Mancos, Fruitland, and Lewis shale. Largest population on Ute and Navajo tribal lands. All populations on lands managed by FFO are protected in the Hogback ACEC.
Mancos milkvetch *Astragalus humillimus*	E	Found in piñon-juniper woodlands and desert shrublands on sandstone rimrock ledges and mesa tops in San Juan County and adjacent Colorado. All populations on lands managed by FFO are protected in the Hogback ACEC.
Colorado pikeminnow *Ptychocheilus lucius*	E	Inhabits sections of the San Juan River and other rivers in the upper Colorado River basin. No wild Colorado pikeminnows have been detected in the planning area.
Colorado pikeminnow designated critical habitat	N/A	Colorado pikeminnow designated critical habitat consists of portions of the San Juan River beginning at the NM Highway 371 bridge in Farmington and continues downstream to Lake Powell.
Razorback sucker *Xyrauchen texanus*	E	Inhabits sections of the San Juan River and other rivers in the upper Colorado River basin. No razorback suckers have been detected in the planning area.
Bald eagle *Haliaeetus leucocephalus*	T	Bald eagles migrate through and winter in the planning area. Important habitats used by the eagles are protected and managed under FFO land use planning decisions and the Bald Eagle ACEC activity plan of 1992.
Mountain plover *Charadrius montanus*	PT	Endemic grassland species in the western U.S. Nine breeding records in the planning area from 1970 to 1999. Suitable nesting habitat on FFO lands has been identified and special management stipulations are attached to permits. May nest on AFO land but not confirmed.
Mexican spotted owl *Strix occidentalis lucida*	T	Found in the southwestern U.S., principally in New Mexico and Arizona. After extensive surveys, no nesting has been confirmed of FFO or AFO.
Mexican spotted owl critical habitat	N/A	Critical habitat designated in 2001. All designated critical habitat in the planning area is located within the boundaries of the proposed Mexican Spotted Owl ACEC.
Yellow-billed cuckoo *Coccyzus americanus*	C	Western subspecies breeds in Arizona, California, and New Mexico. Nests in cottonwood/willow riparian habitat along rivers. Recent data indicates it is very rare in the San Juan River valley. Potential habitat on FFO land was surveyed for this species in 2002.

Species	Status[1]	Comments
Southwestern willow flycatcher *Empidonax trailii extimus*	E	No breeding southwestern willow flycatchers (SWWF) have ever been detected in the planning area. All designated potential SWWF habitat is protected and managed under the guidelines of the Southwestern Willow Flycatcher Habitat Management Plan of 1998.

Sources: Nicholopoulos 2001, BLM 1995a, BLM 2000b, BLM 2000c.
Notes: (1) E = endangered, T = threatened, PT = proposed threatened, C = candidate species.

Critical habitat for the Mexican spotted owl (*Strix occidentalis lucida*) occurs on FFO land, and critical habitat for the Colorado pikeminnow (*Ptychocheilus lucius*) occurs in part of the San Juan River and within the 100-year floodplain from the State Highway 371 Bridge in Farmington down to Lake Powell, downstream from the planning area. Razorback sucker (*Xyrauchen texanus*) critical habitat on the San Juan River occurs from the Hogback Diversion, about 20 river miles downstream from Farmington, to Lake Powell. Listed fish species have the potential to occur in the San Juan River in the area of FFO river tracts. Listed plant species occur on FFO land, and transplanted Knowlton's cactus (*Pediocactus knowltonii*) occurs on USBR lands. Wintering bald eagles (*Haliaeetus leucocephalus*) occur on FFO and USBR lands. The Mexican spotted owl has the potential to occur on FFO land.

Other Special Status Species

Not all rare species receive the legal protection of the ESA of 1973, as amended. These species may not be rare enough to warrant protection under ESA, or there may not be sufficient data collected about the species for the USFWS to make a determination to list under ESA. Rare species or species with insufficient data are often listed as special status species. Federal land management agencies are mandated to manage special status species so that they should not need to be listed under ESA in the future.

Lists of special status species are maintained by several agencies including the USFWS, BLM, USFS, and the State of New Mexico. There are 36 special status species that may have the potential to occur in the planning area (**Table 3-12**). FFO has coordinated with the other agencies to determine which of these 36 species warrant special management, or field studies to collect data.

Six species known to occur in the planning area receive special management: beautiful gilia, also known as Aztec gilia (*Aliciella formosa*), Brack's fishhook cactus (*Sclerocactus cloveriae var. brackii*), American peregrine falcon (*Falco peregrinus anatum*), ferruginous hawk, yellow-billed cuckoo (*coccygus americanus*), and Golden Eagle (*Aquila chrysaetos*). Potential bat habitat is surveyed before construction projects that impact sandstone cliff faces are authorized. Three years of field work has been conducted to determine the potential abundance of the gray vireo. In the future, FFO will cooperate with other agencies to gather data and develop special management for special status species when the situation warrants.

FFO also monitors raptor nesting and applies special stipulations as outlined in the Raptor Policy of 2000, to protect nesting ferruginous hawk, golden eagle, and prairie falcon. Other nesting raptors observed during proposed project biological surveys are also protected by site-specific stipulations.

Table 3-12. State Listed and Other Special Status Species that Occur or Potentially Occur in the Planning Area

Species	Status[1]			Comments
	USFWS Species of Concern[2]	BLM Sensitive Species	State	
Plants				
Acoma fleabane *Erigeron acomanus*	X	X	SOC	Grows in sandy soil at base of Entrada sandstone cliffs. Endemic to McKinley County on and in area of FFO and AFO land.
Aztec gilia *Aliciella formosa*	X	X	E	Grows in salt desert shrublands on soil from Nacimiento Formation. Known from San Juan County in New Mexico on FFO land in tri-cities area.
Bisti fleabane *Erigeron bistiensis*	X	X		Found in Great Basin desert scrub on soils from Ojo Alamo Sandstone Formation.
Brack's fishhook cactus *Sclerocactus cloveriae* var. *brackii*	X	X		Occurs on sandy-clay hills of the Nacimiento Formation in desert scrub habitat.
Knight's milkvetch *Astragalus knightii*	X	X	SOC	On rimrock ledges of the Dakota Formation in conifer woodlands. Known only from the Mesa Prieta area of the middle Rio Puerco on AFO land and could occur in the planning area.
Parish's alkali grass *Puccinellia parishii*	X	X	E	Grows in alkali seeps and wetlands in desert scrub. Occurs on AFO land in Sandoval County, possibly within the planning area.
Ripley's milkvetch *Astragalus ripleyi*	X	X	SOC	Found from sagebrush to ponderosa pine in Rio Arriba and Taos counties in New Mexico and adjacent Colorado. Could occur on FFO land. Not detected on the Jicarilla Ranger District during species-specific surveys.
Sivinski's fleabane *Erigeron sivinskii*	X	X	SOC	Inhabits steep barren shale slopes of the Chinle Formation in coniferous woodlands in McKinley County, New Mexico and Apache County, Arizona. Occurs in the southern part of FFO land.
New Mexico silverspot butterfly *Speyeria nokomis nitocris*	X	X		Found in moist habitats around marshes and along streams in southwestern U.S. May occur, but not confirmed, in riparian habitats on FFO and AFO lands.
San Juan checkerspot butterfly *Euphydryas anicia chuskae*	X	X		Found at high altitudes in alpine tundra and pine forests in the Chuska Mountains in McKinley, San Juan Counties in New Mexico, Apache County, and Arizona. Not likely to occur on FFO land.
San Juan tiger beetle *Cicindela lengi jordai*	X	X		Found along sandy washes in May and June in parts of San Juan County. May occur on FFO land.
San Ysidro tiger beetle *Cicindela willistoni funaroi*	X	X		Found on mudflats from mid-July to August in New Mexico and Arizona. Could occur on mudflats on FFO and AFO lands.

Species	Status[1]			Comments
	USFWS Species of Concern[2]	BLM Sensitive Species	State	
William Lar's tiger beetle *Cicindela fulgida williamlarsi*	X	X		Found along streams and on mudflats in June and July in Arizona and New Mexico, and may occur on FFO and AFO lands.
Roundtail chub *Gila robusta*	X	X	E	Historically occurred in the San Juan, Zuni, San Francisco, and Gila River drainages. Currently, rare in the San Juan River but it may occur in area of FFO river tracts.
American and arctic peregrine falcons *Falco peregrinus anatum* and *F. p. tundrui*	X	X	T	The American peregrine falcon nests in the western and eastern U.S., while the arctic peregrine falcon breeds north of the tree line. The American peregrine falcon nests in New Mexico and both subspecies migrate through the state. There are three nest sites on FFO land but it is not known to nest elsewhere on the planning area.
Baird's sparrow *Ammodramus bairdii*	X	X	T	Breeds in grassland habitat in the northern prairie states and Canada. Likely migrant through FFO and AFO lands.
Black tern *Chlidonias niger*	X	X		Breeds in wetlands in the central and western U.S. Is likely a regular migrant that forages over ponds and uses open riparian areas and emergent wetlands on FFO and AFO lands.
Ferruginous hawk *Buteo regalis*	X	X		Breeds from the Canadian provinces south to New Mexico in grassland habitat. Five to seven active nests on FFO land recently; may also nest on AFO land in the planning area.
Gray vireo *Vireo vicinior*			T	Breeds in much of the southwestern U.S. and Mexico and winters in Mexico. Breeds in piñon-juniper woodlands on FFO land and is fairly common. Also may nest on AFO land and USFS land within the planning area.
Harlequin duck *Histrionicus histrionicus*	X			Populations in western and eastern North America. Western population winters along the pacific coast and breeds along rushing mountain stream from Canada south into Wyoming. Accidental in New Mexico and assumed to occur only rarely in planning area.
Loggerhead shrike *Lanius ludovicianus*	X	X		Breeds throughout much of the U.S. and southern Canada and winters in New Mexico. Is found in the desert scrub and grassland habitat on FFO and AFO lands. May also occur in desert scrub habitat on USFS land within the planning area.
Northern goshawk *Accipiter gentilis atricapillus*				Nests throughout North America. In the southwestern U.S., is most often found in ponderosa pine forests. There is one active goshawk territory on the Jicarilla Ranger District, but has not been recorded as a breeding species elsewhere within the planning area.

Species	Status[1]			Comments
	USFWS Species of Concern[2]	BLM Sensitive Species	State	
Western burrowing owl *Athene cunicularia*	X	X		Breeds in much of the western U.S. and Canada. Populations in New Mexico consist of breeding and wintering birds. Nests in grasslands and desert scrub habitats in association with prairie dogs or other burrowing rodents. Burrowing owls were observed during wildlife surveys on FFO land and it likely occurs elsewhere within the planning area.
White-faced ibis *Plegadis chihi*	X	X		Nests in freshwater marshes from California east into Idaho and Wyoming. May occur in riparian areas or agricultural fields during migration on FFO and AFO BLM lands.
Big free-tailed bat *Nyctinomops macrotis*	X	X		Occurs in South and Central America and the southwestern U.S., mostly in New Mexico and Arizona. Found in rugged country that provides crevices generally below 6,000 feet. Was detected at two locations on FFO land and four locations on the Jicarilla Ranger District.
Fringed myotis *Myotis thysanodes*	X	X		Occurs throughout the western U.S., including all of New Mexico. Can be found at mid-elevation grasslands, shrublands, and woodlands. Was not detected on FFO land in 1997 and 1998, but was captured 21 times on the Jicarilla Ranger District.
Long-eared myotis *Myotis evotis*	X	X		Occurs throughout much of western North America and in New Mexico. Found mostly in coniferous forests. Captured numerous times in FFO land and the Jicarilla Ranger District. Maternity colonies likely occur near some of the capture sites.
Long-legged myotis *Myotis volans*	X	X		Occurs over much of the U.S., including New Mexico. Found in coniferous forests from 6,000 to 9,600 feet. Captured numerous times on FFO and Jicarilla Ranger District land. Maternity colonies may be near some capture sites.
New Mexico jumping mouse *Zapus hudsonius luteus*	X	X	T	This subspecies occurs in Arizona and New Mexico, where it inhabits herbaceous wetland habitats in valley and mountain areas. It may occur in riparian habitat on FFO and AFO lands.
Occult little brown bat *Myotis lucifugus occultus*	X	X		Occurs throughout most of the U.S., including most of New Mexico. Usually found in ponderosa pine and oak-pine forests but can be found in most habitats near water. Not recorded during bat surveys on FFO and USFS land but could still occur in these areas.
Small-footed myotis *Myotis ciliolabrum*	X	X		Occurs throughout the western and eastern U.S., including New Mexico. Occurs in a wide variety of habitat types. Captured numerous times on FFO land and the Jicarilla Ranger District. Captures were in desert scrub to mixed conifer forest.

Species	Status[1]			Comments
	USFWS Species of Concern[2]	BLM Sensitive Species	State	
Spotted bat *Euderma maculatum*	X	X	T	Occurs in the western U.S., with historic records from all counties within the planning area. Found mostly in forested habitat but can also be found at lower elevation sites. The spotted bat was audibly detected once on FFO land and once on the Jicarilla Ranger District.
Townsend's big-eared bat *Plecotus townsendii pallescens*	X	X		Occurs in the western U.S., including the western half of New Mexico. Found in a variety of habitats and is closely tied to caves and mine shafts where it roosts and hibernates. Captured at two locations on FFO land.
Yuma myotis *Myotis yumanensis*	X	X		Occurs in the western U.S., including all of New Mexico. Found in coniferous woodlands in lower elevation habitats near water. Captured once on FFO land.

Source: Nicholopoulos 2001.

Notes: (1) FSOC = federal species of concern, SOC = state species of concern, E= endangered, and T= threatened.

(2) USFWS species of concern have no legal requirements under the ESA.

AIR QUALITY

Air quality within the planning area and its surroundings would be affected by emissions from construction and operation of the alternatives. This section describes the existing air quality resource of the planning area and applicable air regulations that could apply to the alternatives. At the present time, the planning area attains all national and New Mexico ambient air quality standards, and the air resource has not been a substantial constraint to development in the region.

Air quality in a given location is defined by pollutant concentrations in the atmosphere and is generally expressed in units of parts per million (ppm) or micrograms per cubic meter ($\mu g/m^3$). One aspect of significance is a pollutant's concentration in comparison to a national and/or state ambient air quality standard. These standards represent the maximum allowable atmospheric concentrations that may occur and still protect public health and welfare and include a reasonable margin of safety to protect the more sensitive individuals in the population. National standards, established by the U.S. Environmental Protection Agency (USEPA), are termed the NAAQS. The NAAQS represent maximum acceptable concentrations that generally may not be exceeded more than once per year, except the annual standards, which may never be exceeded. State standards, established by the New Mexico Environmental Improvement Board (NMEIB) and enforced by the NMAQB, are termed the New Mexico Ambient Air Quality Standards (NMAAQS). The NMAAQS are at least as restrictive as the NAAQS and they include standards for total suspended particulate matter (TSP) for which there are no national standards. **Table 3-13** presents the national and state ambient air quality standards.

The pollutants of primary concern for this air quality analysis include volatile organic compounds (VOC), nitrogen oxides (NOx), carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), particulate matter less than 10 microns in diameter (PM_{10}), and particulate matter less than 2.5 microns in diameter ($PM_{2.5}$). Although VOCs or NOx (other than nitrogen dioxide) have no established ambient standards, they are important precursors to O_3 formation. Standards for $PM_{2.5}$ have been promulgated, but are not yet enforceable.

Table 3-13. National and New Mexico Ambient Air Quality Standards

Pollutant	Averaging Time	New Mexico Standards[2]	National Standards[1]	
			Primary[2,3]	Secondary[2,4]
Ozone	1-hour	—	0.124 ppm	Same as primary
	8-hour	—	0.084 ppm	Same as primary
Carbon monoxide	8-hour	8.7 ppm	9 ppm	—
	1-hour	13.1 ppm	35 ppm	—
Nitrogen dioxide	Annual	0.05 ppm	0.053 ppm	Same as primary
	24-hour	0.10 ppm	—	—
Sulfur dioxide	Annual	0.02 ppm	0.03 ppm	—
	24-hour	0.10 ppm	0.14 ppm	—
	3-hour	—	—	0.5 ppm
PM_{10}	Annual (arithmetic mean)	—	50 µg/m^3	Same as primary
	24-hour	—	150 µg/m^3	Same as primary
$PM_{2.5}$	Annual (arithmetic mean)	—	15 µg/m^3	Same as primary
	24-hour	—	65 µg/m^3	Same as primary
Lead	Calendar Quarter	—	1.5 µg/m^3	Same as primary
Total Suspended Particulates (TSP)	Annual (geometric mean)	60 µg/m^3	—	—
	30-day Average	90 µg/m^3	—	—
	7-Day	110 µg/m^3	—	—
	24-hour	150 µg/m^3	—	—

Source: USEPA 2001a.

Notes:
(1) Standards, other than for ozone and those based on annual averages, are not to be exceeded more than once a year. The ozone standard is attained when the number of days above the standard in three continuous calendar years is less than four.
(2) Concentrations are expressed in units in which they were promulgated. Units shown as µg/m^3 are based upon a reference temperature of 25ºC and a reference pressure of 760 mm of mercury.
(3) Primary Standards: The levels of air quality necessary, with an adequate margin of safety to protect the public health.
(4) Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.

The planning area consists of San Juan County, the northern two-thirds of McKinley County, and the western portions of Sandoval and Rio Arriba Counties. Identifying the region of influence (ROI) for air quality requires knowledge of the types of pollutants being emitted, pollutant emission rates, topography, and meteorological conditions. The ROI for inert pollutants (pollutants other than O_3 and its precursors) is generally limited to a few miles downwind from a source.

The ROI for O_3 can extend much farther downwind than that for inert pollutants. Ozone is a secondary pollutant formed in the atmosphere by photochemical reactions of previously emitted pollutants, or precursors. Ozone precursors are mainly VOCs and NOx. In the presence of solar radiation, the maximum effect of VOCs and NOx emissions on O_3 levels usually occurs several hours after they are emitted and many miles from the source. Therefore, the ROI for O_3 may include much of the four-corners region.

Baseline Air Quality

The USEPA has designated all areas of the United States as having air quality better than (attainment) or worse than (nonattainment) the NAAQS. A nonattainment designation generally means that a primary NAAQS has been exceeded more than once per year in a given area. Areas without sufficient data to determine the attainment/nonattainment status are designated as unclassified. At the present time, the entire project region attains all national and state ambient air quality standards. However, McKinley and Rio Arriba Counties are designated as unclassified because there are presently no ambient air monitors within these rural areas.

In September 1997, the USEPA promulgated 8-hour O_3 and 24-hour and annual $PM_{2.5}$ NAAQS. Due to a lawsuit in May 1999, the U.S. Court rescinded these standards and USEPA's authority to enforce them. Subsequent to an appeal of this decision by the USEPA, the U.S. Supreme Court in February 2001 upheld these standards. This action will initiate a new planning process to monitor and evaluate emission control measures for these pollutants.

The USEPA intends to develop rulemaking on the implementation of the 8-hour O_3 standard by December 2003. The USEPA has a deadline to promulgate attainment status designations of the 8-hour O_3 standard by April 15, 2004 (USEPA 2002a). An area will attain this standard if its three-year running average of the annual fourth-highest daily maximum 8-hour O_3 concentration remains below 0.084 ppm. Implementation of the 1-hour O_3 standard will not be revoked in a given area until that area achieves this standard. Otherwise, as is the case for the project region, implementation of the 8-hour standard will replace the existing 1-hour standard.

Generally, concentrations of photochemical smog, or O_3, are highest during the summer months and coincide with the season of maximum solar insolation. Inert pollutant concentrations tend to be the greatest during periods of light winds, stable atmospheric conditions, and surface-based temperature inversions. These conditions limit atmospheric dispersion. However, in the case of PM_{10} impacts from fugitive dust episodes, maximum dust impacts within the planning area often occur during high wind events and/or in proximity to manmade ground-disturbing activities, such as agricultural tilling, vehicular activities on paved and unpaved surfaces, and mining operations.

Table 3-14 presents the maximum pollutant levels monitored at locations within the project region from 1995 through 2001 (NMAQB 1997, 2001a; USEPA 2002b). The NMAQB uses the Shiprock Substation site to monitor ambient pollutant impacts from the two large coal-fired electric generating stations in this area. The Bloomfield station occurs within the highly industrialized Bloomfield gas corridor and the NMAQB uses this station to monitor ambient pollutant levels from these sources (NMAQB 2001b). The data in Table 3-14 show that pollutant levels within the project region for the most part have not exceeded any ambient air quality standard during the 1995 through 2001 monitoring period. However, initiation of 8-hour O_3 monitoring in the project region in 1999 identified that in year 2000, O_3 levels equaled the 8-hour standard at the Shiprock Substation monitor and slightly exceeded this standard at the Bloomfield station. These pollutant readings do not represent violations of the 8-hour O_3 standard, as the three-year running average of the annual fourth-highest daily maximum 8-hour O_3 concentrations for these stations is about 0.076 ppm (NMAQB 2002). However, these data demonstrate that the project region is near the nonattainment level for this standard.

Table 3-14. Maximum Pollutant Concentrations Monitored in the Farmington RMP Project Region, 1995 to 2001

Pollutant/Monitoring Station	Averaging Time/ Measurement	Maximum Concentration by Year						
		1995	1996	1997	1998	1999	2000	2001
Ozone								
Bloomfield	1-hour (ppm)	–	–	–	–	–	0.10	0.09
Shiprock Substation		–	–	0.08	0.08	0.08	0.09	0.09
Bloomfield	8-hour (1) (ppm)	–	–	–	–	–	0.085	0.077
Shiprock Substation		–	–	–	–	0.074	0.084	0.077
Carbon Monoxide								
Farmington	8-hour (ppm)	2.8	3.0	2.7	5.2	2.5	1.9	–
	1-hour (ppm)	5.5	6.1	5.4	9.2	8.3	5.4	–
Nitrogen Dioxide								
Bloomfield	Annual (ppm)	–	–	0.010	0.010	0.012	0.011	0.012
Shiprock Substation		–	–	0.007	0.008	0.009	0.009	0.009
Bloomfield	24-hour (ppm)	–	–	0.026	0.022	0.027	0.028	0.033
Shiprock Substation		–	–	0.027	0.026	0.033	0.031	0.034
Sulfur Dioxide								
Bloomfield	Annual (ppm)	–	0.003	0.003	0.002	0.002	0.001	0.002
Farmington Airport		0.002	0.003	0.003	0.002	0.002	0.002	0.002
Shiprock		0.003	0.003	0.003	0.002	–	–	–
Shiprock Substation		0.014	0.013	0.016	0.016	0.009	0.007	0.004
Bloomfield	24-hour (ppm)	–	0.01	0.038	0.012	0.007	–	0.010
Farmington Airport		0.011	0.012	0.035	0.012	0.011	0.008	0.007
Shiprock		0.014	0.012	0.032	0.012	–	–	–
Shiprock Substation		0.045	0.060	0.073	0.075	0.052	0.033	0.020
Bloomfield	3-hour (ppm)	–	0.041	0.096	0.029	0.024	0.019	0.024
Farmington Airport		0.035	0.041	0.077	0.032	0.033	0.026	0.030
Shiprock		0.068	0.043	0.148	0.032	–	–	–
Shiprock Substation		0.196	0.233	0.267	0.267	0.139	0.144	0.058
PM_{10}								
Farmington	Annual Arithmetic Mean ($\mu g/m^3$)	17	16	16	12	16	14	16
Gallup		18	–	–	–	–	–	–
Shiprock		13	13	13	7	–	–	–
Farmington	24-hour ($\mu g/m^3$)	30	31	41	29	84	24	30
Gallup		37	35	–	–	–	–	–
Shiprock		27	30	79	14	–	–	–
$PM_{2.5}$								
Farmington	Annual ($\mu g/m^3$)	–	–	–	–	–	–	6.1
Farmington	24-hour ($\mu g/m^3$)	–	–	–	–	–	–	15.1

Sources: NMAQB 1997, 2001a, 2002; USEPA 2001a, 2002b.

Ambient concentrations of PM_{10} are generally dominated by sources of materials processing or disturbed earth, such as wind-blown dust from rock crushing or unpaved roads. However, materials produced from combustion processes or secondary formation in the atmosphere by photochemical processes tend to make up the majority of $PM_{2.5}$ samples. One of the main contributors to visibility impairment is $PM_{2.5}$.

Regulatory Setting

The federal Clean Air Act (CAA) of 1969 and its subsequent amendments establish air quality regulations and the NAAQS and delegate the enforcement of these standards to the states. The NMAQB enforces air pollution regulations and sets guidelines to attain and maintain the national and state ambient air quality standards within the State of New Mexico, except for tribal lands and Bernalillo County. These guidelines are found in the New Mexico State Implementation Plan. Following is a summary of the federal and state air quality rules and regulations that may apply to emission sources associated with the alternatives. This is an inclusive summary, as the programmatic nature of the alternatives does not provide the level of detail needed to identify all applicable rules and regulations.

The NMAQB enforces the national and state ambient air quality standards by developing rules to regulate and permit stationary sources of air emissions. The New Mexico air quality regulations are found in the New Mexico Administrative Code (NMAC) Title 20, Chapter 2. Any emission source proposed for the RMP would have to comply with the NMAQB regulations and ambient air quality standards. The following summarizes the more pertinent state air quality regulations that could apply to project emission sources.

- *20NMAC2.33—Gas Burning Equipment – NO_2*. New/existing natural gas burning equipment that have a heat input of greater than 1,000,000 million British Thermal Units (BTU) per hour shall not produce NO_2 emissions that exceed 0.2/0.3 pounds per million BTUs of heat input.
- *20NMAC2.35—Natural Gas Processing Plant – Sulfur*. Part 35 regulates sulfur emissions from existing/new gas processing facilities.
- *20NMAC2.42—Coal Mining and Preparation Plants – Particulate Matter*. Part 42 establishes requirements to minimize particulate matter emissions for coal mine and preparation plant sources, such as crushers, conveyors, and coal haul roads.
- *20NMAC2.60—Open Burning*. Part 60 outlines the process to obtain permits for open burning, such as fire management activities.
- *20NMAC2.70—Operating Permits*. Part 70 provides permitting requirements for stationary sources that exceed 100 tons per year (TPY) of a regulated pollutant, 10 TPY of a hazardous air pollutant (HAP), or 25 TPY of combined HAPs. Requirements include emission calculations, dispersion modeling analyses to ensure that the proposed source does not exceed any ambient air quality standard, and annual reporting.
- *20NMAC2.72—Construction Permits*. Part 72 applies to new or modified stationary sources that (1) have a potential emission rate greater than 10 pounds per hour or 25 TPY of any air pollutant for which there is a national or state ambient air quality standard or (2) exceed hourly HAPs emission levels outlined in subpart 502. However, fugitive dust emissions from coal mining operations are exempt from permits under Part 72, as new coal mining activities have to operate with an air pollution control plan for fugitive dust emissions that is approved by the New Mexico Surface Coal Mining Commission, as identified in *19NMAC8.20.2050*. Requirements may include (1) emission calculations,

(2) dispersion modeling analyses to demonstrate that the proposed source would not contribute to an exceedance of an ambient air quality standard or Prevention of Significant Deterioration increment, (3) a determination that the proposed source would not significantly impact air quality within pristine federal Class I areas (such as National Parks greater than 6,000 acres or National Wilderness Areas [NWA] greater than 5,000 acres), and (4) public notifications.

- *20NMAC2.73—Notice of Intent and Emissions Inventory Requirements*. Part 73 requires new or modified stationary sources that have potential emission rates greater than 10 TPY of any regulated air contaminant or 1 TPY of lead to file an NOI prior to construction. Sources subject to this part shall submit annual emissions inventories.
- *20NMAC2.74—Permits – Prevention of Significant Deterioration (PSD)*. The PSD requirements apply to (1) 28 identified source types that emit more than 100 TPY of any pollutant for which there is a national ambient air quality standard or (2) any other source that emits 250 TPY. Requirements include air monitoring, emission calculations, dispersion modeling analyses, implementation of best available control technologies (BACT), and a determination that the proposed source will not significantly impact air quality within pristine federal Class I areas. Within the project region, these areas could include the Mesa Verde National Park and Weminuche NWA in Colorado and the San Pedro Parks NWA in New Mexico.

Regional Air Emissions

The NMAQB compiles countywide emission inventories for stationary sources that emit more than 10 TPY of a pollutant. Additionally, the USEPA estimates point, area, and mobile source emissions are part of their National Emission Trends database. An emissions inventory is not available for the combined planning area that includes all of San Juan County and portions of McKinley, Rio Arriba, and Sandoval Counties. However, the project region encompasses all of San Juan County. This county produces the overwhelming majority of emissions from any county within the planning area, and the majority of project emission sources would occur within this region. Therefore, emissions from San Juan County are used to represent the baseline emissions within the entire planning area. **Table 3-15** summarizes the mobile and stationary source emissions that occurred in San Juan County during 1999 (USEPA 2001b). The largest stationary sources of air emissions within the region are the coal-fired San Juan electric generating station, about 10 miles west of Farmington, and the Arizona Public Service Four Corners electric generation facility on the Navajo Reservation, about 10 miles to the south of this facility. Natural gas production and transmission is the second largest stationary source category in the region. Due to these two activities, San Juan County has the largest amount of stationary source emissions of any county in New Mexico. While fugitive dust is known more as an area source, this source category produces the majority of PM_{10} in the region. The on-road vehicles mobile source category produces a large percentage of combustive emissions in the region and is the main source of CO.

Table 3-15. Summary of 1999 Annual Emissions by Source Category for San Juan County (TPY)

Source Category	VOCs	CO	NOx	SOx	PM10
Electric Services	471	3,887	75,856	72,032	10,285
Crude Petroleum and Natural Gas	252	1,155	3,648	2	75
Natural Gas Liquids	811	2,158	9,587	3,176	65
Petroleum Refining	1,093	115	348	989	31
Construction Sand and Gravel	3	40	98	16	25
Natural Gas Transmission	3,411	8,132	5,685	2	7
Fuel Combustion—Indus/Other	295	1,625	720	124	215
Waste Disposal and Recycling	245	2,301	24	5	333
Petroleum Product Storage/Transport	1,532	–	–	–	–
Solvent Usage	1,483	–	–	–	–
On-Road Vehicles	3,114	30,933	4,233	174	153
Off-Road Vehicles	450	5,994	1,034	166	79
Agricultural and Forestry	–	–	–	–	1,431
Fugitive Dust	–	–	–	–	63,884
Total Source Emissions	**13,160**	**56,340**	**101,232**	**76,686**	**76,583**

Source: USEPA 2001b.

RANGELAND

There are 240 grazing allotments on BLM land within the planning area. In 1992, 63 Section 15 grazing allotments in southern McKinley County were transferred from the FFO to AFO administration, leaving 177 for which the FFO is responsible. This planning effort will have minimal impact on the grazing allotments in southern McKinley County, and the public lands within them will remain identified for eventual disposal.

The number of range allotments is subject to change, due to ongoing relinquishments, combinations, and other management adjustments. Approximately 36,000 acres of FFO land in the planning area have been removed from existing allotments for a variety of reasons, such as lack of forage, lack of water, or conflict with other users. All or part of the following allotments have been removed from grazing: Kutz, Cinder Gulch, Coyote Hills, Mine Facility, La Baca Canyon, Turley, Martinez Mesa, Hart Springs, Rancho Largo (partial), and Sweetwater (partial).

FFO grazing allotments accommodate 162 individuals permitted to graze cattle, horses, sheep, and goats. Within the public land in the Checkerboard area there are 34 Navajo community allotments with 2,200 individual operators administered by the Bureau of Indian Affairs under Section 15 of the 1936 Taylor Grazing Act. BLM administers three Navajo community allotments with 175 permittees under Section 3 of the act. There are approximately 112,800 animal unit months (AUM) of grazing authorized by FFO. An AUM refers to the amount of forage necessary to feed one animal unit for a period of one month. An animal unit is defined as one mature cow of approximately 1,000 pounds and a calf up to weaning, usually six months of age, or their equivalent of other animals.

Most allotments contain a combination of federal, state, and private land. Periods of livestock use vary from year-round to seasonal.

Most of the seasonal allotments are located in the northern half of the FFO area, while year-round grazing is permitted on most of the southern FFO area. Allotments range in size from 40 to over 67,000 acres. The majority is used to graze cattle, sometimes in combination with other livestock. Other allotments are used to provide forage for horses, sheep, goats, or a combination.

FFO rangeland is comprised primarily of five major vegetative types, including grasslands, sagebrush-grasslands, piñon-juniper, ponderosa pine-mixed shrubs, and small riparian areas. A number of the range allotments have been assessed to determine whether they meet the fundamentals of rangeland health established under 43 CFR 4180 and the guidelines for livestock grazing (BLM 2001b).

Prior to issuing a grazing permit in the FFO, an interdisciplinary team of renewable resource specialists conducts an assessment based on the Fundamentals of Rangeland Health to determine if the landscape contained within the allotment meets the appropriate criteria necessary to be considered healthy. Should the assessment indicate that the landscape does not meet the criteria, a team discussion is convened to determine if the current livestock grazing practices are causing this condition. Should corrective action be required, appropriate measures are defined and become the BLM alternative in the EA that is developed before authorizing grazing. Mitigation measures are developed in the EA procedure and are incorporated onto the Terms and Conditions of the grazing permit after the proper process has been completed.

LANDS AND ACCESS

This section describes land status, land management and use, and roads and access ways in the planning area.

Land Status

The boundaries of the planning area encompass almost 8.3 million acres in all or portions of San Juan, Rio Arriba, McKinley, and Sandoval Counties in northwest New Mexico. Generalized land ownership is illustrated in Map 1-2. Within the administrative boundary of each field office is land owned by several entities, including federal, tribal, state, and private. Land ownership within the planning area is summarized in Table 1-1 and Table 1-2.

The planning area includes BLM land managed by the FFO (almost 1.4 million acres) and the AFO (over 370,000 acres). In addition to surface ownership, BLM administers about 2.6 million acres of federal mineral estate. About 342,300 acres of this area is "split estate," where private (or patented) and state-administered surface land overlies federal mineral estate. BLM lands are relatively consolidated in northern San Juan County, the "Checkerboard" area of southern San Juan County, and in western Rio Arriba County. In McKinley County, the Lindrith area of Rio Arriba County, and around the major urban areas, public land is intermingled with a variety of other ownership.

The USBR administers a total of 31,035 acres surrounding and beneath Navajo Reservoir in the planning area, 40 percent of which is below the high water line of the reservoir. The National Park Service administers the Chaco Culture National Historic Park, comprised of approximately 33,000 acres, and Aztec National Monument (320 acres).

The USFS manages about 265,100 acres within the planning area. This land is divided between the Jicarilla Ranger District of the Carson National Forest in the western part of Rio Arriba County, and the Cuba Ranger District in the Santa Fe National Forest in eastern Rio Arriba and part of Sandoval Counties. This portion of the Santa Fe National Forest around the community of Lindrith includes several management areas: Cuba Mesa, La Jara, Corral Canyon, Continental Divide, Laguna Peak, and the North Cuba areas.

The State of New Mexico owns about 332,000 acres in the planning area. The state's land holdings mostly consist of small, consolidated parcels in the coal-rich central portion of the FFO, and isolated sections and smaller tracts throughout the rest of the planning area.

The planning area boundary includes 4.7 million acres of tribal lands belonging to the Navajo, Jicarilla Apache, and Ute Mountain Tribes, of which over 303,000 acres overlie federal minerals. Much of the lands in the southern part of the FFO area are Indian allotments, tribal trust lands, and lands withdrawn for Indian use. Due to the land ownership pattern, the southeast part of the FFO area is often referred to as the “Checkerboard” area.

Private ownership is concentrated around the tri-cities area of Farmington, Aztec, and Bloomfield. Other small communities are located along the San Juan, La Plata, and Animas River valleys, on the east side of the planning area in the Lindrith area, and in the eastern part of McKinley County, north of Interstate 40.

Land Management and Use

The San Juan Basin is characterized by overlapping uses for oil and gas, grazing, and dispersed recreation. Other uses are focused in specific locations and include coal mining, electric power generation, agriculture, and urban development. Federal lands are managed in accordance with applicable laws and resource management plans, which control the use of public lands for a variety of activities. Plans are revised and amended periodically in response to changing conditions and resource values. On BLM lands, areas with special values are delineated and assigned a special designation with management prescriptions that emphasize particular values and protect specific resources, such as wildlife habitat, recreational opportunities, cultural, paleontological, or visual resources.

The USBR operates Navajo Dam and Reservoir for water conservation, supply, storage, and flood control, and keeps a minimum recreation pool to the extent possible. Navajo Lake is the principle storage reservoir for the Navajo Indian Irrigation Project. Navajo Lake State Park, located around Navajo Reservoir in New Mexico, is managed by the New Mexico State Park and Recreation Division. It is heavily used for recreation at developed and dispersed sites.

USFS lands of the Jicarilla Ranger District and the Cuba Ranger District are primarily used for timber production, dispersed recreation, and oil and gas production. Most of these areas are managed to balance recreational use, oil and gas production, and visual resources according to their relative value.

Land use on tribal lands follows the same patterns as elsewhere in the region, including a mix of overlapping uses of grazing; agriculture; oil, gas, and coal production; and scattered homesteads and isolated sites for commercial and industrial use. The tribes manage the use of these lands. Land use on Indian allotments is managed by the allottees, with approval of the BIA.

County governments have jurisdiction over development of non-public lands, but typically county controls over land use in the planning area are minimal. The primary control mechanism is the application of subdivision standards that address parcel size and the basic provisions for infrastructure, such as access, water, wastewater, and utilities. The incorporated urban centers have more extensive land use controls developed through community plans and implemented in zoning codes.

Farmington, Aztec, and Bloomfield comprise a major urban area in the northern part of the planning area. This tri-cities area has a combined population of about 70,000. Suburban commercial and industrial areas link the urban centers. Each of the incorporated cities controls development through zoning and has prepared or is in the process of updating a comprehensive plan. They also control land use within an extraterritorial zone (ETZ), extending between 3 to 5 miles beyond the incorporated boundary, in cooperation with San Juan County. In some locations, the ETZ of one city overlaps with that of another, creating zones with multiple jurisdictional interests. San Juan County enforces subdivision regulations, based on state regulations, but has no zoning ordinance or comprehensive development plan.

One of the major issues facing the tri-cities area is urban expansion. Growth is evident in the concentration of commercial and industrial uses along the major highways linking Farmington, Bloomfield, and Aztec. There is a trend for development to occur in unincorporated areas where land use controls are less stringent and land costs are lower. However, these developing unincorporated areas rely on the urban centers for public services. The Northwest New Mexico Council of Governments is working with the Cities of Aztec and Bloomfield on planning efforts, particularly to consider transportation needs, development of the Bloomfield-Aztec corridor for commerce and industry, and planning for overlapping ETZs.

Crouch Mesa, located within the triangle formed by the highways linking the three cities, is mostly unincorporated and under the jurisdiction of San Juan County. However, most of this area lies within the ETZ of one or more of these cities. Efforts to plan and implement zoning for this area are beginning, but are complicated by existing laws governing the composition of ETZ authorities, which do not provide for multiple incorporated areas. Other key planning issues for the tri-cities area, particularly in light of the interface with adjacent public lands, include providing for and developing outdoor recreational sites and trails near the urban areas, and providing access to rivers for public recreation while also preserving riparian values. Most of the land along the rivers is privately owned, and in some areas, development has occurred within floodplains. This has curtailed access to the river and is causing fragmentation of riparian habitat.

The tri-cities area in proximity to public lands creates an active lands program for the FFO. There is a demand for rights-of-way for roads, utilities, and communication lines. A number of Recreation and Public Purposes leases and patents have been issued, with additional proposals in various stages of implementation. Other smaller populations centers in the planning area include the communities of Blanco, Lindrith, Gobernador, Nageezi, and Counselor.

In addition to expanding urban nodes, there is agricultural use along the Animas and San Juan Rivers and on the Navajo Indian Irrigation Project located between US 550 on the east and Chaco Culture National Historic Park on the west. This project brings water from Navajo Dam through a series of canals to irrigate up to 116,000 acres at build out. Currently about 64,000 acres are under irrigation.

Much of the land area is also used for public infrastructure ROWs. These include roads, utility corridors, and oil and gas distribution lines. Land use within ROWs is restricted to avoid incompatibility or conflict with infrastructure. Some surface activities such as grazing are compatible with ROW lands.

Roads and Access

A regional network of federal and state highways provides the basic transportation infrastructure in the planning area. US 550 is a major highway linking the tri-cities area with the interstate system and major urban centers outside the planning area. Other important roadways within the planning area include US 64, US 666, and New Mexico Highways (NM) 170, 574, 544, 537, 173, 371, 511, 96, and 595.

It is estimated that there are about 15,000 miles of roadway in the planning area, 13,000 miles of which are in San Juan County. Most of these roads are unpaved. In San Juan County about 650 miles are county roads, 400 miles of which are unpaved (Keck 2001). The majority of the road network consists of unpaved roads providing access to resources on federal lands, predominantly oil and gas facilities. In areas with a high level of oil and gas development, there is a dense network of roads, estimated at approximately 4 miles per square mile in the FFO area. Other parts of the planning area have road densities as low as 1 mile per square mile.

Maintenance of roadways is the responsibility of the government entity that owns the roadway. Many roads pass over federal, non-federal and tribal land, complicating maintenance responsibilities. Several county roads are heavily used for access to oil and gas facilities, particularly in the north and northeast part of the FFO area. San Juan County roads that are primarily used to access oil fields include San Juan County 2300, 2310, 2770, 2772, 4450, 7007, 7145, 4600, 4599, and 7250. Traffic counts are not taken for these roadways. County roads are categorized as full county-maintained (maintained at best level possible with resources available), lesser county-maintained (bladed twice a year), and unmaintained roads. Generally, roads that serve school bus routes or residences are full-maintained roads. There is a trend for the county to redesignate roads serving primarily oil and gas facilities as lesser-maintained roads because of limited resources (Keck 2001). San Juan County and its municipalities will be studying the potential to form a Metropolitan Planning Organization (MPO) that would enable them to benefit from increased federal and state resources for transportation projects (NNMCOG 1999).

The USFS manages a road system to provide access for multiple uses and management of USFS lands. As single-purpose roads are not needed to meet their current uses, they are removed and reclaimed. The USFS requires oil and gas producers to maintain the roads that serve their facilities.

WILDERNESS

The planning area includes one WA and six WSAs awaiting Congressional decision regarding their wilderness status.

The Bisti/De-na-zin WA is managed by the FFO. It contains a variety of resource values that are uncommon in the region, including the remote wind-eroded sandstone and shale badlands that contain striking geologic features with high scenic value. This area is a grama-galleta grassland ecotype (Davis 1987), only one of two examples of this ecotype protected as wilderness (the other being the Petrified Forest Wilderness in Petrified Forest National Park, Arizona). It is rich in paleontological resources, and also contains over 50 known archaeological sites. The WA contains three ACECs: the Badlands ACEC with unusual topography of compact, rolling hills, broken by narrow washes filled with mushroom formations and spires; the Log Jam ACEC with massive petrified logs; and the Lost Pine ACEC with a remnant stand of ponderosa pine, a southwestern biogeographical anomaly. The potential for seeing fossils and unique scenery provides outstanding opportunities for primitive and unconfined recreation (BLM 1988).

The Bisti/De-na-zin WA offers outstanding opportunities for primitive and unconfined recreational pursuits such as hiking, backpacking, and horseback riding. The strange geological formations are a delight to amateur and professional photographers alike, and even the casual observer is easily struck by these works of erosional art. Though relatively small, the Bisti/De-na-zin WA, without trails and without water, offers a moderate degree of challenge for the recreationist.

The opportunity for solitude is outstanding. This too is a function of the lack of water and trails—the first keeps the number of visitors venturing far into the wilderness low, and the second disperses those that do penetrate the interior. Appreciation for the serene silence that greets the visitor is one of the most frequent comments in the visitor register. The Bisti/De-na-zin WA is the only designated wilderness within the San Juan Basin.

The FFO manages Ah-shi-sle-pah WSA (6,592 acres) under BLM's *Interim Management Policy and Guidelines for Lands Under Wilderness Review* (BLM 1995b). It is located in a low intensity oil and gas development area about two miles north of the Chaco Culture National Historic Park. The area has outstanding badland scenery characterized by outcrops and highly rugged terrain with spires, towers, and mushroom shaped formations. The soft unconsolidated sediments of variegated sandstones and shales have eroded into a variety of forms. The WSA contains geologic and paleontologic resources that provide intrinsic educational and scientific opportunities. The area also has archaeological sites and sites that are sacred to the Navajo people.

There are no WAs within the AFO in the planning area, but there are five WSAs (either wholly or partially within the planning area), encompassing 70,475 acres. Cabezon WSA (8,159 acres) features a towering volcanic plug popular for rock climbing, and habitat for a variety of raptors and other avian species. The Boco del Oso is the central topographic feature of the Empedrado WSA (9,007 acres), La Lena WSA (10,438 acres), Ignacio Chavez WSA (32,266 acres), and Chamisa WSA (10,605 acres). In addition to recreational opportunities and visual qualities, Ignacio Chavez provides winter range for deer and elk, and La Lena WSA (10,438 acres) has important raptor nesting areas. All five WSAs are within high-intensity oil and gas development areas and have recreational value.

There are no WAs or WSAs within the Jicarilla Ranger District. In the Cuba Ranger District, about 320 acres of the Chama Wilderness is located in the planning area. The Chama River is a National Wild and Scenic River. San Pedro Parks WA is located to the east of the planning area.

FIRE MANAGEMENT

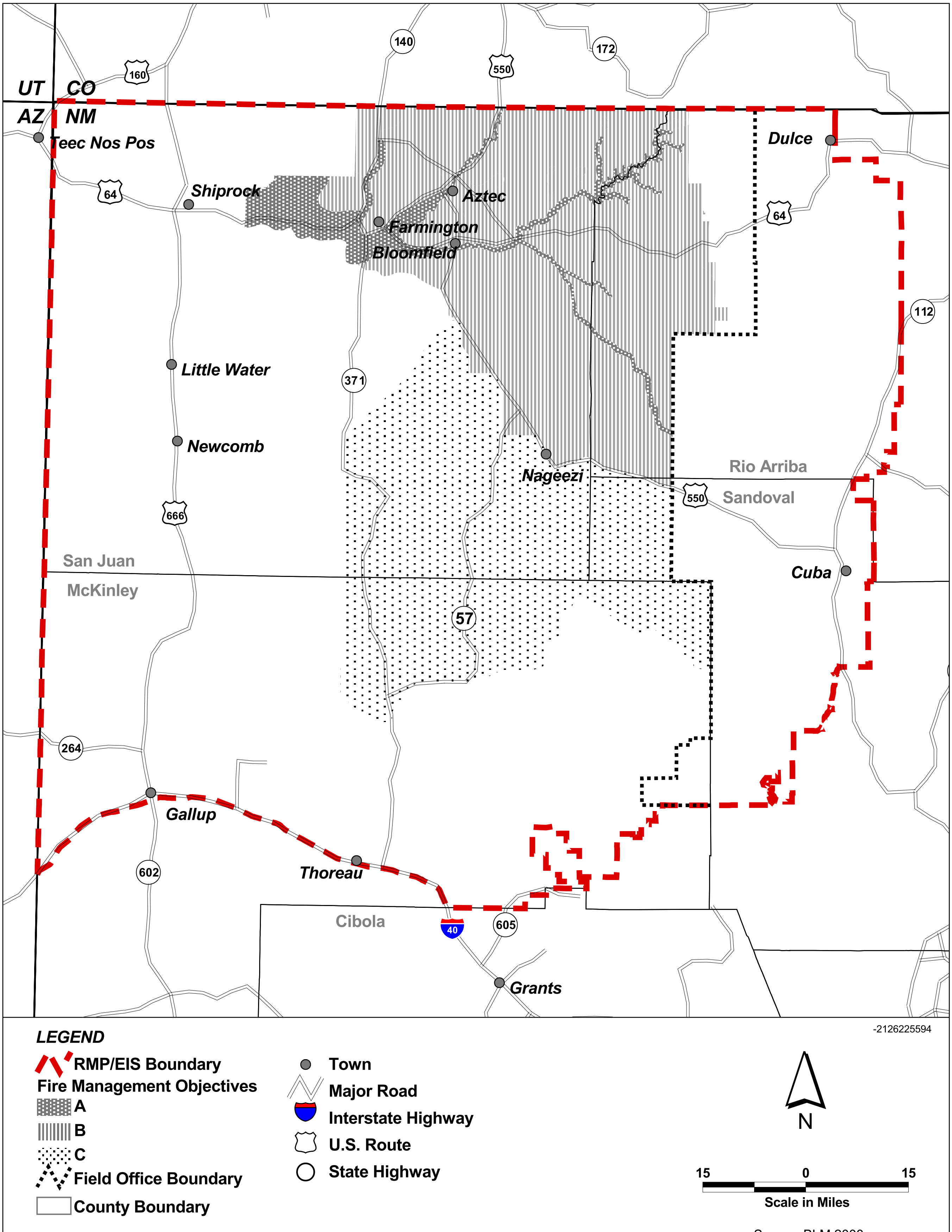
An interdisciplinary team developed resource and fire management objectives for all land within the FFO. The team developed a map that identified areas where fire would be advantageous in achieving management objectives and where fire would not be desirable. Management within these areas is also described according to whether prescribed fires or wildfire suppression should be permitted, and whether fuel reduction projects should be conducted to mitigate existing fire hazards. These areas correlate, in some cases, to the SMAs designated for resource management. Prescriptions for fire management are described for each of these designated areas in the Fire Management Plan. **Map 3-8** shows the location of these fire management areas.

Statistics from 1993 through 2000 indicate that there were 389 fires on a total of 601 acres in the FFO area. From 1987 through 1992, there were an average of 12 Action Fires that burned 61 BLM acres (BLM 2001a). Typically in the past, the period in which fire fighting resources are required to be fire ready in the FFO area was May 31 through August 8. However, in recent years fire season has been occurring over a longer period, from April 10 through August 31.

Fire engine crews are generally available during the period of April 1 through September 30 in order to get equipment ready for the active fire season and to prepare for fall and spring prescribed burns.

Fuel types within the FFO area consist mainly of sagebrush/grass, riparian (cottonwood/willow/saltcedar), piñon-juniper, and stringers of ponderosa pine and Douglas fir. On the northern and eastern exposures, Gambel's oak grows in association with the other tree species. Much of the area is dominated by badlands that have little fuel, and fine fuels are often lacking in the understory throughout much of the area, regardless of the overstory fuel type. In the area of the Jicarilla Ranger District where the BLM has administration authority, the fuels consist of piñon-juniper, ponderosa pine, Gambel's oak, and canyon bottoms of sagebrush.

Summer thunderstorms occasionally produce multiple fire starts during a single day, but these starts have only infrequently resulted in an extended attack fire situation beyond the capability of the FFO. In these instances, neighboring resources, such as the those from the Carson National Forest, the BIA Southern Ute Agency, and 14 volunteer fire departments, to provide assistance.



Map 3-8: Fire Management Units in the FFO Area

Wildfires in the FFO area infrequently extend beyond the burning period in which they were detected and initially attacked. Most wildfires in the area are declared to be controlled on the first day during which they are attacked and are declared out on the day following, so periods of consecutive fire days rarely exceeds several days. New fire starts sometimes occur on consecutive days in the FFO area.

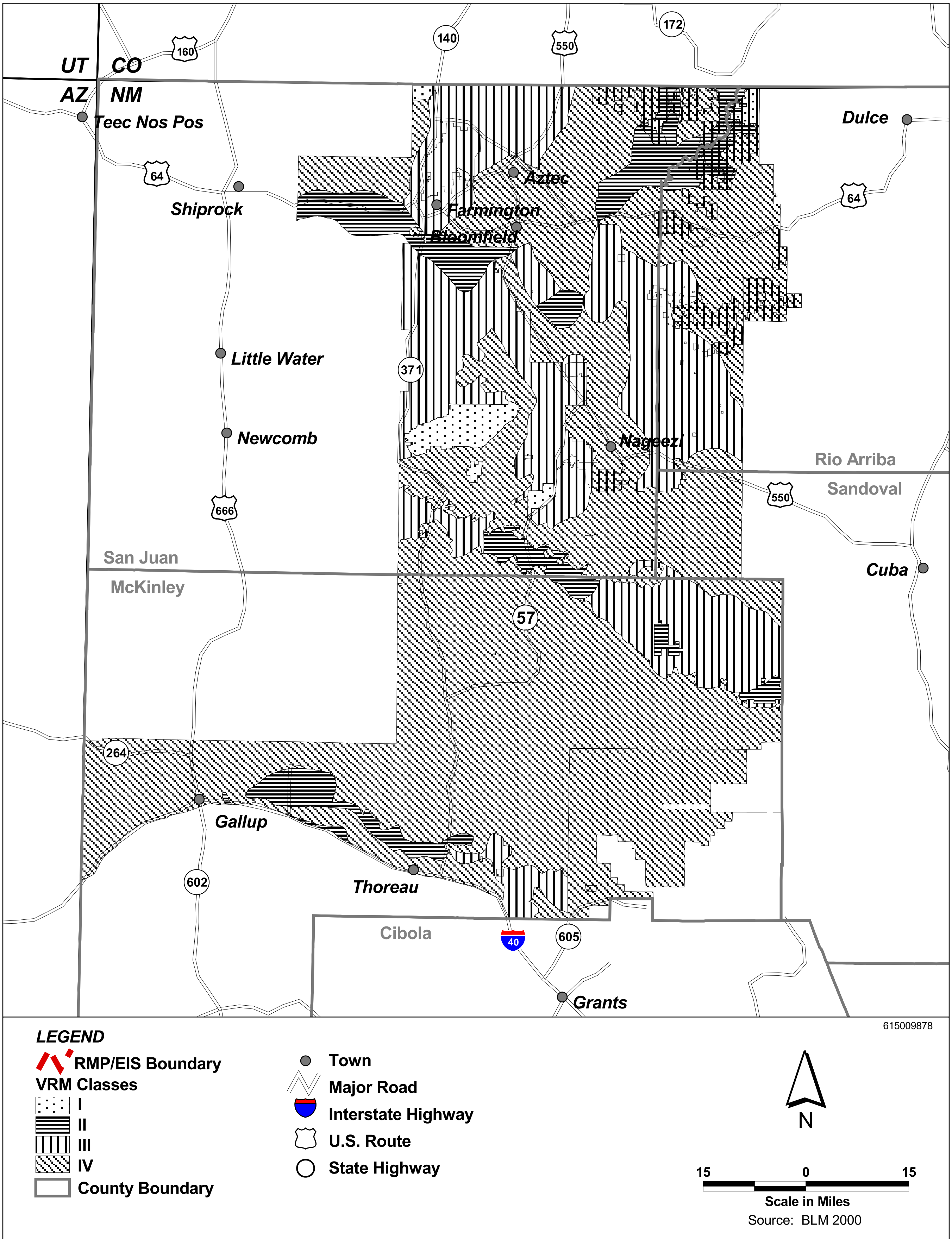
The majority of wildfires in the FFO area are caused by lightning, with fires caused by people, either accidentally or intentionally, as the next major source. The increasing population in the tri-cities area has resulted in an increase in fires in the wildland/urban interface area. Fuel loadings in the urban areas are often moderate, with some areas occasionally having moderate to heavy fuel loadings. With the existing fuel loadings, a wind-driven fire in these areas under dry conditions could threaten structures. Areas containing high fuel loadings, such as cottonwood trees, willows, saltcedar, and alkali sacaton, are usually located on private land. There have been no known fires in either of the WAs during the past 10 years due to the predominance of badlands with little vegetation and scattered stands of sagebrush and grass.

VISUAL RESOURCES

The landscape in the San Juan Basin is diverse, exhibiting many distinctive features and landforms found in arid regions where water and wind erosion have sculpted the land. The San Juan Basin is an area of young plateaus and broad valleys. Distinctive features include steep and colorful escarpments, broad vistas, rugged canyons, and pastel-colored badlands where it is dissected into plateaus and pinnacles. Sagebrush and grassland expanses are prominent in the central and southern portion of the FFO area. Piñon-juniper woodlands, rivers, and manmade structures such as reservoirs, roads, and oil and gas wells dominate the northern portion. Sightseeing is popular in the region where scenic vistas are frequent along highways, high places, and riverfronts.

Both the BLM and USFS actively manage their lands in consideration of visual qualities. BLM Handbook 8410 and BLM Manual 8411 describe the process for rating scenic quality using a combination of scenic quality, visual sensitivity, and distance from viewer. These ratings are used to identify a VRM class that guides management actions. Each class corresponds to suggested degrees of human modification that should be allowed in a landscape from a visual resources standpoint. There are four classes, with Class I including the highest rated landscapes and WAs, wild sections of National Wild and Scenic Rivers, and other Congressionally designated areas. The VRM classes and their corresponding management objectives are described in Chapter 2.

VRM classes have been determined through previous inventories and planning decisions for the entire FFO regardless of land ownership (**Map 3-9**). (It is important to note that BLM manages only the public land visual resources.) The FFO is composed of 55 percent with Class IV values, 32 percent Class III, 8 percent Class II, and 5 percent Class I. The wilderness, WSA, and 16 SDAs comprise the Class I designations. Class I areas with high intrinsic scenic value and visual sensitivity in the FFO include the Bisti/De-na-zin WA, Ah-shi-sle-pah WSA, Fossil Forest RNA, and Negro Canyon, Thomas Canyon, and Caracas Mesa SMAs. Protecting vistas from outside influences in these areas is a concern. Also, the visual context is an important component of the cultural resource values of the Chacoan Outliers, Native American Use and Sacred Areas ACECs, and additional traditional cultural properties.



Map 3-9: Existing VRM Designations in the FFO

Areas in the FFO categorized as Class II include 45 SDAs and other locations where scenic vistas (from major highways), riverfronts, and high places are important because of associated sightseeing and recreational value. Sculpted landscapes of mesas and canyons along State Highway 371 and US 550 offer high scenic value to a large number of people. Within the predominantly open, arid landscape, the San Juan and Animas Rivers and numerous mesas and mountain ranges offer views that are typical in this region (BLM 1987b).

The visual landscape of the FFO has been considerably modified due to the proliferation of gas wells, pipelines, and access roads in much of the FFO. The visual character of areas with substantial oil and gas development has progressively changed over the last several decades, since visual resource inventories were performed in the 1970s and 1980s. As the inventory is updated, it is likely that changes will be reflected in lower classifications for some areas in the FFO.

There are no VRM Class I areas within the AFO in the planning area. About 86,600 acres in 7 SMAs within the high-intensity oil and gas development area are all managed as VRM Class II lands. These include Cabezon Peak SMA, Cañon Jarido SMA, Elk Springs SMA, Empedrado WSA, Ignacio Chavez SMA, Jones Canyon SMA, and La Lena SMA (BLM 1991a).

The USFS system for visual resource management is slightly different from that used by the BLM, with five classifications based on similar principles. Corral Canyon and the western edge of the San Pedro Mountains in the La Jara area of the Santa Fe National Forest are managed to preserve visual resource value, balanced with recreation and timber uses.

BLM land around Navajo Dam and Reservoir is categorized as VRM Class II because of the expanse of water and impressive views. Contiguous USBR land has similar scenic value. The surrounding mountains and plateaus are deeply cut into a dramatic landscape. BLM land beyond the influence of the reservoir is Class IV. The *Navajo Reservoir Resource Management Plan Draft Environmental Assessment* (USBR 1999) provides information about areas that are in view from the reservoir. Most of the lands within a mile of the reservoir appear natural from a distance, but they are heavily interspersed with modifications, mostly gas wells, pipelines, and access roads. Recreational facilities around the marinas and campgrounds contribute to localized zones with visual modification (USBR 1999).

RECREATION

The climate, natural landscape, archaeological sites and cultural traditions of the four-corners region provide features and attractions for a wide range of activities. There are world-reknown attractions including Monument Valley, the Grand Canyon, Chaco Canyon, and Mesa Verde that bring in large numbers of tourists. Outstanding conditions for sporting and recreational pursuits are enjoyed by local residents and regional and out-of state visitors. On a regional basis, favorite activities include camping, hiking, hunting and shooting, fishing, nature viewing, sightseeing, winter sports, horseback riding, mountain biking, motorized sports, rock climbing, kayaking and rafting. With growing visibility of the region (for year round outdoor pursuits in the southern Colorado Rockies and biking on the barren rock shields around Moab in Utah), the FFO is also experiencing an increase in the numbers of persons who are finding and engaging in recreational activities in the management area.

Some public lands contain unique or outstanding recreation values that require special or intensive management to protect the special value and to accommodate public use. In the FFO, a multitude of recreational opportunities exist ranging from the primitive and unconfined in Bisti/De-na-zin WA to the motorized challenge of rock-crawling in the GRTS. Recreational use is the primary emphasis for eight SDAs in FFO. **Table 3-16** lists these areas and describes their opportunities and features.

Table 3-16. Recreation SMAs in the FFO

Name	Size[a]	Recreation Opportunity	Dominant Features
Dunes Vehicle Recreation Area	1,000	Minimal supervision for ORV free-play and competitive events.	Steep canyon walls, talus slopes, sandy washes, rock-filled arroyos, and moderate to steep slopes.
Head Canyon ORV Competition Area	150	ORV competitive events and motocross on a developed track.	Sparse vegetation, with relatively flat terrain sloping to hilly terrain in the south.
Angel Peak Recreation Area and ACEC	10,240 (SRMA) 500 (ACEC)	Camping, hiking, sightseeing, and picnicking.	Angel Peak geologic feature: Kutz Canyon Badlands, with extreme erosional patterns of blue and gray shale.
Carracas Mesa SMA	7,000	Hiking, hunting, primitive camping, and sightseeing. Both motorized and non-motorized.	Consists of piñon-juniper and ponderosa pine habitat, with moderate to steep walled canyons draining into Navajo Lake.
Simon Canyon Recreation Area and ACEC	3,811 (SRMA) 3,491 (ACEC)	Picnicking, camping, fishing, hiking, sightseeing, and backpacking.	Moderately steep to very steep, rough, broken, and hilly terrain. Simon Canyon varies form 5,800 at the bottom to 6,275 at the top of the rim.
Thomas Canyon SMA	4,630	Hiking, hunting, sightseeing, primitive camping, and backpacking.	Forested terrain (piñon-juniper and ponderosa pine) with steep canyons and rugged terrain, sloping up from east to west.
Negro Canyon SMA	1,600	Hiking, hunting, primitive camping, sightseeing, and backpacking.	Piñon-juniper woodland, with the rugged, steep-walled Negro Canyon and its tributaries dominating the landscape.
Glade Run Trail System (GRTS)	33,800	Used for a diverse range of recreation, on- and off-trail, including motorized trail-bike riders, ATV use, four-wheel drive use, equestrian use, mountain bike use, rock climbing, and major competitive events.	Rolling hills, sandy arroyo bottoms, sandstone slick-rock. Vegetation is sparse and varied, including piñon-juniper, sagebrush, and grasses.

Sources: BLM 1991a, 1996, 1998a.

Notes: (a) Acres as reported in BLM planning documents. May vary from acreage calculated in GIS.
SRMA = Special Recreation Management Area, ATV = all-terrain vehicle, ORV = off-road vehicle.

Public lands in the FFO offer the opportunity to enjoy outdoor recreation in three major categories: developed, dispersed and motorized recreation. These are described below.

Developed Recreation

Developed recreational opportunities that benefit from improvements are available at Angel Peak and Simon Canyon Recreation Areas. Facilities support camping and picnicking at these locations. Maintained trails have been developed in some areas (e.g., the GRTS, the Head Canyon Recreation Area) to promote specific modes of use such as bike, horse, walking, or motorized two or four-wheeled vehicles.

Dispersed Recreation

Management of some areas, such as Negro Canyon, Simon Canyon, Caracas Mesa and Thomas Canyon are aimed at preserving quiet and natural character that are important for dispersed activities, such as hiking, backpacking, hunting, and so forth. With the extensive network of oil and gas roads, there are very few inaccessible areas in the FFO. This development has both altered the visual landscape and opportunity for solitude. On the other hand, it affords public access to backcountry for dispersed recreation throughout the field office.

Motorized Recreation

Motorized recreation on public lands includes opportunities for off-highway travel (on existing maintained or primitive roads), and off-road travel (cross country, off existing roads). Motorized vehicles include various classes and types of motorcycles, dune buggies, ATVs, and four-wheel drive vehicles. OHV use has increased in popularity as more versatile vehicles have become affordable and available, making access to more remote areas of public lands possible. This has introduced human presence into remote areas and left a mark on the landscape through creation of noise, dusts, smells, visual intrusions and creation of roads and trails through repeated use. In some cases, OHV use is associated with woodcutting, hunting, mineral exploration and development, livestock operations and administrative functions throughout the FFO. The predominant purpose of recreational and sporting activities occurs mostly near the urban centers.

Recreational conflicts occur when participation in one activity reduces the experience of another. For example, most non-motorized recreationists are usually seeking quiet, and believe the noise and fumes of vehicles diminishes their experience. Many motorized recreationists who stay on roads and trails believe that those who travel cross-country on motorized vehicles are not practicing good land ethics. Under current OHV policy, 1,106,600 acres of public land in the FFO are open to cross-country travel. To meet the needs of diverse users, the FFO has developed special facilities for motorized and non-motorized vehicles use. Trails (for two-wheeled vehicles), open areas for OHV users, and rock-crawling routes are provided in the GRTS. The Dunes Vehicle Recreation Area can be used as an open area for motorized use. Head Canyon SMA has a motocross track, mostly for two-wheeled vehicles. Overall, about 25 miles of trails have been designated in the FFO, mostly for specific uses in order to minimize conflicts between different activities. There are also undesignated trails that users have created. These include trail networks on Piñon Mesa, in the area called “Alien Run” north of Aztec, the Bloomfield/Aztec trail, horse trails at Navajo Lake, and numerous other trails throughout the field office.

The AFO has 12 SMAs in the planning area, of which five have recreation as the resource emphasis. These SMAs, which encompass about 6,100 acres, include Azabache Station, Cabezon Peak, Cañon Jarido, Ignacio Chavez, and Continental Divide Trail Corridor. The Continental Divide SMA has a total of 31,120 acres crossing several states, but only a small portion is within the planning area. Historic Homesteads SMA is managed for cultural and recreational values.

Most of the land in the Jicarilla Ranger District is both accessible and well suited to dispersed recreation but there are no developed sites. Within the Cuba Ranger District, management of Cuba Mesa and Corral Canyon emphasizes recreational values. Hunting, hiking, camping, biking, and limited ORV use occurs on USFS land within the planning area.

The USBR manages Navajo Dam, the reservoir, and the surrounding shoreline areas. The dam was constructed for water conservation and flood control, with a minimum pool generally maintained for recreation. Navajo Lake State Park has facilities for camping and access to the lake. Visitation was about 540,000 in 1997, an increase of 61 percent since 1990 (USBR 1999). The Navajo

Lake Horse Trail system is accessed from the park. Other special recreational areas are located on Simon Mesa and along the Pine River and the San Juan River.

Recreation on the New Mexico portion of Navajo Lake and on the San Juan River below the dam is administered by the New Mexico State Parks and Recreation Division. Above the dam, Sims Mesa and Pine River Recreation Areas have camping, fishing, marina, and boat access to the lake. Below the dam, fishing and camping occur at San Juan River Recreation Area, and day use is facilitated at several sites along State Highway 511. (BLM manages Simon Canyon Recreation Area that has parking and camping facilities.)

CULTURAL RESOURCES

Cultural History

An area so vast as the planning area encompasses evidence of many developments throughout the prehistoric and historic periods. Perhaps best known are the remains associated with the Chaco culture, centered in Chaco Canyon. The general cultural history presented below has been abstracted from Amsden (1993), Anschuetz (1993), Bradley and Brown (1998), Marshall (1997), Riley (1996), Seymour (1996), Stuart and Gauthier (1981), Winter et al. (1993), and Vivian (1990).

Although there are many commonalities in the sequence of development across the region as a whole, there are, at the same time, subtle differences that have caused archaeologists to distinguish four different culture areas typical of the planning area. These include the Navajo Reservoir, San Juan Basin (including Chaco), Jemez/Middle Rio Grande, and Gallinas cultures.

Region-specific phase sequences are presented in **Table 3-17**. In general, the prehistory of the planning area is divided into five major periods. The earliest evidence of human occupations in the region is termed PaleoIndian. This is followed by the Archaic period during which the beginnings of agriculture emerge in the archaeological record. Subsequent developments are designated as the Formative, or Developmental, period when agriculture and large towns began to appear across the Colorado Plateau. This, in turn, is followed by the historic period, which includes developments by both American Indians as well as later Euro-American settlers. Each of these phases is discussed in more detail below.

PaleoIndian (ca. 10000 B.C. to 5500 B.C.)

The archetypal view of the PaleoIndian period is that it was characterized by relatively small bands of hunters relying on large, now extinct, Pleistocene megafauna. There is controversy concerning when these peoples first arrived in North America, with progressively earlier dates from sites of this period appearing almost every year. The earliest evidence in New Mexico conforms to the date range indicated above, although earlier sites will likely be found. Consistent with a seemingly primary focus on large game animals such as mammoth and bison, many of which were migratory. PaleoIndian sites are ephemeral, reflecting periodic movement of camps to areas where animals might be found. At the same time, there is some evidence of reliance on plant resources.

The highest concentrations of PaleoIndian sites have been found in two settings. The first setting is along the margins of playas, small ephemeral lakes that hold water for short periods during the rainy season (Judge 1973). The second setting is along ridge lines paralleling large drainages where, again, water might be available (Vivian 1990). Sites are known from the Puerco Basin, the Chuska valley along the Arizona-New Mexico border, and the Chaco Plateau (Vivian 1990). Most consist of isolated projectile points, again consistent with what seems to be a highly mobile life way.

Table 3-17. Regional Phase Sequences in the Planning Area

Period	Date	Cultural Area			
		Navajo Reservoir	**San Juan Basin**	**Rio Grande/Jemez**	**Gallina**
A.D.	1863-present	Reservation Navajo Lucero (Hispanic)	Reservation Navajo	US Territorial Mexican/Santa Fe Trail Post Pueblo Revolt Pueblo Revolt Contact – Colonial	
	1770-1863	Cabezon	Cabezon		Cabezon
	1650s-1770	Gobernador	Gobernador		Gobernador
	1540-1650s	Dinétah	Dinétah		Dinétah
	1400-1540			Classic (Pueblo IV)	
	1100-1300	(Pueblo III)	McElmo/Mesa Verde (Pueblo III)	Coalition (Pueblo III)	Largo-Gallina
	900-1100	Arboles (Pueblo II)	Bonito (Pueblo II)	Late Developmental (Pueblo II)	
	700-900	Rosa-Piedra (Pueblo I)	White Mound (Pueblo I)	Early Developmental (Pueblo I)	
	500-700	Sambrito (Basketmaker III)	La Plata (Basketmaker III)	Alameda (Basketmaker III)	
	100-400	Los Pinos (Basketmaker II)	Basketmaker II	Rio Rancho (Basketmaker II)	
	100	En Medio			
B.C.	800-A.D.100	En Medio	En Medio		
	1800-800	Armijo	Armijo		
	3200-1800	San Jose	San Jose		
	4800-3200	Bajada	Bajada		
	5500-4800	Jay	Jay		
	10,000-5500	PaleoIndian	PaleoIndian	PaleoIndian	PaleoIndian

Sources: Vivian 1990, Winter et al. 1993, Marshall 1997, Bradley and Brown 1998.

PaleoIndian sites consist of chipped and ground stone tools, including large bifacial projectile points. These points were attached to wooden shafts to form spears or large darts, thrown with an atlatl, or spear thrower. Variations in the ways these points were manufactured, specifically reliance on fluting and lateral thinning, have allowed archaeologists to separate the PaleoIndian period into three time-sequent complexes. Non-fluted Clovis points typify the earliest complex. Later, fluted points signal the appearance of the Folsom complex. Finally, points typified by extreme lateral thinning are indicative of the Plano complex. Rarely are bone and wooden tools preserved.

Paleoenvironmental reconstructions using plant pollen suggest that drought conditions prevailed over much of the San Juan Basin between 8000 and 6500 B.C. Consistent with this reconstruction, evidence of Plano complex occupations is generally lacking for the region as a whole.

PaleoIndian components account for less than one-quarter of 1 percent of the components in the planning area. Despite numerous archaeological surveys and excavations in the planning area, the scarcity of diagnostic artifacts and assemblages currently documented point to a very limited use of the San Juan Basin during the PaleoIndian period.

On FFO lands, there are no ACECs or SMAs that are actively managed to protect outstanding examples of cultural resources from this period. Other examples may be found that merit special designations. Still other examples of resources from this period are managed according to continuing management guidelines.

Archaic Period (ca. 5500 B.C. to A.D. 400)

The Archaic period is signaled by the extinction of earlier Pleistocene fauna, due to the combined effects of the drought noted earlier as well as hunting by PaleoIndian peoples. Although hunting continued to be important throughout the Archaic period, there was greater reliance on gathering of wild plant resources. Consonant with this subsistence shift is the appearance of new classes of artifacts, notably ground stone implements that were used to process plant foods for consumption. Projectile points decrease in size consistent with hunting of smaller animals.

As in the PaleoIndian period, Archaic hunting-and-gathering groups seem to have remained small in size, probably consisting of no more than a few co-residential, extended families. Archaic sites are more visible than PaleoIndian sites, but, with some exceptions, remain relatively ephemeral. This is again consistent with high mobility when groups move to take advantage of geographic and seasonal variations in the availability of plant and animal resources.

Archaic sites are found throughout the San Juan Basin. Most are found north and east of the Chaco River. Sites tend to alternate between semi-permanent (winter) base camps that were repeatedly occupied from year to year and more ephemeral (summer) sites related to the completion of specific seasonal hunting or gathering activities. Sites are found in canyon heads and cliff tops. Based on ethnographic analogies, the size of territories exploited by Archaic groups was inversely proportional to environmental diversity: where diversity was higher, territories probably were smaller and the converse.

General trends in the number of Archaic sites across the planning area are interpreted as reflecting gradual, sustained population growth throughout the Archaic period. Specifically, beginning with relatively few early Archaic Jay phase (ca. 5500 to 4800 B.C.) sites, there is a progressive increase in the number of later Bajada (ca. 4800 to 3200 B.C.), San Jose (ca. 3000 to 1800 B.C.), Armijo (ca. 1800 to 800 B.C.) and En Medio (800 B.C. to A.D. 400) phase sites over the planning area. As well, sites are larger by the San Jose phase and are accompanied by the first evidence of structures, probably constructed of poles and brush. The number and size of sites increases steadily in succeeding phases, all of which is consistent with the aggregation of larger groups of people, population growth, and repeated occupations of larger base camps.

The earliest evidence of domesticated crops, notably maize, appears in the Armijo phase. This presages the much greater reliance on domesticated crops that characterizes the later prehistory of the planning area. At the same time, reliance on domesticates implies the need to maintain fields, as well as store any surpluses that might be generated. Not surprisingly, the appearance of maize in the archaeological record is accompanied by the almost simultaneous appearance of more permanent structures and storage facilities. At the same time, there is some suggestion that maize did not appear in all parts of the San Juan Basin at the same time. Specifically, maize seems to appear earlier in the eastern part of the basin, but is largely absent in western parts of the basin. However, this may reflect an absence of surveys in the western region rather than any fundamental underlying variability in subsistence patterns across the planning area.

Archaic components account for less than 4 percent of the total components in the planning area. Numerous lithic scatters in the planning area lack diagnostic artifacts and assemblages indicating the cultural and temporal association of the sites. These sites comprise approximately 1 percent of the sites in the planning area. Many of these are site components potentially dating to the Archaic period. While comprising a small percentage of the sites in the planning area, they remain an important class of sites for research involving the hunter-gatherer occupation in the region, and the transition to agricultural lifeways.

On FFO and AFO lands, there are 2 ACECs or SMAs that are actively managed to protect outstanding examples of cultural resources from this period. These include:

1. Jones Canyon ACEC (AFO)
2. East Side Rincon Site SMA (FFO)

Other examples may be found that merit special designations. Still other examples of resources from this period are managed according to continuing management guidelines.

Basketmaker II (ca. A.D. 1 to 500)

The Basketmaker II (BM II) Phase represents the first successful agricultural populations developing sedentary settlements in the region. Dating from approximately A.D. 1 to A.D. 500, Basketmaker sites are found in southern Utah, southwestern Colorado, and eastern Arizona, as well as much of New Mexico. Due to the limited amount of research devoted to these sites, the relationship between late Archaic En Medio Phase occupations and the BM II occupation is still poorly understood. The introduction of viable agricultural strains, in particular corn (*Zea mays*), as well as squash and beans is thought to have contributed to the adoption of sedentary habitations, generally aligned with perennial drainages in the Four Corners area. Shallow pit structures and extensive use of storage features mark the adoption of agriculture as a key feature of the occupation. Population aggregation is indicated by settlements with multiple structures. Upland settlements are also found which may represent seasonal use for farming plots as well as exploitation of faunal resources. The first use of ceramic artifacts also occur during the latter part of the period, with simple vessels constructed of alluvial clays similar to those manufactured by Mogollon populations far south of the planning area.

The BM II occupation in the planning area is known from the Chaco Canyon Area and the Chaco River drainage, as well as more extensive occupations in the Navajo Reservoir area. The BM II occupation in the Navajo Reservoir area was designated the Los Pinos phase following extensive inventory and excavation for the Navajo Reservoir project. (Eddy 1966). Los Pinos phase sites cluster along the Pine and Animas rivers, with more intensive occupations to the north in Colorado.

BM II components comprise less than 1 percent of the total known components in the planning area, however are of particular interest to researchers not only due to their rarity, but because of their importance in understanding early transitions to agriculture and the adoption of sedentary settlement patterns. The first signs of population aggregation in the region are marked by the BM II period, with continuing population growth trends for the next 600 years.

On FFO lands, there are no ACECs or SMAs that actively managed to protect outstanding examples of cultural resources from this period. Other examples may be found that merit special designations. Still other examples of resources from this period are managed according to continuing management guidelines.

Basketmaker III (ca. A.D. 500 to 700)

Basketmaker III (BM III) occupations in the San Juan Basin are characterized by widespread adoption of domesticated crops accompanied by the appearance of pithouses, the advent of ceramic manufacturing, and the introduction of bow-and-arrow technology. Notable among the crops recovered from sites dating to this period are maize, squash, and beans. The adoption of agriculture, even in a nascent form, was probably facilitated by a return to increases in effective moisture over much of the Colorado Plateau during this period. Yet, indirect evidence of droughts during this period suggests that this was not a stable climatic regime. As a consequence, BM III groups continued to rely on wild plant and animal resources, with agricultural products largely used to supplement wild resources.

Classic interpretations of BM III suggest that population growth continued at relatively high rates. Current notions suggest the cumulative effect was that BM III groups began to become more densely packed into the landscape. The presence of neighboring groups, who also depended on the same resources, would have constrained the ability of any one group to complete seasonal movements to obtain wild plant and animal resources. It is such constraints on movement, in conjunction with improved climatic conditions, which are thought to have contributed to the more widespread adoption of cultivated crops during this period. Similarly, by late BM III times, a major population shift from the La Plata region into the central portion of the San Juan Basin had occurred, perhaps in response to improved agricultural conditions.

BM III sites are known from the Navajo Reservoir region, Animas-La Plata watersheds, Red Rock Valley, Middle Chuska Valley, Chaco Canyon region, and southward into the Rio Puerco Valley. Relative to earlier periods, BM III sites are far more visible due to longer occupations. The shift to domesticated crops is reflected by changes in settlement patterns during BM III times. Compared to earlier times, BM III sites are disproportionately oriented toward areas containing arable land. Agriculture in higher elevations would have been constrained by frost-free periods, while those in lower elevations would have been constrained by rainfall and surface water availability. It should be emphasized that agriculture during this period relied exclusively on direct rainfall; technologies such as irrigation to supplement water supplies have not been found.

At the same time, there is evidence that BM III was not the same across all parts of the San Juan Basin. While the classic description of BM III emphasizes reliance on agriculture, there is some indication that early BM III groups in the southwestern and western portions of the basin continued to practice hunting-and-gathering to a much greater extent than agriculture. In contrast, there is evidence of greater agriculture in the Navajo Reservoir (Sambrito phase), accompanied by substantially higher populations.

BM III components comprise approximately 2 percent of the total components in the planning area, and exhibit greater size and complexity than the sites of the preceding BM II period. BM III settlements are found in the Navajo Reservoir area, the Chuska Slope and Chaco Canyon area within the Chaco Canyon drainage, and in the La Plata, Animas, Upper San Juan, Largo, Carrizo and Gobernador drainage basins.

On FFO lands, there are 8 ACECs or SMAs that are actively managed to protect outstanding examples of cultural resources from this period. These include:

1. East Side Rincon Site
2. Morris 41
3. Pregnant Basketmaker
4. Carrizo Cranes
5. Encierro Canyon
6. NM 01-39236
7. Martinez Canyon
8. Crow Canyon District

Other examples may be found that merit special designations. Still other examples of resources from this period are managed according to continuing management guidelines.

Pueblo I (ca. A.D. 700 to 900)

The Pueblo I (PI) period on the Colorado Plateau generally is typified by an increase in the number of sites, an increase in average site size, the appearance of above-ground jacal and stone architecture alongside semi-subterranean pithouse structures, and larger storage facilities. Above-ground structures typically exhibit linear or oval configurations and contain about 8 rooms per site. So-called “proto-kivas” first make their appearance at some PI sites in the planning area. With the exception of the Chaco region, these trends are not thought to reflect population growth, but rather consolidation of previously distinct residential groups into larger villages.

In the San Juan Basin, however, the overall number of PI sites is relatively low. This is attributed, in part, to deteriorating environmental conditions on the Colorado Plateau, specifically reduced rainfall and an increase in the overall variability of rainfall. Rainfall estimates appear relatively high between A.D. 700 to 750, but began a steady decline through the early A.D. 800s. Between A.D. 830 to 900, drought conditions are thought to have prevailed over much of the planning area.

The highest concentrations of PI sites are situated in the Mesa Verde region, in the Middle Chuska Valley, Chaco Canyon, Lower Chuska Valley, and the Navajo Reservoir region. The easternmost manifestation of PI, termed the Rosa phase, differs slightly from sites situated further west. Here, settlements tend to be distributed not only along drainages, but as well on outwash fans to maximize agricultural production. Over much of the northern San Juan Basin, sites tend to be situated on mesas, broad ridges, or floodplain terraces overlooking drainages.

As in BM III times, there is evidence for regional differentiation in subsistence patterns. In the southwestern portion of the San Juan Basin, sites assigned to the White Mound phases contain food remains indicating reliance on a mix of horticulture, hunting and gathering. In the northern San Juan Basin, Rosa-Piedra phase sites tend to contain relatively larger amounts of cultigens. In the center of the San Juan Basin, in Chaco Canyon, PI sites contain a similar mix of domesticated and wild resources, suggesting that drought conditions during this period caused subsistence strategies to remain diversified. To the east, reliance on domesticates appears to have been greater than in other parts of the basin.

PI components comprise over 6 percent of the total components in the planning area, with occupations clustering in the Navajo Reservoir area, the Largo, Carrizo, Upper San Juan and Gobernador watersheds, and on the Chuska Slope and Chaco Canyon areas within the Chaco River drainage basin. Recent research on PI communities in the Navajo Reservoir area have identified several large complex communities aggregated around Great Pit Houses, the early predecessor to the Great Kivas known from the later Pueblo II and Pueblo III periods. Population growth and aggregation during this period is a critical factor in the development of the later complex communities and social structures present in the Pueblo II and Pueblo III periods in the planning area.

On FFO lands, there are 8 ACECs or SMAs that are actively managed to protect outstanding examples of cultural resources from this period. These include:

1. East Side Rincon Site
2. Morris 41
3. Pregnant Basketmaker
4. Carrizo Cranes
5. Encierro Canyon
6. NM 01-39236
7. Martinez Canyon
8. Crow Canyon District

Other examples may be found that merit special designations. Still other examples of resources from this period are managed according to continuing management guidelines.

Pueblo II (ca. A.D. 900 to 1050)

The Pueblo II (PII) period is characterized by an increase in the number of sites, an increase in average site size, a shift toward above-ground coursed masonry architecture, the appearance of larger numbers and larger sizes of storage facilities, and the appearance of formal kivas. Sites typically contain between 6 and 9 rooms per site, most arranged in a linear fashion. Larger sites containing more numerous rooms are often laid out in a quadrilateral pattern around central plazas.

It is during PII times that the Chaco phenomenon truly flourishes, accompanied by the establishment of very large towns, the appearance of multistoried room blocks, increasingly complex architectural elaboration of kivas, the advent of field systems in an effort to boost agricultural production, and the development of road systems to facilitate trade and exchange.

These changes seem to signal a return to accelerating population growth in response to dramatically improved climatic conditions. Unlike the PI period, climatic reconstructions for A.D. 900 to 1050 indicate a return to higher rainfall levels, although this was accompanied by episodic droughts whose intensity varied from place to place. In areas less affected by droughts, settlements were pushed into areas that would have been marginal in PI times. It is suspected that differential spatial distributions of critical resources probably became more pronounced in PII times over much of the San Juan Basin.

In short, current theories suggest that much of the PII period is typified by imbalances between people and resources, both temporally and geographically. Such imbalances necessitated the introduction of various buffering mechanisms in an effort to offset these imbalances. Among the buffering mechanisms inferred from the archaeological record were improved storage facilities, expansion of regional exchange networks, and more frequent abandonment and reestablishment of large villages in areas better suited for agriculture. One consequence is that PII sites often were occupied for relatively short periods of time.

Subsistence practices indicate greater reliance on cultivated plants, although evidence of use of wild resources persists at most PII sites. Maize, beans, and squash are quite common at both large and small sites. Evidence of agricultural intensification derives from the identification and dating of the first water control structures in the San Juan Basin. These structures were designed to augment rainfall, thereby increasing overall productivity of given plots of land. Many of these water control devices seem to provide water to outwash fans, areas that are often marginal for direct rainfall agriculture.

Earlier dissimilarities between sites in the southern San Juan Basin and those in the northern basin largely disappear during PII times. The emergence of region-wide (relative) homogeneity in ceramics, architecture, subsistence practices, and settlement patterns has been interpreted as evidence supporting the inference that region-wide trade and exchange systems emerge in full force during PII times.

One notable exception to this homogeneity is found in the Chaco Canyon region, where settlement in the Chaco heartland is typified by numerous small habitation sites distributed around fewer, but very much larger and more complex towns (central places) containing kivas, great kivas, reservoirs, dams, and roads. Sourcing studies suggest that non-local materials were being imported from far-flung parts of the Southwest.

These facts, combined with the pan-regional distribution of ceramics that are virtually identical, suggests that Chaco Canyon may have been the primary focal point for trade and exchange networks whose limits extended into northeastern Arizona, southern Colorado, and west-central New Mexico. Analyses of ceramics and chipped stone indicate that source areas for such critical resources gradually shifted over time from the southeastern part of the area (Zuni) to the western (Chuska) region and, finally, to the northern portion of the San Juan Basin. It is likely that these regions approximate the outer limits of this exchange and trading network. There is some evidence suggesting that turkeys and perhaps corn were among the crucial subsistence resources being imported into the Chaco region. If such inferences are accurate, reliance on imported foodstuffs underscores the tenuous agricultural conditions that prevailed across the central San Juan Basin during PII times.

Chaco Canyon, and the outlying sites related to it, are unique in Southwestern prehistory. One indication of the importance of

Chaco is its designation in 1987 as a World Heritage locality (UNESCO 1987).

The Chaco phenomenon is defined on the basis of multiple attributes. There are two alternating site types—great houses and villages—viewed by many as indicative of economic and political differences inherent in the Chaco system. Multistoried great houses, usually consisting of upwards of 200 rooms, typically were constructed as a series of temporally discrete units (Kantner and Mahoney 2000, Saitta 1997). In contrast, surrounding villages usually consist of single story structures ranging from 20-40 rooms in extent. Obvious differences in site construction characteristics are underscored by the recovery of exotic goods in great house sites and the virtual absence of such goods in villages. Among these goods are copper bells, turquoise, shell jewelry, and macaws from Central America (Mathien and McGuire 1986, Toll 2001). Finally, great houses appear to be nodes for upwards of 70 constructed roads or road segments, often interpreted as remnants of transportation/communication routes (Renfrew 2001; Vivian 1997a, b).

Because the "Chaco phenomenon" is one of the most well-documented archaeological manifestations in the Southwest, it is no surprise that it provides a basis for widespread discussion of the factors that contributed to its appearance, operation, and eventual collapse. The phenomenon of "Chaco" has been viewed by different scholars as either (1) largely a local geographic phenomena that appears in response to generally favorable climatic conditions and is typified by redistributive activities or (2) as one component of a much larger Mexican-Southwestern interaction network founded largely on ideational factors. The characteristics of inferences necessarily vary considerably between these perspectives.

Chaco as a Regional System

Those who view Chaco as a somewhat localized Southwestern phenomena underlain by redistributive activities assume that Chaco exhibits attenuated links to other regions (e.g., Mexico). Researchers of this perspective generally focus on the occurrence of two alternating site types, great houses and villages, as well as the presence of exotic goods and constructed roads as consistent with strategies to control access to and redistribution of goods—both subsistence resources and trade items—across the San Juan Basin (Renfrew 2001).

Those advocating the presence of religico-political elites cite the presence of large proportions of non-residential rooms at great house sites as evidence for storage of surplus foodstuffs, which were then redistributed by elites residing in great house communities. There are differences of opinion on this theme primarily with respect to inferred degrees of political centralization, ranging from egalitarian (Vivian 1990) or ranked (Grebinger 1973) to chiefdoms (Earle 2001, Lekson 1999, Saitta 1997). Others, however, find insufficient evidence to conclude that hierarchical elites were present (Feinman et al. 2000, Saitta 1997, Sebastian 1992, Vivian 1997b, Windes and Ford 1996).

The presence of upwards of 70 constructed road segments, possibly built through some form of non-coerced or coerced communal labor (Saitta 1997), is viewed by some as reinforcing the notion of politico-religious authorities coordinating road construction to facilitate transport and communication across the San Juan Basin (Cameron and Toll 2001, Nelson 1995, Vivian 1997b). Among the activities inferred for Chacoan roads are transport of beams into great house communities for use in roof construction (Snygg and Windes 1998), as access routes for pilgrims to ceremonies and periodic markets centered in great house communities (Judge 1989, Malville and Malville 2001, Renfrew 2001, Roney 1992, Vivian 1997b), as routes for the movement of turquoise, much of which seems to have been used within Chacoan communities (Mathien 2001), or as routes for military activities undertaken to forcibly integrate outlying communities into the Chaco system (Wilcox 1994). Others, however, have concluded that these roads were too wide to have been designed simply as transportation routes, regardless of what might or might not have been transported (Roney 1992, Kantner 1997, Vivian 1997b).

Similarly, while exotic items of Mexican origin (e.g., copper bells, macaws) are known from Chacoan sites, those subscribing to the notion that Chaco was a regional network note that the overall quantity of such remains is too small to reflect widespread trade or exchange with Mexico (Renfrew 2001). At the same time, some have suggested that the value, not quantity, of exotic items from Mexico may be a far more important factor in evaluating the presence of such items at Chaco (Reyman 1995).

Finally, some see Chaco's settlement system as based largely on cosmology (Stein and Lekson 1992). Specifically, the Chaco phenomenon is argued to have been predicated on shared ritual ideology linked to cosmological events (e.g., solstices, equinoxes) which, in turn, were manifested in the structured spatial arrangement of archaeological sites (e.g., kivas, shrines, rock art, water control features, and roads) across Chacoan landscapes (see also Sofaer 1997).

Chaco as a Pan-Regional System

Most recently, Lekson has proposed that Chaco may be part of a much larger Mexican-Southwest settlement system. Lekson (1999) focuses on the supposed alignment of structures found at the New Mexico sites of Aztec Ruins and Chaco Canyon, along with the site of Paquimé in northern Mexico, on a north-south axis running from nearly Colorado into northern Chihuahua. These complexes are suggested to be time-sequent residences of religico-political elites that moved in response to a succession of deteriorated environmental intervals. Specifically, he proposes that a politico-religious elite, originally resident in Chaco Canyon, moved successively to Aztec (ca. A.D. 1125) and then Paquimé (A.D. 1275). What is perhaps most controversial about Lekson's argument is the notion that the arrangement of these three sites along a given meridian represents a deliberate effort to construct sites according to some preconceived plan by a multi-generational elite that spanned more than 200 years and 630 kilometers.

Not surprisingly, there are objections to Lekson's view of Chaco. For example, Phillips (2000) demurs about this model, observing that the alignment of these three sites along a given meridian may be more apparent than real and, moreover, that the presumptive similarity of architecture across these three sites is without foundation. Further, Phillips notes that, in particular, ceramic assemblages from Paquimé are quite dissimilar from Chacoan ceramics in general, suggesting that a time- and space-transgressive elite is not responsible for constructing these three sites.

Summary

This very brief overview of varying perspectives swirling around the "Chaco phenomenon" simply underscores a number of points. First, there is an on-going debate about appropriate geographic scales of analysis, particularly with respect to settlement analyses. Second, as this discussion makes clear, there are debates regarding the nature of evidence from Chacoan sites and the inferences based on such evidence. Finally, while the San Juan Basin has perhaps the largest suite of dated sites in the Southwest, attempts to identify stimuli (environmental fluctuations) and possible responses (centralization, redistribution, migration) still rely on accurate chronologies. Only as issues of this sort are addressed will the Chaco phenomenon be more completely understood. Consequently, Chaco will remain one of the most important venues in the American Southwest for examining these issues.

PII components account for approximately 7 percent of the total known components in the planning area. However, dual PII-PIII components are quite common across the planning area, adding another 8 percent of the components that date to this broad time interval. During this period the Navajo

Reservoir, Largo, Carrizo, Upper San Juan and Blanco watersheds are virtually abandoned, with populations shifting to the north, south and west. Population aggregation and community development is enhanced in these areas during the PII period. Large and complex communities are linked by formalized road networks within the San Juan Basin, with Chacoan Great Houses and communities tied to the central hub in Chaco Canyon.

On FFO and AFO lands in the planning area, there are 21 ACECs or SMAs that are actively managed to protect outstanding examples of cultural resources from this period. These include:

1. Jones Canyon (AFO)
2. Headcut Prehistoric Community (AFO)
3. Cañon Jarido (AFO)
4. Morris 41
5. Kin Nizhoni
6. Pierre's Site
7. Halfway House
8. Twin Angels
9. Jacques Site
10. Holmes Group
11. Casamero Community
12. Toh-la-kai
13. Indian Creek
14. Upper Kin Klizhin
15. Bis sa'ani
16. Andrews Ranch
17. Church Rock Outlier
18. North Road
19. Ah-shi-sle-pah Road
20. Crownpoint Steps and Herradura
21. Bee Burrow

Other examples may be found that merit special designations. Still other examples of resources from this period are managed according to continuing management guidelines.

Pueblo III (ca. A.D. 1050 to 1300)

The Pueblo III (PIII) period is typified by the aggregation of populations into progressively larger centers, accompanied by the gradual collapse of the Chaco phenomenon that so defines early and middle PII times. Some researchers suggest that populations began to move northward into the northern San Juan Basin near Aztec, as well as southward out of the Mesa Verde region. Concurrent with Chaco's gradual decline in importance is a seeming realignment of social interaction spheres northward toward Mesa Verde. For example, sites along the Chuska Mountains seem to evidence a period of increased building events, accompanied by the replacement of Chacoan ceramics with those more typical of Mesa Verde. As well, the appearance of bi- and tri-wall buildings, nominally characteristic of the Mesa Verde region at sites in the San Juan Basin, suggests the gradual outward expansion of Mesa Verde peoples into areas formerly containing Chaco components. Over much of this period, sites contain between 13 and 30 rooms, with larger sites exhibiting upwards of 200 rooms.

These changes are attributed to the onset of a period of dramatically decreased rainfall after ca. A.D. 1220, accompanied by increased spatial variability in rainfall across the basin as a whole. Areas adversely affected by reduced rainfall, the central and southern San Juan Basin, seem to act as donor areas for population out-migration, while areas less subject to reduced rainfall, like the Mesa Verde and McElmo regions, become recipient areas for immigrants. Many parts of the Basin appear to have been abandoned toward the terminal portion of the PIII period.

Approximately 6 percent of total known components in the planning area date to PIII times, yet they are some of the largest and most complex Puebloan settlements in the region. Further, as noted in the PII discussion, dual PII-

PIII components are quite common across the planning area, adding another 8 percent to the total known components dating to this somewhat broad interval. PIII components are virtually absent from the Navajo Reservoir area, while the Upper Largo and Rio Chama drainages exhibit large clusters of Gallina phase settlements. Concentrations of sites and large communities are found on the Chuska Slope and the Chaco River watershed, the Upper Puerco, Rio Chama, San Jose and Rio Puerco drainages, and the Lower San Juan and its tributary drainages, including the Animas, La Plata, and Mancos.

On FFO and AFO lands in the planning area, there are 23 ACECs or SMAs that are actively managed to protect outstanding examples of cultural resources from this period. These are:

1. Jones Canyon (AFO)
2. Headcut Prehistoric Community (AFO)
3. Cañon Jarido (AFO)
4. Morris 41
5. Kin Nizhoni
6. Pierre's Site
7. Halfway House
8. Twin Angels
9. Jacques Site
10. Holmes Group
11. Casamero Community
12. Toh-la-kai
13. Indian Creek
14. Upper Kin Klizhin
15. Bis sa'ani
16. Andrews Ranch
17. Church Rock Outlier
18. North Road
19. Ah-shi-sle-pah Road
20. Crownpoint Steps and Herradura
21. Bee Burrow
22. Farmer's Arroyo Site
23. Chacra Mesa Complex

Other examples may be found that merit special designations. Still other examples of resources from this period are managed according to continuing management guidelines.

Pueblo IV (ca. A.D. 1300 to 1540)

Further movements of peoples into riverine valleys where relatively more reliable surface water supplies are found characterize the Pueblo IV (PIV) period. This marks an end to higher elevation agricultural endeavors dependent on rainfall and, perhaps, the explicit recognition that agriculture, if it was to be successful, had to rely on surface water. Sites dating to this period are generally small, containing between 1 and 4 rooms. A small subset of sites contains 100 rooms, while an even smaller subset of the largest sites contains upwards of 500 rooms.

Major settlements dating to this period are situated primarily in the Rio Grande, Rio San Jose, and Zuni River watersheds. As well, during this period, the first evidence of direct diversion irrigation systems appears among the pueblos along the Rio Grande.

Material culture also became more elaborate. For example, PIV coincides with the introduction of glaze-decorated ceramics and the use of red and yellow slips. Other examples of PIV material culture include mural paintings, petroglyphs, stone effigies, decorated pipes, and carved bone tools. The descendents of some of these groups are the contemporary Puebloan villagers.

The PIV occupation of the planning area is primarily limited to the Rio Chama watershed, where concentrations of PIV components comprise less than 1 percent of the total number of components.

On BLM lands in the planning area, there are no ACECs or SMAs that are actively managed to protect outstanding examples of cultural resources from this period. Other examples may be found that merit special designations. Still other examples of resources from this period are managed according to continuing management guidelines.

Historic Period (ca. A.D. 1540 to Present)

Before considering historic Navajo occupations of the planning area, it should be mentioned that small numbers of Southern Ute and Jicarilla Apache components are found in the northern reaches of the planning area. These components are probably related to activities following the establishment of the Southern Ute Reservation (1868-1877) and the Jicarilla Apache Reservation (1887). Because these components are so infrequent, they are not discussed in any detail here.

Navajo

Navajo cultural sites in the planning area constitute a high percentage of the historic period. Approximately 30 percent of all recorded cultural site components in the planning area are Navajo affiliated. These sites encompass a full range of types and include but are not limited to scatters of artifacts, game drives, small and large habitations, trails, and rock art. The culture and history of the Navajo people is also intertwined with a varied and diverse landscape that recognizes places that have pan-tribal as well as local significance.

While there is some debate on the chronology of the early Navajo and their entry into the American Southwest, the archaeological evidence indicates that they were here by at least the mid-16th century. Navajo traditional histories place them in northwest New Mexico even earlier. By about 1710, most Navajos were probably located west of Abiquiu and the Chama River, having been driven out by conflicts with Spanish, Ute, and Comanche combatants.

Navajo chronology is generally expressed in a series of phases that include the Dinétah (1540 to mid- 1600s), Gobernador (mid-1600s to 1770), Cabezon (1770 to 1863), and Reservation phases (1863 to present). The date ranges presented here are general, and various scholars may present slightly different schemes. All of these phases are manifested in the RMP planning area to varying degrees. Some areas have been extensively investigated and the distribution of Navajo sites of varying ages and types is well documented. Other areas have received only sporadic investigations and the distribution and character of Navajo sites is less well defined. Almost half of all known Navajo sites, or 10.5 percent of all components known in the planning area, cannot be assigned to any of these three general phases and are identified simply as "Unknown Navajo."

Dinétah/Gobernador Phases (ca. A.D. 1500 to 1753)

Early Navajo occupation of northwest New Mexico is documented from at least the Abiquiu/Chama River area extending west to concentrations at the eastern ends of San Juan County and the western ends of Rio Arriba County, in what is known as Dinétah ("Among the People"). Early Navajo sites are also know from the southern reaches of the San Juan Basin and in the Rio Puerco drainage, most notably at Big Bead Mesa and Chacra Mesa. Although a growing body of evidence indicates that Dinétah and Gobernador phase sites were more widely distributed across the San Juan Basin and the Colorado Plateau in general than previously believed only a few years ago, the greatest occurrence remains the Dinétah area, and elsewhere the numbers are far lower. Approximately 26 percent of all Navajo site components in the study area are dated to this time period, and the vast majority is located in the Largo and Gobernador Canyons and their drainages. Regardless of where early Navajo sites may be found on the Colorado Plateau, Dinétah is the type locality for comparative purposes with other early Navajo sites.

The Navajo of the period represent an evolving tradition originating out of a hunting and gathering existence to one that enhanced those traditions with the agricultural practices and some of the ceremonial practices of the Pueblo world, and the pastoral economies introduced by the Spanish. Some key characteristics of the Navajo of the period include conical forked-pole hogans, defensive masonry pueblitos, elaborate ceremonially based rock art, plain gray and polychrome ceramics, low percentages of trade ceramics from nearly all pueblo areas, distinctive stone tool styles, agriculture, and pastoral economies. Many of the sites, particularly in the 18th century, are located in defensive locations.

Sometime around A.D. 1760 to 1770, the Dinétah Navajo had moved or was in the final stages of moving into other areas of the Colorado Plateau and Dinétah was effectively depopulated. Archaeological data shows little evidence for site occupation or construction after this time. Concurrent with this movement away from Dinétah, the Navajo appear to have experienced a revitalistic movement that prescribed the discarding of certain puebloan traits such as painted pottery, masonry houses, and permanent ceremonially oriented rock art.

Dinétah/Gobernador components comprise about 7.5 percent of the total components known in the planning area. On FFO and AFO lands in the planning area, there are 55 ACECs or SMAs that are actively managed to protect outstanding examples of cultural resources from this period. These include:

1. Jones Canyon (Dinétah and Gobernador phases) (AFO)
2. Cañon Jarido (Dinétah and Gobernador phases) (AFO)
3. Superior Mesa Community (Dinétah and Gobernador phases)
4. Bi Yaazh (Dinétah and Gobernador phases)
5. Gould Pass Camp (Dinétah and Gobernador phases)
6. Four Ye’i (Dinétah and Gobernador phases)
7. Largo Canyon Star Ceiling (Dinétah and Gobernador phases)
8. Star Spring (Dinétah and Gobernador phases)
9. Blanco Star Panel (Dinétah and Gobernador phases)
10. Shield Bearer (Dinétah and Gobernador phases)
11. Big Star (Dinétah and Gobernador phases)
12. Rabbit Tracks (Dinétah and Gobernador phases)
13. Delgadita/Pueblo Canyons (Dinétah and Gobernador phases)
14. Cibola Canyon (Dinétah and Gobernador phases)
15. Encierro Canyon (Dinétah and Gobernador phases)
16. NM 01-39236 (Dinétah and Gobernador phases)
17. Martinez Canyon (Dinétah and Gobernador phases)
18. Shephard Site (Gobernador phase)
19. Crow Canyon District (Gobernador phase)
20. Hooded Fireplace and Largo School District (Gobernador phase)
21. Tapacito and Split Rock District (Gobernador phase)
22. Frances Ruin (Gobernador phase)
23. Christmas Tree Ruin (Gobernador phase)
24. Simon Ruin (Gobernador phase)
25. San Rafael Canyon (Gobernador phase)
26. Romine Canyon Ruin (Gobernador phase)
27. Prieta Mesa Site (Gobernador phase)
28. Delgadito Pueblito (Gobernador phase)
29. Cagel’s Site (Gobernador phase)
30. Adams Canyon Site (Gobernador phase)

31. Casa Mesa Diablo (Gobernador phase)
32. Rincon Rockshelter (Gobernador phase)
33. Hill Road Ruin (Gobernador phase)
34. Gomez Canyon Ruin (Gobernador phase)
35. Adolfo Canyon Site (Gobernador phase)
36. Unreachable Rockshelter (Gobernador phase)
37. Compressor Station Ruin (Gobernador phase)
38. Foothold and Overlook Ruins District (Gobernador phase)
39. Pointed Butte Ruin (Gobernador phase)
40. Rincon Largo District (Gobernador phase)
41. Kin Yazhi (Little House) (Gobernador phase)
42. Canyon View Ruin (Gobernador phase)
43. NM 01-39344 (Gobernador phase)
44. Deer House (Gobernador phase)
45. Kachina Mask (Gobernador phase)
46. Hummingbird (Gobernador phase)
47. Blanco Mesa (Gobernador phase)
48. Ye'is-in-Row (Gobernador phase)
49. Kiva (Gobernador phase)
50. Pretty Woman (Gobernador phase)
51. Gomez Point (Gobernador phase)
52. Santos Peak (Gobernador phase)
53. Salt Point **(TCP)**
54. Huerfano Mesa **(TCP)**
55. Cho'li'i (Gobernador Knob) **(TCP)**

Other examples may be found that merit special designations. Still other examples of resources from this period are managed according to continuing management guidelines.

Cabezon Phase (ca. A.D. 1753 to 1868)

Cabezon phase Navajo sites are less well documented but nonetheless are present in the planning area. They are rarely reported, even by large-scale multi-thousand acre surveys. Problems with recognition and site dating during field surveys may account for some of the rarity of Cabezon phase sites. Cabezon Phase components make up about 1 percent of the total Navajo site record in the planning area. This is in stark contrast to the density and numbers of site from the preceding period. This period can be viewed as one during which the widely dispersed Navajo population may have begun coalescing into the areas encompassed by the modern day limits of the reservation.

Cabezon phase sites are characterized by a continuation of many of the economies present in the earlier phases, with perhaps a decline in agriculture and increasing reliance in pastoral pursuits. As previously noted, many of the obvious puebloan traits seem to have disappeared or receded in importance. Fortified defensive sites still occur but on a much smaller scale. Circular masonry hogans and cribbed-log hogans occur along side the earlier forked-pole hogan and may begin to gain predominance during this phase. Antelope game traps are first identified during this phase. Artifactually, there are sporadic occurrences of polychrome ceramics and the plain gray styles continue with some minor but notable technological distinctions that distinguish it from the earlier types. Near the end of the phase, glass and metal artifacts begin to occur more often but in limited numbers.

Cabezon components comprise less than one-half of one percent of the total components known in the planning area.

On FFO lands, there are 3 ACECs or SMAs that are actively managed to protect outstanding examples of cultural resources from this period. These include:

1. Salt Point **(TCP)**

2. Huerfano Mesa **(TCP)**

3. Cho'li'i (Gobernador Knob) **(TCP)**

Other examples may be found that merit special designations. Still other examples of resources from this period are managed according to continuing management guidelines.

Reservation Phase (ca. 1868 to Present)

Reservation phase sites span the time from the Kit Carson campaign (A.D. 1863 to 1864) and subsequent internment at Bosque Redondo (A.D. 1863 to 1868), to the present time. These sites account for nearly 37 percent of the total Navajo sites in the study area, with most of those dating to the 20th century. Post-Bosque Redondo 19th century sites amount to only about 1 percent or less of total Navajo sites. This time period witnesses a near complete replacement of forked-pole hogans by circular forms, and in later years the adoption of housing styles from the dominant non-Native culture. Pastoral economies continue to gain preeminence with livestock herds in the thousands not uncommon. As the population grew and natural limits to pastoral economies were encountered, wage labor made significant inroads into the local economies and became increasingly important in supplementing the traditional economies.

On public lands, small and large habitations sites often represent sites of this period. The occasional abandoned hogan or "home site" areas are found, often completely salvaged of useable materials. Other sites include those associated with pastoral activities such as corrals and camps. The occurrence of these sites is particularly noticeable within the Eastern Navajo Agency where land patterns follow a checkerboard pattern and the use of public lands is historically common. In areas where public lands are less fragmented, reservation era sites are much less frequent.

Reservation phase components comprise about 11 percent of the total components known in the planning area.

On FFO lands, there are 3 ACECs or SMAs that are actively managed to protect outstanding examples of cultural resources from this period. These include:

1. Salt Point **(TCP)**

2. Huerfano Mesa **(TCP)**

3. Cho'li'i (formally Gobernador Knob) **(TCP)**

Other examples may be found that merit special designations. Still other examples of resources from this period are managed according to continuing management guidelines.

Euro-Anglo Period

There is obvious overlap between events that occurred during the preceding Navajo historic periods and events more closely associated with Euro-Anglo occupations of the planning area. While reference is made to related Navajo events, the primary focus of this section is on events related to post-contact (A.D. 1540) Euro-Anglo activities. This general period, in turn, is segmented into Spanish, Mexican, and Anglo (A.D. 1848-present) periods.

Spanish Colonial Period (A.D. 1540-1821)

The earliest evidence of Spanish entry (*entrada*) into New Mexico is associated with the appearance of Coronado's expedition in 1540 (Winship 1990). Initial contacts with the inhabitants were not promising insofar as the Spaniards, prompted by Marcos' reports of great wealth, viewed the region's inhabitants as potential sources of wealth or information about where such wealth could be found (Winship 1990). Greeted by showers of arrows at some pueblos, Coronado's men soon found that reports of gold were overstated and that their likely reception in other villages would be equally confrontational (Winship 1990). In 1542, after smaller expeditions into the surrounding country revealed no great wealth, Coronado's expedition withdrew to Mexico.

The Spanish did not return to the region until several decades had passed. In 1598, Oñate arrived with a large party of colonists, soldiers, and priests, to establish the village of San Gabriel, near the modern-day Pueblo of San Juan. This marked the first serious attempt to establish permanent settlements in the region. According to Salmerón (1966), Oñate found little of the wealth that had prompted Coronado's expedition some 50 years earlier. In 1604, Oñate traversed portions on the planning area on his way to the Hopi Mesas and thence westward to California (Salmerón 1966). He returned by the same route, but did not establish any new Spanish settlements along the way. It is during Oñate's travels that we find the first written reference to the presence Navajo Indians in what is today the Navajo heartland; they were referred to by Salmerón as "Apache Indians of Nabaju" (1966).

There is almost no documentary evidence regarding the planning area between Oñate's arrival in 1598 and the Pueblo Revolt of 1680. Seventeenth century Spanish settlements in the area were minimal and concentrated almost solely along the eastern margin of the planning area in or near the Rio Grande valley. During this period, small settlements such as San José de Guisewa (1620) pushed westward into the planning area, only to be abandoned shortly thereafter (Williams 1986).

It is reasonable to assume that Spanish settlement brought new technologies and ways of life to indigenous peoples. Among the most important introductions were the use of metal, the introduction of domestic animals and, to the detriment of the region's inhabitants, Old World diseases. By 1650, sheep and goat husbandry appear as progressively more important components of Navajo subsistence. This inference is further supported by the archaeological recovery of European goods at seventeenth century Navajo sites, although it is unclear whether these goods were obtained by raiding or trading with Puebloan groups along the Rio Grande.

The Pueblo Revolt of 1680, as well as the 1694 rebellion that followed Vargas' 1692 Reconquest of New Mexico, was accompanied by the relocation of the inhabitants of some Rio Grande pueblos. Including both Tanoan- and Keresan-speaking elements, this population dispersal probably accelerated the adoption of Puebloan cultural elements—notably masonry architecture and painted pottery—into Navajo culture during the eighteenth century. Vintage Spanish documents, supported by substantial archaeological evidence, suggest defensively-sited Navajo hogans and pueblitos, likely in response to raiding by both Utes and Comanches, as well as threats from the Spanish. In addition, there appears to have been some Navajo dislocations southward during the eighteenth century as a result of intensive raiding by the Utes.

Spanish activities during eighteenth century focused primarily on consolidating their holdings in the Rio Grande valley. Settlements in the heart of the planning area were almost non-existent. Exceptions to this generality include, for example, the settlement of Ranch de la Posta (1780). Yet, two activities—new land grants and new trading routes—emerge as important events affecting the planning area during this period.

As in the seventeenth century, new land grants were established in the eighteenth century, mostly along the eastern margin of the planning area (Williams 1986). These included Plaza Colorado (1739), Plaza Blanca (1739), Cañada de Cochiti (1740), Abiquiu (1754), Polvadera (1766), and Piedre Lumbre (1766). Some, such as Ponderosa (1768) were established and have remained occupied, while others such as La Ventana (ca. 1778) were soon abandoned due to raiding (Julyan 1996, Swadesh 1974).

It was also during the eighteenth century that the Old Spanish Trail was established (Crampton and Madsen 1994) (**Map 3-10**). The Old Spanish Trail is a collective assortment of pack routes that connected Santa Fe and Los Angeles. It was first traversed in its entirety in 1829 and experienced about 20 years of use by traders, slavers, trappers, and immigrants until being replaced by other trails. It undoubtedly followed older Native American trail routes in some areas and portions that had been used by earlier Spanish exploring and trading ventures. In the FFO, the Old Spanish Trail has not been physically identified, but segments of the trail followed Largo Canyon (Armijo route) and Carracas Canyon (Northern Route). On December 4, 2002, President Bush signed Public Law 107-325 designating the Old Spanish Trail as a National Historic Trail.

Spanish Colonial components comprise less than one-half of 1 percent of the total components known in the planning area.

On FFO lands, there is 1 SMA, Santos Peak, that is actively managed to protect outstanding examples of cultural resources from this period.

Other examples may be found that merit special designations. Still other examples of resources from this period are managed according to continuing management guidelines.

Mexican Period (A.D. 1821-1848)

Mexico's declaration of independence from Spain in 1821 was accompanied by the opening of the Santa Fe Trail. This inaugurated a period of progressively greater interaction between Euro-Anglos from America and New Mexico's Native American and Hispanic residents.

Excluding events taking place in Navajo country, discussed earlier, this period is not particularly noteworthy with respect to Mexican activities in the planning area. There were additional Mexican land grants finalized during this period, including most notably the San Joaquín del Rio Chama (1806, Swadesh 1974), Tierra Amarilla grant (1832, Swadesh 1974), Baca Location #1 (1835), and the Lobato grant (Williams 1986). As well, small towns such as Gallina (1818) and Cabezon (1826) also appeared in the planning area.

Trading across the Old Spanish Trail, discussed above, intensified during the Mexican Period and included both Mexican and Anglo traders (Swadesh 1974). Many of the alternate routes along the trail, which shortened its distance, were identified and used by traders traveling to California. According to the Frenchman, Duflot de Mofras (BLM 2002a):

> Caravans traveled once a year from New Mexico to Los Angeles. These consist of 200 men on horseback, accompanied by mules laden with fabrics and large woolen covers called serapes, jerzas, and cobertones, which are valued at 3 to 5 piasters each. This merchandise is exchanged for horses and mules on a basis, usually of two blankets for one animal. Caravans leave Santa Fe, New Mexico, in October, before the snows set in, and finally reach the outlying ranchos of California from where the trail leads into El Pueblo de los Angeles. This trip consumes two and one-half months. Returning caravans leave California in April in order to cross the rivers before the snow melts, taking with them about 2,000 horses.

Thus, while trade expanded during the Mexican Period, settlements and associated populations remained largely restricted to the Rio Grande valley and its major tributaries. Aside from periodic trading expeditions, the planning area was instead typified by Navajo settlements.

Map 3-10: Alignment of the Old Spanish Trail

Like their Spanish Colonial predecessors, Mexican period components are notably scarce across the planning area, comprising less than one-half of 1 percent of the total components known in the planning area.

On FFO and AFO lands in the planning area, there are no ACECs or SMAs that are actively managed to protect outstanding examples of cultural resources from this period.

Other examples may be found that merit special designations. Still other examples of resources from this period are managed according to continuing management guidelines.

Euro-Anglo Period (1848 to Present)

In 1846, Doniphan's California Column entered New Mexico, ushering in a new era in the region's history. With the subsequent defeat of the Mexican Army, New Mexico officially became a territory of the U.S.

Conditions during the period between 1848 and the outbreak of the Civil War remained largely unchanged from those observed during the Mexican Period. Anglo or Hispanic settlements were very few in number and still concentrated mostly in the Rio Grande basin.

At the same time, largely in response to raiding by Native Americans, there was an increasing presence of U.S. military forces. Indeed, this period is marked by the appearance of a succession of forts (Acrey 1994, Williams 1986). These included Ft. Defiance (1851), Ft. Wingate (1849, 1862, 1868), Ft. Lowell (1866) and an unnamed Army post west of Haynes Station (1870s).

The chaos that seemed to characterize the newly-acquired territory grew even worse with the outbreak of the Civil War. Between 1861-1862, Confederate forces seized a series of Union posts beginning in El Paso, TX, and extending northward up the Rio Grande toward Santa Fe. Only after the Confederates were defeated at the Battle of Glorieta Pass in the spring of 1862 did any semblance of order return to the territory. By 1865, the Santa Fe-Durango stage route extending from Santa Fe northwestward through San Ysidro, Cuba, Haynes Station, Truby Stop, and Largo to Aztec had been established in an effort to improve communications and travel in the planning area (Williams 1986). This stage line was to remain in operation until 1881.

Perhaps the most notable event of the Civil War period was the attempt to remove all Navajo from their homelands. Termed "The Long Walk," this saw the removal of upwards of 10,000 Navajo from the eastern part of their traditional homeland (Ackerly 1998, Bailey 1988). This effort proved largely a failure, due in no small measure to Carleton's gross underestimate of the population of the Navajo Nation. By 1868, the reservation at Bosque Redondo (Ft. Sumner) was abandoned and the Navajo returned to their homeland.

The initial impetus for Anglo settlement in the planning area can be traced to passage in 1862 of the Homestead Act. Intended to promote settlement of the American West, the Act provided 160 acres to claimants once they "proved up" their claim by living and working on it. In the planning area, however, homesteading was inhibited by deteriorating conditions between settlers and Navajos, as well as constraints imposed by the outbreak of the Civil War in 1862. Further, since land ownership was unclear, settlements remained tenuous until passage of the 1868 treaty that allowed the Navajo displaced by the Bosque Redondo experiment to return to their homelands.

Accordingly, Anglo and Hispanic (Lucero phase) settlements in the planning area did not emerge until the late 1870s. Among the earlier Hispanic settlements in the region are Blanco (1879), Cuba (1887) and Rosa (1888). Anglo settlements included Aztec (1879), Bloomfield (1879), Farmington (1879), Lumberton (1881), Dulce (1883), Cedar Hill (1887), San Luis (1890), Fruitland (1891), and Sheep Springs (1892). Others such as Fairpoint (1894-1898), Pendleton (1903-22), Liberty (1907-1920), Haynes (1908-1929), and Gobernador (1916-1942) were established only to be abandoned within a few years or decades (Williams 1986).

Many initial economic activities typical of the mid-late nineteenth century focused on farming and ranching. Farming varied from rainfall-based dryland farming in upland areas to irrigated agriculture in river valleys that had relatively permanent flows. The establishment of the settlements listed above were almost invariably accompanied by the immediate construction of irrigation ditches (Ackerly 2002). For example, the La Plata Indian and McDermott ditches in the La Plata basin are believed to date to the late 1870s. In the Animas basin, the Star ditch is believed to date to the late 1870s. Irrigation systems drawing water from the San Juan River and dating to ca. 1880 include the Hammond Conservancy District, Castiano Ditch, San Juan #4, and Cuadi Ditch.

Ranching focused almost exclusively on sheep, although some cattle were also raised. Sheep ranching expanded rapidly, with totals in the state increasing from 250,000 in 1830 to upwards of 4,000,000 in 1880. Beginning in the 1850s and persisting through the 1860s, there were trail drives of large herds westward along a route that closely paralleled the Old Spanish Trail (Williams 1986). By the early twentieth century, there were 1.8 million head of sheep on the Navajo Reservation, comprising almost 93 percent of all livestock (Acrey 1994).

The rapid pace of settlement, accompanied by expansion of both farming and ranching, led to the construction in 1881 of the "Farmington Branch" of the Denver and Rio Grande Western Railroad. Intended largely to transport commodities, particularly fruit, northward and manufactured goods into the San Juan Basin, a spur line extending from Durango, CO, southward to Aztec and Farmington was completed in 1905 (Myrick 1990). What is perhaps most notable is that this spur was standard gauge, a novelty on the Denver and Rio Grande Western Railroad's system of narrow-gauge rails; it was replaced with narrow-gauge rails in 1923 (Myrick 1990).

In Navajo county, the late nineteenth century and early twentieth century were characterized by the establishment of numerous trading posts. Beginning in 1869, trading posts associated with army garrisons at Ft. Defiance and Ft. Wingate were opened for Navajo trade (Acrey 1994). In the mid-1880s, a trading post was opened in Fruitland (Acrey 1994), soon followed by trading posts at Crystal (1892) and Two Gray Hills (1897). Trading posts provided both an outlet for goods, notably blankets and jewelry, produced by Navajo craftspeople, as well a source for manufactured Anglo goods.

Historic Euro-Anglo components comprise only 3.1 percent of the known components in the planning area. Most are situated along the eastern margins of the planning area, mirroring the locations of early settlements as described above.

On FFO and AFO lands, there are 11 ACECs or SMAs that are actively managed to protect outstanding examples of cultural resources from this period. These include the:

1. Margarita Martinez Homestead
2. Dogie Canyon School
3. Rock House-Nestor Martin Homestead
4. Gonzales Canyon-Senon S. Vigil Homestead
5. Martin Apodaca Homestead
6. Jones Canyon (AFO)
7. 1870s Wagon Road Trail (Recreation) (AFO)
8. Historic Homesteads (Recreation) (AFO)
9. Azabache Station (Recreation) (AFO)
10. Headcut Prehistoric Community (AFO)
11. Cañon Jarido (AFO)

Other examples may be found that merit special designations. Still other examples of resources from this period are managed according to continuing management guidelines.

Navajo Sites of Unknown Age

Approximately 36 percent of the Components in the planning area that are ascribed to the Navajo culture are insufficiently documented with regard to age. At the moment, a lack of time sensitive diagnostic artifacts or other information prevents assignment of these sites to a particular period.

Sites of Uncertain Age

The final category of components in the planning area is sites whose age is uncertain and whose affiliation is unclear. Grouped under the rubric of "Unknown," approximately 18.4 percent, or almost one component in five, cannot accurately be assigned to any time period.

Traditional Cultural Properties

Traditional cultural properties (TCP) are another class of cultural resources that occur within the planning area. These are places that have cultural values that transcend, for instance, the values of scientific importance that are normally ascribed to cultural resources such as archaeological sites. The National Park Service has defined TCPs as follows:

> A traditional cultural property can be defined generally as one [a property] that is eligible for the National Register because of its association with cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community (National Register Bulletin 38).

TCPs may or may not coincide with places that yield artifactual remains such as archaeological sites. Mountains, buttes, mesas, hills, or other high points in an area are often potential TCPs. Places that cause echoes ("talking rocks") may be favored as places of worship for the ability to amplify prayers and songs. Eagle nesting sites may also have great significance.

Prehistoric and historic Native American archaeological sites are quite often considered TCPs by some tribes or pueblos. For example, the Zuni Tribe views all prehistoric Pueblo sites as sacred and significant to the Zuni people. Many of the larger prehistoric Pueblo sites in the San Juan Basin, such as the Chaco outliers, have Navajo names and are linked in some cases to origin stories and ceremonies, and are recognized as part of a local community's landscape. Another form of archaeological site, rock art, is of particular interest to several tribes who regard them as places of ongoing traditional and spiritual significance. For instance, the Hopi believe that certain design elements are evidence of the migrations of clans that have ancient and modern ties to the Hopi people.

In some cases, the importance is seemingly more secular than sacred. As an example, the location and associated oral history of an old Native American battle site can be just as powerful to a community's sense of identity as a any number of Civil War battlefields are to their associated communities and descendants.

Traditional cultural properties are not restricted to Native American cultural associations. Native Americans have in the past been the "community" most likely to identify TCPs, perhaps because they may be the only "community" that most federal agencies approach. Cultural resources regulations and legislation specifically identifies Native American tribes as a required point of contact on certain occasions and this may have biased the TCP identification efforts. There are good reasons to expect that non-Native American communities may have TCPs in the planning area. Hispanic and other Euro-American properties may qualify as candidates for TCP status. Portions of the planning area had a significant period of Hispanic homesteading settlement in the mid-late 19th century and early 20th century. As an example, the "Largo Cemetery" is a place that several Hispanic families in the area maintain and they have collected historical information about it and several historic homesteads in Largo Canyon.

These old ranches and the cemetery may qualify as a TCP.

A comprehensive inventory of TCPs in the planning area is not available. When compared to the plethora of archaeological surveys that have been completed, only a handful of TCP surveys have been completed in the planning area. Compounding this dearth of information, it is only within the past 10-15 years that TCPs have been regularly considered by federal agencies as a class of cultural properties to seek out and identify in advance of federally initiated or permitted actions, and even then identification efforts can be erratic. There are a small number of historical studies that identified TCPs, such as the work of scholars in the 1930s to 1940s studying the landscape and religious geography of the Navajo (e.g., Richard Van Valkenburgh) and the field surveys by archaeologists and anthropologists working for the Navajo Nation during the Navajo Lands Claim studies in the 1950s - 1960s.

In most cases, TCP surveys are not regularly conducted on federal lands within the planning area, particularly on small scale undertakings. In the planning area, it is often only the larger actions (e.g., coal mines, major pipelines) or undertakings potentially affecting known or previously suspected TCP areas that carry such requirements. Within the past decade or so, the development of large gas delivery systems have regularly included TCP studies as part of the overall cultural resource survey. On some tribal lands within the planning area (e.g., Navajo Nation), all cultural resource surveys are required to consider and attempt to identify TCPs. When large undertakings involve lands of varying jurisdiction in the so-called “checkerboard area” of the San Juan Basin and the planning area, TCP identification efforts are conducted on all affected lands.

Identification efforts not only entails on-the-ground inspections, but consultation with knowledgeable individuals and a review of the existing literature. Non-Native American approaches to identifying TCPs are different than those studies conducted by Native American investigators. An archaeologist trained from a perspective of western science will operate within a well defined set of scientific principles and methods at conducting research. A Native American investigator or consultant would probably be the first to admit that TCPs cannot often be identified scientifically, but only by reliance on the knowledge of traditional practitioners. In many cases, seasonality can affect the identification efforts because only during certain times of the year is it appropriate to discuss sacred matters. In other cases, the traditional consultant will ask to remain anonymous and will disclose information only if details are kept confidential and not made public. For many traditionalists, this is a conundrum to disclose information that should be withheld and run the risk of compromising the important place, or to withhold information and risk damage or destruction of the important place.

For this existing situational analysis, information about TCPs or potential TCPs was gleaned from a number of sources including popular publications, unpublished manuscripts, and cultural resource management documents. As a result of this effort, references to 73 TCPs or potential TCPs on federal, private, or state lands within the planning area were identified. Twenty-four Native American Tribes and 27 Navajo Chapters were also contacted. Places on tribally controlled lands are not included.

In some cases, the TCPs are well known (e.g., Huerfano Mesa), but others are only known to a handful of traditional practitioners who in many cases requested that the specific location and nature of the place be held in confidence. In most cases, the location is adequately known, but there are a handful of TCPs where the specific locations are either vague or inconclusive because of the quality of the information. The kinds of places identified as TCPs or potential TCPs include clan origin places, landscape associated with origin history, battle sites, offering places, springs, antelope game traps/corrals, pottery gathering, a now abandoned community, trails, and a hanging location. As previously noted, most archaeological sites are viewed or potentially viewed as TCPs by one or more Native American tribes, but they are not separately counted in this inventory of TCPs. However, several of the TCPs in the current inventory do coincide with the locations of archaeological sites.

Site Density, Site Types, and Attributes of Sites

The following section discusses variability in archaeological sites by gross time period, cultural affiliations/components, average size, and occurrence of features in each of the 20 watersheds comprising the planning area. **Table 3-18** shows the relative frequency of sites by watershed and gross time period (prehistoric, historic, multicomponent prehistoric and historic, and unknown). **Map 3-11** shows the distribution of recorded archaeological sites in each watershed. More detailed information on methodology, site density, and distribution are documented in a supporting document (SAIC 2002b).

For the planning area as a whole, the ratio of prehistoric to historic sites is 1.50, or roughly three prehistoric sites for every two historic sites. Watershed-specific ratios of prehistoric sites to historic sites vary from a high of 15.1 (Rio Chama) to 5.2 (Mancos) to as little as 0.07 (Chinle). The most common, or modal, watershed-specific ratio is less than or equal to 1.0 (nine watersheds), indicating that historic sites are more common or as common as prehistoric sites. In contrast, watersheds exhibiting high ratios of prehistoric to historic sites are less common; using an arbitrary threshold of 2.0, prehistoric sites outnumber historic sites by 2:1 or more in only five of 20 watersheds. It is not clear whether these proportions are a function of total numbers of sites recorded in each watershed. Statistical analyses indicate that the ratio does not appear to be a function of sample size.

Table 3-19 summarizes the modal, or most common, types of sites likely to be found in each watershed. Salient attributes of these sites, including size and elevation, are also presented. This table provides a snapshot of the kinds of sites that archaeologists would be likely to encounter as they work in a watershed. Each site contains a variety of features. Among these, hearths, hogans, roomblocks, middens, and mounds are most common.

PALEONTOLOGY

A variety of paleontological resources exist in the planning area, including animal fossils, fossil leaves, palynomorphs, petrified wood, and trace fossils, occurring in the Triassic, Jurassic, Cretaceous, and Tertiary rocks. There are four areas that have been identified as paleontologically significant (BLM 1987a):

- Santos Peak area—important paleobotanical content and potential for vertebrate remains in the Eocene San Jose Formation.
- Kutz Canyon—numerous locations containing Paleocene mammal fossils in the Nacimiento Formation.
- West of Farmington—paleontology type sections are located in the Pictured Cliffs Sandstone, Fruitland Formation, and Kirtland Shale on or near public land.
- Regina area in the southeastern edge of the planning area—produced the classic vertebrate collections of early paleontologists from the San Jose Formation.

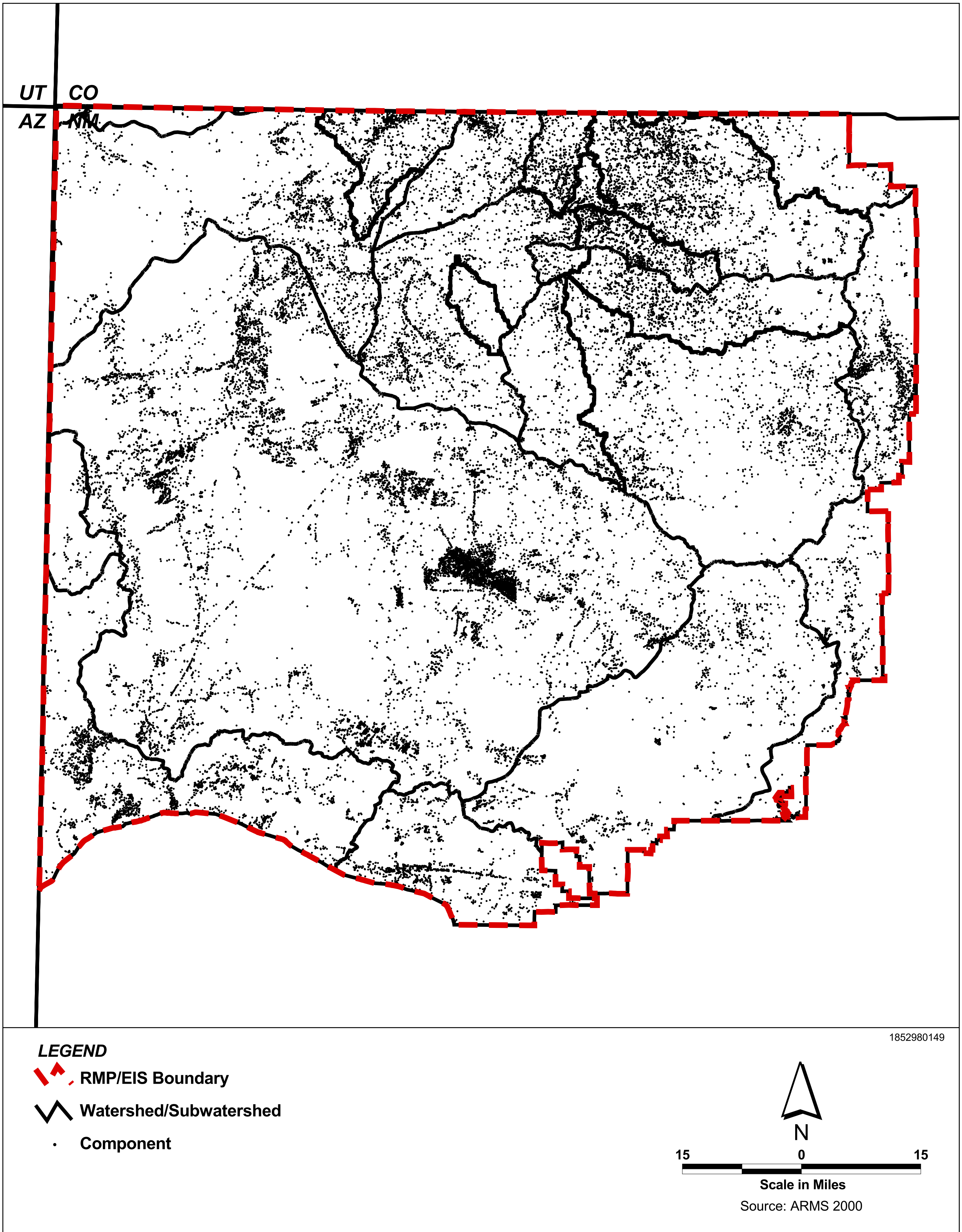
SMAs designated to protect paleontological resources are included in Table 2-5 and Table 2-6. Management prescriptions for all of these SMAs include the following:

- Implement a Limited ORV designation restricted to existing roads and trails, except as authorized.
- Develop and implement an activity and monitoring plan.
- Require paleontological clearance and mitigation for all surface disturbing activities.

Table 3-18. Frequency of Components by Watershed and Cultural Affiliation

Watershed	Paleo	Archaic	BM II	BM III	Unknown Anasazi	PI	PII	PIII	PIV	Unknown Navajo	Din/ Gob	Cabezon	Reserva-tion	Apache	Ute	Pueblo	His-panic	Euro-Anglo	General Unknown	TOTALS
Animas	1	64	22	65	26	279	201	155	1	14	223	12	4	2	0	0	7	90	210	1,376
Arroyo Chico	3	174	24	16	41	31	103	128	3	156	21	17	418	0	0	7	42	36	513	1,733
Blanco	0	8	2	22	5	31	16	9	3	59	59	7	134	0	0	0	6	4	230	595
Carrizo	1	19	8	114	37	333	117	49	2	56	601	32	8	20	0	2	30	12	147	1,588
Chaco Wash	32	795	120	1,183	1,305	2,908	4,439	3,079	18	3,017	82	105	2,475	1	1	16	32	82	3,209	22,899
Chinle	0	19	0	0	3	0	2	0		45	1	1	54	0	0	0	0	5	17	147
Gobernador	0	25	10	88	21	366	69	13	2	61	659	38	13	0	1	0	34	40	168	1,608
Kutz Canyon	0	28	1	3	1	3	8	6	1	2	5	0	7	0	0	0	0	5	42	112
La Plata	0	47	10	77	57	189	455	356	3	14	59	10	12	0	1	1	7	84	239	1,621
Largo	0	50	16	101	61	277	461	588	38	90	486	41	81	29	0	6	45	67	378	2,815
Mancos	0	6	0	10	3	25	36	30	0	11	0	0	7	0	0	0	0	0	14	142
Middle San Juan	8	134	8	117	85	216	525	415		164	7	8	353	0	1	2	0	116	457	2,616
Navajo Reservoir	0	30	76	353	121	1,779	386	119	2	58	690	34	14	68	0	6	81	89	423	4,329
Pump Canyon	0	1	41	62	13	130	42	18	1	42	294	15	3	0	0	1	14	24	199	900
Rio Chama	2	26	1	8	26	58	442	859	295	2	2	1	1	62	0	0	9	39	67	1,900
Rio Puerco	0	23	3	10	30	32	95	115	22	23	10	2	2	0	0	2	18	65	217	669
Rio San Jose	0	13	8	19	139	229	810	336	2	133	2	3	168	0	0	2	4	33	170	2,071
Upper Puerco	0	45	9	131	202	330	910	498	5	599	36	25	748	0	0	5	5	97	280	3,925
Upper San Juan	8	236	28	90	48	355	185	132	4	105	240	18	431	84	0	1	18	78	948	3,009
TOTALS	**55**	**1,743**	**387**	**2,469**	**2,224**	**7,571**	**9,302**	**6,905**	**402**	**4,651**	**3,477**	**369**	**4,933**	**266**	**4**	**51**	**352**	**966**	**7,928**	**54,055**

Source: NM ARMS 2001.



Map 3-11. Distribution of Archaeological Components in the Planning Area

Table 3-19. Summary of Most Likely Kinds of Sites to Be Encountered in Watersheds in the FFO Area

Watershed	Modal Types of Sites Likely to be Encountered, and Their Attributes
Animas	Equally likely EITHER prehistoric Anasazi PI period components (20%) OR historic Navajo Dinétah/Gobernador period components (16%).
Arroyo Chico	Equally like EITHER historic Navajo Reservation period sites (24%) containing hogans, sweatlodges, hearths, middens, and/or corrals OR unknown sites (30%) whose content is not well understood.
Blanco	Equally like EITHER historic Navajo Reservation period sites (23%) containing hogans, sweatlodges, hearths, middens, and/or corrals OR unknown sites (39%) whose content is not well understood
Carrizo	Equally likely EITHER prehistoric Anasazi PI period components (21%) OR historic Navajo Dinétah/Gobernador period sites (38%)
Chaco	Equally likely EITHER prehistoric Anasazi PI period components (13%) OR prehistoric Anasazi PII period components (19%) OR prehistoric Anasazi PIII period components (14%) OR historic Navajo Reservation period components (11%) OR historic Navajo sites of uncertain affiliation (13%).
Chinle	Equally likely EITHER historic Navajo sites of uncertain affiliation (31%) OR historic Reservation period components (37%).
Gobernador	Disproportionately EITHER historic Navajo Dinétah/Gobernador period components (41%) prehistoric Anasazi PI period components (21%).
Kutz Canyon	Disproportionately unknown prehistoric components (38%) whose content is not well-documented OR Archaic components (25%).
La Plata	Equally likely EITHER prehistoric Anasazi PII period components (28%) OR prehistoric Anasazi PIII period components (22%) OR Unknown sites (15%) whose content is not well understood.
Largo	Equally likely EITHER prehistoric Anasazi PII period components (16%) OR prehistoric Anasazi PIII period components (21%) OR historic Navajo Dinétah/Gobernador period components (17%) OR Unknown sites (13%) whose content is not well understood.
Mancos	Equally likely EITHER prehistoric Anasazi PI period components (21%) OR prehistoric Anasazi PII period components (29%) OR prehistoric Anasazi PIII period components (19%).
Middle San Juan	Equally likely EITHER prehistoric Anasazi PII period components (20%) OR prehistoric Anasazi PIII period components (16%) OR Unknown sites (18%) whose content is not well understood.
Navajo Reservoir	Disproportionately prehistoric Anasazi PI period components (41%) with a secondary mode of historic Navajo Dinétah/Gobernador period components (15%).
Pump Canyon	Equally likely EITHER historic Navajo Dinétah/Gobernador period components (33%) OR Unknown sites (22%) whose content is not well understood OR prehistoric Anasazi PI period components (14%).

Watershed	Modal Types of Sites Likely to be Encountered, and Their Attributes
Rio Chama	Equally likely EITHER prehistoric Anasazi PIII period components (45%) OR prehistoric Anasazi PII period components (23%) OR prehistoric Anasazi PIV period components (16%).
Rio Puerco	Disproportionately unknown components (32%) whose content is not well understood OR prehistoric Anasazi PIII period components (17%) OR prehistoric Anasazi PII period components (14%).
Rio San Jose	Disproportionately prehistoric Anasazi PII period components (39%) OR prehistoric Anasazi PIII period components (16%).
Upper Puerco	Equally likely EITHER prehistoric Anasazi PII period components (23%) OR historic Navajo Reservation period components (19%) OR historic Navajo components (15%) whose content is not well understood.
Upper San Juan	Disproportionately unknown components (32%) whose content is not well understood OR historic Navajo Reservation period components (14%) OR prehistoric Anasazi PI period components (12%).

Sources: NM ARMS 2001and SAIC GIS data.

NOISE

Noise is generally defined as unwanted or annoying sound that is typically associated with human activity and interferes with or disrupts normal activities. Although exposure to high noise levels has been demonstrated to cause hearing loss, the principal human response to environmental noise is annoyance. The response of individuals to similar noise events is diverse and influenced by the type of noise, perceived importance of the noise and its appropriateness in the setting, time of day and type of activity during which the noise occurs, and sensitivity of the individual. Noise from oil and gas compressors has been identified by the public as an issue of primary concern in the planning area.

Sound levels are usually measured and expressed in decibels. The method commonly used to quantify environmental sounds involves evaluating all of the frequencies of a sound according to a weighting system, which reflects that human hearing is less sensitive at low frequencies and extremely high frequencies than at the mid-range frequencies. This is called "A" weighting, and the decibel level measured is called the A-weighted sound level (dBA). A sound level range of 0 to 10 dB is approximately the threshold of human hearing and is barely audible under extremely quiet listening conditions. Normal speech has a sound level of approximately 60 dB. Sound levels above about 120 dB begin to be felt inside the human ear as discomfort and eventually pain at still higher levels. Sound levels of typical noise sources from oil and gas activities are shown in **Table 3-20**.

Compressor station operations represent the largest and most long-term noise source associated with production. Sound levels measured at existing oil and gas facilities range from 44 to 69 dBA at a distance of 500 feet from a compressor station (BLM 2000d). Compressor stations operate throughout the life of an oil or gas well, but compressors can be designed and operated to reduce noise to acceptable levels.

Residences located within approximately 2,800 feet and in direct line-of-sight to production activities could experience noise levels in excess of the 55 dBA in USEPA guidelines. Recreational areas located within approximately 500 feet and in direct line-of-sight could experience noise levels in excess of 70 dBA (BLM 2000d).

Table 3-20. Noise Levels Associated with Oil and Gas Activity

Noise Source	Sound Level at 50 Feet (15 Meters)[1]
Well Drilling	83 dBA
Pump Jack Operation	82 dBA
Produced Water Injection Facilities	71 dBA
Gas Compressor Facilities	89 dBA

Source: BLM 2000d.

Note: (1) Sound levels are based on highest measured sound levels and are normalized to a distance of 50 feet (15 meters) from the source.

SOCIAL AND ECONOMIC CONDITIONS

The section contains qualitative and quantitative social and economic data. Quantitative information includes demographics, economic activity, income and poverty levels, housing, and public services and finances. A profile is provided of the four primary economic sectors: trades and services, oil and gas production, recreation and tourism, and agriculture. Economic activities associated with BLM lands are emphasized, including public land grazing, recreation, and oil and gas development. Oil and gas tax receipts are identified and their distribution back to local governments is described. Qualitative information is also presented to provide context for evaluating the relative potential for impacts from changes in operations for some sectors.

The ROI for economic activity in the planning area includes San Juan, Rio Arriba, McKinley, and Sandoval Counties. San Juan County and the tri-cities area of Farmington, Bloomfield, and Aztec are most directly affected by oil and gas activity because this area is central to the high oil and gas development areas, and many suppliers and workers are located there. The population base and economic activity in Sandoval County, although partially within the planning area, is primarily located near the Albuquerque metropolitan area. The portion of San Juan Basin oil and gas development located in Sandoval County is relatively small. Some social and economic patterns in the planning area extend into the four-corners area (into Arizona, Utah, and Colorado). However, the FFO does not administer lands in those areas, and their activities do not directly affect public finances or activities on public lands in this extended area.

Demographics

Table 3-21 shows the current and projected population in McKinley, Rio Arriba, Sandoval, and San Juan Counties. Sandoval County, reflecting the influence of growth of Rio Rancho and the Albuquerque metropolitan area, is expected to grow the most by 2010. Very little of the Sandoval County population resides in the planning area. Rio Arriba County with its rural character and lack of an urban center is predicted to grow the least. In northwest New Mexico, the Farmington urban area experienced steady population growth over the last decade.

Table 3-22 shows the population growth in the three cities of San Juan County, as well as the county itself. In 2000, while 50,639 people lived in an incorporated area, 63,162 lived in the county outside the cities. In the 1980s and 1990s, Farmington had planned for steady population growth within its borders because of its available infrastructure. Instead, more population growth happened in the unincorporated areas of the county, in large measure because of cheaper land and housing costs.

Table 3-21. Population in Four Counties and New Mexico

County	1990	2000	Annual % Change, 1990-2000	Projected 2010	Projected Annual Average Population Growth Rate (%)
McKinley	60,879	74,798	2.33	81,673	0.92
Rio Arriba	34,507	41,190	1.99	41,201	0.0027
Sandoval	63,520	89,908	4.2	128,396	4.28
San Juan	91,605	113,801	2.42	125,614	1.04
New Mexico	1,505,619	1,819,046	2.08	N/A	1.04

Source: UNM BBER 2000.

Table 3-22. Population Growth in Three Cities and San Juan County, New Mexico

Community	1990 Census	2000 Census	Percent Increase
Aztec	5,479	6,378	16.4
Bloomfield	5,214	6,417	23.1
Farmington	33,997	37,844	11.3
San Juan County	91,605	113,801	24.2

Source: US Census 2000.

Table 3-23 shows some of the boom and bust that has characterized historical population figures. Primarily related to the cyclical nature of the oil and gas economy, Farmington and San Juan County experienced a boom in the 1950s, followed by stagnation in the 1960s. At a much smaller scale, the pattern was repeated in the 1970s and 1980s. Table 3-23 also shows that Farmington became an important locus for the county's population, but that importance has tapered off somewhat in the last couple of decades. In 1960, nearly 45 percent of the county's population lived in Farmington, while in 2000, that figure had dropped to 33 percent.

Table 3-23. Historical Population, Farmington and San Juan County, 1910-2000

Year	Farmington	Percent Change	Annual Growth Rate	San Juan County	Percent Change	Percent of County
1910	785	NA	NA	8,504	NA	9.2
1920	728	-7.3	NA	8,333	-2.0	8.7
1930	1,350	85.4	6.4	14,701	76.4	9.2
1940	2,161	60.1	4.8	17,115	16.4	12.6
1950	3,637	68.3	5.3	18,292	6.9	19.9
1960	23,786	554.0	20.7	53,306	191.4	44.6
1970	21,979	-7.6	NA	52,517	-1.5	41.9
1980	32,677	48.7	4.0	81,433	55.1	40.1
1990	33,997	4.0	0.4	91,605	12.5	37.1
2000	37,844	11.3	1.1	113,801	24.2	33.3

Source: City of Farmington 2000.
Note: NA = Not applicable.

Economic Activity

Farmington, as its name implies, was oriented to agriculture from its earliest days of settlement. Orchards were in production as early as 1878, and apple and other fruit growing was the dominant force in the economy at the beginning of the twentieth century (Crawford 2000). The industry continued to expand through the 1950s, when declining railways curtailed the fruit markets and the oil and gas boom hit the area. Table 3-23 shows the dramatic jump in the population of Farmington during the 1950s, from 3,600 to nearly 24,000. From early experimental wells in the 1920s to fully commercial operations with a developing infrastructure, oil and gas development has since come to characterize the regional economy. The industry provides nearly $1 billion per year in taxes, royalties, and interest on investments to the state of New Mexico, at least half of it related to production in the San Juan Basin. Over 11,000 people are employed in the industry in northwest New Mexico (Four Corners Journal 2000).

Only in the last decade have civic leaders and citizens talked about the growing diversity of the region's economy, as Farmington's role as a regional retail and service center has grown. As the largest city within a 150-mile radius, Farmington draws upon a market of 250,000 people. It is becoming a regional trade area for northwestern New Mexico and southwestern Colorado. The area also benefits greatly from recreation and tourism in the four-corners region. At the same time, the oil and gas industry remains a primary employer and provides higher paying jobs than many other sectors. Agriculture, while small in terms of income and employment, remains the historical legacy of the region and is highly valued for cultural reasons and as a strategy for a diversified economy.

Energy Industry

Of the 1.6 billion Mcf of gas produced in New Mexico in 1997, almost 1.1 billion (about two-thirds) was from the planning area. This increased slightly to 68 percent of the state's production by 2000. San Juan County is the largest natural gas producing county in the state, producing about between 650 and 700 million Mcf annually. McKinley County produces little natural gas, and Sandoval County produces less than 1 percent of the state's total.

The value of gas production in New Mexico in 1997 was $3.6 billion, of which 64 percent, or $2.3 billion, came from the planning area. San Juan County accounted for $1.4 billion of this production. The value of gas production increased dramatically in 2000, up to $6.1 billion in the state. This was reflected in a similar increase, up to $3.8 billion in the planning area, or 63 percent of the state's natural gas value. Prices of gas show wide fluctuations, ranging from $1.60 to $6.53 per Mcf over 18 months (NMEMNRD 2001).

The planning area is much less important for its oil production, producing only 5 percent of the state's oil in 1997. The state produced 73.7 million bbls of oil in 1997, of which 3.7 million bbls were from the planning area. In 2000, the state produced slightly less oil at 69.8 million bbls, and the planning area has a similar decline, producing on 4.4 percent, or less than 3.1 million bbls, in 2000. San Juan and Rio Arriba County are the primary producing counties in the planning area.

The state produced $1.4 billion in oil in 1997, of which the planning area produced about 4.8 percent. In 2000, even though the quantity of oil produced by the state decreased in 2000, the value increased to $2.0 billion. The value of oil in the planning area in 2000 was 3.9 percent of the state's total value, mostly from San Juan and Rio Arriba Counties.

The value of produced oil and gas determines the viability of economically producing the reserves with alternative drilling technologies, which incur additional costs and risks over conventional methods.

The historic well costs in the San Juan Basin include drilling costs and tangible and intangible production costs. Drilling costs include surveying and staking, permits, dirt work associated with construction of the pad, access road, gathering line, drilling personnel and equipment, mud, chemicals, water, environmental clearances, and special mitigation measures that can include offset environmental mitigations. Tangible production costs include casing and tubing, wellhead equipment, flowlines, and tanks. Intangible production costs include well logging, acidizing and fracturing, completion fluids, bits, and well testing. Drilling depth, drilling time, and the types of completion and production technical requirements also affect well costs.

The planning area produced 26.8 million metric tons (mmt) of coal in 1997, increasing slightly to 27.3 mmt in 2000 (NMEMNRD 2001). Active mines include Navajo, San Juan, La Plata, McKinley, Lee Ranch, and the newly opened San Juan Underground mine. (These values differ somewhat from those reported by Hill and Associates in *Western U.S. Coal Supply Series, 2000*, where 25.9 mmt were reported for the planning area in 1997 and 29.8 mmt projected for 2000.) Production is expected to stay relatively even over the next few years. By 2006, production levels may see a slight decline back to the 1997 level. The San Juan surface mine is expected to close by 2003, and McKinley mine by about 2007, but these closures would be compensated for by increased production at the San Juan Underground mine and new production at Fence Lake, pending State District Court decision on issuing the permit (Hill and Associates 2000).

The value of coal sold in New Mexico was about $554 million in 2000, and about $531 million in the planning area. The average price per ton in 2000 was $20.42 in New Mexico, down slightly from a value of $22.58 in 1999, but considerably higher than the national average of $16.63 in 2000.

Recreation and Tourism

Little documentation exists on the number of visitors to northwest New Mexico. The New Mexico Department of Tourism estimated that visitor travel expenditures increased by about 77 percent between 1989 and 1999, from $2.0 billion to $3.6 billion. During this period, expenditures in the planning area more than doubled from $165 million to $3.6 million. It is also estimated that the planning area supports about 5,250 jobs related to tourism and recreation (NMDT, n.d.). Visitation rates are not collected for the FFO area, but BLM staff note a moderate, steady increase in the use of developed sites through observation. Visitor surveys of the Farmington Convention and Visitor Bureau indicated that the most popular visitor destination in the region is Navajo Lake.

Regionally distinctive recreation activities that bring people and outside dollars into the area are the motorized and non-motorized vehicle events and opportunities. These activities make direct use of BLM lands, although some of this activity is individual and unrecorded. Local observers point to the huge amount of activity the area sees from visitors who come to ride mountain bikes, motorcycles, and other vehicles on public lands. The Durango area is considered by local sports shop owners and sports enthusiasts to be an important source of visitors who are attracted to the lower elevation, sunnier climate, and distinctive recreation opportunities available locally.

In recent years, the number of planned recreation events designed to draw in visitors from outside the area has increased. Several biking, motorcycle, motocross, and four-wheeler events on public lands attract over 2,000 participants annually with an estimated economic impact of over $2,533,000 generated by visitor spending (Preister 2001). It is estimated that these same events draw between 10,000 and 20,000 spectators each year. These figures do not include the substantial benefit to local individuals and unorganized recreation activity that is not recorded. Given local stories about the popularity of public lands in the area, this activity is understood to be substantial.

The City of Farmington, Parks and Recreation Department, holds a permit for the annual Road Apple Rally and the Battle of the Badlands mountain bike races. Downtown Aztec has spawned a number of stores oriented to recreation, supplying bicycling, mountaineering, and other outdoor sports. A number of civic leaders indicated that the Farmington area is "on the cusp" as far as attracting high quality recreation. Mountain bikers compare the experience of their sport with Moab, Utah, which has exploded with use in the last decade. The "slick rock" experience of the area is well known for attracting four-wheel drive enthusiasts, especially from Colorado and increasingly from other locations.

Other recreation activities on BLM land that generate economic value for the planning area include fishing, hunting, and wildlife watching. Fishing and hunting licenses are distributed by the New Mexico Department of Game and Fish. Big Game Units 2A and 2B overlap with the lands with highest hunting potential, while Unit 7 is also within the planning area.

Trades and Services

The trades and services sector of the regional economy has grown in overall activity and in its relative proportion of economic activity. This economic activity is related to a growing regional population involved in retail and commercial businesses, a visitor population that makes use of local services on a seasonal basis, and increasing numbers of retirees as a segment of the population that brings money into the economy via transfer payments and local spending.

Trades and services are considered important means to diversify the local economy. Elected officials and economic development planners in the region have pointed to the problems created by the dominance of the oil and gas industry, which is prone to boom and bust cycles. As the Farmington area has grown as a regional service center, through the development of shopping centers and major chain outlets, the area is somewhat buffered from downturns in the economy for oil and gas production. However, trades and services are lower paying than other basic sectors such as oil and gas employment. The average weekly wage for a worker in mining is $807, while services workers make only $529 and retail trade workers make $310. Also, the indirect effect of continued spending from trades and services employment is less than in the mining and manufacturing sectors.

Agriculture

Agriculture is an important part of the history and customs of northwest New Mexico, but also an important component of the economy. Agriculture provides diversity in an economy that has grown more dependent on oil and gas industries, but also provides a way for people to supplement other work and to maintain traditional lifestyles and culture.

In 1999, the value of all farm commodities for the four-county region totaled almost $115 million (USDA 1999). Of this, almost 60 percent ($67.6 million) was from livestock and 40 percent from crops. San Juan County is the largest producer, with $66.5 million in agricultural products. This is largely due to the Navajo Agricultural Products Industry (NAPI), which has over 52,000 acres in diverse commodity production, irrigated by water conveyed from Navajo Reservoir. Crop values were 57 percent of the county's total, with livestock being somewhat less important in this county only due to irrigated production. Aside from NAPI, most of the irrigated farmland in the region is within the San Juan, Animas, and La Plata valleys, and relies primarily on water delivered by the USBR.

Over the last several decades, there has been a decline in the acreage and value of agriculture on farms throughout the region. Smaller "hobby" farms are increasing and provide supplemental income for many farmers.

Most livestock operators use a combination of federal, private, and state land for grazing, with the majority being federal. Permits associated with cattle grazing allotments issued by the BLM typically have been long-standing, held by a small set of families. They are used in combination with private land and sometimes state lands to make a ranch. When a ranch sale occurs, it is often as a unit. Following the ranch purchase, the new owner usually qualifies for and receives the associated public lands grazing permit from BLM.

BLM grazing permits specify how many livestock can graze, where and when they graze, and for how long. The quantity of AUMs grazed is the product of the number of livestock (an "animal unit") times the number of days they graze. This number fluctuates over time and is affected by yearly grazing conditions, the livestock market and other economic influences, and BLM management actions.

There has been a decline in the number of AUMs permitted on FFO lands over the last decade.

The formula for calculating the cost of an AUM (grazing fee) was established by the Public Rangelands Improvement Act (PRIA) of 1978 (Public Law 95-514 [43 USC 1901]) on a seven-year trial basis. Because Congress failed to legislate a new fee authority following the expiration of the trial period, President Reagan issued EO 12548 on February 14, 1986, to continue indefinitely the PRIA fee formula, and added a provision that established a minimum fee of $1.35 AUM. Federal grazing fees are not directly comparable to private land grazing lease rates. The former is only the fee for forage consumed by the livestock while permitted on BLM lands, while the latter can include charges for maintaining improvements, livestock caretaking, or other management services as specified in the lease.

Employment

Table 3-24 shows that, with the exception of Sandoval County, unemployment in the planning area is above the state average and declined slightly between 1998 and 1999. Sandoval County's lower unemployment rate reflects the stronger economy and higher number of job opportunities in the Albuquerque metropolitan area.

Table 3-24. Labor Force and Unemployment in the Planning Area, 2000

County	1998 Annual Average			1999 Annual Average		
	Civilian Labor Force	Number of Unemployed	Unemployment Rate	Civilian Labor Force	Number of Unemployed	Unemployment Rate
McKinley	25,285	2,082	8.2%	24,485	1,761	7.2%
Rio Arriba	19,145	1,707	8.9%	19,179	1,413	7.4%
Sandoval	43,106	2,172	5.0%	42,112	1,740	4.1%
San Juan	50,304	4,118	8.2%	48,643	3,716	7.6%
New Mexico	831,052	51,351	6.2%	809,094	45,485	5.6%

Source: NMDL 2000.

In 1998, employment in the four-county region was almost 125,000 in 1998. **Table 3-25** shows that San Juan County has the highest portion of workers in the mining sector, which includes oil and gas-related and coal industry jobs. In 1998, about 8.5 percent, or 4,570 jobs in San Juan County were in this sector, of which, about 930 jobs (about 20 percent) were associated with coalmines in the county (Hill and Associates 2000). Most of the remaining 3,640 jobs were in the oil and gas industry. Although data is not reported for McKinley County, only 6 percent of the workforce is in the agricultural, mining, and construction sector combined (about 1,620 jobs), of which 660 jobs were reported for the two large coalmines in McKinley County, namely, McKinley and Lee Ranch (Hill and Associates 2000). Overall, almost 7,000 jobs in the planning area were directly related to the extractive energy industry in the four-county area in 1998. Sandoval County has the most diversified economy, with almost 25 percent of its employment in manufacturing and wholesale trade. This is largely attributable to microchip manufacturing.

Table 3-25. Percent Employment by Sector, 1998

Sector	County			
	McKinley	Rio Arriba	Sandoval	San Juan
Agricultural services, forestry, and other[1]	(–)	1.2	1.0	0.7
Mining[2]	(–)	0.6	0.3	8.5
Construction	(–)	6.1	6.5	10.1
Manufacturing[3]	6.6	4.9	(–)	3.3
Transportation and public utilities[4]	3.7	3.7	3.1	6.8
Wholesale trade	8.4	1.5	(–)	3.6
Retail trade	22.6	16.2	19.6	20.1
FIRE[5]	4.2	3.8	5.6	4.2
Services	23.9	37.1	25.7	27.7
Government	24.6	25.0	12.7	14.8
Total Employment[6]	**27,046**	**13,798**	**30,236**	**53,771**

Source: BEA 2000.

Notes:
(1) "Other" consists of the number of jobs held by U.S. residents employed by international organizations and foreign embassies and consulates in the U.S.
(2) Mining includes oil and gas extraction employment, drilling of oil and gas wells, and support activities.
(3) Manufacturing includes mining equipment and machinery as well as petroleum refinery.
(4) Transportation includes pipeline transportation and maintenance.
(5) Finance, Insurance, and Real Estate.
(6) Includes full time and part time jobs.
(–) Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.

The number of employees of the ten largest employers in San Juan County totaled almost 7,300 in 1997 and are listed below (NM Business Journal 1999). Of these, about 28 percent were employed by energy-related companies, including BHP Minerals, Arizona Public Service Company, and Public Service Company of New Mexico. This illustrates the importance of energy industries in the local area.

Employers	Industry	Number of Employees
Farmington Schools	Government	1,183
Central Consolidated Schools	Government	1,095
San Juan Regional Medical Center	Services	1,000
BHP Minerals	Mining	990
City of Farmington	Government	743
Arizona Public Service Company	Transport and Utilities	563
Public Service Company of New Mexico	Transport and Utilities	520
Bloomfield Schools	Government	478
Aztec Schools	Government	405
Presbyterian Medical Services	Services	320

Earnings by Sector

Table 3-26 shows the earnings of the economic sectors in the four counties. When compared to the number of jobs in each sector (see Table 3-25), earnings for the mining and transportation and public utilities sectors tend to be high compared to other sectors, while retail trade and services sector jobs tend to be the lowest. This indicates that jobs in these sectors, on average, tend to be better paying than in other sectors. For example, the average earnings per employee in the mining and transportation and public utilities sectors in 1998 were about $51,000 and $45,600, respectively, compared to about $15,400 and $19,200 in retail trade and services, respectively.

Table 3-26. 1998 Earnings by Sector in San Juan Basin ($000)

Sector	County			
	McKinley	Rio Arriba	Sandoval	San Juan
Agricultural services, forestry, and other[1]	(–)	$1,296	$2,356	$3,268
Mining[2]	(–)	$1,791	$1,099	$232,989
Construction	(–)	$13,847	$56,030	$150,719
Manufacturing[3]	$21,860	$12,374	(–)	$47,806
Transportation and public utilities[4]	$37,822	$14,852	$22,904	$166,814
Wholesale trade	$20,327	$3,118	(–)	$59,103
Retail trade	$97,616	$29,135	$80,626	$166,802
FIRE[5]	$18,673	$8,383	$25,490	$42,719
Services	$110,085	$82,834	$135,354	$284,897
Government	$224,549	$82,959	$113,384	$259,766
Total Earnings[6]	**$597,902**	**$250,589**	**$859,473**	**$1,414,883**

Source: BEA 2000.

Notes: (1) "Other" consists of the number of jobs held by U.S. residents employed by international organizations and foreign embassies and consulates in the U.S.

(2) Mining includes oil and gas extraction employment, drilling of oil and gas wells, and support activities.

(3) Manufacturing includes mining equipment and machinery as well as petroleum refinery.

(4) Transportation includes pipeline transportation and maintenance.

(5) Finance, Insurance, and Real Estate.

(6) Includes full time and part time jobs.

(–) Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.

Public Finance

Commercial activities on public land in the region generate millions of dollars annually. Funds are collected by the U.S. Treasury, with portions reverting back to New Mexico and disbursed to the relevant counties where production has occurred. Revenues from the energy extractive industry are of particular interest in the planning area.

Tax Revenues Generated by New Mexico from Energy Resources

The New Mexico Department of Finance and Administration calculated that state revenues from oil and gas sales in fiscal year (FY) 2001 were almost $1.3 billion (see Table 3-27). These revenues are derived from six taxes related to oil and gas production: Oil and Gas Emergency School Tax, Oil and Gas

Severance Tax, Oil and Gas Conservation Tax, Ad Valorem Production, Ad Valorem Production Equipment, and Natural Gas Processors Tax. The following are brief descriptions of each of these taxes:

- *The Oil and Gas Emergency School Tax* is levied on the "privilege of doing business as a severer of oil, gas, liquid hydrocarbon or carbon dioxide" (Legislative Council Service 2000). Natural gas is taxed at 4 percent and all other products at 3.15 percent, although allowances are given for low-producing ("stripper") wells and for other conditions.
- *The Oil and Gas Severance Tax* is levied at the rate of 3.75 percent "taxable value" (price for the product minus federal, state, and Indian royalties and reasonable trucking expenses to the "first place" of market) for the privilege of "severing" oil and gas from the soils of New Mexico.
- *The Oil and Gas Conservation Tax* is levied on the sale of oil and gas products at the rate of 19/100 of 1 percent of taxable value.
- *The Oil and Gas Ad Valorem Production Tax* is a tax in lieu of property tax levied on the value of oil and gas natural reserves wherein annual production is used as an approximation of the value of reserves.
- *The Ad Valorem Production Equipment Tax* is a property tax on oil and gas production equipment. Assessed value is determined at 27 percent of the sales value of the product for the previous calendar year against which the 33.3 percent "uniform assessment ratio" is applied.
- *The Natural Gas Processors Tax* is imposed on processing plants.

In FY 1997, about $376 million were collected by the state in taxes on oil and gas (Legislative Council Service 2000), and in FY 2000, this increased to $646 million (NMDFA 2001), reflecting a doubling in production value. Additional revenues come from rents and royalties paid by producers on public lands. In 2000, this amount was $638 million.

Revenues from these taxes are paid into the general fund, severance tax bonding fund, and land grant permanent fund. The general fund collects about 56 percent of these revenues. Revenues (which are based on the variable value of the product) are prone to fluctuate and represented 10 percent of general fund revenues in 1999 and 18 percent in 2001 (NMDFA 2001). Considering that 80 percent of all oil and gas produced in the state comes from public lands, about 80 percent of the revenues is attributable to natural gas, and the San Juan Basin is the major natural gas producing region, the planning area contributes significantly to state revenues.

Table 3-27 shows the projected taxes and royalties from fluid minerals in New Mexico in FY 2001. Direct revenue was split about evenly between taxes and rents/royalties, with the latter paid only by producers on public lands. **Table 3-28** presents the federal mineral revenue distributions received by New Mexico from federal royalties, rents and bonuses, based on mineral resources in the planning area.

Table 3-29 summarizes state and local tax revenues and royalties generated from coal production in New Mexico in 2000. Revenues generated from severance, resources excise, and conservation taxes on the state's coal production totaled $31.8 million in 2000. In addition, gross receipts taxes on coal (at an effective rate of 5.3 percent of gross sales revenues) generated an estimated $29 million and about $7.2 million in property taxes for the producing counties. The state received royalties, rent, and bonuses payments from coal leases on state lands of $1.4 million. In addition, the state received 50 percent of the royalties collected by the federal government from coal leases on public land. In 2000, federal royalties from coal leases in the state amounted to $17.3 million (with about $8.6 million dispersed to the state of New Mexico). The total tax and royalty revenues to the state from coal production were $41.8 million dollars. Base on share of production, about $40.1 million of this was attributable to coal production in the planning area. This represents less than one percent of New Mexico general fund revenues.

Table 3-27. Taxes and Royalties from Fluid Minerals in New Mexico, FY 2001

Revenue Fund	Million $		
	Crude Oil	Natural Gas	Total
General Fund			
Oil and Gas Emergency School Tax	54.7	261.6	316.3
Oil and Gas Conservation Tax	3.5	12.4	15.9
Natural Gas Processing Tax	–	13.3	13.3
Federal Leasing Royalties	42.0	312.1	354.1
State Land Rents and Bonuses	10.3	12.6	22.9
Subtotal	**110.5**	**612.0**	**722.5**
Severance Tax Bonding Fund			
Oil and Gas Severance Tax	64.6	235.9	300.4
Land Grant Permanent Fund			
State Land Royalties	93.0	169.0	261.0
Total	**268.0**	**1,016.9**	**1,283.9**

Source: NMDFA 2001.

Table 3-28. Federal Energy Mineral Revenue Disbursements ($) to the State of New Mexico (by County of Origin), FY 2000

Resource	McKinley	Rio Arriba	Sandoval	San Juan	ROI
Coal	435,120	–	–	6,208,793	6,643,913
Gas	–	41,424,105	$76,942	68,123,333	109,624,380
Gas Plant Products	–	3,872,127	5,857	8,005,563	11,883,547
Oil	9,737	1,154,887	99,933	1,187,754	2,452,311
Other	3,820	2,033,400	27,919	3,562,670	5,627,809
Rent	36,768	20,990	115,863	74,016	247,637
Bonus	1,680	4,315	4,640	343,153	353,788
Total	**$487,125**	**$48,509,824**	**$331,154**	**$87,505,282**	**$136,833,385**

Source: USDI 2001b.

Table 3-29. State and Local Tax Revenues and Royalties from Coal Production in New Mexico

Tax	Effective Tax Rate (%)	FY 2000
Volume Produced (MMT)		27.3
Gross Sales Value ($000,000)		554
Tax Revenues ($ millions)		
Severance	2.67	14.8
Severance Surtax	2.03	11.2
Resource Excise	0.6	3.3
Conservation	0.15	0.8
Gross Receipts	5.3	29.4
Property	1.3	7.2
Total	**12.1**	**66.7**
Royalties, Rents, and Bonuses ($ millions)		
Federal		17.3[1]
State		1.4
Indian Lands		20.1
Total		**38.8**

Source: O'Donnell and Clifford, n.d.
Note: (1) FY 1999.

Local Tax Revenues

Some portion of the oil and gas tax revenues are distributed to counties, school districts, and municipalities based on the location of the tax districts containing the taxed assets. The primary source of these revenues is from the Oil and Gas Ad Valorem Production Taxes that are distributed on a monthly basis to county treasurers. Ad Valorem Production and Production Equipment Tax revenues are also distributed according to the property tax rates imposed by counties. **Table 3-30** summarizes the impact of these revenues on counties in the planning area. It shows that the Equipment tax has a relatively minor impact on producing counties' revenues, but that Production tax is a major component (almost 30 percent) of Rio Arriba's budget. School districts receive additional revenues from the State of New Mexico through the Department of Finance and Administration based on state land royalties, rents and bonuses.

The federal government also makes payments to local governments to offset the loss of property taxes because of nontaxable federal lands within their boundaries. These payments are called Payments in Lieu of Taxes (PILT). Public Laws 94-565 (1976) and 97-258 (1982) are the central laws authorizing such payments. PILT payments are used by local governments to finance vital services such as firefighting, police protection, and the construction of roads and public schools. The BLM administers the program for the Department of the Interior using formulas for fair distribution established by law. **Table 3-31** shows the PILT payments to the counties in the planning area as well as the total figure paid to the State of New Mexico. The planning area received over 20 percent of the total PILT payments to New Mexico in FY 2000.

Table 3-30. Impact of Tax Revenues on County Budgets from Energy Resources, FY 2000-2001

Revenue Source	San Juan		Rio Arriba		McKinley	
	$000	%	$000	%	$000	%
Total Budgeted Fund Revenues	46,334	100	32,135	100	20,831	100
Ad Valorem Oil and Gas Production Tax	3,353	7.2	8,842	27.5		<1
Ad Valorem Oil and Gas Production Equipment Tax	667	1.4	763	2.3		<1

Sources: McKinley County 2001, Olguin 2002, NMDFA 2001.

Table 3-31. Payments in Lieu of Taxes to New Mexico and Select Counties, 1999-2000

County	FY 1999 Payment ($)	FY 2000 Payment ($)
San Juan	639,353	675,137
Rio Arriba	841,676	889,964
McKinley	289,267	316,551
Sandoval	675,699	715,643
New Mexico Totals	**11,597,426**	**12,323,237**

Source: BLM 2001c.

PILT payments are allocated according to a formula that includes population, receipt sharing payments, and the amount of federal land (entitlement acreage) within an affected county. **Table 3-32** shows the number of federal entitlement acres within each county in the planning area. Although Rio Arriba County has more than twice as much federal land as other counties in the planning area, it received only somewhat higher payments, due to the application of the formula.

Table 3-32. Payment in Lieu of Taxes, Entitlement Acreage by County and Agency, FY 2000, New Mexico

County	BLM[1]	USFS[1]	USBR[1]	NPS[1]	USACE[1]	Total
San Juan	813,561	0	17,551	27,864	0	858,976
Rio Arriba	583,398	1,412,266	25,933	0	2,860	2,024,457
McKinley	228,756	179,205	0	3,306	0	411,267
Sandoval	513,275	384,663	0	25,517	580	924,035
Total Acres	**12,754,913**	**9,080,130**	**253,421**	**374,479**	**21,040**	**22,499,750**

Source: BLM 2001d.

Notes: (1) BLM = Bureau of Land Management, USFS = U.S. Forest Service, USBR = Bureau of Reclamation, NPS= National Park Service, USACE = U.S. Army Corps of Engineers.

Economic Trends

A number of trends are discernible in the planning area, related to demographics, economics, and quality of life. These include:

- The economy of the planning area, particularly San Juan County, will continue its trend toward diversification, with increased activity in the trades and services sectors related to medical, retirement, commercial, and tourism interests.
- The importance of agriculture will continue to decline modestly in terms of economic productivity, while retaining its importance as a cultural value and as a means to preserve open space.
- Oil and gas production will remain the dominant force in the economy, with related primary and secondary businesses adding higher-than-average wages to the local economy.
- The lifestyle amenities available in the Farmington area will increasingly attract urban, retirement, and recreation-oriented interests.
- Quality of life considerations are becoming more important in local public policy and planning as a component of economic diversity and viability. The increasing population; the attraction of the area for recreationists; and immigrating retired people, medical professionals, and others, coupled with the limited private land base, brings public land use and policy into the realm of local community government.
- BLM scoping efforts found widespread concern among residents about the impacts of oil and gas activities. Without attention to these issues, it is expected that the concerns will intensify.

ENVIRONMENTAL JUSTICE

Federal agencies are required to conduct their programs, policies, and activities that substantially affect human health or the environment in a manner that ensures that no person is excluded from participation therein, denied the benefit thereof, or subjected to discrimination due to their race, color, or national origin. EO 12898 requires federal agencies to assess their projects to ensure they do not result in disproportionately high and adverse environmental, health, or safety effects on minority and low-income populations.

Table 3-33 shows that American Indians represent a high percentage of the population of McKinley and San Juan Counties, primarily reflecting the presence of the Navajo Nation and the Ute Mountain Reservation. Hispanics represent a high percentage of Rio Arriba County, compared to the state as a whole.

The current percentage of the population that is under the age of 18 and classified as children is presented in **Table 3-34**. The table shows that children, as a percentage of the population, are declining—dramatically in the case of McKinley County, but significantly in the other counties as well. In contrast, the State of New Mexico's proportion of children declined only slightly, while for the U.S. as a whole, not at all.

Poverty rates shown in **Table 3-35** indicate a high rate of poverty in McKinley County, while all but Sandoval County show higher poverty rates than the state average.

Table 3-33. Population, Ethnicity, and Race in 2000

	U.S.		New Mexico		McKinley County		Rio Arriba County		Sandoval County		San Juan County	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Total Population	281,421,906	100	1,819,046	100	74,798	100	41,190	100	89,908	100	113,801	100
Hispanic or Latino (All Races)	35,305,818	12.5	765,386	42.1	9,276	12.4	30,025	72.9	26,437	29.4	17,057	15.0
Not Hispanic or Latino	246,116,088	87.5	1,053,660	57.9	65,522	87.6	11,165	27.1	63,471	70.6	96,744	85.0
Population of One Race	241,513,942	85.8	1,027,867	56.5	64,329	86.0	10,821	26.3	62,033	69.0	95,045	83.5
White	194,552,774	69.1	813,495	44.7	8,902	11.9	5,619	13.6	45,227	50.3	52,922	46.5
Black or African American	33,947,837	12.1	30,654	1.7	287	0.4	85	0.2	1,418	1.6	429	0.4
American Indian and Alaska Native	2,068,883	0.7	161,460	8.9	54,742	73.2	5,002	12.1	14,239	15.8	41,290	36.3
Asian	10,123,169	3.6	18,257	1.0	327	0.4	47	0.1	857	1.0	279	0.2
Native Hawaiian and Other Pacific Islander	353,509	0.1	992	0.1	25	0.0	25	0.1	86	0.1	36	0.0
Some Other Race	467,770	0.2	3,009	0.2	46	0.1	43	0.1	206	0.2	89	0.1
Population of Two or More Races	4,602,146	1.6	25,793	1.4	1,193	1.6	344	0.8	1,438	1.6	1,699	1.5

Source: US Census 2000.

Table 3-34. Children in the Population, 1990, 2000

Location	Children Under 18, 1990	% of Population	Children Under 18, 2000	% of Population
McKinley	23,556	38.8	28,423	25.1
Rio Arriba	34,365	32.3	11,780	28.6
Sandoval	20,241	32.0	26,613	29.6
San Juan	33,340	36.4	37,099	32.6
New Mexico	446,439	29.5	509,333	28.0
U.S.	63,606,544	25.6	72,325,430	25.7

Source: US Census 2000.

Table 3-35. Poverty Rates, 1995

Location	Total Number of Poor Persons	Total % Poor	Number of Poor Related Children Age 5-17	% Poor Related to Total Children Age 5-17
McKinley County	25,727	37.7	7,865	41.6
Rio Arriba County	9,021	23.7	2,923	34.1
Sandoval County	11,173	13.2	3,721	19.7
San Juan County	23,262	22.5	7,786	27.8
New Mexico	346,994	20.2	106,556	29.2

Source: US Census 1999.

Note: Those below poverty level as determined by U.S. Department of the Census.

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