SECTION 2
MRG WATERSHED AND HISTORICAL DATA OVERVIEW

2.1 Middle Rio Grande and Hydrology of its Watershed

This study addresses portions of the MRG between Angostura Diversion Dam in southeastern Sandoval County to the Isleta Diversion Dam, at the northern border of Isleta Pueblo, a distance of approximately 42 river miles. The MRG watershed located in southern Colorado and north-central New Mexico (Figure 2.1) encompasses approximately 17,900 square miles. The size of the study area watershed (watershed) downstream of Cochiti Dam and Jemez Dam is approximately 2,000 square miles. The portion of the MRG watershed addressed in this study includes all or parts of Cochiti, Santo Domingo, San Felipe, Santa Ana, Isleta, and Sandia Pueblos, and the Cities of Bernalillo, Rio Rancho, Corrales, and Albuquerque.

The flow of surface water through the watershed is highly regulated through an extensive and complex system of canals, drains, diversions, pump stations, and stormwater detention basins, along with natural and channelized arroyos. The watershed's topography is varied, and its elevations range from 10,678 feet above sea level at Sandia Crest down to 4,882 feet at the Isleta Diversion Dam. With the wide variation in topography, there is a corresponding variation in climate; however, rainfall is scarce throughout the watershed. Annual total precipitation at lower elevations in the watershed is typically between 8 and 10 inches. Annual total precipitation in the mountains can reach 20 inches; however, much of that precipitation falls as snow rather than rain. Annual average precipitation in the foothills and plateaus is intermediate between the valley and mountains. On average, approximately one-half of the total annual rainfall occurs during the monsoon months of July, August, and September, when rain often falls in brief but intense thunderstorms.

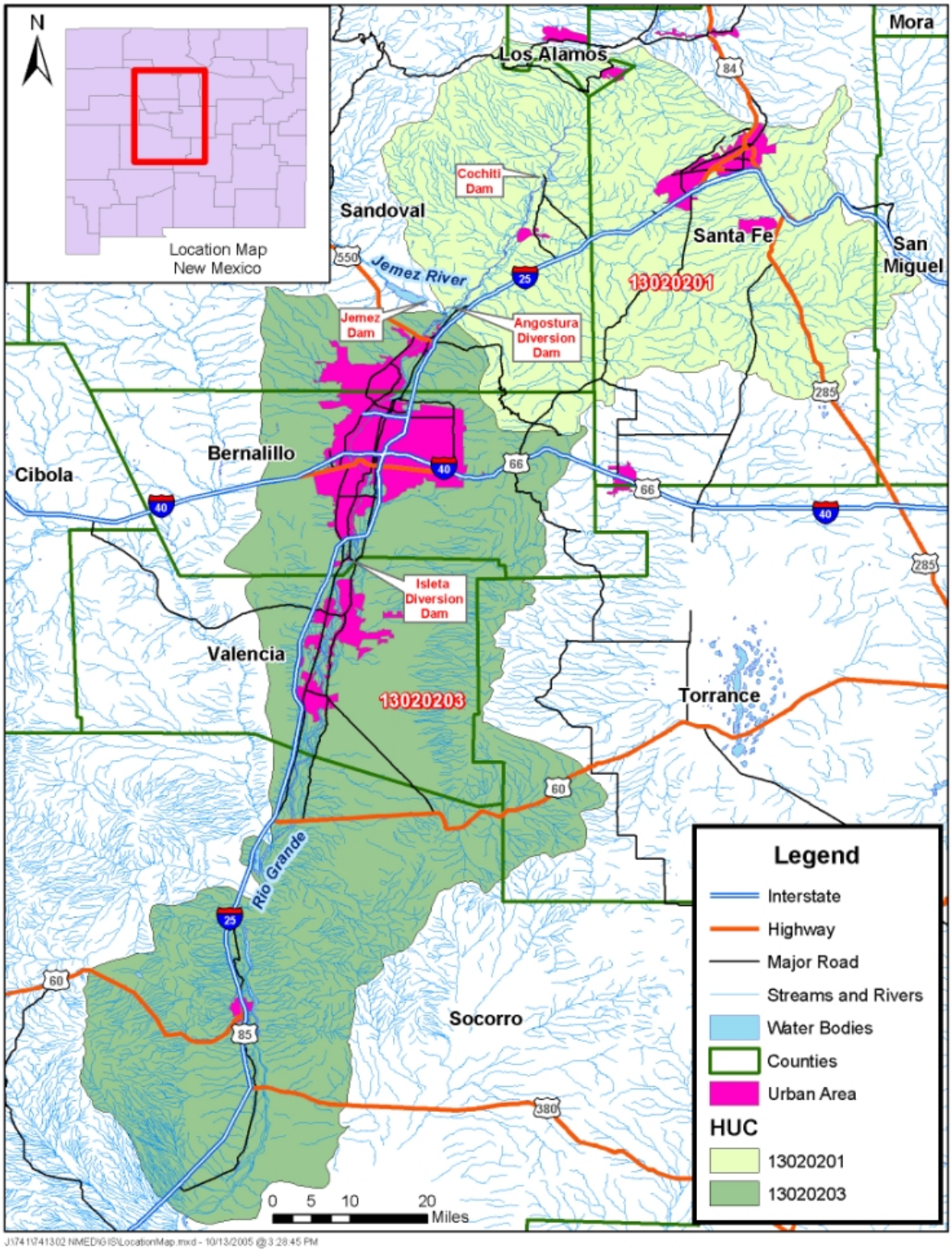
Runoff from the frequent thunderstorms of the summer monsoon is thought to transport large quantities of fecal bacteria to the MRG through its network of arroyos and storm drains. It is believed this runoff leads to exceedance of water quality criteria designed to protect the contact recreation and ceremonial use of the MRG. The MRG TMDL document (NMED 2002) identified nonpoint source runoff transported through storm water conveyances as the main source of fecal coliform bacteria to the MRG. These sources include sewage spills, livestock, wildlife, and pets. The TMDL document also identified discharges from certain wastewater treatment facilities (WWTF) as contributors of excessive fecal coliform.

2.2 Summary of Historical Fecal Coliform Monitoring Data

Water quality monitoring of the MRG indicates that fecal coliform water quality criteria are frequently exceeded. The most recent NMED/SWQB data were collected during the summer of 1999 by the Surveillance and Standards Section. These data were collected over a 6-week period and included both dry and rainfall-influenced sampling days. Table 2.1 lists the fecal coliform data for eight water quality monitoring stations from the 1999 NMED sampling effort and summarizes this information with respect to the water quality criteria. It is apparent from these results that levels of fecal coliform were higher following significant rainfall events.

Also, there is a consistent increase in fecal coliform levels with the degree of urbanization of the watershed.

Figure 2.1 Middle Rio Grande Watershed



J:\741\741302 NMED\GIS\LocationMap.mxd - 10/13/2005 @ 3:28:45 PM

Table 2.1 Results of 1999 SWQB Fecal Coliform Sampling of the Middle Rio Grande

Site	Date YYMMDD	Time	Fecal Coliform Col/100 mL
Rio Grande Below Angostura Diversion Dam	990628	1010	20
	990706	**0800**	**300**
Geometric Mean = 110 CFU/100 mL 0% of samples exceed 400 CFU/100 mL	990712	0855	110B
	990719	**0830**	**300**
	990726	0850	80B
Rio Grande Above Highway US 550 Bridge	990628	1025	34
	990706	**0820**	**900**
Geometric Mean = 232 CFU/100 mL 20% of samples exceed 400 CFU/100 mL	990712	0920	160B
	990719	**0850**	**340**
	990726	0910	400
Rio Grande Above Rio Rancho WWTF #3	990628	1055	37
	990706	**0855**	**1600L**
Geometric Mean = 291 CFU/100 mL 40% of samples exceed 400 CFU/100 mL	990712	0955	200
	990719	**0925**	**1600**
	990726	0945	110B
Rio Grande Above Rio Rancho WWTF #2	990628	1125	49
	990706	**0925**	**500**
Geometric Mean = 302 CFU/100 mL 43% of samples exceed 400 CFU/100 mL	990712	1030	330
	990719	**1000**	**2400**
	990726	1010	90B
	990729	1000	82B
	990802	**0840**	**1600L**
Rio Grande Above Alameda Bridge	990628	1200	2400
	990706	**0955**	**1000**
Geometric Mean = 620 CFU/100 mL 57% of samples exceed 400 CFU/100 mL	990712	1055	250
	990719	**1030**	**1300**
	990726	1040	350
	990729	1035	81B
	990802	**0910**	**1600L**
Rio Grande Above Rio Bravo Bridge	990628	1230	180B
	990706	**1030**	**2400B**
Geometric Mean = 574 colonies/100 mL	990712	1200	170B

Site	Date YYMMDD	Time	Fecal Coliform Col/100 mL
57% of samples exceed 400 colonies/100 mL	**990719**	**1105**	**5000**
	990726	1120	500
	990729	1115	70B
	990802	**0945**	**1600L**
Rio Grande Above I-25 Bridge	990628	1300	540
	990706	**1100**	**2100B**
Geometric Mean = 868 colonies/100 mL 71% of samples exceed 400 colonies/100 mL	990712	1235	170B
	990719	**1130**	**16000**
	990726	1150	500
	990729	1200	150B
	990802	**1010**	**1600L**
Rio Grande Above Isleta Diversion Dam	990628	1315	400B
	990706	**1115**	**1800B**
Geometric Mean = 663 colonies/100 mL 43% of samples exceed 400 colonies/100 mL	990712	1245	290
	990719	**1145**	**5000**
	990726	1200	240
	990729	1215	140B
	990802	**1020**	**1600L**

"L" Remark Code = Off scale high. Actual value not known, but known to be greater than value shown
"B" Remark Code = Results based upon colony counts outside the acceptable range
"K" Remark Code = Off scale low. Actual value not known, but known to be less than value shown
Dates with more than ¼ inch of rain during previous 48 hours are in bold.

The TMDL document identified several potential sources of fecal bacteria to the MRG. The potential sources discussed include:

1. National Permit Discharge Elimination System (NPDES) permitted discharges from WWTF;
2. periodic spills of incompletely treated sewage and end-of-pipe permit violations at permitted facilities;
3. nonpoint source runoff of storm water contaminated by livestock, wildlife, pets, and other domestic animals, and discharged to the river through arroyos and storm drains;
4. seasonally abundant migratory waterfowl in the river;
5. failing or ill-sited septic systems;
6. leaks, breaks, and overflows from sanitary sewer collection systems; and
7. illicit connections between sanitary sewers and storm drains that allow sewage to enter storm drains.

Of these sources, the TMDL document indicates that septic systems and failures in sanitary sewer systems (5, 6, and 7 above) do not appear to be a large contributor to the elevated fecal coliform levels in the MRG. Nonpoint source runoff is identified as the likely major contributor to fecal coliform contamination.

The maximum fecal coliform assimilative capacity was calculated to be 9.205×10^{12} colony-forming units per day (cfu/day) for Segment 20.6.4.105, and 9.205×10^{11} cfu/day for Segment 20.6.4.106, at the minimum 4-day, 3-year discharge (4Q3) low flow. The river's capacity to assimilate fecal coliform without exceeding water quality criteria increases in proportion with flow.

2.3 Study Design and Identification of Potential Fecal Sources

In light of the expected importance of contaminated runoff from land as a source of fecal contamination, it was important to evaluate land uses and potential fecal sources by individual subwatersheds contributing runoff to the MRG. The geography, complex hydrology, historical sampling stations, and an understanding of potential fecal sources as outlined in the NMED 2002 Fecal Coliform TMDL influenced the sampling design of this MST study. NMED, AMAFCA, and Bernalillo County collaborated to recommend monitoring stations throughout the MRG watershed. After evaluating and prioritizing these recommendations, 30 sampling sites were identified and incorporated into a quality assurance project plan (QAPP) which was approved by USEPA and dictated data quality objectives (DQO) and all field sampling and laboratory analysis procedures and protocols. These sites included points on the MRG, as well as a number of contributing subwatersheds with varying land uses and potential sources.

2.3.1 Sampling Sites and Subwatersheds

This study included thirty different sampling sites which are displayed in Figure 2.16 at the end of this subsection. Eight sampling sites on the MRG were investigated. These sites were at the same locations where historical water quality sampling was performed. The north-most site at Angostura Diversion Dam drained a primarily rural watershed without wastewater inputs. For the eight sites investigated, the wastewater volume and degree of urbanization of the watershed increased on the MRG with its distance downstream. Another 22 sites within contributing subwatersheds with varying land uses and potential sources were also selected for investigation.

The subwatershed of each monitoring site was also evaluated to obtain a more thorough understanding of the potential for human and nonhuman sources of fecal contamination from rainfall runoff. First, the contributing watershed to each site was delineated using both automated computer programs based on the U.S. Geological Survey (USGS) National Elevation Dataset (Gesch, *et al*. 2002) and manual tracing of contributing storm drain and arroyo linear features. In some cases there was considerable uncertainty regarding the watershed boundary and/or discharge point to the Rio Grande. Figures 2.2, 2.3, and 2.4 display subwatershed boundaries for some of the sampling stations located on tributaries and arroyos. Next, the land uses in each subwatershed were identified from the National Land Cover Dataset (USGS 1999) which is displayed in Figure 2.5 and summarized by category in Table 2.2 presented later in this section.

Figure 2.2 Subwatersheds for Select Northwest Sampling Stations

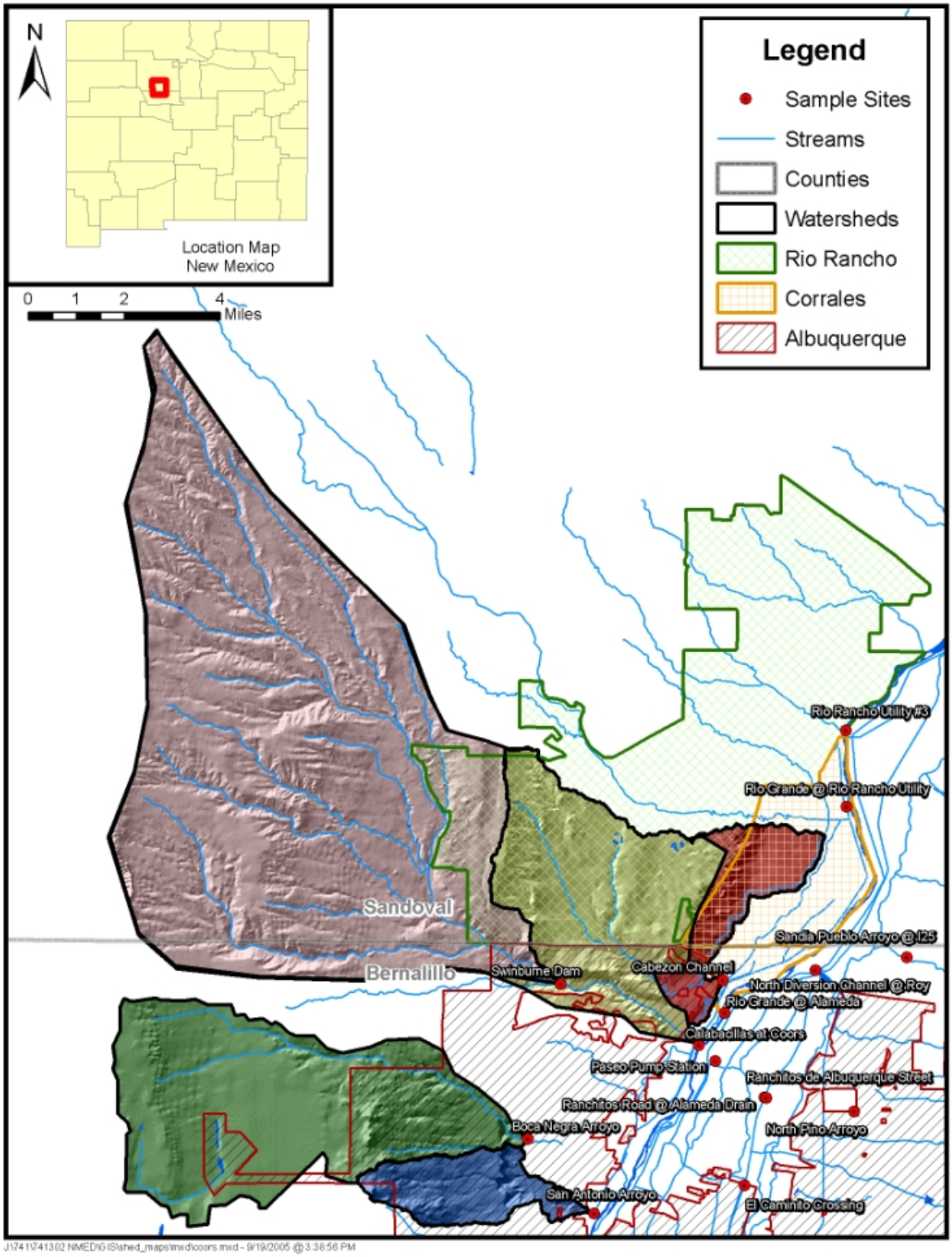


Figure 2.3 Subwatersheds for Select Northeast Sampling Stations

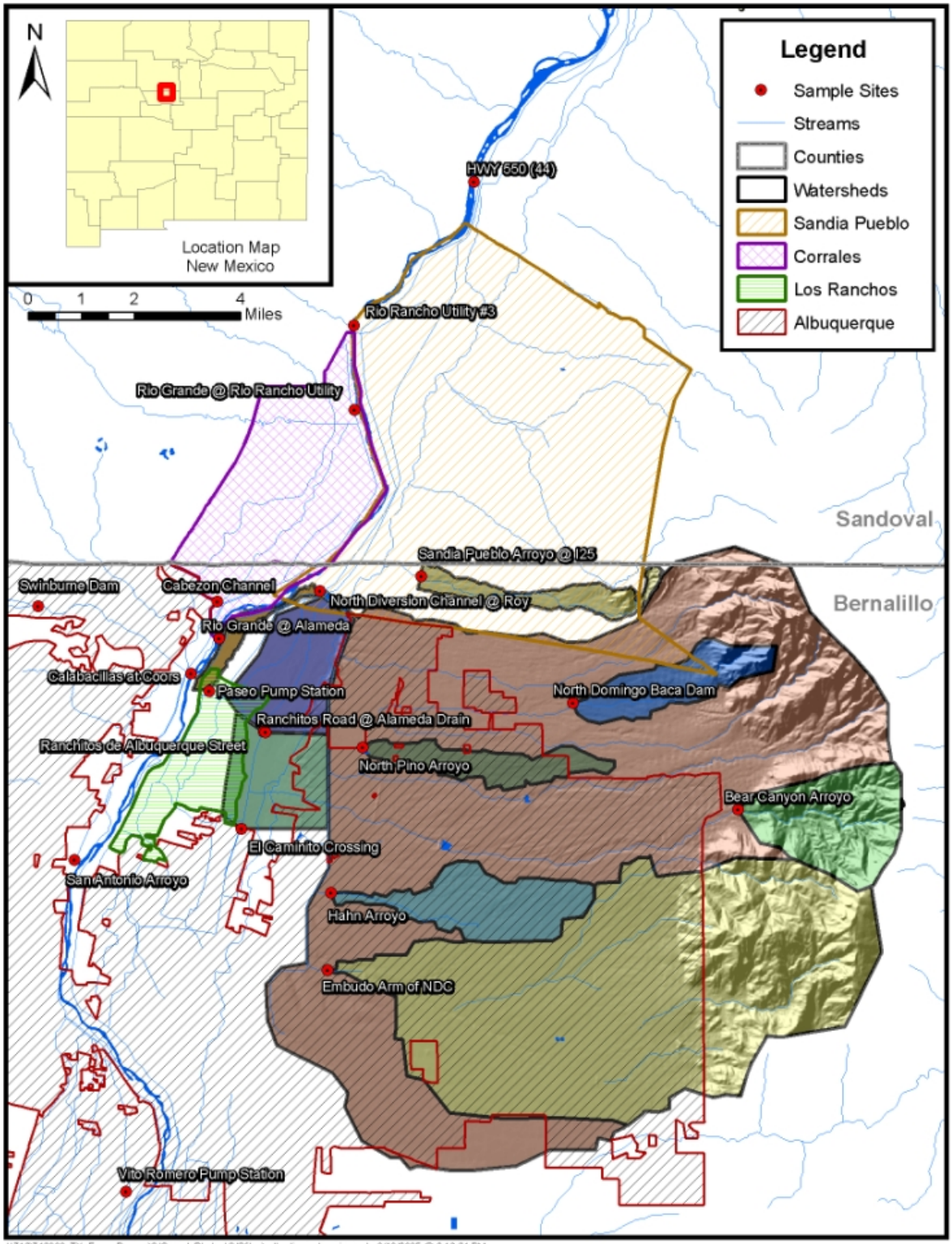
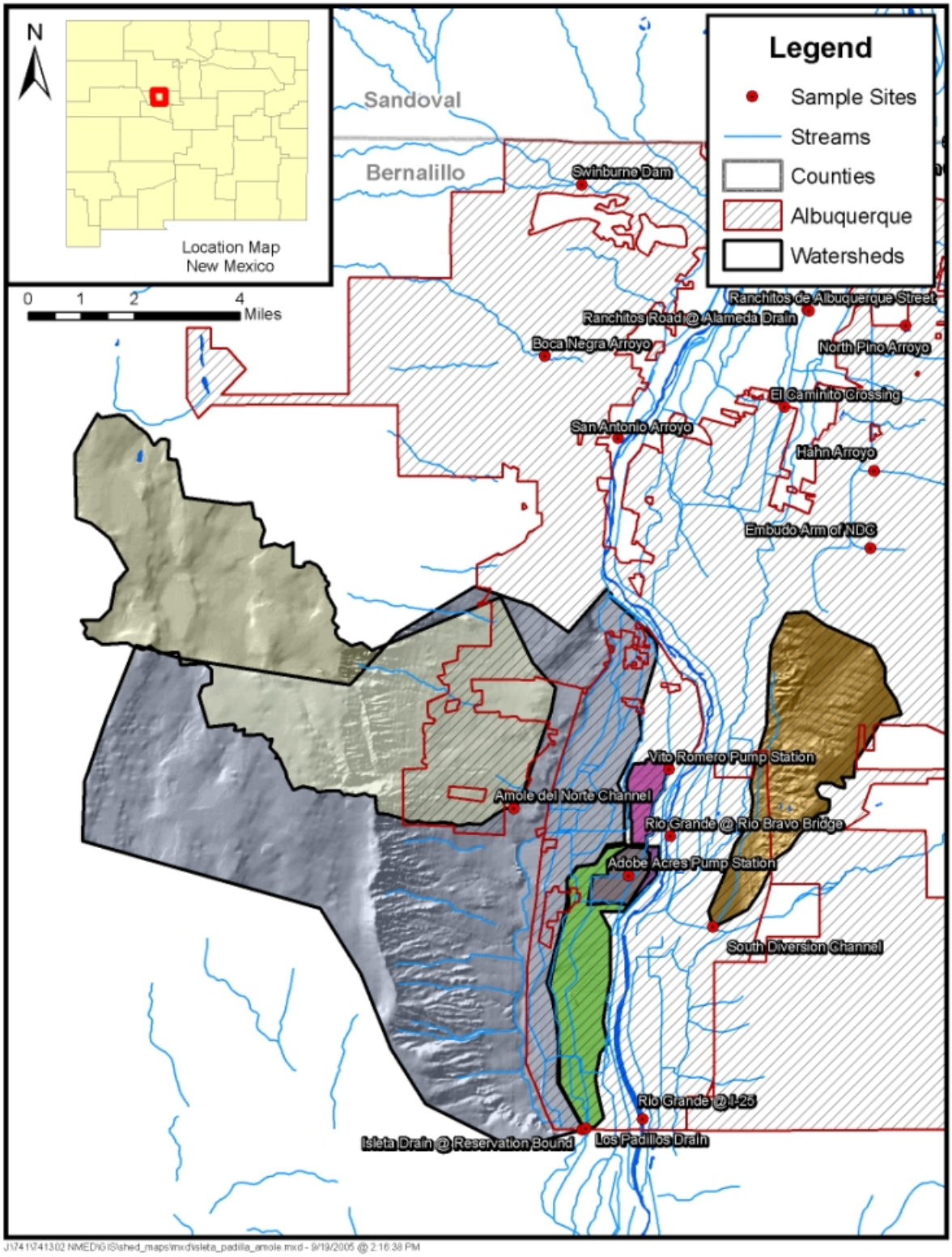
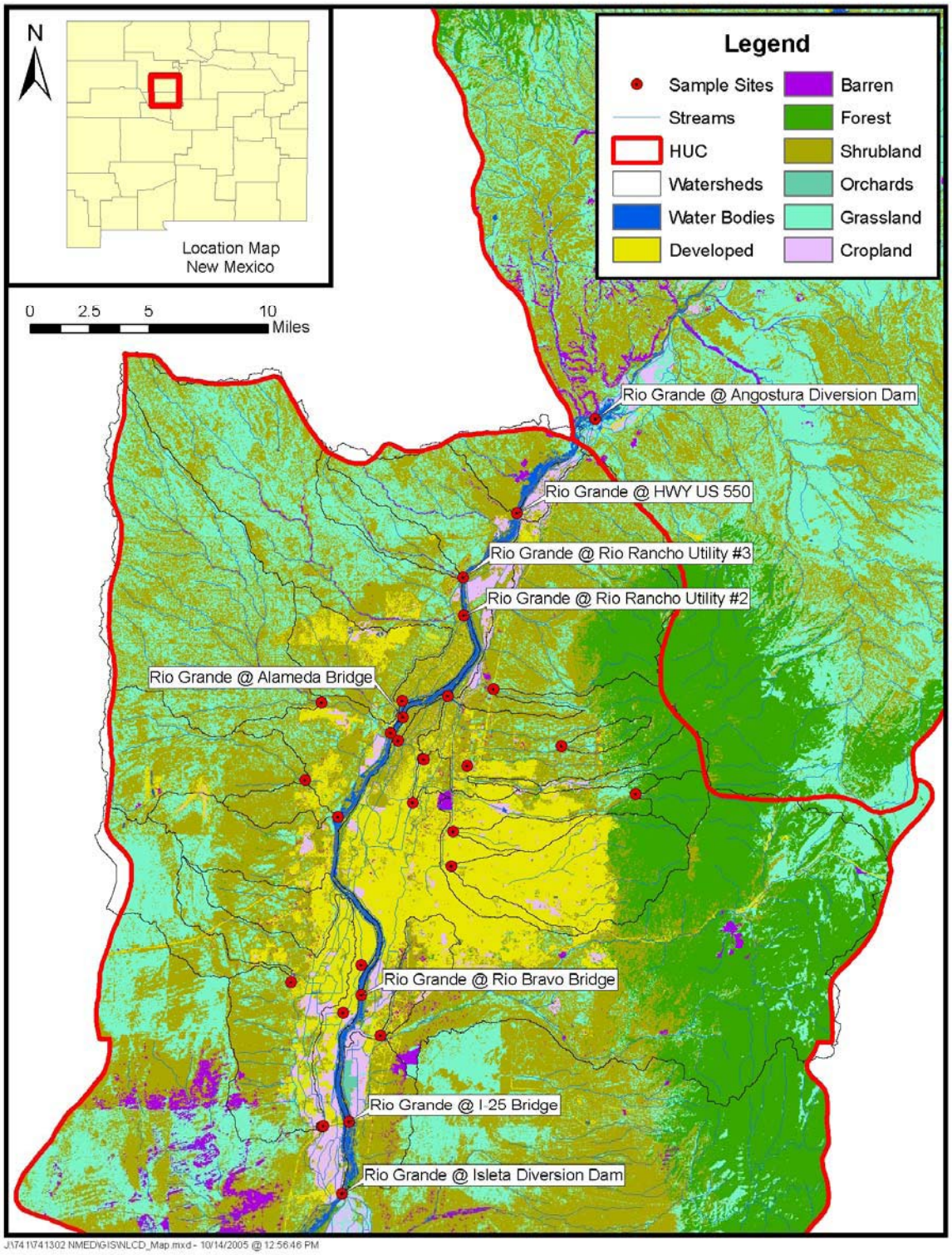


Figure 2.4 Subwatersheds for Select South Sampling Stations



J:\741\741302 NMED\GIS\shed_maps\mxd\isleta_padilla_amole.mxd - 9/19/2005 @ 2:16:38 PM

Figure 2.5 Land Use/Land Cover in the Middle Rio Grande Watershed



The human population residing in each subwatershed was estimated from the 2000 federal census at block resolution. The method of household sewage disposal (public sanitary sewer, septic tank, or other), and the number of households with farm income in each subwatershed were estimated from 1990 federal census data at block group resolution (Table 2.3). Populations of dogs and cats were estimated from the 2000 census data based on national average statistics on pet ownership per household, as reported by the American Veterinary Medical Association (AVMA 2002). The populations of livestock could not be estimated for each subwatershed, but county total populations of major livestock species were retrieved from the National Agricultural Statistics Service of the U.S. Department of Agriculture. A more spatially resolved estimate of livestock distributions within counties was obtained as the fraction of households with farm income for each subwatershed, as reported in the 1990 federal census at the block group level. While it was not possible to quantify wildlife populations, abundant wildlife species were identified through a review of available reports on hunting and bird surveys, as well as through a physical tour of the watershed. Each of the 30 total sites is described below, the first eight being those sites located on the Rio Grande. Tables 2.2 and 2.3, presented after the descriptions below, provide additional statistics on each subwatershed.

1. Rio Grande at Angostura Diversion Dam - The most upstream site, depicted in Figure 2.6, is downstream of Cochiti Reservoir but upstream of the Jemez River confluence. Excluding portions above the Cochiti Reservoir, the watershed contributing to the MRG at this point covers 1,230 square miles. No NPDES-permitted facilities discharge wastewater to this reach of the MRG. The primary land cover is grassland, and less than 1 percent of the land is developed (Table 2.2). The overall human population density of the watershed in 2000 was approximately 20 persons per square mile (Table 2.3).

Figure 2.6 Rio Grande at Angostura Diversion Dam

2. Rio Grande at Highway US 550 – The second most upstream site (Figure 2.7) on the MRG is approximately 6 miles downstream of the Angostura Diversion Dam. The Jemez River enters the Rio Grande between these two sites. While the Jemez River has a substantial watershed of over 1,000 square miles, it is impounded by the Jemez Dam just a few miles above its confluence with the Rio Grande. The unimpounded portion of the

Jemez watershed that directly contributes to the Rio Grande is small and thus, the watershed is primarily the same as that at Angostura Diversion Dam.

Figure 2.7 Rio Grande at Highway US 550

3. Rio Grande above Rio Rancho Utility #3 - Approximately 4 miles downstream of Highway US 550, this site (Figure 2.8) is immediately upstream of the wastewater discharge outfall of Rio Rancho Utility #3. Watershed properties are similar to those of the upstream sites; however, it also receives treated domestic wastewater discharged by the City of Bernalillo, and is immediately upstream of the wastewater discharge from Rio Rancho Utility #3.

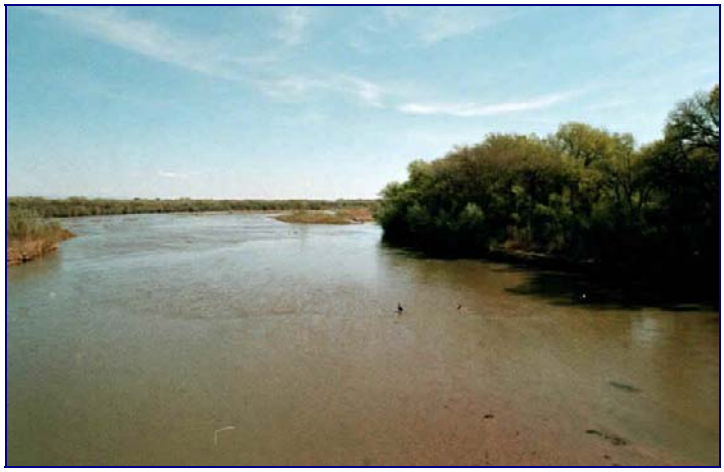
Figure 2.8 Rio Grande above Rio Rancho Utility #3

4. Rio Grande above Rio Rancho Utility #2 - Less than 2 miles downstream of the Rio Rancho Utility #3 site and with no major tributaries in between them, this site has essentially the same watershed as Rio Rancho Utility #3. However, the site is influenced by treated wastewater discharged by Rio Rancho Utility #3, and is immediately upstream of the wastewater discharge outfall of Rio Rancho Utility #2 (Figure 2.9).

Figure 2.9 Rio Grande above Rio Rancho Utility #2

5. Rio Grande at Alameda Bridge – This site, depicted in Figure 2.10, is approximately 6 miles downstream of Rio Rancho Utility #2. The North Diversion Channel and the Upper Corrales Riverside Drain enter the MRG above Alameda Bridge, vastly increasing the urban influence in the Rio Grande's watershed at this site. The North Diversion Channel drains much of the City of Albuquerque east of the river. The percentage of the watershed with "developed" land uses, which include residential, commercial, industrial, and transportation, increases to 3.8 percent from 0.6 percent at the nearest upriver site, and the human population density of the watershed increases almost tenfold to 223 per square mile. While the portion of households served by public sanitary sewers increase from 33 percent to 95 percent, the density of septic tanks also increases from two to four per square mile. Along with the increasing urban nature of the watershed, the portion of households in the watershed with farm income declines to less than 1 in 100; however, the overall density of households with farm income increases substantially.

Figure 2.10 Rio Grande at Alameda Bridge



6. Rio Grande at Rio Bravo Bridge – This site is approximately 14 miles downstream of the Alameda Bridge (Figure 2.11). In addition to the watershed contributing to the upstream site, the MRG's watershed at this point includes Corrales,

Rio Rancho, and most of Albuquerque on both banks, including portions draining to the Alameda Drain, the Lower Corrales Riverside Drain, and several arroyos. The human population density of the contributing watershed is 275 per square mile, and 4.7 percent of the watershed is developed land. The number of households in the watershed served by public sanitary sewer declines from 95 percent to 92 percent between these two sites.

Figure 2.11 Rio Grande at Rio Bravo Bridge

7. Rio Grande at Interstate 25 - This site is approximately 6 miles downstream of the Rio Bravo Bridge (Figure 2.12). However, the contributing watershed is almost the same as that at Rio Bravo, as no significant tributaries discharge into the river in this reach. The possible exception is the Tijeras Arroyo which discharges to the Rio Grande above Interstate 25. The South Diversion Channel discharges to the Tijeras Arroyo. The City of Albuquerque WWTF discharges to this reach of the Rio Grande. A permitted concentrated animal feeding operation (CAFO) is located within this watershed on the east side of the river. The CAFO is a dairy located west of Highway 47 and south of Mountainview.

Figure 2.12 Rio Grande at Interstate 25

8. Rio Grande at Isleta Diversion Dam - This site is approximately 3 miles downstream of the Interstate 25 Bridge and is within the Isleta Pueblo (Figure 2.13). In

addition to the watersheds of upstream sites, the contributing watershed includes the southeast parts of Albuquerque drained by Tijeras Arroyo, the South Diversion Channel, Albuquerque Riverside Drain, Isleta Riverside Drain, and Atrisco Riverside Drain. The watershed includes essentially all the urbanized area with the exception of southwestern portions drained by the Isleta and Los Padillas Drains, which discharge to the Rio Grande downstream of the Isleta Diversion Dam. Thus, this site is considered an "integrator" site because it integrates the cumulative impact of the entire watershed of concern. The contributing watershed area, excluding portions above Cochiti and Jemez Reservoirs, is approximately 2,000 square miles. Almost 600,000 people and an estimated 137,000 dogs and 156,000 cats lived in this watershed in 2000. Approximately 6 percent of the watershed is developed land. Other major land use categories include grassland (41%), shrubland (31%), and forest (18%). Approximately 3 percent of the watershed is used to grow crops, and slightly less than one in 100 households reported farm income in 1990. Public sanitary sewers conveyed sewage to WWTFs from 91 percent of the households, with the balance utilizing septic tanks or other private sewage systems. Three permitted CAFOs (dairies) are located within this watershed on the west side of the river. Two CAFOs are located approximately 1 mile northwest of Highway 45 and Los Padillas Road Southwest. The third dairy is located approximately 1 mile northwest of Coors Boulevard Southwest and Powers Way Road.

Figure 2.13 Rio Grande at Isleta Diversion Dam

9. North Diversion Channel at Roy – This site is just upstream of the North Diversion Channel discharge to the Rio Grande (Figure 2.14). The North Diversion Channel drains much of the eastern half of Albuquerque to the Sandia Mountains. Tributaries include the Embudo (I-40) Channel and Embudo Arroyo, Pino Arroyo, North Pino Arroyo, Hahn Arroyo, Bear Canyon Arroyo, Domingo Baca Arroyo, La Cueva Arroyo, and Grant Line Channel. Approximately 45 percent of the watershed area is developed land, and 98 percent of households are served by public sanitary sewers.

Figure 2.14 North Diversion Channel at Roy

10. North Domingo Baca Arroyo Dam at Primary Spillway – This small (3 square mile) watershed is just northeast of the City of Albuquerque in the foothills of the Sandia Mountains. Approximately 40 percent of the watershed is forested, and 7 percent is developed land. Only 34 percent of the households in the watershed were served by a public sewer system in 1990, and septic tank density is relatively high for this area (111 per square mile).

11. North Pino Arroyo above North Diversion Channel – This small watershed in Albuquerque is densely populated, with over 4,000 persons per square mile. Over half of the land area is developed.

12. Hahn Arroyo above North Diversion Channel at Carlisle – This small watershed in Albuquerque is almost completely developed land. The population density is 5,282 persons per square mile; the highest of the watersheds investigated. Essentially all households in the watershed are served by public sewers.

13. Embudo Channel above Confluence with North Diversion Channel – This watershed covers 30 square miles of Albuquerque and Sandia Mountain foothills. Approximately 60 percent of the land is developed. Essentially all households in the watershed are served by public sanitary sewer.

14. Bear Canyon Arroyo – This small watershed drains the west side of the Sandia Mountains and appears to be entirely unpopulated and undeveloped. The land cover is primarily forest.

15. South Diversion Channel just above Tijeras Arroyo – The South Diversion Channel watershed is primarily developed land in southern Albuquerque just east of the Rio Grande (Figure 2.15).

Figure 2.15 South Diversion Channel just above Tijeras Arroyo

16. Sandia Pueblo Natural Arroyo at I-25 Crossing – This watershed lies just south of the Bernalillo-Sandoval County line east of the river. It is unpopulated and essentially undeveloped.

17. Paseo del Norte Pump Station – This station drains a small watershed between the Rio Grande and 4th Street at Paseo del Norte. The septic tank density in 1990 was 334 per square mile, approximately one for every 2 acres, which is relatively high for this area.

18. Alameda Drain at Ranchitos Road – The Alameda Drain watershed at this point covers a small area between the Rio Grande and the North Diversion Channel just north of the city limits of Albuquerque. The septic tank density in 1990 was the highest of the studied sites, at 390 per square mile.

19. Alameda Drain at El Caminito Road – The drainage area of the Alameda Drain includes that at Ranchitos Road, and an additional area of approximately equal size. The watershed properties are similar to those at Ranchitos Road, though the area closer to El Caminito is more developed, more households are served by public sewers, and septic tank density is somewhat less.

20. Ranchitos de Albuquerque Storm Drain – This storm drain is located near the intersection of Ranchitos Road and 2nd Street at the Alameda Drain. The contributing watershed area could not be determined, but it is expected to be similar to that of the Alameda Drain at Ranchitos Road.

21. Cabezon Channel – The Cabezon Channel appears to drain a 20-square mile area west of the Rio Grande, including much of Corrales, the southern half of Rio Rancho, and a small portion of northwest Albuquerque. One quarter of the watershed is developed land, and 57 percent is shrubland.

22. Calabacillas Arroyo at Swinburne Dam – Calabacillas Arroyo drains a 76-square mile area north and west of Albuquerque. The watershed is primarily undeveloped shrubland and grassland. The population density in 2000 was low – 69 persons per square mile. Septic tank density was only one per square mile in 1990.

23. Calabacillas Arroyo at Coors Road – This site, downstream of Swinburne Dam and just upstream of the Rio Grande, includes an additional 10 square miles that are more populated. At the time of the 2000 census, the population of the Calabacillas watershed at Coors Road was 38,843, compared to 5,257 at Swinburne Dam. The septic tank density was also much higher at Coors Road – 19 per square mile.

24. Boca Negra Arroyo at Tesuque Road – This arroyo drains part of western Albuquerque. Approximately 3 percent of the watershed is developed land; most of the balance is shrubland. The population density is very low – only 20 persons per square mile.

25. San Antonio Arroyo at Rio Grande (Montana) oxbow – This arroyo also drains a portion of western Albuquerque, but this watershed is more densely populated than the watershed associated with Boca Negra Arroyo at Tesuque Road.

26. Amole del Norte Channel above Amole Dam – The watershed of this southwestern drainage way is primarily grassland, and the population density was only 70 persons per square mile in 2000.

27. Adobe Acres Pump Station – Most of the small area draining to this pump station near the Rio Grande south of Albuquerque is developed land, but 13 percent is cropland and 2 percent of the households reported farm income in 1990. The density of septic tanks in 1990 was moderately high (118 per square mile) compared to other watersheds.

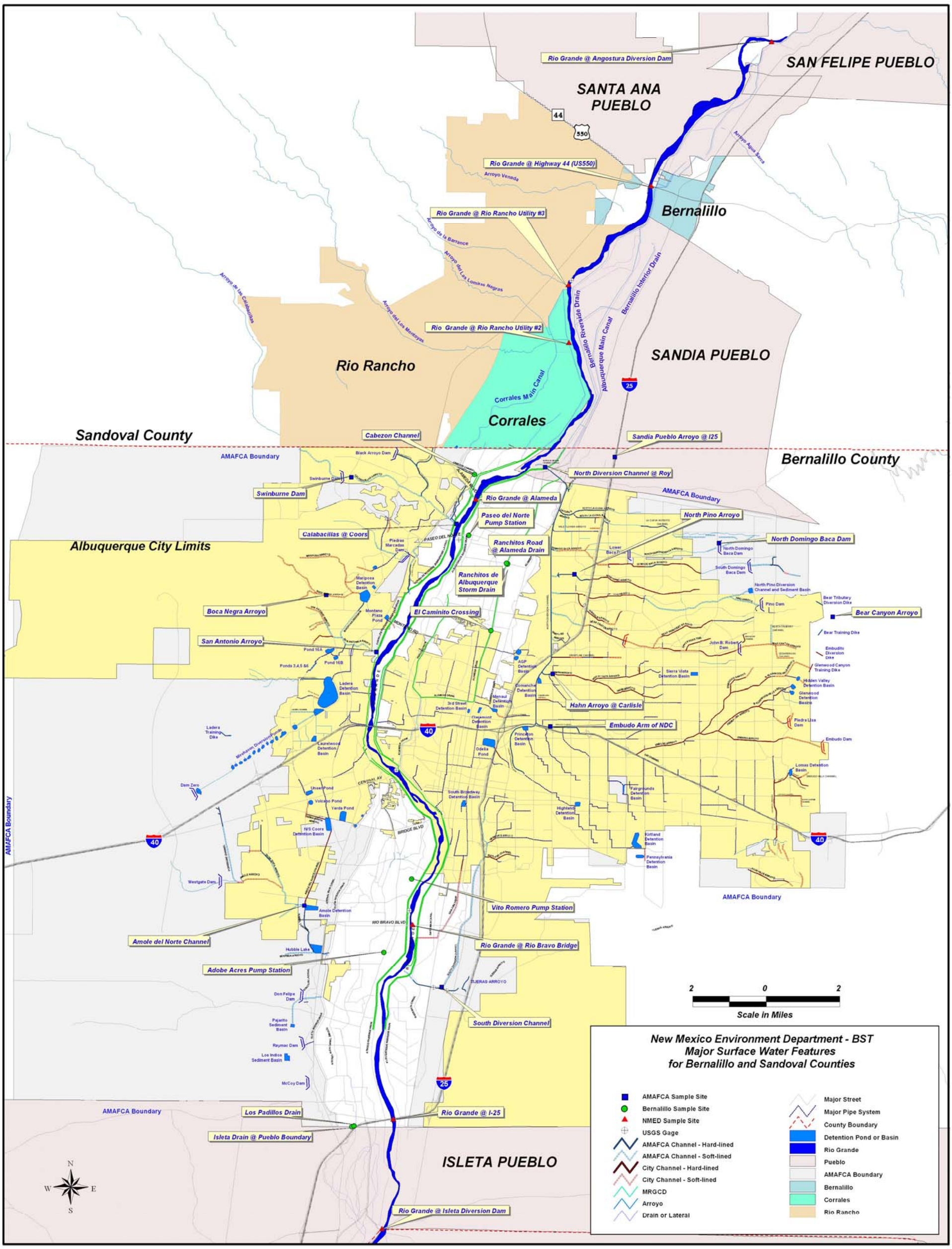
28. Vito Romero Pump Station – Draining a small watershed near the MRG north of Adobe Acres, its watershed is 98 percent developed land. The population density, at over 4,000 persons per square mile, is high in comparison to most other areas in the MRG basin.

29. Los Padillas Drain just upstream of the confluence with the Isleta Drain – Draining a 5 square mile watershed south of Albuquerque and just west of the Rio Grande, this watershed comprises a mixture of residential and cropland uses. Cropland composes a larger portion of the watershed (35%) than any other watershed investigated in this study. Almost 4 percent of the households reported farm income in 1990. Only 37 percent of the households were served by public sanitary sewers in 1990, and the density of septic tanks was 239 per square mile.

30. Isleta Drain just upstream of the confluence with the Los Padillas Drain – Draining an approximately 60 square mile watershed mostly southwest of Albuquerque and adjacent to Los Padillas Drain, this watershed is much less developed than that of Los Padillas. Cropland and developed land are less abundant in the Isleta Drain watershed, and shrubland and grassland are the major land covers. Eighty percent of the households in the watershed reported in 1990 that they were attached to public sewer systems.

THIS PAGE INTENTIONALLY LEFT BLANK

Figure 2.16 Middle Rio Grande Microbial Source Tracking Study Sampling Stations



THIS PAGE INTENTIONALLY LEFT BLANK

Table 2.2 Land Use in Middle Rio Grande Watersheds and Subwatersheds[1]

Sampling Site	Watershed Size (mi^2)	Land Use / Land Cover						
		Developed	Barren	Forest	Shrubland	Grassland	Cropland	Water & Wetlands
1. Rio Grande at Angostura Diversion Dam	16,090 (1,230†)	0.64%	1.10%	16.98%	25.12%	55.52%	0.53%	0.11%
2. Rio Grande at Highway US 550	17,189 (1,289†)	0.63%	1.29%	17.61%	25.60%	54.13%	0.53%	0.21%
3. Rio Grande above Rio Rancho Utility #3	17,221 (1,321†)	0.63%	1.30%	17.33%	25.95%	53.99%	0.54%	0.26%
4. Rio Grande above Rio Rancho Utility #2	17,221 (1,321†)	0.63%	1.30%	17.32%	25.95%	53.98%	0.54%	0.27%
5. Rio Grande at Alameda Bridge	17,393 (1,493†)	3.81%	1.22%	17.24%	26.62%	50.28%	0.49%	0.34%
6. Rio Grande at Rio Bravo Bridge	17,658 (1,758†)	4.73%	1.12%	15.52%	30.41%	47.07%	0.77%	0.38%
7. Rio Grande at I-25 Crossing	17,658 (1,758†)	5.05%	1.11%	15.46%	30.32%	46.89%	0.77%	0.40%
8. Rio Grande at Isleta Diversion Dam	17,900 (2,000†)	5.78%	1.12%	17.56%	30.81%	41.24%	2.95%	0.53%
9. North Diversion Channel at Roy	100	45.42%	0.40%	28.44%	20.38%	5.37%	0.00%	0.00%
10. North Domingo Baca Arroyo Dam at Primary Spillway	3	6.52%	0.74%	39.73%	35.94%	17.07%	0.00%	0.00%
11. North Pino Arroyo above North Diversion Channel	2	53.85%	0.52%	3.08%	36.72%	5.83%	0.00%	0.00%
12. Hahn Arroyo above N. Diversion Channel at Carlisle	5	97.92%	0.14%	0.13%	1.79%	0.02%	0.00%	0.00%
13. Embudo Channel above confluence with North Diversion Channel	30	60.62%	0.13%	30.96%	8.12%	0.17%	0.00%	0.00%
14. Bear Canyon Arroyo	5	0.00%	0.00%	97.46%	2.20%	0.34%	0.00%	0.00%
15. South Diversion Channel just above Tijeras Arroyo	9	62.57%	3.39%	1.46%	31.91%	0.33%	0.33%	0.00%

Sampling Site	Watershed Size (mi^2)	Land Use / Land Cover						
		Developed	Barren	Forest	Shrubland	Grassland	Cropland	Water & Wetlands
16. Sandia Pueblo Natural Arroyo at I-25 Crossing	2	0.88%	0.00%	7.92%	59.32%	31.88%	0.00%	0.00%
17. Paseo del Norte Pump Station	0.7	13.91%	0.10%	0.00%	73.10%	3.10%	0.00%	9.80%
18. Alameda Drain at Ranchitos Rd.	4	34.09%	0.23%	0.16%	63.81%	1.66%	0.03%	0.02%
19. Alameda Drain at El Caminito Crossing	7	44.82%	3.68%	0.22%	48.99%	2.21%	0.07%	0.01%
20. Ranchitos de Albuquerque Storm Drain	watershed could not be determined							
21. Cabezon Channel	20	25.32%	0.85%	0.17%	57.47%	16.12%	0.02%	6.00%
22. Calabacillas Arroyo at Swinburne Dam	76	0.22%	0.29%	0.11%	49.23%	50.15%	0.00%	0.00%
23. Calabacillas Arroyo at Coors Rd.	86	5.28%	0.46%	0.11%	50.64%	43.49%	0.00%	0.01%
24. Boca Negro Arroyo at Tesuque Rd.	28	3.16%	0.22%	0.12%	61.91%	34.59%	0.00%	0.00%
25. San Antonio Arroyo at Rio Grande (Montano) Oxbow	5	11.45%	0.33%	0.67%	78.22%	9.34%	0.00%	0.00%
26. Amole del Norte Channel above Amole Dam	18	1.54%	0.13%	0.11%	34.54%	63.68%	0.00%	0.00%
27. Adobe Acres Pump Station	1	78.92%	0.44%	0.59%	3.84%	3.18%	13.03%	0.00%
28. Vito Romero Pump Station	0.9	97.82%	0.04%	0.04%	0.29%	1.80%	0.00%	0.00%
29. Los Padillas Drain just upstream of the confluence with the Isleta Drain	5*	47.80%	0.20%	0.23%	13.40%	2.96%	35.42%	0.00%
30. Isleta Drain just upstream of the confluence with Los Padillas Drain	62*	16.18%	1.15%	0.14%	49.04%	30.98%	2.51%	0.00%

1 USGS (U.S. Geological Survey). 1999. National Land Cover Dataset. Reston, VA. Available via http://landcover.usgs.gov/natllandcover.asp.

† below Cochiti Reservoir and Jemez Dam

**Note that Isleta Drain and Los Padillas Drain flow into the Rio Grande downstream of the Isleta Diversion Dam*

Table 2.3 Selected Features and Properties of Middle Rio Grande Watersheds and Subwatersheds

Sampling Site	Human Population†	Persons† per mi^2	Households†	Households with Public Sewer‡	Septic Tanks ‡ per mi^2	Farm Households‡	Dogs†	Cats†
1. Rio Grande at Angostura Diversion Dam	25,132	20	8,905	33%	<1	1.50%	5,165	5,877
2. Rio Grande at Highway US 550	27,115	21	9,745	30%	<1	1.92%	5,652	6,432
3. Rio Grande above Rio Rancho Utility #3	33,140	25	11,768	33%	<1	1.91%	6,825	7,767
4. Rio Grande above Rio Rancho Utility #2	33,140	25	11,768	33%	<1	1.92%	6,825	7,767
5. Rio Grande at Alameda Bridge	333,500	223	138,614	95%	<1	0.79%	80,396	91,485
6. Rio Grande at Rio Bravo Bridge	484,319	275	195,288	92%	<1	0.85%	113,267	128,890
7. Rio Grande at I-25 Crossing	505,018	286	202,188	92%	<1	0.87%	117,269	133,444
8. Rio Grande at Isleta Diversion Dam	590,473	294	235,788	91%	1	0.87%	136,757	155,620
9. North Diversion Channel at Roy	273,625	2,736	116,994	98%	23	0.70%	67,857	77,216
10. North Domingo Baca Arroyo Dam at Primary Spillway	2,740	982	1,128	70%	111	2.12%	654	744
11. North Pino Arroyo above North Diversion Channel	9,455	4,221	3,696	99%	17	0.66%	2,144	2,439
12. Hahn Arroyo above N. Diversion Channel at Carlisle	25,196	5,282	10,672	100%	3	0.70%	6,190	7,044
13. Embudo Channel above confluence with North Diversion Channel	96,383	3,234	41,045	100%	6	0.61%	23,806	27,090
14. Bear Canyon Arroyo	0	0	0	NA	0	NA	0	0
15. South Diversion Channel at Tijeras Arroyo	20,136	2,288	9,026	99%	8	0.35%	5,235	5,957

Sampling Site	Human Population†	Persons† per mi^2	Households†	Households with Public Sewer‡	Septic Tanks ‡ per mi^2	Farm Households‡	Dogs†	Cats†
16. Sandia Pueblo Natural Arroyo at I-25 Crossing	0	0	0	NA	0	NA	0	0
17. Paseo del Norte Pump Station	463	634	175	13%	218	2.13%	102	116
18. Alameda Drain at Ranchitos Rd.	5,796	1,529	2,182	27%	390	1.72%	1,266	1,440
19. Alameda Drain at El Caminito Crossing	7,438	1,019	2,775	41%	238	1.02%	1,610	1,832
20. Ranchitos de Albuquerque Storm Drain	watershed could not be determined							
21. Cabezon Channel	34,941	1,792	13,498	75%	115	0.68%	7,829	8,909
22. Calabacillas Arroyo at Swinburne Dam	5,257	69	1,799	97%	1	0.30%	1,043	1,187
23. Calabacillas Arroyo at Coors Rd.	38,843	452	14,525	83%	19	0.57%	8,425	9,587
24. Boca Negro Arroyo at Tesuque Rd.	550	20	43	99%	0	0.45%	25	28
25. San Antonio Arroyo at Rio Grande (Montano) Oxbow	5,719	1,126	2,028	97%	7	1.81%	1,176	1,338
26. Amole del Norte Channel above Amole Dam	1,247	70	359	80%	3	0.79%	208	237
27. Adobe Acres Pump Station	2,260	2,253	729	84%	118	2.1%	423	481
28. Vito Romero Pump Station	3,670	4,078	1,162	95%	53	0.93%	674	767
29. Los Padillas Drain just upstream of the confluence with the Isleta Drain	6,530	1,335	2,160	37%	239	3.8%	1,253	1,426
30. Isleta Drain just upstream of the confluence with Los Padillas Drain	58,699	945	18,485	80%	44	0.79%	10,721	12,200

2.3.2 Livestock in the Middle Rio Grande Watershed

As noted previously, agricultural census data are reported only at the state and county levels; therefore, it is not possible to estimate livestock populations for individual subwatersheds within the study area. However, livestock populations for the counties comprising a significant portion of the studied watersheds – Bernalillo, Sandoval, and Santa Fe – are summarized in Table 2.4 to provide insight into the potential livestock sources of fecal coliform to the MRG. These estimates are compiled from the 2002 census of agriculture, as reported by the National Agricultural Statistics Service. It must be noted that these estimates may be low – the census addresses only those animals on farms, defined as a place where $1,000 or more of agricultural products are produced and sold. Thus, animals kept as pets or livestock maintained for household use would not be counted.

Table 2.4 Livestock Populations of the Middle Rio Grande Watershed in 2002

Type	Bernalillo County Population	Sandoval County Population	Santa Fe County Population
All Cattle	10,235	11,287	10,961
Beef Cows	3,487	nr†	7,729
Dairy Cows	2,920	nr†	9
Other Cattle	3,828	3,871	3,223
Horses and Ponies	2,496	1,648	1,745
Sheep and Lambs	1,780	525	440
Goats	505	307	564
Hogs and Pigs	117	nr†	57
Rabbits	nr†	183	186
Llamas	267	14	390
Chickens	>100,000†	1,119	2,205
Turkeys	110	36	54
Ducks and Geese	156	92	243
Other Poultry‡	195	nr†	120

‡ *includes pigeon, squab, pheasant, emu, ostrich, and other*

† *not reported in census, to avoid disclosing herd size of one or two farms*

2.3.3 Wildlife of the Middle Rio Grande Watershed

While no estimates of wildlife populations were found for the specific watersheds, an attempt was made to elucidate the most abundant species based on a variety of sources.

2.3.3.1 Wild Birds

Wild birds have been found to be a significant source of *E. coli* in many watersheds around the United States. Riparian-associated birds feed or reside in or adjacent to water and may serve as direct *E. coli* sources to natural waters. Upland birds tend to serve as

indirect sources of *E. coli*, through rainfall into natural waters. Populations of most birds vary seasonally in the MRG watershed; however, the Albuquerque area has a significant population of avian species since the MRG falls within a major migratory bird flyway.

Direct population estimates were not available for wild birds in the MRG watershed. However, bird lists are based on extensive observations of birds, and provide an indication of the relative seasonal abundance of birds in specific geographic areas. Bird lists were retrieved for several areas in north and central New Mexico, comprising various types of habitat. Kirtland Air Force Base in Albuquerque includes primarily upland habitat: grasslands, foothills, and canyons. Salinas Pueblo Missions National Monument and Sevilleta National Wildlife Refuge also include primarily upland habitat, with small riparian areas. Bosque del Apache National Wildlife Refuge includes primarily riparian areas with adjacent uplands. Petroglyph National Monument, just west of the Rio Grande in Albuquerque, is primarily shrubland habitat. Rio Grande Nature Center State Park, along the eastern bank of the Rio Grande in Albuquerque, has abundant riparian habitat.

Bird abundance is typically grouped into the following categories based on the frequency with which they are seen: abundant, common, uncommon, occasional, rare, and accidental. Birds that represent the greatest potential sources of *E. coli* in the MRG watershed are the abundant riparian species, and the upland species that are abundant in the summer and/or fall when rainfall levels are higher. Table 2.5 provides a list of some bird species that are potentially significant sources of fecal coliform in portions of the MRG watershed.

Table 2.5 Some Common Birds of the Middle Rio Grande Watershed

Pied-billed grebe	Mourning dove	White-crowned sparrow
Great blue heron	Rock dove (pigeon)	Brewer's sparrow
Snowy egret	Northern flicker	Chipping sparrow
Canada goose	American crow	Lincoln's sparrow
Snow goose	Pinyon jay	Vesper sparrow
Green-winged teal	Scrub jay	Black-throated sparrow
Mallard	Northern mockingbird	Green-tailed towhee
Northern pintail	Great-tailed grackle	Spotted towhee
Northern shoveler	Western meadowlark	Rufus-sided towhee
Gadwall	Barn swallow	Song sparrow
Wood duck	House sparrow	Wilson's warbler
American coot	Tree swallow	MacGillivray's warbler
Sandhill crane	Blue grosbeak	Orange-crowned warbler
Killdeer	American robin	Yellow warbler
Lesser nighthawk	Western kingbird	Hermit thrush
Red-winged blackbird	Ruby-crowned kinglet	Horned lark
Red-tailed hawk	Lesser goldfinch	Bewick's wren
Turkey vulture	House finch	Curved-bill thrasher
Ladder-back woodpecker	Hummingbirds	Fly-catchers
Oriels		

2.3.3.2 Wild Mammals

It is difficult to find data sources on the populations of wildlife in the MRG Basin. The USGS Gap Analysis Program has created habitat-based maps of likely areas where various species could occur, but there is no indication of their abundance. The NM Biota Information System (BISON-M) (http://fwie.fw.vt.edu/states/nm.htm) of the NM Department of Game and Fish provides a list of New Mexico mammal species and the counties where those species occur. For most species, BISON-M also provides an indication of how common they are by way of descriptions such as "demonstrably secure in NM," "apparently secure in NM," "rare or uncommon in NM," or "imperiled in NM." The mammal species with secure reproducing populations reported in portions of Bernalillo and/or Sandoval Counties are listed below in Table 2.6. More than half of the species identified are rodents.

Table 2.6 Some Common Mammals of the Middle Rio Grande Watershed

Big brown bat	Rock pocket mouse	White-throated wood rat
California myotis bat	Brush mouse	Long-tailed vole
Southwestern myotis bat	Cactus mouse	Common muskrat
Pallid bat	Deer mouse	Common porcupine
Western pipistrelle bat	Northern grasshopper mouse	Coyote
Silver-haired bat	Crawford's desert shrew	Common gray fox
Jack rabbit	Dusky shrew	Kit fox
Colorado chipmunk	Western harvest mouse	Black bear
Cliff chipmunk	Plains harvest mouse	Ringtail
Spotted ground squirrel	Pinyon mouse	Common raccoon
Abert's squirrel	Merriam's kangaroo rat	Long-tailed weasel
Red squirrel	Ord's kangaroo rat	American badger
White-tailed antelope squirrel	Northern rock mouse	Western spotted skunk
Botta's pocket gopher	Norway rat	Striped skunk
Hispid pocket mouse	White-footed mouse	Bobcat
Plains pocket mouse	Mexican wood rat	Mule deer
Silky pocket mouse	Southern plains wood rat	

2.3.4 Sanitary Survey

A reconnaissance tour, or sanitary survey, of the MRG watershed was performed by Parsons in May and June 2002 to identify sources of fecal coliform that could potentially be missed by a review of available data and literature. The sanitary survey proved valuable as it provided greater understanding of the diversity of animal species, location, and condition of wastewater infrastructure, and hydrology (pollutant loading pathways) throughout the MRG watershed. This step was important and influenced the sampling approach taken for collecting fecal samples for development of a local library of known

isolates. A particular focus was placed on sources near the river and drainages, especially in the vicinity of the investigated sites, as those sources might exert large impacts on the observed fecal coliform source distribution.

No malfunctioning septic systems or sewer lines were observed during the sanitary survey. The only significant human sources observed, excluding NPDES-permitted WWTF outfalls, were dirty diapers among trash discarded along rural roads. Cattle and especially horses were observed in abundance throughout the watershed. Other livestock observed included sheep, llamas, donkeys, goats, pigs, chickens, guinea fowl, and bison (on the Sandia Pueblo). It was noted during the sanitary survey that there were a significant number of households throughout the watershed with one to 10 head of livestock (*e.g.*, horses, cows, goats) which are not accounted for in the county livestock census data discussed in Section 2.3.2.

Wild mammals observed included prairie dogs, rabbits, wood rats, squirrels, and signs of raccoon, beaver, ground squirrel, and other small rodents. Wild birds observed included pigeon (rock dove), house finch, American crow, European starling, northern mockingbird, barn swallow, tree swallow, cliff swallow, turkey vulture, western kingbird, mallard, snowy egret, downy woodpecker, northern flicker, killdeer, mourning dove, burrowing owl, blue grosbeak, lazuli bunting, Canada geese, blue-winged teal, wood duck, northern shoveler, black-chinned hummingbird, American coot, black-crowned night heron, and roadrunner.

The City of Albuquerque's Rio Grande Zoo was identified as a potential source of fecal material in runoff due to the concentration of animals and its location on the banks of the Rio Grande.