SECTION 5
IMPLEMENTATION OPTIONS

5.1 Targeting Controllable Sources

This section provides inferences to assist water quality managers in targeting management measures to address specific fecal source categories based on the ribotyping results at the eight sampling sites along the MRG. It is not the intention of this section to provide a detailed implementation plan for reducing fecal coliform loadings to the MRG. A wide array of management measures and best management practices (BMP) are discussed in the MRG Fecal Coliform TMDL report that in some combination could result in reductions of fecal coliform loading to the MRG and its tributaries and arroyos. As stated in the TMDL Report:

> *Management measures are "economically achievable measures for the control of the addition of pollutants from existing and new categories and classes of nonpoint sources of pollution, which reflect the greatest degree of pollutant reduction achievable through the application of the best available nonpoint pollution control practices, technologies, processes, siting criteria, operating methods, or other alternatives" (USEPA 1993).*

Table 4.2 of the previous section identified storm water runoff as the major source of fecal coliform in the MRG. Table 4.3 indicated that fecal coliform counts were also exceeding the numeric criteria at the North Diversion Channel and the Rio Grande at the I-25 bridge downstream. Discharge Monitoring Reports provided to NMED by the local WWTFs suggest that continuous wastewater discharges may be an intermittent source of the fecal coliform loading. These three factors, along with the knowledge of the main source categories of fecal coliform at the eight MRG sampling stations, provide sufficient data to more effectively target the implementation of management measures by subwatershed.

5.2 Fecal Coliform Isolates by Source Detected at Eight Sampling Stations

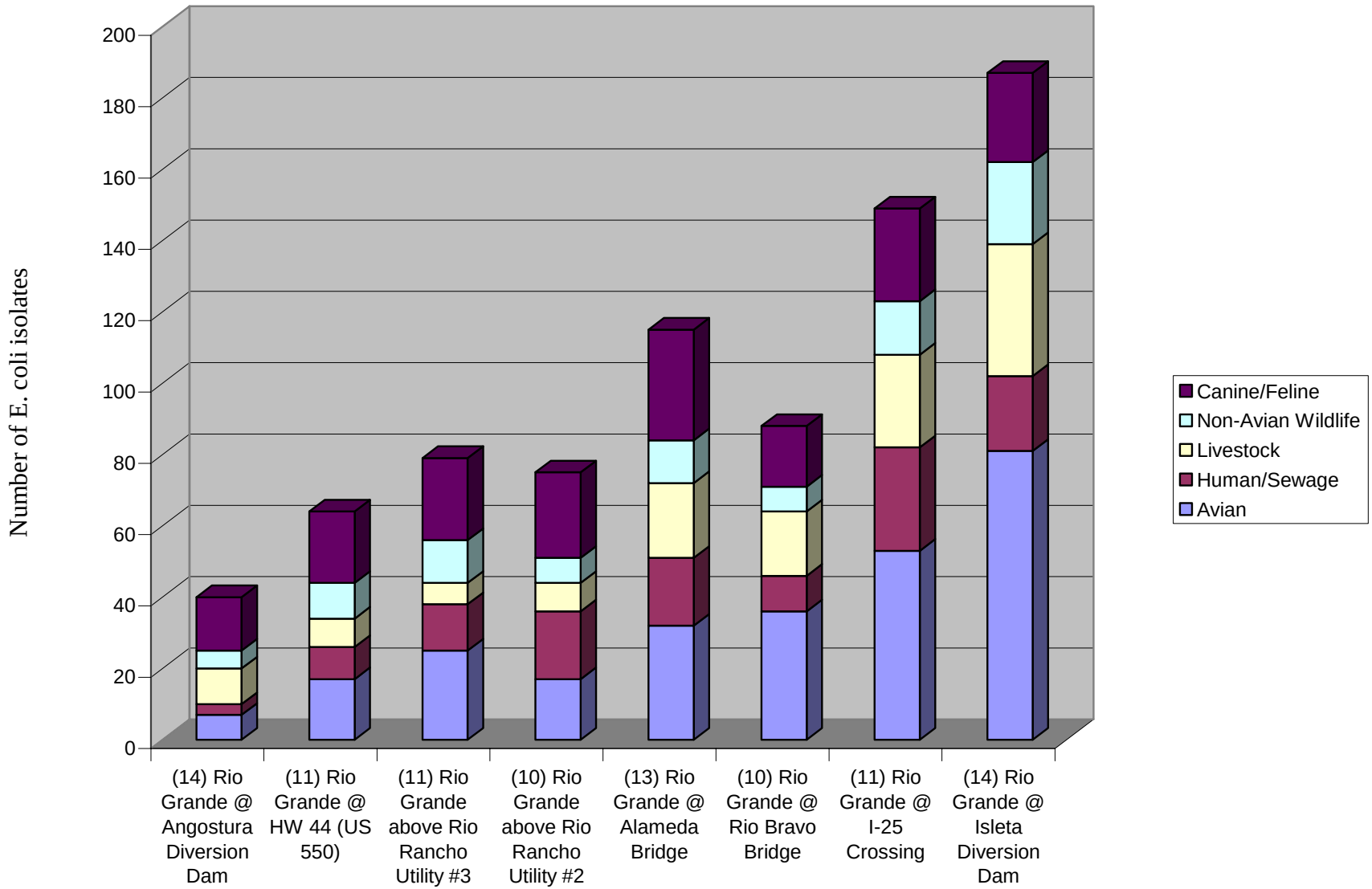
Figure 5.1 identifies the number of *E. coli* isolates matched for each source category group at each of the eight sampling sites on the Rio Grande. The number of samples taken at each station is shown in parenthesis.

As mentioned in Section 4, some isolates are associated with two or more species and are counted as unknown. The numbers of unknown isolates are not included in the totals shown in Figure 5.1, or in the text below.

5.2.1 Rio Grande at Angostura Diversion Dam

Forty-one *E. coli* isolates were identified from water samples at this sampling site and are shown on Figure 5.1. The individual number of isolates for each category was: seven Avian, three Human/Sewage, 10 Livestock, five Non-Avian Wildlife, and 15 Canine/Feline. Although not broken out individually in Figure 5.1, isolates from canine (35%), cattle (20%), and avian species (17%) make up the majority of *E. coli* detected at the Angostura Dam. The contributing watershed of this sampling site is approximately 1,230 square miles, all of which are considered outside of the study area.

Figure 5.1 Comparison of Fecal Coliform Sources for 8 Monitoring Sites on the Rio Grande



The primary purpose of conducting MST analysis at this station was to establish some benchmark for magnitude of fecal coliform concentrations (background level) and an understanding of the source categories coming from outside of the study area.

Although the fecal coliform contribution above the dam is relatively low compared to downstream stations, the data suggest the WQS of 200 cfu/100 mL is exceeded when the river contains local rainfall runoff. Given the land use characteristics of this subwatershed and the fact that exceedances of the water quality criteria occur only occasionally at this site, the value of targeting management measures upstream of the Angostura Diversion Dam needs to be carefully evaluated. Controlling cattle and dog waste by methods described in Subsection 5.3 may be an effective means of reducing these fecal coliform contributions.

5.2.2 Rio Grande at Highway US 550

The total number of *E. coli* isolates identified from water samples at this sampling site and shown on Figure 5.1 was 67. The individual number of isolates for each category was: 17 avian, nine human/sewage, eight livestock, 10 non-avian wildlife and 20 canine/feline. The major source categories identified in this subwatershed include canine (28%), avian (26.6%) and human/sewage (14%). The MRG watershed upstream of Highway US 550 is only slightly larger in size and very similar in land use/land cover to the river upstream of the Angostura Diversion Dam according to the fecal coliform concentrations shown in Table 4.2. Given the significant increase in percent contribution of fecal coliform from the human/sewage category, emphasis should aimed at identifying specific pathways of fecal loading from human sources particularly in the subwatershed area downstream of the Angostura Diversion Dam.

5.2.3 Rio Grande above Rio Rancho Utility #3

This sampling station is approximately 3 miles downstream of the Highway US 550 sampling site. The total number of *E. coli* isolates identified from water samples at this station and shown on Figure 5.1 was 82. The individual number of isolates for each category was: 25 avian, 13 human/sewage, six livestock, 12 non-avian wildlife, and 23 canine/feline. The major source categories identified in this subwatershed include avian (31.6%), canine (24%), human/sewage (16.5%), and rodent (15.2%). It should be noted that the three upstream most sampling sites on the Rio Grande (Angostura, Highway US 550, and Rio Rancho Utility #3) all have percent contributions from the rodent source category greater than 10 percent. The combined contributions of avian species and rodent species at these three sites indicate significant contributions from wildlife species in these largely rural watersheds.

Water samples collected at this station contain treated wastewater from the town of Bernalillo. The east side of this segment of the river is much more urbanized (Rio Rancho) than the two upstream segment subwatersheds. Given the significant increase in percent contribution of fecal coliform from the human/sewage category, emphasis should be aimed at identifying specific pathways of fecal loading from human sources, particularly in the subwatershed area downstream of the Highway US 550 station. A field survey that focuses on identifying sewer system overflows and popular locations for exercising pets such as parks, and penned livestock, is recommended. The field survey

data can be used to direct efforts using the methods described in the next subsection.

5.2.4 Rio Grande above Rio Rancho Utility # 2

This sampling station is 1.7 miles downstream of the previous station. The total number of *E. coli* isolates identified from water samples at this station and shown on Figure 5.1 was 89. The individual number of isolates for each category was: 17 avian, 19 human/sewage, eight livestock, seven non-avian wildlife, and 24 canine/feline.

The major source categories identified in this subwatershed include canine (32.0%), human/sewage (25.3%), and avian (22.7%). This subwatershed is urbanized on the west side of the river with farms on the east side.

Fecal coliform concentrations collected at this station demonstrate the influence of treated wastewater upstream from Rio Rancho Utility #3. According to USEPA's Permit Compliance System (PCS) database, the Rio Rancho Utility #3 WWTF has on an intermittent basis, discharged fecal coliform in excess of the NPDES permit limits on 10 occasions from May 2001 through June 2003. The NPDES permit limits are a monthly average of 100 cfu/100 mL and a maximum limit of 200 cfu/100 mL on any one day. The range of fecal coliform concentrations above the permit limits are 184 cfu/100 mL to 10,000 cfu/100 mL. A summary of the PCS data is located in Appendix E. It is recommended that the method of effluent disinfection at the WWTF be analyzed by a qualified engineer. The most common cause of inadequate disinfection is undersized capacity of the disinfection unit during peak flow events or improper design. Given the significant increase in percent contribution of fecal coliform from the human/sewage category, emphasis should be aimed at identifying specific pathways of fecal loading from human sources, particularly in the subwatershed area downstream of the Rio Rancho Utility #3 sampling site.

5.2.5 Rio Grande at Alameda Bridge

This sampling station is approximately 6 miles downstream of the previous station. According to the calculated geometric mean fecal coliform concentration (Table 4.2), this subwatershed contributes four times the fecal coliform than the previous upstream station. The total number of *E. coli* isolates identified from water samples at this station (Figure 5.1) was 119. The individual number of isolates for each category was: 32 avian, 19 human/sewage, 21 livestock, 12 non-avian wildlife, and 31 canine/feline. The major source categories identified in this subwatershed include avian (27.8%), canine/feline (27.0%), and human/sewage (16.5%). There was also a significant increase in the percent contribution from horses (10.4%) compared to any of the stations upstream of the Rio Rancho Utility #2 site. A major factor that must be considered when evaluating this sampling site is the fecal source contributions from the North Diversion Channel, which joins the Rio Grande above the Alameda Bridge sampling site. The major source categories identified from the North Diversion Channel subwatershed include avian (25.8%), human/sewage (23.7%), canine (22.7%), rodent (17.5%) and equine (5.2%). No bovine isolates were detected in the North Diversion Channel.

The subwatershed drains a very large urban area interspersed with small farms. It should be noted that the *E. coli* count for livestock isolates increased from eight at the upstream station to 21 at this station. Controlling the fecal coliform contribution from

livestock within such a large area may require educating the community and obtaining the backing of the majority before passing and enforcing local ordinances. This is discussed further in Subsection 5.2.1.

Water samples collected at this station contain treated wastewater from Rio Rancho Utility #2. According to USEPA's Permit Compliance System database, the Rio Rancho Utility #2 WWTF has on an intermittent basis discharged fecal coliform in excess of the NPDES permit limits on 11 occasions from July 1998 through September 2004. The NPDES permit limits are a monthly average of 100 cfu/100 mL and a maximum limit of 200 cfu/100 mL on any one day. The range of fecal coliform concentrations above the permit limits are 111.5 cfu/100 mL to 1,300 cfu/100 mL (September 2004). The two permit violations reported in 2004 are believed to be the result of an unusually high amount of rainfall that year. Again, it is recommended that a qualified engineer analyze the disinfection system to determine if the WWTF design capacity can handle the storm water charged sewers.

5.2.6 Rio Grande at Rio Bravo Bridge

This sampling station is approximately 14 miles downstream of the Alameda Bridge. According to Table 4.2, the maximum fecal coliform count from a sample collected at this bridge was 650,000 cfu/100 mL and the geometric mean (2,320 cfu/100 mL) was 42 percent higher than the Alameda Bridge station. The total number of *E. coli* isolates identified from 10 water samples at this station (Figure 5.1) was 90. The individual number of isolates for each category was: 36 avian, 10 human/sewage, 18 livestock, seven non-avian wildlife, and 17 canine/feline. The major source categories identified in this subwatershed include avian (41%), livestock (20%), canine/feline (19%).

Avian and non-avian wildlife species accounted for almost 50 percent of the typed isolates in the samples collected. This is congruent with the large number of water fowl that frequent stretches of the Rio Grande south of Rio Rancho Utility #2. There was also a considerable decrease in percent contribution from human/sewage sources and an increase in bovine contributions. A field survey to identify pathways of pet, livestock, and human waste in this subwatershed should be conducted. A public education campaign and passing and/or enforcing local ordinances to control this waste are recommended.

5.2.7 Rio Grande at Interstate 25

This sampling station is approximately 6 miles downstream of the Rio Bravo Bridge. According to Table 4.2, the maximum fecal coliform count from a sample collected at this bridge dropped to 360,000 cfu/100 mL, but the geometric mean was almost double that upstream at the Rio Bravo Bridge. The total number of *E. coli* isolates identified from water samples at this station (Figure 5.1) was 152. The individual number of isolates for each category was: 53 avian, 29 human/sewage, 26 livestock, 15 non-avian wildlife, and 26 canine/feline. The major source categories identified in this subwatershed include avian (35.6%), human/sewage (19.5%), and canine (14%). The increase in *E. coli* isolates identified as human or sewage again suggests the need for a focus on identifying specific pathways of fecal loading from human/sewage sources. The total isolates identified with controllable sources (human, canine, bovine, equine, feline, porcine, sheep) are 54 percent of the total. The source category contributions at this

station indicate that fecal loadings from a large and diverse population of domestic animals in this urbanizing subwatershed need to be addressed. The same field survey, public education, and ordinance enforcement recommended previously also apply to this subwatershed. A major factor that must be considered at this station is the fecal source contributions from the South Diversion Channel which outfalls above the Rio Grande at Interstate 25 sampling site. The major source categories identified from the South Diversion Channel subwatershed include avian (31.5%), canine (30.3%), and human/sewage (15.7%).

It appears some sources of fecal coliform may be more consistent than intermittent, which is verified in Table 4.3 – fecal coliform under non-runoff conditions. One source worth further investigation is Albuquerque's Southside Water Reclamation Plant. According to USEPA's Permit Compliance System database, the Southside Water Reclamation Plant has, on an intermittent basis, discharged fecal coliform in excess of the NPDES permit limits on 21 occasions from July 1998 through September 2004 (See Appendix E). The NPDES permit limits are a monthly average of 100 cfu/100 mL and a maximum limit of 200 cfu/100 mL on any one day. The range of fecal coliform concentrations above the permit limits were 106 cfu/100 mL to 19,200 cfu/100 mL (both July 1999). Two of the maximum day permit exceedances occurred as recently as April and July 2004. Again, it is recommended that a qualified engineer analyze the disinfection system at the Southside Water Reclamation Plant to determine if the design capacity can handle the recorded-high peak flow rate.

5.2.8 Rio Grande at Isleta Diversion Dam

As the downstream most site, the results of this sampling station reflect the overall contributions of source categories from the entire study area. The total number of *E. coli* isolates identified from water samples at this station (Figure 5.1) was 202. The individual number of isolates for each category was: 81 avian, 21 human/sewage, 37 livestock, 23 non-avian wildlife, and 25 canine/feline. Avian and non-avian species account for approximately 56 percent of the total. Controllable source categories (human, canine, bovine, equine, feline, porcine [swine], sheep) account for approximately 44 percent of the total. The human/sewage and canine/feline categories accounted for approximately 25 percent of the total isolates identified.

The prioritization and targeting of management measures throughout the MRG study area will directly affect future fecal coliform loading reductions measured at the Isleta Diversion Dam. However, additional field reconnaissance should be undertaken to identify pathways of controllable sources in the large subwatershed southeast of Albuquerque that drains directly into the Rio Grande upstream of the Isleta Diversion Dam. The increased livestock contribution is attributed to the many irrigation drains entering the river upstream of this station. Manure management, discussed in the next subsection, may be an effective method to reduce the livestock fecal coliform contribution. The same field survey, public education, and ordinance enforcement implementation methods recommended previously also apply to this subwatershed.

5.3 Implementation Discussions

Rainfall runoff throughout the MRG watershed flushes fecal matter into the river. Ribotyping *E. coli* identified both controllable sources, such as livestock, pets, and

untreated sewage, and natural sources such as wildlife. The following provides a general description of strategies to reduce the fecal coliform contributions from controllable sources. The degree of control of the fecal coliform contributions from canine/feline, livestock, and human/sewage categories is proportional to funding and community commitment. A discussion on natural sources follows.

5.3.1 Pets

Urban areas within the MRG contain an overpopulation of dogs and cats (CABQ 2005). Table 2.3 shows that in the overall 2,000 square mile watershed associated with Isleta Diversion Dam, there are an estimated 136,757 dogs and 155,620 cats. A 1978 estimate put the number of stray animals between 60,000 to 70,000 in Albuquerque alone (Funk 1996). In 2002 and 2003 the number of dogs and cats picked up by the City of Albuquerque animal control was 23,368 and 25,473, respectively (Sanchez 2004). Pet adoption rates were 20 percent and 23 percent for those years (Sanchez 2004). The City of Albuquerque and Bernalillo County impose a limit of four dogs and cats per household (Ordinance 9-2-3-1 and Section 6). Bernalillo County will allow six dogs and cats if they are spayed or neutered.

Dogs can be asymptomatic carriers of internal parasites like *Giardia* and *Cryptosporidium*. Infected animals pass up to 10 million *Giardia* cysts and/or 10 billion *Cryptosporidium* oocysts per gram of feces. Infection can occur with ingestion of one *Cryptosporidium* oocyst (City of Boulder 2004). Although no outside sources were found that addressed internal parasites in cats, this study determined that 17 percent of hemolytic *E. coli* found in the ambient water samples were from cats.

There are approximately 80,000 dogs registered with the City of Albuquerque producing 20 tons of feces per day (CABQ 2004). This figure does not include unregistered or stray dogs or dogs living outside of Albuquerque.

The most effective means of controlling dog waste in parks are the installation of signs, pick-up bag dispensers, receptacles, and fining ordinance violators. Albuquerque has three no-leash required dog parks with waste collection amenities.

The following are some suggested methods for reducing the fecal coliform contribution from pets to the MRG:

- Enforce adopted city and county pet ordinances.
- Continue public participation and education efforts. Provide public information about the problems, such as diseases, associated with animal feces entering the MRG. This could be accomplished through public service announcements on radio or television, investigative news articles in newspapers, brochures posted within public buildings, and information on websites.
- Place additional pick-up bag dispensers and receptacles in known problem areas such as hike and bike trails.

5.3.2 Livestock

Livestock in CAFOs, such as chickens, sheep, goats, donkeys, horses, and cattle, occupy land near and adjacent to the MRG (CDM 2000). In some cases, penned animals have direct access to the MRG for watering purposes (NMED 2002). Some owners

gather manure from within the pen and store it in an uncovered pile (CDM 2000). A 1,000-pound beef cow produces approximately 11 tons of manure per year, and a 1,000-pound dairy cow produces approximately 15 tons (Ohio NRCS 1999). Assuming the average dairy or beef cow in the MRG watershed weighs 750 pounds, the manure production of 35,000 cows is approximately 800 tons per day. Commercial CAFOs are also located in the Isleta Drain (three) and Interstate 25 Bridge (one) watershed.(CDM 2000).

A single horse produces 350 pounds per week of manure (Card 2004). The manure production of 10,000 horses is approximately 250 tons per day.

It is possible that some of this manure is gathered and used on local gardens and farms as fertilizer. No ordinances were located regulating manure handling practices or prohibiting landowners from allowing livestock to enter the MRG.

For obvious reasons, the density of penned livestock is regulated differently in urban areas than in rural areas.

The following are some suggested methods for reducing fecal coliform released from penned livestock.

- Pass an ordinance regulating manure handling and disposal practices. Identify property owners with penned livestock or CAFOs that may be contributing to the fecal coliform standard exceedance. Determine if these properties meet current ordinances. Enforce ordinance.
- Modify existing websites and media addressing the handling of dog waste to include livestock.
- People are more cooperative when adequately informed about a health problem that they have some control over, such as cleaning livestock pens and avoiding exposure to storm water. Knowledge of the source of the problem may modify the behavior of people responsible for a known source of fecal coliform.

On December 7, 2004, USEPA Region 6 published notice of proposed general permit for discharges from CAFOs. As of September 2005, the proposed general permit had not been finalized.

5.3.3 Untreated or Inadequately Treated Sewage

The MRG water budget developed by the Middle Rio Grande Water Assembly (MRGWA 1999) indicates approximately 10 acre-feet of treated septic system wastewater enters the area's shallow aquifers each year. The report also states approximately 220 acre-feet of water from these shallow aquifers enter the MRG as seeps and springs. Nevertheless, based on the relatively low fecal coliform contribution from human waste, septic systems are not believed to be a major fecal coliform contributor to the MRG (NMED 2002).

Owners of WWTFs with an NPDES permit are required to report SSOs to NMED and USEPA Region 6. USEPA Region 6 is requiring permittees to eliminate SSOs or face large monetary fines. USEPA is encouraging permitted WWTF owners to implement an asset management approach to better manage their sewer systems.

Seventy percent of SSOs are caused by structural or electrical failures or pipe capacity restrictions (EPA http://www.epa.gov/npdes/sso/control/causes.htm). The most popular method of mitigating and managing SSOs is the Capacity Management, Operations, and Maintenance (CMOM) program. Permittees implementing the CMOM program are likely to be in a better position to negotiate SSO penalties with USEPA. See http://www.parsons.com/asset/capabilities/capabilities06.asp and http://cfpub.epa.gov/npdes/home.cfm?program_id=4 for more information. The City of Albuquerque has implemented a CMOM program and has been successful in addressing issues associated with SSOs.

5.3.4 Wildlife

The MRG watershed provides habitat for a diverse population of wildlife. The Rio Grande is a major bird flyway for migratory water fowl and other bird species. Approximately 90,000 lesser snow and Ross geese and Sandhill cranes visit the MRG each year and can contribute up to 19.8 quadrillion (19.8×10^{15}) fecal coliform bacteria each day (CDM 2000). This fecal coliform contribution occurs every migratory season and is considered a natural source. It is recommended that NMED, the Sandia Pueblo, and USEPA discuss and reach consensus on how natural background sources of fecal coliform from wildlife (avian and non-avian species) should be handled. A decision will need to be made regarding how progress toward meeting fecal coliform reduction goals established by the TMDL will be evaluated, and what the relationship between background concentrations of fecal coliform and interpretation of state and Tribal WQSs will be.

5.3.5 Milestones and Evaluation of Implementation Programs

A critical element of any watershed implementation plan is a well-designed water quality monitoring approach to evaluate the improvement in water quality conditions in response to implementation of control actions and management measures. It is recommended that fecal coliform sampling at stations addressed in this report be continued at as many of the stations as possible. This will allow verification of the effectiveness of the suite of management measures chosen to achieve fecal coliform reduction. It is also recommended that setting fecal coliform reduction goals should follow more intensive field surveys. The field surveys will identify the obvious problem areas (*e.g.*, sewer overflows, effluent disinfection, penned livestock, and CAFOs) and will allow assessments of the success of implementation programs. Goals may then be set prior to this initial program implementation. The effectiveness of reducing fecal coliform at these "easier" sites can be measured through routine fecal coliform sampling.

Milestones will be used for determining if control actions are being implemented and, ultimately, if WQSs are being attained. The milestones proposed in the MRG TMDL need to be refined and linked to the suite of management measures selected to address the controllable sources of fecal coliform outlined in Subsection 5.3. The milestones listed in the MRG TMDL include the following:

- Develop BMPs to reduce fecal coliform loading in storm water;
- Implement BMPs;
- Monitor effectiveness of BMPs after implementation;

- Re-assess BMP effectiveness; and
- Design new BMP approaches if original approach proves ineffective.

Monitoring BMP effectiveness and revised milestones need to be integrated, both spatially and temporally, to provide water resource managers and the public with information needed to modify implementation strategies.