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Assessment of Regional Water Quality Issues and Impacts to the Water Supply

Assurance of availability to meet future water demands requires both a sufficient quantity of water and water that is of sufficient quality for the intended use. Contaminants impacting surface water or groundwater quality may impair the use of available water resources. This assessment was prepared for the Mid-Region Council of Governments (MRCOG) by Daniel B. Stephens & Associates, Inc. (DBS&A). The scope of work for this report includes (1) an assessment of water quality issues for the Middle Rio Grande (MRG) planning region and (2) an examination of the water quality impacts on the region's water supply.

Most drinking water supplies in the MRG planning region are derived from groundwater sources within the basin fill sediments of the Santa Fe Group and younger alluvial deposits. Generally, this groundwater is of high quality and suitable for drinking water supply without additional treatment. Surface water in the Rio Grande and its smaller tributaries is of suitable quality to provide most of the irrigation water supply, with groundwater also providing a small part of the irrigation supply. In the past, surface water has not been a primary drinking water source; however, this will change under the City of Albuquerque's plan to begin treating Rio Grande water for municipal use.

Where drinking water supply options are limited, water quality impairment can be a significant and expensive problem if the drinking water supply becomes degraded to the point where additional and costly treatment must be provided or additional water supplies located. Although standards are generally not as high for irrigation and livestock uses as for drinking water, water quality must, nevertheless, be suitable to meet these uses.

Water quality for the MRG planning region was assessed for this report mainly through existing documents and databases. Two surface water studies prepared pursuant to Section 305(b) of the Federal Clean Water Act were especially helpful: (1) a list of surface waters within New Mexico that do not meet or are not expected to meet water quality standards (NMED, 2002a) and (2) *Water Quality and Water Pollution Control in New Mexico, 2002,* a report prepared by the State of New Mexico for submission to the United States Congress (NMWQCC, 2002). Information regarding groundwater quality was obtained primarily from the latter document and information on specific sites and facilities that may have the potential to impact surface water or groundwater quality was obtained from various NMED databases.

Water quality issues place constraints on the water available to the MRG planning region in two ways: (1) contaminant impacts on water supplies and (2) naturally occurring water quality constraints. Contaminant impacts clearly render a portion of the region's water unsuitable for use and require extensive remediation efforts. Only a portion of the region's groundwater has suitable naturally occurring quality to meet current drinking water and agricultural uses; much of the deeper water in the Santa Fe Group basin fill deposits or outlying formations is too saline for most uses. The widespread natural occurrence of arsenic in the region's aquifers is an extremely important emerging issue, which will require extensive treatment of drinking water supplies and be a key issue in all future water supply development plans.

This report addresses key water quality issues for the MRG planning region and the associated impacts on water supply. Section 1 presents water quality issues related to contamination sources. Section 2 presents water quality issues related to naturally occurring water quality. Finally, Section 3 summarizes the water quality impacts on available water supplies.

1. Contaminant Impacts on Water Quality

Contaminant issues affect both the region's surface water and groundwater supplies. Sources of contamination are considered point sources if they originate from a single location or nonpoint sources if they originate over a widespread or unspecified location. Groundwater remediation is needed at many sites in the region to minimize impact to the region's water supplies.

In addition to numerous known and potential contaminant sources, the evolving understanding of water quality issues and the ongoing re-evaluation and updating of water quality standards bring continuing changes that water supply planners must address. Water quality standards for surface water and drinking water are periodically revised, requiring new approaches to maintain environmental protection and safe water supplies. Some new potential contaminants, such as pharmaceuticals and endocrine disrupters, are a growing concern, and water quality standards for these substances have not been adopted for surface water or drinking water.

This section describes the regulatory programs that directly protect water supplies from contaminant releases that could impact water quality. Many other regulatory programs also institute measures for environmental protection, public health, and safety. For example, the Endangered Species Act does not directly regulate water quality, but influences the development of water quality protection requirements to help protect endangered species. Together, existing regulatory programs provide broad water quality protection, although improvements can always be made. The primary water contaminant issues affecting the MRG planning region are discussed in the following sections.

1.1 Surface Water Quality

Potential sources of contamination and measured impacts to surface waterbodies are described in Sections 1.1.1 and 1.1.2, respectively.

1.1.1 Potential Sources of Surface Water Contamination

Point source discharges must comply with the Clean Water Act and the New Mexico Water Quality Standards by obtaining a permit to discharge. These permits are referred to as National Pollutant Discharge Elimination System (NPDES) permits. A summary of NPDES permitted discharges in the MRG planning region is included in Table 1 (NMED, 2002c).

Nonpoint sources of pollutants are a major concern for surface water in the MRG planning region. Potential sources of pollutants or threats to surface waters include activities related to agriculture, recreation, hydromodification, road and highway maintenance, silvicultural activities, resource extraction, land disposal, and road runoff (NMWQCC, 2002). Other natural and unknown sources also affect surface water in the planning region. Specific pollutants or threats to surface water quality resulting from these nonpoint sources are turbidity, stream bottom deposits, metals, total ammonia, pathogens, plant nutrients, and abnormal water pH, temperature, and conductivity (NMWQCC, 2002).

1.1.2 Existing Surface Water Quality

The MRG planning region is drained by portions of the Rio Grande and Rio Puerco watersheds. Water quality in the area is generally good; however, several reaches of rivers within the middle portion of the Rio Grande Basin have been listed on the 2000-2002 New Mexico 303(d) list (NMED, 2002a). This list is prepared by the NMED to comply with Section 303(d) of the federal Clean Water Act, which requires each state to identify surface waters within its boundaries that do not meet or are not expected to meet water quality standards. Table 2 summarizes information about each of the reaches in the planning region on the 303(d) list.

Section 303(d) further requires the states to prioritize listed waters for development of total maximum daily load (TMDL) management plans. A TMDL documents the amount of a pollutant a waterbody can assimilate without violating a state water quality standard. It also allocates that load capacity to known point sources and nonpoint sources at a given flow. As shown in Table 2, numerous TMDL management plans have already been developed for streams in the planning region, such as the Rio Grande, the Santa Fe River, and listed streams in the Jemez watershed.

The TMDL management plan for the Rio Grande (from the northern border of Isleta Pueblo to the southern border of Santa Ana Pueblo) was developed to address exceedances of fecal coliform. Impairment to the abovementioned stream segment primarily originates from municipal point sources, urban runoff, and storm sewers. There are 12 existing NPDES permits and 1 pending NPDES permit on this reach. The management plan outlines various structures that, once implemented, would reduce the input of fecal coliform to the river.

Two TMDL management plans have been developed for the Santa Fe River (from Cochiti Pueblo to the Santa Fe wastewater treatment plant [WWTP]) to address exceedances of chlorine, stream bottom deposits, pH, and dissolved oxygen. The lower part of this listed reach lies within the MRG planning region. The main sources of impairment are municipal point sources, agriculture, and resource extraction. The only permitted NPDES discharge on this reach is for the Santa Fe WWTP.

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

In addition to the 303(d) listings, the State of New Mexico has listed Fenton Lake on the impaired lakes list and has issued fish consumption advisories for Cochiti Reservoir (Table 3). These advisories pertain to mercury, which has been found in some fish at concentrations that could lead to significant adverse human health effects. Although the levels of mercury in waters of these lakes are insignificant, very low levels of elemental mercury found in bottom sediments are passed through the food chain progressively from smaller to larger fish, resulting in elevated levels in the larger fish. The advisories are guidelines only; no associated legal restrictions on catching or eating fish from these lakes have been issued. The State continues to recommend fishing and camping at these lakes, but urges that those who catch and eat fish from these lakes make an informed decision as to what fish they can safely eat. Although the occasional consumption of fish from these lakes poses little risk and the water quality standards for mercury are not exceeded, repeated ingestion over a long period could result in serious health problems.

Table 3. Impaired Lakes and Waters with Fish Consumption Guidelines Proposed for the 2000-2002 §303(d) List

Water Body Name	Total Size Affected [a]	Probable Source(s) of Pollutant/Threat	Specific Pollutant(s) or Threat	Toxics at Chronic Levels	Acute Public Health Concern
Fenton Lake	27	• Agriculture • Recreation • Road Maintenance • Land Disposal • Reduction of riparian vegetation	• Total phosphorus • Siltation • Nuisance algae	NA	No
Cochiti Reservoir	1,240	• Atmospheric deposition • Agriculture	• Fish guidelines • Siltation • Nuisance algae • Pesticides	Hg	No

Source: NMED, 2002a.
[a] Acres within the jurisdiction of the State of New Mexico.
NA = Not applicable
Hg = Mercury

1.2 Groundwater Quality

Current and potential uses of the MRG planning region's groundwater resources require that groundwater be protected from contamination. Groundwater contamination has already occurred from both point and nonpoint sources in some areas of the planning region. For this assessment, information about existing facilities that may have the potential to impact groundwater quality was examined through a review of NMED records.

1.2.1 Point Sources of Groundwater Contamination

Within New Mexico, NMWQCC (2002) reports the following statewide frequency of point source groundwater impacts from various contaminant sources:

- Underground (fuel) storage tanks (USTs) 58.5 percent
- Oil and gas 13.7 percent
- Miscellaneous industry 10.1 percent
- Centralized sewage works 4.5 percent
- Mining 3.7 percent
- Aboveground (fuel) storage tanks/pipelines 3.4 percent
- Dairies and meat packing 2.8 percent
- Landfills 0.8 percent
- Unknown/other 2.5 percent

NMWQCC (2002) reports 28 cases of point source contamination of groundwater and 86 contaminated supply wells in Sandoval County and 239 cases of point source contamination of groundwater and 513 contaminated supply wells in Bernalillo County. In addition, 52 cases of point source contamination of groundwater and 161 contaminated supply wells are reported in Valencia County (NMWQCC, 2002).

Underground Storage Tanks

Leaking underground storage tanks (USTs) are one of the most significant point source contaminant threats. As of September 2002, NMED (2002d) had reported 734 leaking UST cases in the planning region (Table 4). These leaking USTs represent releases of gasoline, jet fuel, diesel, gasoline additives, and petroleum constituents such as benzene, toluene, ethyl benzene, and xylene. The leaking UST sites do not necessarily signify that groundwater contamination or water supply well impacts have actually occurred, but that the potential exists. Details indicating whether groundwater has been impacted and the status of site investigation and clean-up efforts for individual sites can be obtained from the database, which is accessible from the NMED website (www.nmenv.state.nm.us/ust/leakcity.htm).

Table 4. Summary of Leaking Underground Storage Tank Sites in the Middle Rio Grande Planning Region

County	City	Number of Sites	Number of Sites with Water Supply Impacts
Bernalillo	Albuquerque	600	12
	Cedar Crest	1	0
	Kirtland Air Force Base	18	0
	Tijeras	10	3
Sandoval	Bernalillo	12	0
	Corrales	1	0
	Cuba	16	0
	Jemez Springs	5	1
	Rio Rancho	9	0
	San Ysidro	3	1
Valencia	Belen	33	2
	Bosque Farms	10	2
	Los Lunas	16	2

Source: NMED, 2002d

Most leaking UST sites in the planning region are concentrated around developed municipal areas such as Albuquerque and are inherently in close proximity to the water supply sources serving these communities. Many additional facilities with registered USTs that are not leaking are also included in the NMED UST database. These USTs present a potential for groundwater quality impacts that could affect available water resources in and near the population centers in the region.

Groundwater Discharge Plans

The NMED Groundwater Quality Bureau regulates facilities with wastewater discharges that have a potential to impact groundwater quality. These facilities must comply with NMWQCC regulations and obtain an approved discharge plan that stipulates measures to be taken to prevent, detect, and if necessary, remediate groundwater contamination. Facilities that are required to provide discharge plans include mines, sewage discharge facilities, dairies, food processors, sludge and septage disposal operations, and other industries. A summary list of the discharge plans in the MRG planning region is provided in Table 5.

The NMWQCC regulations have requirements for the clean-up of groundwater contamination that is detected under an approved discharge plan. However, these facilities still have the potential to contaminate groundwater in ways that may affect the quantity and availability of water supplies. Details indicating the status of discharge plan, waste type, and treatment for individual permittees can be obtained from the NMED website (www.nmenv.state.nm.us/gwb/Web%20Site-DPs.xls).

Superfund Sites

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) was enacted by the U.S. Congress on December 11, 1980. This law created the Superfund program to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment. Information regarding the location and status of sites within the MRG planning region listed by EPA as Superfund hazardous waste sites is provided in Table 6. In addition, the EPA prepares a National Priorities List (NPL) that identifies, through a hazard ranking system, which of these sites warrants remedial action. Currently, there are 3 sites within the planning region on the NPL and 12 sites that have either been removed from the list or have no further action planned. The remaining 16 sites either need investigation or are under investigation to determine if the site will be placed on the NPL.

Landfills

Landfills used for the disposal of municipal and industrial solid waste can contain a variety of potential contaminants that may impact groundwater quality. Landfills operated since 1989 have been regulated under the New Mexico Solid Waste Management Regulations. Many small landfills throughout New Mexico, including landfills in the planning region, closed before the 1989 deadline to avoid more stringent final closure requirements. Within the planning region, there are currently 5 operating landfills and 43 closed landfills (NMED, 2000, 1996, and 1990; Nelson, 1997) (Table 7). Landfills present concerns for water quality, because impacts can occur from leachate, landfill gas, and storm water runoff.

1.2.2 Nonpoint Sources of Groundwater Pollution (Septic Systems)

A primary water quality concern in the planning region is shallow groundwater contamination due to septic systems in Bernalillo, Corrales, Albuquerque, Carnuel, Bosque Farms, Los Lunas, and Belen (NMWQQC, 2002). In shallow water table areas, septic system discharges can percolate rapidly to the underlying aquifer and increase concentrations of:

- Total dissolved solids (TDS)
- Iron, manganese, and sulfides (anoxic contamination)
- Nitrate
- Potentially toxic organic chemicals
- Bacteria, viruses, and parasites (microbiological contamination)

Because septic systems are generally spread throughout rural and urban areas, they are considered a nonpoint source. Most of the serious septic system impacts have occurred where groundwater is shallow. Collectively, septic systems and other on-site domestic wastewater disposal constitute the single largest known source of groundwater contamination in New Mexico (NMWQCC, 2002), with many of these occurrences in the shallow water table areas along the Rio Grande valley. Protection of shallow groundwater quality in the populous valley areas of the planning region plays an important role in maintaining the available water resources in these areas.

Measures are being taken to lessen the impacts of septic systems on water quality in the planning region. Bernalillo County has recently enacted a strengthened wastewater ordinance (Bernalillo County Municipal Code, 2001) to address this issue. The new ordinance is performance-based in that treatment requirements are determined by on-site physical conditions and an assessment of the potential risk that effluent will contaminate groundwater. Ongoing progress is also being made to connect expanded areas to centralized sewer systems, and vacuum sewer designs have been implemented to minimize leakage that occurs in pressurized sewage lines. The Bernalillo County wastewater ordinance and progress in expanding centralized sewer systems can be used as a model for similar ordinances to address the issue of groundwater contamination from septic tank discharges in vulnerable areas throughout the planning region.

2. Naturally Occurring Water Quality

Water resources within the MRG planning region are constrained by naturally occurring water quality conditions. Most surface water is suitable to provide irrigation supplies, but can only be used as a drinking water supply with treatment. The planning region has groundwater supplies that can be used for drinking water without treatment (other than chlorination for municipal systems). Other groundwater in the region is of unsuitable quality, without treatment, for most uses because of high salinity or the presence of trace metals, as discussed in the following sections.

2.1 Groundwater Salinity

The largest source of fresh groundwater suitable for drinking water supplies and most other uses is the middle and upper Santa Fe Group alluvial sediments of the Middle Rio Grande basin. The terminology used for classification of water quality based on the total dissolved solids is presented in Todd (1980) and summarized in Table 8.

Table 8. Classification of Saline Groundwater

Classification	Total Dissolved Solids (mg/L)
Fresh water	0 - 1,000
Brackish water	1,000 - 10,000
Saline water	10,000 - 100,000
Brine	>100,000

mg/L = Milligrams per liter

Groundwater meeting the New Mexico drinking water standard of 1,000 mg/L occurs up to a depth of approximately 3,000 feet below ground surface (ft bgs) in the middle Rio Grande basin (Kelley, 1974; U.S. Department of the Interior, 1970). At greater depths in the Santa Fe Group sediments, groundwater becomes progressively more saline.

Saline and brackish groundwater exists in formations at the western boundary of the MRG planning region. This saline water is present in deeper portions of the San Andres Limestone and Glorieta Sandstone aquifers in the western portions of Sandoval, Bernalillo, and Valencia

Counties. Outside the planning region, the San Andres and Glorieta are important aquifers, but where they occur in the region, they contain highly mineralized water. Constraints on groundwater availability at the eastern margin of the planning region are primarily related to the uplift of the Sandia and Manzano Mountains and the limited water production of formations that overlie the uplifted Precambrian basement rocks. A number of formations provide good water quality in the East Mountain portion of the planning region; however, the yield of these formations to small public water supply systems and domestic wells is relatively small compared to the yield from the central basin Santa Fe Group aquifer.

Desalination can be used to convert brackish or saline water to fresh water by removing dissolved minerals (e.g., sodium and chloride ions). Sources of brackish and saline groundwater are available within the planning region, and desalination can make these currently unused water sources usable. The ability to develop these sources depends largely on whether pumping the brackish or saline groundwater will affect existing freshwater sources within the middle Rio Grande basin. Brackish and saline groundwater in the lower Santa Fe Group sediments of the middle Rio Grande basin, below approximately 3,000 ft bgs, has been considered as a potential water resource (U.S. Department of the Interior, 1970). However, pumping this deep groundwater within the basin could draw shallow groundwater of good quality into deeper portions of the aquifer, adversely impacting the fresh water quality and contributing to water level declines in the upper fresh water aquifer. Whether or not pumping of deep saline groundwater will have an adverse impact on fresh water must be evaluated on a case by case basis.

2.2 Arsenic and Other Trace Metals in Groundwater

Trace metal constituents occurring in New Mexico groundwater at concentrations that sometimes exceed drinking water standards include arsenic, iron, manganese, radium, and uranium. EPA's primary maximum contaminant levels (MCLs) for these constituents, which must be met by all public water supplies, are listed in Table 9.

Table 9. Drinking Water Standards for Selected Trace Constituents

Constituent	EPA MCL [a]
Arsenic	10 µg/L [b]

Constituent	EPA MCL [a]
Iron	0.3 mg/L [c]
Manganese	0.05 mg/L [c]
Radium	5 pCi/L
Uranium	30 μg/L [d]
Gross alpha radiation	15 pCi/L

[a] Pursuant to the Safe Drinking Water Act, 42 U.S.C. 300f *et seq*.
[b] New arsenic MCL becomes effective in January 2006.
[c] Secondary (non-enforceable) standard established for aesthetic reasons.
[d] New uranium MCL takes effect December 8, 2003.

EPA = U.S. Environmental Protection Agency
MCL = Maximum contaminant level
μg/L = micrograms per liter
mg/L = milligrams per liter
pCi/L = picocuries per liter

These constituents are widespread as a result of their natural occurrence in groundwater, although they may also occur as anthropogenic contaminants. Iron and manganese are mobilized from soils under anaerobic conditions that can be caused by septic systems and other organic contaminant releases (NMWQCC, 2002).

Arsenic is currently the most significant naturally occurring contaminant for two reasons. First, it is widespread in areas that are currently used for drinking water supplies in the planning region. Second, in January 2001, the U.S. Environmental Protection Agency (EPA) lowered the arsenic drinking water standard from 50 μg/L to 10 μg/L. The new standard applies to both community water systems and non-transient, non-community water systems. Public drinking water supplies must comply with the new 10 μg/L arsenic MCL within five years of promulgation of the new rule, that is, on or before January 22, 2006. However, certain provisions for extensions due to technical or economic hardship are available.

An extensive study of the occurrence of arsenic in the Middle Rio Grande basin is presented by Bexfield (2001). This study included sampling groundwater from 288 wells and springs distributed across the basin. The source of arsenic-rich waters is recognized as the Jemez Mountains volcanic center, from which arsenic-bearing sediments have been distributed throughout the Santa Fe Group sediments in the Rio Grande basin (Bexfield, 2001). Arsenic concentrations tend to be highest in the northwestern and central portions of the basin, where they may exceed 20 μg/L (Bexfield, 2001).

Approximately one-third of the supply wells in the planning region may exceed the new arsenic standard of 10 µg/L (Bexfield, 2001) and will need to be brought into compliance with treatment. Without treatment, water supplies in the planning region will be substantially limited and the continued use of many existing public water supply wells will not be possible. Many of the same technologies used for arsenic treatment are also applicable to the removal of the other constituents such as dissolved iron, manganese, and uranium. Specific arsenic treatment technologies and costs are discussed in Section 3.3.

Secondary Water Quality Implications of Arsenic Treatment

All types of arsenic treatment produce wastes that can have secondary implications for potential water quality degradation. The primary environmental concern for arsenic treatment (and treatment to remove other trace constituents) involves the management of waste residuals, such as reverse osmosis (RO) brine, coagulation/microfiltration sludge, or spent ion exchange resins.

Generation and disposal of RO brine (highly concentrated, saline water) may be undesirable for several reasons including potential impacts on groundwater or surface water quality, water conservation, and economic considerations. Alternatives for the disposal of brine and the associated water quality issues include:

- *Deep subsurface injection*: Must meet regulatory requirements to prevent impacts on other water resources and requires a Class V well permit from the NMED Underground Injection Control (UIC) Program.

- *Discharge to surface watercourses:* Requires an approved NPDES permit. Within the MRG planning region, it appears that this type of discharge may not be permitted because of degradation of surface water quality.

- *Discharge to sanitary sewer:* Brine disposal to sanitary sewers may not require a permit if the quantities are small enough to ensure that there is no significant salinity change in total flow to the wastewater treatment plant.

- *Discharge to evaporation ponds:* Disposal of brine in lined evaporation ponds requires an approved Ground Water Discharge Plan from NMED under the NMWQCC regulations.

- *Evaporation, crystallization, and disposal of solid salt in a solid waste landfill:* Solid salt is generated from the brine, but water is lost to evaporation.

Solid wastes generated by the alumina absorption, coagulation/microfiltration, or ion exchange processes require disposal in a permitted landfill. The most important consideration is whether the waste sludge or solids are classified as hazardous wastes under the Resource Conservation and Recovery Act (RCRA) regulations. This determination is based on the results of laboratory testing using the Toxicity Characteristic Leaching Procedure (TCLP) to determine if the arsenic concentration exceeds the TCLP limit of 5 mg/L. If the waste fails the TCLP test, it is classified as a RCRA hazardous waste based on the toxicity characteristic for arsenic. Wastes that pass the TCLP test would be classified as non-hazardous municipal waste and could potentially be disposed of at any permitted municipal landfill. This regulation also applies to waste products generated from treatment processes to remove trace constituents other than arsenic.

3. Water Quality Impacts on Water Supply

The water supply available in the MRG water planning region is limited, since the quality of surface water and groundwater restricts supplies to certain uses that are suitable for the quality available. Surface water provides much of the irrigation supply in the planning region, but requires treatment and incurs higher costs to meet drinking water standards. High quality groundwater from the Santa Fe Group aquifer in the Middle Rio Grande basin provides most of the drinking water in the planning region. In total, more than 700,000 residents rely almost exclusively on groundwater for drinking water supplies (Bexfield, 2001). However, the quantity of high quality groundwater is limited, and in portions of the MRG planning region groundwater supplies are more saline and are unsuitable for most uses. Additionally, some of groundwater currently used for drinking water supplies within the planning region contains arsenic at concentrations that exceed the new MCL of 10 µg/L.

This section addresses the most significant water quality issues that affect water supply availability in the MRG planning region. First, a summary of contamination impacts in the planning region is provided. This is followed by discussions of programs currently being implemented and potential approaches to address the following key issues:

- Groundwater quality protection
- Arsenic treatment
- Septic system impacts

3.1 Contaminant Impacts on Water Supply

Numerous contaminant sources exist in the planning region that have caused or have the potential to cause adverse water quality impacts. Within the planning region, the NMWQCC (2002) reports 760 contaminated supply wells. These include both public supply and domestic wells and constitute a significant loss of water supply capacity.

The overall effect on water supply from contaminant impacts is uncertain. There are many contaminated sites, not all of which are well defined, and the extent of future contaminant migration and impacts cannot be predicted with certainty. Within the planning region, the number of sites where groundwater is contaminated or threatened can be summarized as follows:

Bernalillo County

- 239 cases of contamination
- 513 contaminated supply wells
- 629 leaking underground storage tank sites
  - 15 sites that impact water supply
- 21 CERCLA Superfund sites
- 119 groundwater discharge plans (potential point source)
- 31 landfills

Sandoval County

- 28 cases of contamination
- 86 contaminated supply wells
- 46 leaking underground storage tank sites
  - 2 sites that impact water supply

- 8 CECRLA Superfund sites
- 41 groundwater discharge plans (potential point source)
- 12 landfills

Valencia County

- 52 cases of contamination
- 161 contaminated supply wells
- 59 leaking underground storage tank sites
  - 6 sites that impact water supply
- 2 CERCLA superfund sites
- 49 groundwater discharge plans (potential point source)
- 5 landfills

Another variable that can be used to assess water quality impacts on water supply is the rate and success of contaminant remediation efforts. Remediation is important to prevent expansion of groundwater contaminant plumes and further migration of soil contaminants. Within the planning region, soil and/or groundwater remediation projects have been implemented as follows (NMWQCC, 2002):

- *Bernalillo County:* 87 projects
- *Sandoval County:* 15 projects
- *Valencia County:* 24 projects

The value and importance of remediation efforts should not be overlooked in the efforts to provide a safe water supply, as it is generally less costly to remove contaminants before they have become widespread than afterward. The full long-term impact of contaminants on water supply availability and costs for remediation and/or development of replacement water supplies is uncertain.

3.2 Groundwater Quality Protection

Groundwater protection and permitting requirements under New Mexico regulatory programs provide for technical review and permitting of nearly all contaminant sources that have a significant potential to impact water quality. These established programs provide critical protection of water supplies, preventing losses of water resources that, in some cases, may be irreversible.

Within Bernalillo County, the importance of water supply protection has led the County and City of Albuquerque to adopt stringent measures under the Albuquerque/Bernalillo County Ground-Water Protection Policy and Action Plan (GPPAP) (Policy Coordinating Committee, 1995). The GPPAP limits certain potential contaminant sources within areas that are vulnerable to aquifer contamination or are designated for current or future water supply. Aquifer vulnerability has been analyzed for Bernalillo County using a numerical ranking system that considers depth to groundwater and aquifer and soil properties (Aller et al., 1987) to map the County. The GPPAP calls for delineation of specified wellhead protection areas to be established around each public supply well, within which potential contaminant sources are restricted. Wellhead protection areas include the estimated 10-year capture zone around each well, providing additional protection of the water supply system and protecting significant volumes of water for future use.

Delineation of aquifer vulnerability and wellhead protection areas has not been implemented for Sandoval and Valencia Counties. The New Mexico Source Water Assessment and Protection Program (SWAPP) could be employed by communities in these counties to monitor and control development near public supply wells to protect against possible sources of contamination. This is a federally funded program, overseen by the U.S. EPA, that assists communities in protecting their drinking water supplies. The New Mexico SWAPP will assist local communities in:

- Determining the source water protection area for the water system
- Taking inventory of actual and potential contaminant sources within the source water protection area
- Determining the susceptibility of the source area and water system to contamination
- Reporting the SWAPP findings to the water utility, its customers, and the community
- Working with the community and other stakeholders to implement source water protection measures that safeguard and sustain the water supply into the future.

More information about this existing program, which can be used to address protection of public supply wells with minimal additional cost to the local community, is available at the SWAPP website (http://www.nmenv.state.nm.us/dwb/swapp.html).

Installation of individual supply wells by property owners has not been restricted to date, but water quality impacts could lead to regulatory restriction on installing wells where contaminants may be present or in areas vulnerable to groundwater contamination. A property owner's right to drill a domestic well falls under the purview of the New Mexico Office of the State Engineer (OSE), but local governments can implement additional controls. The issue of restricting wells in sensitive areas is as much a social and political issue as it is a technical one.

Restricting wells can limit public exposure to contaminated groundwater, but will not alleviate the water contamination issue. Moving the point of groundwater withdrawal may bypass the contamination, but does not replace the loss of the water supply resources within the impacted area. Instead, groundwater depletions must be increased elsewhere, in areas of higher quality groundwater. Any restrictions that may be placed on supply well locations to protect against contaminant exposure will impact water supply systems and the location of water production.

3.3 Arsenic Impacts on Water Supply

As mentioned in Section 2, the dominant water quality issue now facing the planning region is how to achieve compliance with the new federal arsenic standard of 10 µg/L, beginning in 2006. Naturally occurring arsenic impacts a far greater volume of the planning region's water supply than all of the other contaminant sources combined. Bexfield (2001) estimates that approximately one-third of water supplies in the planning region may exceed the new standard. For example, nearly half of the City of Albuquerque's 92 supply wells have arsenic concentrations that exceed 10 µg/L (Bexfield, 2001).

Because arsenic affects groundwater that the planning region relies on for its water supply, the development of plans and technologies for cost-effective arsenic treatment is critical to maintain the existing supply. In addition, future water supply development will be strongly influenced by the distribution of arsenic in the aquifer, causing development plans to shift to areas where supply wells are most likely to meet the arsenic standard. The added cost of arsenic treatment for groundwater will also make surface water more attractive as a drinking water supply source, although it has been more costly than groundwater in the past because of the need to treat the water prior to use.

3.3.1 Arsenic Treatment Technologies

Treatment technologies to reduce arsenic concentrations are relatively new. In recent years, considerable research has been conducted in this area, leading up to adoption of the new, more stringent MCL for arsenic. Technologies for arsenic removal are still evolving rapidly, and technology breakthroughs are likely in the coming years. Both the U.S. EPA and the American Water Works Association Research Foundation (AWWARF) have investigated available technologies for the removal of arsenic from groundwater and currently support the development of new technologies.

The U.S. EPA has identified the following types of processes as applicable to the removal of arsenic from drinking water (U.S. EPA, 2000):

- Precipitation processes (e.g., coagulation/filtration, lime softening, etc.)
- Sorption processes (e.g., activated alumina)
- Ion exchange processes
- Membrane processes (e.g., nanofiltration, RO)
- Alternative technologies

AWWARF has identified the following technologies as the most promising for aboveground arsenic removal: (1) sorption on activated alumina or other solid media, (2) ion exchange, (3) coagulation/microfiltration, and (4) nanofiltration/RO (Amy et al., 2000). Subsurface arsenic treatment is an innovative and potentially cost-effective technology for in situ arsenic treatment in a zone surrounding an affected supply well (Miller, 2001). In areas with water quality impacted by trace constituents such as fluoride, nitrate, or uranium, treatment processes for arsenic removal can also be used to remove these other constituents.

3.3.2 Selection of Preferred Arsenic Treatment Technology

Many factors must be considered in selecting the most appropriate arsenic treatment technology for a given site including source-water arsenic concentration, total flow rate, general water chemistry, and proximity to an approved disposal site for waste sludge. Water conservation is an important consideration in selecting the preferred technology for a given site, since some technologies for arsenic removal, such as RO, result in a large wastewater stream, while others, such as activated alumina adsorption or coagulation/microfiltration, waste very little water (Chwirka et al., 2000). The high water loss from some technologies may be a significant detriment in a planning region with limited water supplies.

Another consideration is whether the situation requires numerous separate treatment facilities or a single large facility. In many communities in the MRG planning region, the dispersed locations of supply wells, coupled with the large elevation difference between wells, requires that arsenic treatment systems be installed at each wellhead or storage tank rather than at a single large treatment plant (Chwirka et al., 2000). This restriction limits the possibility of economy of scale, making certain technologies more appropriate than others.

Small communities may be able to use point-of-use, ion exchange, or RO systems to remove arsenic within the home. However, treatment costs for small systems will always be higher per household served than centralized systems (Gurian and Small, 2002). Therefore, where feasible, the regionalization of water treatment systems benefits consumers.

3.3.3 Financial Considerations

Communities in the MRG planning region that rely on groundwater with high concentrations of arsenic face increased costs for treatment when the new MCL goes into effect. While federal funding may become available to assist communities in complying with the new drinking water standard, the operation and maintenance costs for arsenic treatment plants will ultimately be passed on to customers. Bitner (2001) has investigated anticipated arsenic treatment costs in New Mexico and found that in addition to the variables mentioned above, the most cost-effective technology for arsenic treatment at a particular location depends largely on system capacity. For example, RO may prove the most cost-effective for small point-of-use systems, whereas large public water supplies may find the coagulation/microfiltration technology most economical.

The American Water Works Association (AWWA) arsenic work group developed a tool to help communities estimate their costs to comply with the new drinking water standard (AWWARF, 2000; Chwirka and Narasimhan, 2000). The tool helps calculate capital and operations and maintenance (O&M) costs, as well as monthly rate increases that can be expected by customers. CH2M-Hill (1999) has investigated arsenic treatment costs ease of implementation for the City of Albuquerque and concluded that coagulation/microfiltration is the preferred technology. Ion exchange was rejected because of the large volumes of generated waste brine and salt that would require disposal.

3.4 Septic System Impacts on Water Supply

Another dominant water quality issue that affects water supply in the planning region is the degradation of shallow groundwater by septic systems. Septic systems and other on-site domestic wastewater disposal systems constitute the single largest known source of groundwater contamination in New Mexico (NMWQCC, 2002). The impact of septic systems is an issue that must be addressed at the local level, because New Mexico regulatory programs do not cover widely distributed septic systems with the same stringent water quality protection that point-source dischargers receive.

Septic system impacts affect the Rio Grande valley, where groundwater is particularly vulnerable, and other areas where numerous septic systems are used. The impact of septic systems is compounded by the fact that areas with numerous septic tanks also have numerous domestic supply wells. The close proximity of domestic wells to septic systems represents a serious regional water contamination and public health issue. Broad areas of the valley and hundreds of supply wells have been affected (Policy Coordinating Committee, 1993). Domestic supply wells tend to be shallow and are easily contaminated by nitrate, iron, manganese, and coliform bacteria that result from septic tank releases. Elevated contaminant concentrations and impacted supply wells have also occurred in areas with deeper groundwater and in the East Mountain area (Policy Coordinating Committee, 1993).

Ongoing efforts to reduce septic system use by extending centralized sewage systems in Bernalillo County seek to improve groundwater quality in affected areas (Hansen and Gorbach, 1997). The future enactment of strengthened on-site wastewater treatment ordinances in Sandoval and Valencia Counties, modeled after the Bernalillo County ordinance discussed in Section 1, may help address the issue of regional water contamination from septic tanks within the planning region.

3.4.1 Alternative Technologies for Septic System Replacement

Alternative technologies are available to replace conventional septic systems with systems that provide better protection of groundwater quality. Two general alternatives are available, and both have been implemented to some degree within the planning region, demonstrating their feasibility. In broad terms, these alternative technologies include:

- *Construction of expanded regional wastewater collection systems.* Under this approach, septic systems are replaced with connections to centralized wastewater collection, treatment, and disposal facilities. In some areas, this involves expansion of collection systems tied to existing wastewater treatment facilities. In areas distant from existing treatment facilities, entirely new systems would need to be designed and constructed. This infrastructure is costly, although funding may be available from a variety of sources. Actual costs depend on the location and density of the septic systems being replaced and on the distance to the treatment facility. A benefit of this approach is that treated wastewater may be put to secondary use for irrigation purposes or to obtain return flow credits from the OSE.

- *Advanced on-site wastewater treatment systems.* A wide variety of commercially available secondary and tertiary wastewater treatment systems are suitable for individual wastewater systems at a cost of approximately $5,000 to $15,000 for installation (Rose, 2001). These systems use filtration, disinfection, and other biological processes to improve effluent quality. Ongoing operation and maintenance of the on-site treatment systems is also required. An excellent resource on this subject is the National Onsite Wastewater Recycling Association, Inc. (http://www.nowra.org/who.shtml).

To address serious groundwater pollution problems in vulnerable areas, local governments may consider adopting regulations that call for advanced on-site wastewater treatment technologies for most new residences that would otherwise install simple septic systems. Ordinances may also include wording that requires existing systems to convert to new technologies over time.

3.4.2 Water Quality and Water Supply Enhancements

Protection of groundwater quality is the predominant reason to implement alternatives to conventional septic systems; however, other water supply enhancements could be realized by addressing this issue. Managing the use of groundwater in impacted areas can also be beneficial. Impacted groundwater may not be of suitable quality for domestic wells without treatment, but may be suitable for irrigation. Pumping impacted water for irrigation can reduce withdrawals of surface water for irrigation and help to remove contaminants from the shallow aquifer.

An important issue for the planning region is the use of wastewater for return flow credits or secondary reuse. Collecting wastewater for centralized treatment could increase the allowable diversion for water supply, based on the amount of return flow to surface water. Another beneficial approach is the reuse of treated effluent for irrigation or other suitable uses to meet growing demands and offset the use of high quality groundwater.

With increased wastewater flows for centralized treatment, most municipalities in the planning region would be eligible for increased return flow credits to the Rio Grande. Water supply diversions may be increased under OSE approval of a return flow plan. Such a plan can credit a user with return flows and allow diversions to increase by the same amount. Increased return flow credits would allow a municipality to increase diversions for use elsewhere in its water system. Such offsets could allow additional pumping from municipal wells or increased surface water withdrawals.

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