8. Analysis of Strategies for Meeting Future Demand

The goal of regional water planning is to ensure that the region is prepared to meet future water supply needs. Accordingly, after a region has assessed its available water supply and projected future demand for water, the next step in regional water planning is to develop strategies for meeting the projected water demand. Strategies (also sometimes referred to as alternatives) developed for regional water plans are actions that the region can take to increase supply, reduce demand, protect or improve water quality, or better manage water resources so that the water supply of the region continues to be viable.

In the Northeast region water demand may increase by up to 8 percent (high use scenario [Section 6.4]) by 2050. Additionally, groundwater supply is declining in some areas of the region, and multiple studies suggest that communities supplied by the Ogallala aquifer may have exhausted their supply within 30 to 40 years (CH2M Hill, 2005d) (additional information regarding water supply is provided in Section 5).

Because current water supplies are not sustainable in northeast New Mexico, strategies for how best to meet projected demand with the available supply were evaluated. This section provides information on the process used to identify and screen strategies for meeting future demand (Section 8.1) and analyzes the feasibility of priority strategies selected by the Steering Committee (Sections 8.2 through 8.10).

8.1 Identification and Selection of Strategies

An initial list of potential strategies was developed at Steering Committee meetings, which were open to the public. This initial list was revised and expanded at a series of community meetings held in Clovis, Logan, Clayton, and Mosquero in October 2005. Citizens added to the list of strategies, and each group, through a voting process, identified strategies that they considered to be most important for the region.

To assist the Steering Committee in prioritizing strategies, DBS&A prepared a table listing all potential strategies that had been discussed for the region along with the number of votes received by each strategy at each of the five meetings (Appendix F). From this listing, DBS&A identified 16 potential strategies that received half or more votes during at least one of the five meetings where the strategies were voted on. At subsequent Steering Committee meetings, this short list of strategies was discussed with the purpose of selecting 12 or fewer strategies to be analyzed in this regional water plan.

Through this process the Steering Committee selected the following nine priority strategies:

- Municipal conservation
- Agricultural conservation
- Groundwater management
- Rangeland conservation and watershed management
- Water rights protection
- Eastern New Mexico Rural Water System
- Infrastructure upgrades
- Planning for growth
- Dam construction

In accordance with the ISC template, these priority strategies were evaluated with regard to their technical, financial, and political feasibility as well as anticipated hydrological, environmental, social, and cultural impacts. The results of these evaluations are described in Sections 8.2 through 8.10.

8.2 Municipal Conservation and Management

Water conservation is an important aspect of regional water planning because it allows the region to make efficient use of, and thereby extend, existing resources. The municipal conservation and management strategy was selected to help municipalities identify conservation opportunities and sources of inefficiencies. This strategy illustrates potential savings if water conservation programs are implemented by the municipal suppliers, rural public systems, and self-supplied domestic wells.

As the agricultural sector is the largest water user in the planning region, agricultural conservation probably represents the greatest opportunity for reducing demand and delaying depletion of aquifers (Section 8.3). However, though municipal demand is a smaller part of total demand, and municipal conservation will thus not greatly affect the overall water budget in the region, controlling municipal demand is important for reasons other than balancing the overall regional water budget:

- For any water rights permitting change that requires OSE approval, such as a change in point of diversion or place of use, the OSE will consider conservation. This requirement is part of an overall strategy by the State to ensure that water is being used wisely before additional diversions are permitted.

- The Water Trust Board, New Mexico Finance Authority (NMFA), and other state and federal funding programs for water supply infrastructure also require demonstration of adequate municipal water conservation as a condition of funding. Section 72-14-3.2 of the NMSA 1978 states that any public supply system with diversions of ". . . at least 500 acre-feet annually for domestic, commercial, industrial, or government customers for other than agricultural purposes, may develop, adopt and submit to the State Engineer, by December 31, 2005, a comprehensive water conservation plan, including a drought management plan, and that after December 31, 2005, neither the Water Trust Board nor the New Mexico Finance Authority shall accept an application from a covered entity for financial assistance in the construction of any water diversion, storage, conveyance, water treatment or wastewater treatment facility unless the covered entity includes a copy of its water conservation plan."

- Water conservation can also prevent or delay the need for expensive capital expenditures for developing new water supplies and acquiring additional water rights.

- Municipal conservation programs can provide benefits to individual systems and raise public awareness of the importance of controlling excessive water use.

- Mutual domestic water suppliers and individuals on shared wells could extend the productive life of their wells using indoor and outdoor conservation measures.

Municipalities and water suppliers in the Northeast Region are well aware of the need for conservation, and many have already undertaken some form of water conservation activity. For example:

- The City of Clovis has a conservation program that includes a water conservation ordinance, projects to implement wastewater reuse, and an active public education campaign.

- The Village of Mosquero has a water conservation ordinance that includes watering and water waste restrictions.

- The City of Portales has completed a 40-year water plan and has a conservation program that includes a schedule of increasing block rates, a leak detection and pipe repair/replacement system, treatment of effluent wastewater used irrigate farmland, a water meter testing, repair and replacement program, and an active public education campaign.

- Quay County has completed a 40-year water plan that identifies the steps it will undertake to address conservation needs.

- Union, Harding, Quay, and Curry Counties have requirements for low-flow plumbing and other conservation measures as part of their subdivision regulations.

Smaller water suppliers have not had the funding to develop comprehensive conservation plans, but have undertaken projects to replace leaking lines and install and replace meters. Table 8-1 summarizes additional recommended municipal conservation activities for the planning region.

Table 8-1. Recommended Municipal Conservation Activities
Northeast Region
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Water Supplier	Recommendations
Union County	
City of Clayton	• Implement a public education program • Consider revising rate structure to implement an increasing block rate structure • Adopt and implement a 40-year water plan • Obtain funding to implement conservation objectives such as addressing distribution system leaks • Consider adding a water conservation ordinance, including drought management planning • Complete a water system audit • Consider implementing a leak detection program for the water distribution system • Consider providing xeriscape incentives and requiring xeriscaping and graywater and/or rainwater systems in all new development
Village of Grenville	• Implement a public education program • Consider revising rate structure to implement an increasing block rate structure • Adopt and implement a water conservation plan • Complete a water system audit • Consider implementing a leak detection program for the water distribution system • Consider adding a water conservation ordinance, including drought management planning • Consider providing xeriscape incentives and requiring xeriscaping and graywater and/or rainwater systems in all new development
Village of Des Moines	• Implement a public education program • Consider revising rate structure to implement an increasing block rate structure • Adopt and implement a water conservation plan • Complete a water system audit • Consider implementing a leak detection program for the water distribution system • Consider adding a water conservation ordinance, including drought management planning • Consider providing xeriscape incentives and requiring xeriscaping and graywater and/or rainwater systems in all new development
Village of Folsom	• Implement a public education program • Consider building a water system (the Village currently does not have one), potentially joining with the Village of Des Moines to create a regional water system; include conservation measures with system expansion • Consider providing xeriscape incentives and requiring xeriscaping and graywater and/or rainwater systems in all new development

Table 8-1. Recommended Municipal Conservation Activities
Northeast Region

Water Supplier	Recommendations
Harding County	
Village of Mosquero	• Implement a public education program • Consider revising rate structure to implement an increasing block rate structure • Continue implementing water conservation projects and enforcing the existing water conservation ordinance • Complete a water system audit • Consider implementing a leak detection program for the water distribution system • Consider providing xeriscape incentives and requiring xeriscaping and graywater and/or rainwater systems in all new development
Village of Roy	• Implement a public education program • Consider revising rate structure to implement an increasing block rate structure • Adopt and implement a water conservation plan • Complete a water system audit • Consider implementing a leak detection program for the water distribution system • Consider adding a water conservation ordinance, including drought management planning • Consider providing xeriscape incentives and requiring xeriscaping and graywater and/or rainwater systems in all new development
Quay County	
City of Tucumcari	• Implement a public education program • Consider revising rate structure to implement an increasing block rate structure • Continue implementing meter installation and replacement programs • Adopt and implement a water conservation plan • Complete a water system audit • Consider implementing a leak detection program for the water distribution system • Consider adding a water conservation ordinance, including drought management planning • Consider providing xeriscape incentives and requiring xeriscaping and graywater and/or rainwater systems in all new development
Village of House	• Implement a public education program • Consider revising rate structure to implement an increasing block rate structure • Adopt and implement a water conservation plan • Continue and strengthen the existing public education program • Complete a water system audit • Consider implementing a leak detection program for the water distribution system • Consider adding a water conservation ordinance, including drought management planning • Consider providing xeriscape incentives and requiring xeriscaping and graywater and/or rainwater systems in all new development

Table 8-1. Recommended Municipal Conservation Activities
Northeast Region
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Water Supplier	Recommendations
Village of San Jon	• Implement a public education program • Consider revising rate structure to implement an increasing block rate structure • Continue implementing meter installation and replacement programs • Adopt and implement a water conservation plan • Complete a water system audit • Consider implementing a leak detection program for the water distribution system • Consider adding a water conservation ordinance, including drought management planning • Consider providing xeriscape incentives and requiring xeriscaping and graywater and/or rainwater systems in all new development
Village of Logan	• Implement a public education program • Consider revising rate structure to implement an increasing block rate structure • Adopt and implement a water conservation plan • Complete a water system audit • Consider implementing a leak detection program for the water distribution system • Consider adding a water conservation ordinance, including drought management planning • Obtain funding to implement conservation objectives identified in the Logan Infrastructure Plan • Consider providing xeriscape incentives and requiring xeriscaping and graywater and/or rainwater systems in all new development
Curry County	
City of Clovis	• Complete wastewater reuse project • Continue implementing water conservation projects and enforcing the existing water conservation ordinance • Complete a water system audit • Consider providing xeriscape incentives and requiring xeriscaping and graywater and/or rainwater systems in all new development
Village of Melrose	• Implement a public education program • Adopt and implement a water conservation plan • Consider adding a water conservation ordinance, including drought management planning • Complete a water system audit • Consider providing xeriscape incentives and requiring xeriscaping and graywater and/or rainwater systems in all new development

Table 8-1. Recommended Municipal Conservation Activities
Northeast Region
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Water Supplier	Recommendations
Village of Texico	• Implement a public education program • Consider revising rate structure to implement an increasing block rate structure • Adopt and implement a water conservation plan • Complete a water system audit • Consider implementing a leak detection program for the water distribution system • Consider adding a water conservation ordinance, including drought management planning • Consider providing xeriscape incentives and requiring xeriscaping and graywater and/or rainwater systems in all new development
Village of Grady	• Implement a public education program • Consider revising rate structure to implement an increasing block rate structure • Adopt and implement a water conservation plan • Complete a water system audit • Consider implementing a leak detection program for the water distribution system • Consider adding a water conservation ordinance, including drought management planning • Consider providing xeriscape incentives and requiring xeriscaping and graywater and/or rainwater systems in all new development
Roosevelt County	
City of Portales	• Enforce the water conservation measure that has been adopted by the City • Make water conservation plan improvements as recommended in the 2004 Water Conservation and Use Report • Complete a water system audit • Consider providing xeriscape incentives and requiring xeriscaping and graywater and/or rainwater systems in all new development
Village of Elida	• Implement a public education program • Consider revising rate structure to implement an increasing block rate structure • Adopt and implement a water conservation plan • Complete a water system audit • Consider implementing a leak detection program for the water distribution system • Consider adding a water conservation ordinance, including drought management planning • Consider providing xeriscape incentives and requiring xeriscaping and graywater and/or rainwater systems in all new development

Table 8-1. Recommended Municipal Conservation Activities
Northeast Region
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Water Supplier	Recommendations
Village of Dora	• Implement a public education program • Consider installing production and customer meters on the distribution system • Consider implementing an increasing block rate structure • Adopt and implement a water conservation plan • Complete a water system audit • Consider implementing a leak detection program for the water distribution system • Consider adding a water conservation ordinance, including drought management planning • Consider providing xeriscape incentives and requiring xeriscaping and graywater and/or rainwater systems in all new development
Village of Causey	• Implement a public education program • Consider installing production and customer meters on the distribution system • Consider implementing an increasing block rate structure • Adopt and implement a water conservation plan • Complete a water system audit • Consider implementing a leak detection program for the water distribution system • Consider adding a water conservation ordinance, including drought management planning • Consider providing xeriscape incentives and requiring xeriscaping and graywater and/or rainwater systems in all new development

8.2.1 Technical Feasibility

The overall objective a water conservation plan is to lower water use through a variety of conservation measures that can be easily implemented by a water supplier and its customers in a phased approach. This strategy description is not a comprehensive guide to water conservation. To implement successful conservation programs, water suppliers need to obtain the requisite funding to develop a conservation plan for each individual system; each conservation plan should include detailed information such as results of a water audit, estimated water savings for each aspect of the water conservation program, and development of an implementation scheme, including a task force and drought management coordination. General recommendations for the larger systems in the Northeast Region are provided in Table 8-1. These recommendations are based on the water system surveys discussed in Section 6.1. Additional local auditing and public and government involvement will be key to finalizing conservation plans for each individual system.

The following is a discussion of the various aspects of a municipal water conservation program. Conservation can be implemented through voluntary measures such as public education and rebates, through rate structures that provide an incentive to reduce demand, and/or through ordinances that institute fines for wasting water, require watering at certain times, or require other conservation measures.

8.2.1.1 Public Education Program for Residential and Commercial Users

For water conservation efforts to be successful, individuals must know why water conservation is essential and what they can do to save water. Consequently, public education and community outreach are important aspects of a comprehensive water conservation program. *A Water Conservation Guide for Public Utilities* (NM OSE, 2001) recommends two main components of a public education program:

- Using a wide range of resources to reach the public and assigning staff of the conservation entity (either the local government or local utility) to specific aspects of a public information campaign. The types of resources that can be used for dissemination of public information include:

- News media
- Speakers programs
- Public information materials (e.g., pamphlets, billing inserts)
- Exhibition, tours, or special events
- Web site

- Outreach in the public schools. Children who learn about conservation in the classroom will take that information home and educate their own families.

Numerous materials for all types of public education and school outreach programs are available on the OSE water conservation website (http://www.ose.state.nm.us/water-info/conservation/index.html). Other websites currently offer interactive water calculators to help users understand how much water they use and where they use it (http://www.h2ouse.net and http://www.tampagov.net/dept_water/conservation_education). These web calculators provide a simple method for doing a "home water checkup" and allow individuals to compare their home use with average use.

8.2.1.2 Water Audits

Audits of the water system help to provide information to identify current water uses by category, reduce losses in revenue, and identify problem areas. A primary objective of a water audit is to estimate and reduce water losses in the system. Comparison of production metering to meter readings for customer water accounts allows the utility to evaluate non-revenue water (NRW). NRW can result from inaccurate customer water meters, leakage in water mains and distribution lines, and failure to meter all the demands (e.g., fire hydrants are often not metered). Many utilities track water losses as a way to determine and locate problems in the water system.

Audits also help to determining the largest user categories, which can help to tailor a water conservation program that will have the greatest benefit.

8.2.1.3 Leak Detection

A program of systematically surveying portions of the water system should be conducted twice a year. A leak detection and repair program includes the use of computer-assisted leak detection equipment, a sonic leak detection survey, or any other acceptable method for detecting and locating leaks along water mains, at valves, and at meters. To help prevent leaks from occurring in the first place, loss prevention programs include pipe inspection, cleaning, and lining, as well as other maintenance and improvement of the distribution system to prevent leaks and ruptures from occurring. Remote sensors, which can provide ongoing monitoring of source, transmission, and distribution facilities as well as provide alerts to operators regarding leaks, pressure changes, equipment failures, and other issues, are also valuable.

8.2.1.4 Pressure Reduction

Because the rate of flow increases with pressure increases, water systems that are over-pressurized result in inefficient and higher water use. Reducing pressure can decrease water leakage, the volume of water released at faucets, and pipe and joint stresses, which can result in new leaks. Lower pressures can also extend the life of the water distribution system as well as decrease maintenance and repairs to the system.

Pressures above 80 pounds per square inch (psi) at customer meters should be assessed for pressure reduction (U.S. EPA, 1998; NM OSE, 2001). Subdivision requirements for Union, Harding, and Quay Counties require pressures below 80 psi for new development. To reduce pressures to 80 psi or less, pressure regulators or flow restrictors on services at the meter can be installed.

8.2.1.5 Wastewater Reuse

Municipalities are often positioned to water parks and golf courses with treated effluent. In 1992, the U.S. EPA published guidelines for water reuse, defining a broad range of reuse applications and presenting guidelines for treatment water quality and implementation; however, these guidelines are not legally binding, and to date, no federal regulations have been proposed for either nonpotable or potable reuse (Pontius et al., 2002).

The NMED's existing policy for the use of treated wastewater effluent for nonpotable uses was issued in 1985 and updated in August 2003 (NMED, 2003). The guidelines are intended to be used in conjunction with a groundwater discharge permit for any applications of the reuse water that can result in percolation to an underlying aquifer. This permit, which describes the reuse application (use, flows, etc.) and specifies a water quality monitoring program, must be filed with NMED for each reuse site. NMED guidelines do not allow for reuse of wastewater for potable applications. Generally, where overlap occurs, NMED guidelines are similar to or less conservative than U.S. EPA guidelines.

Communities in the Northeast Region seeking to conserve water could reuse wastewater in the following ways:

- *To supplement agricultural needs.* Treated wastewater may be pumped directly to agricultural areas for irrigation. As an example, during nine months of the year the City of Roswell, New Mexico sells all of its treated effluent to nearby farmers for irrigation, and wastewater is reused in Clovis and Portales for fodder crops. Wastewater reuse for irrigation is practical only if the point from which the treated wastewater is pumped is within a reasonable distance of the point of irrigation. Additionally, in New Mexico treated wastewater may only be used for non-food crops, such as alfalfa, unless the wastewater does not come into contact with the edible portion of the crop. The City of Clovis is also considering the reuse of wastewater for industrial and/or City landscape irrigation purposes.

- *For recreational uses (landscape irrigation).* Treated wastewater is commonly used for landscape irrigation, such as at parks, schools, and athletic fields, as other recreational uses involve bodily contact and potential human ingestion. As with agricultural uses, reusing wastewater for landscape irrigation is feasible only if the source of treated wastewater is within a reasonable distance of the reuse point. Wastewater is reused at Cannon AFB to water a golf course, and Tucumcari and Melrose plan to use treated effluent to water sports fields, golf courses and cemeteries.

Whether used for agriculture, recreation, landscape watering, aquifer recharge, manufacturing and industry, or return flow credits, wastewater must be treated prior to use to comply with applicable regulatory standards. In addition, some applications require a groundwater discharge plan under the NMWQCC regulations. The degree of treatment and the standards to be met depend upon the end use of the reclaimed water. For all reuse options where human contact with the treated wastewater is likely (i.e., landscape irrigation and recreational use), wastewater treatment will likely require secondary and tertiary (filtration and disinfection) treatment to meet applicable water quality standards.

- For all reuse options where treated wastewater is likely to come in contact with groundwater (e.g., agricultural irrigation, landscape irrigation, and aquifer recharge), a New Mexico groundwater discharge plan permit is necessary. Multiple reuse applications can be covered under the same groundwater discharge plan.

- The degree of treatment required for land application of wastewater for irrigation purposes depends on the types of crops grown.

- If water would be discharged to a natural waterbody for agricultural use, it must first be dechlorinated or disinfected by a method such as ultraviolet radiation or ozone injection.

- Discharging treated wastewater to a river (for return flow credits, for instance) requires treatment to meet the standards required by a U.S. EPA Region 6 written and enforced NPDES permit. (NPDES permitting in New Mexico is currently overseen by the U.S. EPA, but the NMED is negotiating to acquire primacy for the NPDES process.)

- If treated wastewater is discharged to a stream designated by the NMWQCC as "impaired," it may need to meet the receiving water quality standards established to meet the designated uses of that particular stream segment.

Maximizing the use of treated effluent will allow municipalities to reduce pumping of nonrenewable potable groundwater supplies.

8.2.1.6 Reducing Water Waste

Common types of water waste are overwatering (applying more water than is needed to keep landscapes green) and fugitive water, which can be seen in the form of runoff into City streets from lawns and landscaping for buildings and other properties. Overwatering also results in higher outdoor water use due to increased evaporation and evapotranspiration. To reduce water waste, communities can develop an ordinance that will provide for fines or surcharges when water waste occurs. A prototype for a water waste ordinance is included in the OSE guidance for municipal water systems (NM OSE, 2001). This ordinance template provides measures that apply to both normal operations and water emergencies and includes the following main elements:

- Designation of the types of prohibited water waste:
  - Water running off an area during landscape irrigation
  - Washing of impervious surfaces with a hose (except when needed to protect public health and safety)
  - Water leaks not fixed within eight hours
  - Landscape watering outside prescribed hours (e.g., typical prescribed hours are before 10:00 a.m. and after 6:00 p.m.)

- Fines and penalties for violations, which increase with the number of citations assessed to a property:
  - Imposition of a water waste surcharge to any customer in violation
  - Temporary or permanent restriction or discontinuance of flow to a property with recurring violations

- Exceptions, the opportunity to cure violations, and refunds of surcharge

- Administrative appeal process for customers (e.g., appeal to administrative hearing officer, water utility's general manager, or the board of directors)

The OSE prototype ordinance assumes implementation and enforcement by the utility general manager and board of directors. If a county-wide enforcement system is developed, a certain amount of coordination is needed to develop and enforce the ordinance.

8.2.1.7 Promotion of Xeriscaping

Xeriscaping is a type of landscaping that can significantly reduce outdoor water use, especially during the summer months. A municipality can promote xeriscaping by:

- Developing an ordinance to require xeriscaping on new development
- Promoting xeriscaping at existing residences through
  - Public education
  - Development of xeriscape demonstration projects and other technical assistance
  - Rate structures that provide an incentive for voluntary conservation measures
  - Implementation of a rebate program for replacement of existing lawns with xeriscaping.

Xeriscaping involves much more than simply removing grass and replacing it with gravel or other types of turf. A number of different principles or approaches are considered xeriscaping:

- *Low-water-use plants:* Select plant varieties that are most appropriate for the landscape design and that require low amounts of water.

- *Soil improvement:* Improve soil composition to increase water retention and promote root development and proper drainage.

- *Small turf areas:* Create small areas of turf for a specific function or aesthetics and use low-water-use grass varieties.

- *Efficient irrigation:* Design a landscape by zoning plants according to water needs, and use efficient watering techniques such as drip irrigation, which delivers water directly to the roots of the plant. Maintenance of an irrigation system is essential.

- *Soil covering:* Use mulch to cover the soil, thereby reducing evaporation and erosion.

8.2.1.8 Graywater Use

Graywater reuse refers to either residential or commercial reuse of water that does not contain blackwater (from toilets) or kitchen wastes. Water from sinks (excluding kitchens), laundries, bathtubs, or showers is considered to be graywater. Municipalities can support graywater reuse by:

- Providing educational materials and/or rebates for residents who want to install systems
- Requiring graywater reuse on new construction

New Mexico allows individual residences to apply up to 250 gallons per day (gpd) of graywater to household gardening and landscape irrigation without a discharge permit (Sections 74-6-2 and 74-6-4, NMSA 1978). Advantages of reusing graywater include the following:

- Replaces potable water use and therefore lowers water bills and possibly sewer bills for utility customers
- When used for outdoor irrigation, may support plant growth (due to the nutrients in graywater)
- Reduces energy and chemical use
- Possibly decreases the need to expand wastewater treatment facilities

Reusing graywater also has some disadvantages:

- May spread disease if system is not properly operated
- May develop odors if stored more than 24 hours
- May adversely impact soil (salt buildup)
- Decreases the amount of wastewater going to the treatment plant, which may affect the overall wastewater system
- Lowers the availability of reclaimed water for return flow credits (where applicable) or other uses

The standard components of a graywater system include (Little, 2003):

- Conveyance piping to collect water from a source and deliver it to the graywater system
- Surge tank to hold flows (e.g., plastic trash barrel)
- Filter to remove particles such as lint and hair (e.g., sock, sand filter)
- Storage tank to hold water until ready to use

- Three-way valve to allow graywater to go to sewer or septic system
- Pump to move water to distribution point such as irrigation system

A permit is required by NMED for use of more than 250 gpd of graywater. The permit needed is the same type of permit required for a septic system (Duttle, 1994). In issuing the permit, NMED considers treatment, storage, and disposal of the water (underground leach field versus surface disposal for irrigation).

No permit is required for less than 250 gpd if the following conditions are met:

- System overflow is directed to an existing wastewater system.
- Storage tank is enclosed and access is restricted.
- System is outside the floodway.
- The vertical distance between graywater and the groundwater table is at least 5 feet.
- Pipes for the graywater system are marked as nonpotable water.
- Graywater does not leave the property.
- Standing water is minimized and prohibited for more than 24 hours.
- Graywater is never applied by spraying.
- Graywater use complies with local ordinances.

8.2.1.9 Rainwater Harvesting

Rainwater harvesting is the collection of water from surfaces, including roofs, patios, and parking lots, and can be used for landscape irrigation, indoor plant irrigation, and fire protection, as well as many other applications. Historically, people have relied on rainwater harvesting for crop irrigation, drinking water, and landscape watering. Rainwater harvesting opportunities exist for residential and commercial sites and can easily be incorporated into a landscape during the design phase of new development. Harvested rainwater can also be used for drinking water, but is not recommended since it can be expensive to treat captured rainwater to meet drinking water standards.

Municipalities can require new construction with landscaping to include rainwater harvesting systems. Municipalities may want use a rainwater harvesting ordinance similar to the one recently adopted by Santa Fe County (Santa Fe County, Ordinance No. 2003-6). Under this new ordinance, Santa Fe County requires all commercial and residential developments (of 2,500 square feet [ft^2] of heated area or greater) to collect roof drainage into cisterns for reuse in landscape irrigation. Residential developments of less than 2,500 ft^2 of heated area are required to have cisterns, rain barrels, or other catchment basins to capture water from at least 85 percent of the roofed area.

The use of rainwater for landscaping can significantly reduce potable water use. Advantages of rainwater harvesting include the following (TWDB, 2004; COA, 1995; Waterfall, 2004):

- The water is free, not derived from the municipal supply; the only cost is associated with collection and use.
- Rainwater provides a source of water when other sources are not viable or available.
- Plants thrive on rainwater because it is free of salts, disinfection byproducts, and other chemicals that can be harmful to root growth.
- Holding rainwater on site can reduce off-site flooding and erosion
- Use of rainwater can reduce dependence on groundwater
- When relatively large volumes of water are held in areas with underlying pervious materials, some of that water may percolate to groundwater.
- Rainwater use helps the utilities reduce the summer water demand peaks
- Consumer's water utility bills may be reduced
- There are few limitations, and many harvesting systems are simple and inexpensive.

Many methods for rainwater harvesting are available, and many of them are inexpensive and have a relatively simple design. The three primary components of a rainwater harvesting system include the supply (rainfall), the demand (plant requirements), and the delivery system (Waterfall, 2004). Rainwater harvesting systems generally include a catchment, a distribution system, and a landscape holding area. A catchment is any system (preferably hard and smooth surfaces) from which rainwater can be harvested, such as roofs, pavements, and patios. The distribution system connects the catchments with the landscape holding areas and can include (Waterfall, 2004):

- Gutters and downspouts that direct roof water to the holding area
- Sloped sidewalks that move water directly to plants
- Channels, ditches, and swales that direct water to holding areas

- Curb cutouts that channel water runoff from streets and other impervious surfaces in urban centers, such as parking lots and sidewalks, to landscaped areas

Landscape holding areas are areas that hold water in the soil for use by plants. Holding areas can include crescent-shaped soil berms downslope of trees or planting areas to catch runoff, concave depressions vegetated with grasses or other plants that decrease erosion and increase the penetration of water into the soil, a grouping of large rocks covered in mesh wire (gabions) to contain water and reduce erosion, as well as other forms of holding areas.

Designing and installing rainwater harvesting systems can be as simple as diverting rainwater runoff to planted areas using a contoured landscape. More complex systems capture and store large amounts of water and distribute the water with a pump and drip irrigation delivery system. The OSE, through the New Mexico Water Conservation Program, provides information on the types of rainwater harvesting systems available, as well as how to determine the amount of water that can be collected and how to build, install, and maintain a rainwater harvesting system (http://www.ose.state.nm.us/water-info/conservation/rainwater.html). OSE policy states that the collection of rainwater harvested from rooftops “should not reduce the amount of runoff that would have occurred from the site in its natural, pre-development state.” Harvested rainwater may only be appropriated for on-site landscape irrigation and other on-site domestic uses (NM OSE, 2004).

8.2.1.10 Indoor Conservation Incentives

Toilets, washing machines, faucets, and showers account for more than 90% of indoor use (Vickers, 2001); therefore, efficient water-use appliances can significantly reduce indoor water use. To achieve reductions in indoor use municipalities can offer the following incentives to utility customers:

- A rebate for installation of low-water-use washing machines and/or toilets
- Toilet leak detection kits
- Retrofit kits that have a low-flow showerhead and faucet components

In addition, standards requiring the use of water-saving plumbing fixtures can be included in local building codes and subdivision requirements in accordance with OSE guidelines for new subdivisions.

8.2.1.11 New Construction Standards

The easiest way to implement water conservation into residential and commercial uses is to design and build water conservation features during construction. Construction standards can address issues such as graywater harvesting, rainwater harvesting, indoor plumbing fixtures, low-water-use appliances, and xeriscaping.

8.2.1.12 Water Conservation Incentives through Rate Structuring

Nationally, many utilities use pricing as a demand management tool. According to a 1992 AWWA survey, approximately 60 percent of the utilities in the U.S. use a conservation rate structure (NH DES, 2001). Four different types of rate structures can generally be classified as conservation oriented:

- *Uniform commodity rates:* All usage is charged at the same unit rate. Although not often viewed as water efficiency-oriented, uniform rates are an improvement over declining-block rate structures in which the price of water decreases as the volume of water used increases.

- *Flat seasonal rates:* This rate structure incorporates two or more different uniform volume charges for different seasons during the year. Generally, a higher rate is charged during the peak water usage season than during the off-peak season.

- *Inclining block rates:* An inclining-block rate structure (also called inverted block) involves the use of increasing rates for units of water consumption at higher levels of usage; that is, as water consumption increases, so does cost. Individuals who want to reduce cost will thus have an incentive to use less water. The City of Portales has this type of rate structure.

- *Excess use rates:* An excess use rate structure establishes an average base water usage volume during the non-peak period and a corresponding base water usage rate. During the peak period or season, water usage above the base level is charged at the base rate plus an excess use rate. Several variations of the excess use rate structure exist. Some utilities provide an allowance above the base usage during the peak season to recognize an increase in non-discretionary use during peak periods.

Each utility should analyze whether any of the above rate structures can achieve conservation in the local community. If an inclining block or excess use structure is implemented, the amount of water required for "basic human needs" can be determined and kept at an affordable rate for low-income households; thereafter, rates can increase. Some municipalities, such as Albuquerque, provide for an administrative waiver for low-income households that include more members than the number used in the "basic human needs" assumptions.

Conservation rate structures may result in uncertainty in forecasting revenue. Utilities must assess the interrelationships among rates, consumption, and costs and the effect that these issues will have on the revenue requirements of the utility. Table 8-2 shows the current water rates for communities in the Northeast Region.

Table 8-2. Water Rates in Northeast New Mexico Communities

	Residential		Commercial	
Municipality	Number of Connections	Charge for 6000 Gallons per Month [a] ($)	Number of Connections	Average Monthly Rate [a] ($)
Clayton	1,267	14.90	269	14.90
Des Moines	78	28.79	19	28.79
Elida	98	19.00	25	38.00
Logan	820	16.75	40	16.75
Melrose	321	11.31	44	11.31
Mosquero	67	21.50	13	25.00
Portales	3,951	14.41	726	14.41
Roy	173	14.00	27	14.00
San Jon	118	19.00	16	19.00
Texico	385	25.11	30	25.11
Tucumcari	2,317	19.92	517	23.32
Average of all New Mexico towns/cities	4,098	19.49	471	27.39

Source: NMED, 2005d
[a] Includes monthly meter service charge

8.2.1.13 Metering

Metering is an essential element in water conservation. Metering of both production and individual user consumption is the only way to track water use and ensure that conservation goals are being achieved. With the use of water meters, a water utility can track water production and deliveries in the system and thereby locate any leakage in the system, create a more equitable billing system that directly benefits water-conserving customers, and gain a greater ability to manage water demand through pricing. The City of Portales has a meter installing and replacement program that began several years prior to 2001 (Wilson, 2001).

A regulation, resolution, or ordinance should be in place to require the installation and regular reading of meters at all water sources, including import or export points, customer service connections, and public landscape sites. All water provided free of charge for public use, including construction water from fire hydrants, should also be metered to allow the utility to more accurately account for water use. The City of El Paso provides portable fire hydrant metering of construction water use (Padilla, 2004). A schedule for checking water customer meters against a calibrated meter should be developed. If meter readings are consistently above the 2 percent error that was required at the time of installation, the meter should be repaired or replaced.

8.2.1.14 Drought Planning.

Conservation ordinances can also establish requirements that apply during times of drought. Generally, the ordinance defines three or four different levels or triggers, which have increasingly strict restrictions on water use and include enforcement provisions. Sample levels and associated requirements are summarized in Table 8-3 and described below.

- Stage 1 is voluntary and is triggered by lower-than-normal precipitation. At this level of restriction, water users are encouraged to minimize landscape irrigation and other activities that consume water.

- Stage 2 is triggered by demand that is greater than available production for a specified period of time. Stage 2 places greater restrictions on water use, such as limiting outdoor watering to only odd or even days outside of a specified time bracket, limiting refilling of

Table 8-3. Summary of Example Conservation Measures and Drought Stages

Stage 1	Stage 2	Stage 3
Water shortage advisory: Voluntary conservation and normal conditions	*Water shortage watch: Mandatory increased conservation*	*Water shortage warning: Mandatory restrictions*
Possible trigger: Annual precipitation 75 percent of normal	*Possible trigger: Annual precipitation 50 percent or less of normal*	*Possible trigger: Inadequate storage/system capacity to meet demand*
• Provide public with current storage levels. • Conduct public education campaign regarding need to reduce use.	• Increase public education • Ban sprinkler use. • Restrict outside watering to two days per week. • Prohibit washing paved areas. • Prohibit allowing water runoff into street. • Prohibit filling swimming pools and water fountains. • Ban car washing, except for solid waste vehicles for public health reasons. • Reduce flushing of water mains, sewers, storm drains, streets. • Reduce frequency and duration of irrigation of public landscape (e.g., golf courses, parks).	• Implement a moratorium on new water hookups. • Ban use of water hoses. • Prohibit all outdoor water use. • Ban new landscaping with water from the utility. • Curtail irrigation of parks, athletic fields, cemeteries, and golf courses.

swimming pools, or placing restrictions on car washing and other water consuming activities.

- Stage 3 is again triggered by the relationship between demand and available supply on the system. It is instituted by a declaration from the town manager when an emergency exists in his/her judgment. The stage 3 condition may severely restrict or eliminate all outdoor watering and allows the town manager to impose other restrictions as s/he deems necessary.

For all of the Northeast Region water systems that continue to rely solely on groundwater for their supply, drought planning should focus on managing increased demands for outdoor irrigation that occur in hot, dry weather. Communities that intend to rely on surface water from Ute Reservoir should have full drought contingency plans in place.

8.2.2 Hydrologic Impacts

Successful water conservation ordinances and/or public education programs can reduce the amount of water needed to meet demand. This reduced demand will enable communities to extend their water supplies over a longer period of time before they need to develop additional expensive infrastructure (such as new wells or pipelines) or purchase additional water rights to meet the population’s needs.

The first step in developing the best tools to conserve water is to understanding both the current community water use patterns of different types of water user groups and the real needs of customers. The difference between the actual use of water (demand) and the actual need (efficiency level) is the conservation potential. This potential for water savings determines which efforts should be undertaken and when it becomes cost-effective to implement them. Once the water savings potential has been determined for a customer group, a conservation strategy can be developed for each system.

Based on reviews of water use in the Northeast Region and surrounding communities and on example programs from around the country (i.e., those with proven track records), some communities in the planning region could achieve significant water savings through integrated application of a conservation program. The City of Las Vegas, New Mexico has reduced water use by 25 percent, from an average of 189 gpcd during 1985 to 1989 to an average of 142 gpcd during 2000 to 2004. Albuquerque has reduced demand by 23 percent, Tucson by 30 percent, Los Angeles by 25 percent, Austin by 27 percent, and Irvine by 54 percent (landscape use) and 12 percent (residential use). The City of Santa Fe has reduced per capita demand by 40 percent (from 170 gpcd in 1995 to 112 gpcd in 2004) (City of Santa Fe, 2005).

While both Las Vegas and Santa Fe reduced demands to below 150 gpcd during the drought period from 2000 to 2004, the lower level of demand represented a hardship in both of these communities. A municipal per capita demand of 150 gpcd is still relatively low and is based on demand in communities that have implemented a conservation program. Thus, 150 gpcd is viewed as an achievable ongoing goal for a conservation program; further reduction can be as needed to respond to drought emergencies. However, each community will need to assess its water use patterns and set ideal goals for per capita demand.

The communities served by small systems have an average use of:

- 195 gpcd in Union County (average of Clayton, Des Moines, and Grenville)
- 179 gpcd in Harding County (average of Roy and Mosquero)
- 246 in Quay County (average of Logan, San Jon, House, Liberty Mutual Domestic Water Users Association, and Nara Visa Water Co-op)
- 195 gpcd in Curry County (average of Turquoise Estates Water Co-op, Desert Ranch Water System, Melrose, Grady, and Texico)
- 209 gpcd in Roosevelt County (averaging Causey, Dora, Floyd, and Elida).

Larger communities sometimes have higher demand rates because commercial and industrial uses of water are included in the per capita demand and those uses are often more prevalent in larger rather than smaller communities; however, this is not always the case in northeast New Mexico. Per capita demand calculated from 2004 water system survey data (Barnes, 2005) yields per capita rates of 199 gpcd for Tucumcari and 148 gpcd for Clovis. The Portales 40-year plan lists per capita demand of 192 gpcd in Portales.

The water use by domestic wells was estimated by assuming that indoor use was 85 gpcd (for a non-conserving home) (Vickers, 2001) and the outdoor demand was based on the assumption that each house has 2,500 ft^2 of turf (mix of Kentucky bluegrass, Bermuda grass and buffalo grass), 1,000 ft^2 of trees and shrubs and 200 ft^2 of vegetable gardens. Using a procedure outlined by Wilson (1996), the estimated demand to landscape watering in the five counties varied from 67 gpcd in Union County to 129 gpcd in Quay County, for a total current demand by domestic wells of 152 to 214 gpcd.

A conservation program that uses tools such as rate structures and public education could reduce demand to 150 gpcd in communities (including commercial uses) and to approximately 100 gpcd in residential-only areas.

The ideal demand in self-supplied homes is estimated to range from 83 in Union County to 103 gpcd in Quay County, based on indoor usage of 65 gpcd (Vickers, 2001) and outdoor watering usage limited to 800 ft^2 of turf, 1000 ft^2 of trees and 200 ft^2 of vegetable garden (Wilson, 1996).

To assess potential water savings from the implementation of a conservation program that includes both rate structures (for community systems) and public education, current demands in individual communities in the Northeast Region were compared with the achievable goals of 150 gpcd for municipal and approximately 100 gpcd for self-supplied systems. Table 8-4 shows the current per capita demand for rural water systems, urban water systems and domestic wells (self supplied) for each county. The per capita demands for the rural communities in this planning region have room for significant savings. Per capita demand could be reduced in all of these systems through conservation efforts by up to 34 percent in some areas. If all water systems and self-supplied domestic wells implemented conservation measures, total demand for public supply could be reduced by about 20 percent (Table 8-4). With the current demand, implementation of a successful conservation program would reduce water demand by more than 1,600 ac-ft/yr.

The actual reduction potential will depend on current water use patterns (i.e., the amount used for landscape watering, tourism, etc.). Figure 8-1 shows the potential reduction of projected

Table 8-4. Potential Water Savings Achievable with Water Conservation

County	System Type	Communities	Population	Per capita Demand (gpcd)		Potential Reduction in Demand		
				2004	Ideal [a]	gpcd	ac-ft/yr	%
Union	Rural water systems [b]	Clayton, Des Moines, Grenville	2,678	101	93 [c]	8	24	8
	Domestic wells [d]	---	1,496	105	83	22	37	21
Harding	Rural water systems [b]	Roy, Mosquero	416	134	104 [c]	30	14	22
	Domestic wells [d]	---	394	116	94	22	10	19
Quay	Rural water systems [b]	San Jon, Logan, Liberty MDWUA [e], House, Nara Visa Water Co-op [e]	1,737	169	113 [c]	56	109	33
	Domestic wells [d]	---	2,429	123	103	20	54	16
	Urban [b]	Tucumcari	5,989	199	150 [f]	49	329	25
Curry	Rural water systems [b]	Grady, Melrose, Texico, Turquoise Estates Water Co-op [e], Desert Ranch Water System [e]	2,071	158	104 [c]	54	125	34
	Domestic wells [d]	---	4,106	115	94	21	97	18
	Urban [b]	Clovis	32,667	148	150 [f]	0	0	0
	Urban [b]	Cannon Air Force Base [e]	6,200	222	150 [f]	72	500	32
Roosevelt	Rural water systems [b]	Elida, Dora, Causey, Floyd [e]	496	129	107 [c]	22	12	17
	Domestic wells [d]	---	1,217	118	97	21	29	18
	Urban [b]	Portales, Roosevelt County Water Co-op [e]	16,305	165	150 [f]	15	274	9
		Region total	78,201	143 [g]	114 [g]	29 [g]	1,613	20 [g]
						Total current diversions	17,320	

[a] Ideal per capita demand is the lowest expected to be achieved if water conservation efforts are maximized. This demand is not expected to be reached in the short term. Values are based on Wilson (1996) for outdoor and Vickers (2001) for indoor.

[b] Total water supplied by water systems divided by population served by the system (Barnes, 2005, unless otherwise noted)

[c] To account for additional landscape watering needs, 10 gpcd was added to domestic use for rural water systems.

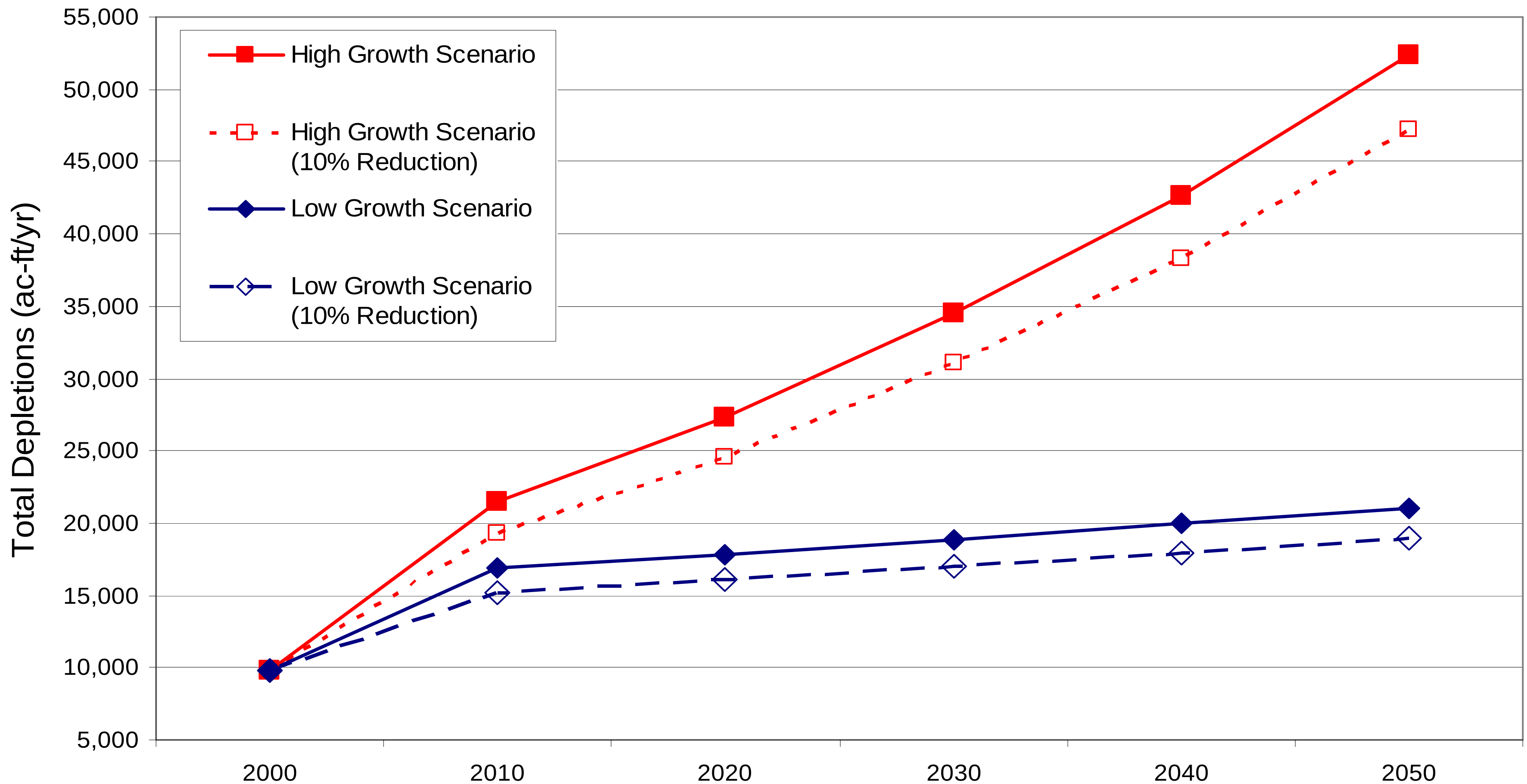
[d] Based on an assumed indoor demand of 85 gpcd and outdoor use for irrigating 3,700 ft^2 of landscaping

[e] Wilson et al., 2003

[f] A demand of 150 gpcd was used for urban systems based on Santa Fe and Las Vegas, New Mexico reductions.

[g] Average

gpcd = Gallons per capita per day
ac-ft/yr = Acre-feet per year
MDWUA = Mutual domestic water users association



NORTHEAST NEW MEXICO REGIONAL WATER PLAN

Potential Effects of Municipal Conservation on Regional Water Demand, High and Low Population Projections

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3/23/07

Figure 8-1

municipal and domestic demand (for both the low and high growth population projections) for an example case in which demand is decreased by 10 percent (actual demand reductions may be more or less). Under the low growth scenario, demand in 2050 would be reduced by about 1,700 ac-ft/yr, from a projected 16,800 to 15,100 ac-ft/yr. Under the high growth scenario, the region could reduce water use by about 5,000 ac-ft/yr, from a projected 49,600 to 44,600 ac ft/yr.

The success of a given conservation program will depend upon (1) the accuracy of the data, (2) the commitment of the local leaders, and (3) the thoroughness of the implementation. Conservation through ordinances, education, and the adoption of a conservation ethic is essential to planning for the future water supply in the Northeast Region.

8.2.3 Financial Feasibility

Compared to costs for water rights and infrastructure and to other costs associated with developing new water supplies, the costs of conservation programs are very low. Approximate costs for these programs are discussed in Sections 8.2.3.1 through 8.2.3.5. Several of the measures are generally funded through combined programs, in which case, they are discussed together.

8.2.3.1 Conservation Ordinances, Public Education, and Program Auditing

The primary financial burden on local governments associated with implementing water conservation programs is labor:

- A staff member would be needed to oversee the process of drafting and implementing water conservation ordinances and/or policies.

- Utility staff would need to be trained and made available to undertake water waste enforcement duties. Existing field staff could be trained and sworn in as water waste officers if they have several hours available each week.

- Staff would be needed to develop and implement new rate structures. Billing would need to be retooled to use the new rates.

- Public education would require at least a part-time person devoted to public and school outreach programs, as well as minimal funding for educational materials.

- A staff member would be needed to track and audit records of water usage, operation and maintenance costs, and revenue.

- Indoor water audits would require at least a part-time person devoted to educating the public about the indoor water audit program and at least one field staff member to be trained to conduct these audits.

- A staff member would be needed to oversee the process of drafting and implementing outdoor and landscape ordinances.

- Existing field staff could be trained to conduct outdoor and landscape audits if they have several hours available each week.

A major financial reward of adequate municipal conservation ordinances and education is increased eligibility for many funding programs.

8.2.3.2 Municipal Wastewater Reuse

Costs for wastewater reuse strategies depend on the standards to be met, the volume treated, the end use, the distance treated effluent must be pumped and/or piped, and the cost of permitting. Costs are also highly dependent on the type of wastewater treatment process, which differs depending upon the reuse application.

Various costs associated with wastewater reuse include the following:

- Acquisition of raw wastewater supply

- Construction and operation of treatment facilities needed to meet standards for planned end uses

- Construction and operation of storage facilities needed to ensure a reliable supply on a day-to-day basis, accounting for seasonal differences in effluent supply and use (e.g., because turf facilities have peak demand in the summer, effluent produced in the winter may need to be stored for summer use on these facilities)

- Construction and operation of the transmission and distribution system

- Costs of resolving issues related to diminished return flows for downstream users who have relied upon effluent discharges

- End-user adaptation costs such as on-site hookup and re-plumbing, special corrosion-resistant equipment, safety and public health practices, and other costs associated with the use of wastewater effluent

Reuse options away from municipalities typically are limited due to a lack of locally generated wastewater and the high cost of conveying wastewater.

8.2.3.3 Leak Detection and Repair and Pressure Reduction

The primary financial burden on local governments associated with leak detection and repair and water system pressure reduction is materials and labor:

- A staff member would be needed to monitor the collection and distribution systems, including water storage and conveyance systems, water treatment facilities, municipal water main networks, etc. This task could be done concurrently with water auditing (Section 8.2.3.1).

- Utilities can contract for leak detection. Night flow assessment, sonic leak detection, and strategic replacement of old deteriorating water mains are sometimes necessary and can be costly.

- At least one, full-time technical staff member in larger municipal systems, would be needed to determine areas where there may be excessive pressure, conduct pressure tests, determine where pressure-reducing valves are needed, and install the valves.

8.2.3.4 Graywater Reuse

The cost to implement a graywater system varies greatly depending on whether the work is done by the owner or by professionals. The cost to retrofit a graywater system where plumbing is relatively accessible is estimated to range from $135 to $2,000. Costs would be prohibitive for existing structures where plumbing is inaccessible. The cost to build a graywater system during new construction is estimated to range from $65 to $650 (Little, 2003).

The graywater filtering system needs to be cleaned on a regular basis to prevent clogging. Annual cleaning and other maintenance costs are estimated to range from less than $100 up to $600 for residential graywater recycling units, depending on whether the work is performed by the owner or under a maintenance contract. This cost would cover disinfectant use, regular cleaning, and replacement of filters throughout the year.

8.2.3.5 Rebate and Retrofit Programs

A rebate program will require at least a part time staff to oversee and check the effectiveness of the rebates and distribute retrofit kits. Costs will vary depending on the rebates and retrofits offered but are usually on the order of:

- Toilet retrofit devices — $1
- Toilet replacement — $50 to $200
- Reduce toilet leaks — $5
- Low-flow showers and faucets — $4
- Replace dishwashers — $100 to $500
- Replace washing machines — $100 to $500
- Replace turf with buffalo grass & drip irrigation — $500 to $1,000

The City of Albuquerque offers rebates for replacement of old appliances with low-flow toilets, high-efficiency washing machines, and recirculating hot water heaters, as well as rebates for purchase of rain barrels and multi-setting sprinkler timers (COA, 2006).

8.2.4 Environmental Impacts

Water conservation efforts can significantly reduce demands on local water supply and treatment facilities. Municipal conservation can contribute to the long-term sustainability of water resources and should be an area of emphasis for larger communities in the planning region.

Most of the conservation measures discussed in Section 8.2.1 are not expected to adversely affect the environment. However, environmental issues are raised by the implementation of wastewater reuse and graywater recycling, as discussed below.

The key environmental issue related to municipal wastewater reuse is the discharge of treated wastewater to the environment. If treatment standards are sufficient, no adverse environmental impact should result from this strategy. However, if treatment is insufficient, environmental issues could arise. Environmental and public health concerns regarding wastewater reuse often focus on the potential for adverse effects from endocrine disrupters, hormones, antibiotics, and other substances that typically are not removed at wastewater plants; however, the potential impacts from these substances exist whether the effluent is reused or discharged. The key issue with municipal reuse is the increased likelihood of human contact, which makes assurance of disinfection effectiveness and reliability very important.

Although not a general environmental concern, water quality is an issue in graywater reuse, and it should be carefully monitored by the user. Graywater should never contain wastewater from toilets, washing machine loads that contain baby diapers, or kitchen waste, and systems should be turned off when someone in the household is diagnosed with an infectious disease. Additionally, household chemicals should never be disposed of in graywater systems.

When used for outdoor irrigation, the nutrients in graywater will support plant growth, but if graywater use is not rotated with harvested rainwater or fresh water, buildup of salts may damage soil (Prososki-Marsland, 1995). In addition, plants can be damaged from graywater containing sodium, bleach, borax, or liquid fabric softeners (Duttle, 1994). Use of biodegradable soap low in sodium content is recommended as well as selection of plants that are salt-tolerant and not edible (Prososki-Marsland, 1995).

8.2.5 Political Feasibility and Social/Cultural Impacts

Counties and municipalities have the authority to pass ordinances and implement conservation plans; however, plans for implementing the tools discussed in Section 8.2.1 will be adopted only if local governmental bodies find them politically acceptable. Although the general public tends to support the concept of water conservation, individuals are generally less supportive of measures that will curtail their individual water use or increase their own water bills. The public is especially aware of scarce water resource issues after a drought, and the elected officials may find more political acceptance during this period of heightened awareness. Alternatively, if additional or more restrictive ordinances are not politically acceptable, efforts can be focused on conservation education.

8.3 Agricultural Conservation

In 2000, agriculture accounted for 80 percent of the total depletions in the Northeast Region; therefore, improvements in agricultural efficiency can significantly contribute to optimal water resource management in the planning region. This strategy identifies conservation measures that can reduce the quantity of water that must be delivered to a farm to satisfy crop water requirements. Table 8-5 indicates the primary crops and acreages irrigated, by county. Additional information on irrigated lands in the region is presented in Section 6.1.3.

Table 8-5. Irrigated Acreage by Crop and County for 2002

Crop	Irrigated Acres				
	Union	Harding	Quay	Curry	Roosevelt
Wheat	25,000	---	10,000	65,000	47,000
Corn for grain	25,000	---	---	24,000	17,500
Corn for silage	2,000 [a]	---	---	17,500 [a]	15,500 [a]
Sorghum for grain	1,700	---	1,300	14,000	7,000
Cotton upland	---	---	2,500	7,000	9,000
Total	54,200	---	13,800	127,500	96,000

Source: USDA, 2004
[a] The number of acres harvested; planted acreage unavailable.
--- = No data available

Agricultural conservation methods typically focus on changes in farming practices (on-farm improvements) and improvements to delivery systems (off-farm improvements) to increase efficiencies and reduce water losses. Because groundwater irrigation systems generally involve piping water from the well directly to the irrigated field, delivery system efficiencies are generally not an issue where groundwater is used for agricultural irrigation, as is the case for approximately 80 percent of agriculture in the planning region. Delivery system efficiencies are of most concern when unlined ditches are used to bring water from rivers or streams for flood irrigation. Accordingly, delivery system efficiencies may be important in some areas of the planning region, such as the Arch Hurley Conservancy District.

Because irrigation is such a large component of the region's water budget, even modest improvements in on-farm efficiency can translate into significant water conservation. Sections 8.3.1 through 8.3.5 evaluate the technical feasibility, hydrologic impacts (amount of water saved), financial feasibility, environmental impacts, and political feasibility and social/cultural impacts associated with implementing known and proven measures that can increase irrigation efficiency.

8.3.1 Technical Feasibility

An important concept in understanding irrigation efficiency is the difference between depletions and diversions. Diversions (referred to also as withdrawals) represent the amount of water diverted from a stream or well, and depletions represent the amount of water actually consumed. For example, under OSE accounting rules, because water that percolates past the root zone is not consumed by the plants, it is assumed to eventually return to the aquifer or surface water system and is thus not counted as a depletion.

Even in the most efficient irrigation systems, significantly more water must be available for diversion than is consumed by plants. Currently in the planning region, surface water diversions are approximately 3 times the anticipated depletions and groundwater diversions are approximately 1.2 times the anticipated depletions.

Off-farm efficiency includes the amount of water that reaches the farm divided by the amount of water that was diverted from the stream. Conveyance efficiencies from unlined ditches can be as low as 43 percent (the corollary of which is that losses can be as much as 57 percent) in Arch Hurley with 110 miles of canals and 172 miles of laterals.

On-farm water efficiency is a simple ratio of the quantity of water taken up or consumed by crops, including evapotranspiration, divided by the quantity of water delivered to a farm. On-farm irrigation efficiency can be further broken down into two components:

- *Application efficiency:* Ratio of water reaching the soil to water delivered to the farm
- *Consumption efficiency:* Ratio of water used by crops to water applied to the soil

The two general goals of on-farm conservation are to:

- Decrease the amount of diversion required to enable use of an allotted depletion
- Decrease the amount of depletion per amount of crop grown, or per amount of profit gained from the crop

According to Kay (1986), on-farm efficiency is affected by the following factors:

- *Farm layout:* The shape and slope of the farmed areas irrigated by basin (flood) and border irrigation systems affect the farm's ability to promote efficient root zone saturation while diminishing losses to deep percolation.

- *Soil types:* Differing soil types on a farm or in multiple basins can cause uneven watering effectiveness and extremely high losses to deep percolation.

- *Land preparation practices:* Land should be leveled every five to ten years to ensure that water does not pond and that it flows freely in basins.

- *Farm canal condition:* Large amounts of water can be lost to seepage in on-farm canals.

- *On-farm water management:* Supplying crops with the right amount of water at the right time can minimize water waste and save money.

- *Irrigation scheduling:* Informed scheduling of on-farm water deliveries can help maximize crop yields while minimizing evaporative losses.

- *Methods of irrigation:* The choice of irrigation method (e.g., flood [basin], border, furrow, or drip/micro-irrigation) can optimize water use.

- *Crop type:* Different crops require different amounts of water. Emphasis should be placed on growing crops with high monetary value relative to their water consumption.

Several available on-farm technologies can increase the efficiency of production agriculture irrigation systems. However, while these technologies do save significant quantities of water, they can also be expensive to implement. Sections 8.3.1.1 through 8.3.1.3 provide background information about these technologies for improving on-farm efficiency, and Section 8.3.1.4 provides background information on off-farm efficiency. Section 8.3.1.5 discusses metering as a tool for monitoring agricultural conservation. Finally, Section 8.3.1.6 summarizes an innovative hydroponic technology that may reduce the amount of water required for growing livestock forage, an important crop in the planning region. Potential hydrologic and economic impacts of implementing these technologies are described in Sections 8.3.2 and 8.3.3, respectively.

8.3.1.1 Irrigation Technologies

A primary method of improving on-farm efficiency is to convert farms from irrigation methods that result in water loss (e.g., through evaporation, as in flood irrigation) to methods that minimize losses, increasing the proportion of irrigation water that reaches plants. Table 8-6 lists the attainable irrigation efficiencies for different systems. Currently, most of the farms in the planning region use sprinkler irrigation, but many also use flood irrigation, especially in Quay County.

Table 8-6. Attainable On-Farm Irrigation Efficiencies for Various Irrigation Systems

System Type	Efficiency (%) Current Northeast Region [a]	Efficiency (%) Attainable [b]
Gravity irrigation		
Improved gravity [c]	55–60	75–85
Furrow		55–70
Flood		40–50
Sprinkler systems		
Hand-move or portable	65–80	60–65
Sideroll		60–80
Traveling gun		60–65
Center pivot		70–85
Solid set or permanent		65–80
Low-energy precision application		90–98
Drip/micro-irrigation	85	80–95

[a] Wilson et al., 2003
[b] Vickers, 2001
[c] Includes tailwater recovery, precision land leveling, and surge flow systems

Background information about the types of irrigation methods that may improve on-farm efficiency is summarized in the Sections 8.3.1.1.1 and 8.3.1.1.2, while techniques to improve the efficiency of existing irrigation systems are discussed in Sections 8.3.1.1.3 through 8.3.1.1.5. Further information on these and other irrigation methods is available in *Selection of Irrigation Methods for Agriculture* (Burt et al., 2000).

8.3.1.1.1 Sprinkler Systems. As shown in Table 8-6, sprinkler systems can provide some efficiency improvements if they are used to replace flood or furrow irrigation. Most crops can be irrigated with some type of sprinkler system, although crop characteristics such as height must be considered in system selection. In 1999, 265,500 acres (over 80 percent of all irrigated land in the Northeast Region) were irrigated with sprinkler systems (Wilson et al., 2003). Sprinkler systems are well suited for germinating seed and establishing ground cover for crops like alfalfa and lettuce because they can provide the light, frequent applications that are desirable for this purpose.

Most soils can be irrigated with the sprinkler method, although soils with an intake rate below 0.2 inch per hour may require special measures. Sprinkler systems are particularly useful for irrigating soils that are too shallow to permit surface shaping or too variable for efficient surface irrigation. In general, sprinklers can be used on any topography that can be farmed, and land leveling is not normally required.

There are disadvantages to using sprinkler systems for irrigation. Sprinklers may require more pumping energy than other irrigation methods. They also require better quality (or filtered) source water than other surface irrigation methods with the exception of drip/micro-irrigation (Section 8.3.1.1.2). If source water is salty, sprinkler methods that apply water to leaves may be unsuitable. Sprinkler systems can be labor-intensive, especially those systems that must be moved manually.

Many types of sprinkler devices and sprinkler systems are available. Sprinkler devices include rotating head sprinklers that apply water in circular pattern, low-pressure spray nozzles (often used on center pivot and linear move systems or in orchards), under-tree rotating heads that keep the spray below tree foliage, and perforated pipe that sprays water from small-diameter holes in pipes. The more common types of systems include:

- *Hand-move or portable sprinkler systems* that consist of a lateral pipeline, typically made of aluminum, with sprinklers installed at regular intervals. The lateral is operated in one location until sufficient water has been applied and is then disassembled and moved to the next position. Initial costs for this type of system are low, but the labor costs associated with moving the lateral lines are fairly high. These systems can be used on variable terrain and for most crops, except tall crops such as corn that make moving the lateral difficult.

- *Sideroll systems* have lateral lines mounted on wheels, with the pipe forming an axle that is high enough to clear the crop as it is moved. A drive unit is used to move the system from one irrigation position to another by rolling the wheels. These systems are vulnerable to high winds and may be damaged or pushed long distances if not staked down.

- *Traveling gun systems* use a high-volume, high-pressure sprinkler "gun" mounted on a trailer and are commonly operated as continuous move systems, with the gun sprinkling as the trailer moves. Although appropriate for most crops, these systems are best used on coarse, permeable soils because of the large droplets and high application rates produced.

- *Center pivot systems* consist of a single sprinkler lateral supported by a series of self-propelled towers that allow the lateral to rotate around a pivot point (one end of the lateral) in the center of the irrigated area. The time required for a single revolution can range from a half day to many days. The length of the lateral affects the speed at which the end of the lateral travels, as well as the size of the area irrigated by the end section. Because of this, the water application rate must increase with distance from the pivot point to deliver an even application amount, and the high application rate at the outer end of the system may cause runoff on some soils. Also, because of the circular application area, the corners of the field are not irrigated unless special equipment is added to the system. Center pivots, which have moderate initial costs and low labor costs, can be used for most field crops.

- *Linear move systems* are similar to center pivot systems in construction except that neither end of the lateral pipeline is fixed. The whole line moves down the field in a direction perpendicular to the lateral and is designed to irrigate rectangular fields free of tall obstructions. As with the center pivot system, the linear move system can provide very efficient water application. These systems require high capital investments, but labor costs are low.

- *Low energy precision application* (LEPA) systems are similar to linear move irrigation systems except that the lateral line is equipped with drop tubes and very-low-pressure orifice emission devices that discharge water just above the ground surface into furrows. This distribution system is often combined with micro-basin land preparation for improved runoff control (and for retention of rainfall). High-efficiency irrigation is possible, but requires either very high soil intake rates or adequate surface storage in the furrow micro-basins to prevent runoff or non-uniformity along a furrow.

- *Solid set and permanent systems* are similar to the hand-move lateral sprinkler system, except that they include enough laterals placed in the field to avoid the necessity of moving pipe during the season. The solid set system requires significant labor at the beginning and end of the irrigation season, but minimal labor during the irrigation season. A permanent system is a solid set system where the main supply lines and the sprinkler laterals are buried and left in place permanently (this is usually done with polyvinyl chloride [PVC] pipe).

As indicated above, labor requirements vary depending on the degree of automation and mechanization of the equipment used. Hand-move systems require the least degree of operational skill, but the greatest amount of labor. At the other extreme, center pivot, linear move, and LEPA systems require considerable skill in operation and maintenance, but a low overall amount of labor.

8.3.1.1.2 Drip/Micro-Irrigation Systems. In 1999 only 345 acres the Northeast Region were irrigated with drip/micro systems (Wilson et al., 2003). Drip/micro-irrigation methods can conserve water because they deliver water directly to the root zone through emitters placed along a water delivery line (typically a polyethylene hose). In contrast to most other types of irrigation systems, a properly designed and well operated drip/micro-irrigation system:

- Can be used on steep slopes
- Requires minimal land grading
- Can be installed on land parcels of any size or shape
- Has few, if any, runoff problems and little likelihood of excessive over-irrigation
- Has greater distribution uniformity (especially the newer system designs)
- Provides optimal soil moisture through more frequent irrigation
- Allows direct application of fertilizer to the root zone

Systems can be installed permanently (typical for orchards and vineyards) or seasonally (typical for row crops), or they may consist of permanent main lines with removable or disposable lateral lines. Because drip/micro-irrigation system components typically remain in place for the growing season, the systems can be automated; however, they should be monitored and shut off temporarily as appropriate during rainy periods.

Drip/micro-irrigation systems should be tailored to meet crop needs. For example, water is generally applied to plants through drip/micro-irrigation systems daily or several times per week. However, some crops (such as lettuce) do not yield as well with irrigation that is too frequent, and the watering frequency should be adjusted accordingly. Because emitter devices typically have low flow rates (0.4 to 2.1 gallons per hour [gph]), larger plants such as trees may require multiple emitters (Burt et al., 2000).

Regional and micro-climate conditions should also be considered in the design of drip/micro-irrigation systems. For example, in arid regions emitters are often spaced so that at least 60 percent of the potential root zone volume is wet, thereby providing an adequate moisture reservoir for periods of high evapotranspiration and insurance against several days of breakdowns. A lower percentage of wetted area is common in areas that receive supplemental rainfall.

Drip/micro-irrigation systems are of three main types: (1) aboveground drip systems, (2) buried drip systems, and (3) aboveground microspray and microsprinkler systems. Aboveground drip systems have been used in orchards and vineyards since the 1980s, and a variety of designs can be used depending on the crop, orchard configuration, and available water pressure. Where rows do not exceed 12 or 13 feet in width, one hose is typically used per row, with varying numbers of emitters per tree or vine. Typically the hose is thin-walled with built in emitters (drip tape). The drip tape can be installed under plastic, rolled up to allow cultivation and harvest, or buried just below the ground surface (maximum ½ to 2 inches deep) to protect it from the wind (Burt et al., 2000).

Buried drip systems have been tested for irrigation of crops. Interest in this technology is high, as it potentially reduces soil evaporation and weeds and allows workers to drive through or cultivate a field at any time, regardless of the irrigation schedule. Drawbacks include potentially extensive soil surface wetting due to low soil hydraulic conductivity or excessive emitter flow rates, pinching of the hose by roots, root intrusion into the emitters, and a high installation cost. In addition, the proper depth and location of buried emitters with respect to plant trunks is not yet fully understood (Burt et al., 2000).

Buried drip systems are often used for "one-crop" row crops such as strawberries and sugar cane, where the drip can be installed before planting and removed before the plants are disked into the soil. Permanently buried systems are also used commonly in the southwestern U.S., where more than 150,000 acres of high-value crops such as tomatoes, peppers, broccoli, lettuce, and cauliflower are estimated to be irrigated with permanent drip systems (Burt et al., 2000). These systems are designed to be in place for 6 to 10 years; however, special equipment is needed during tilling to ensure that the drip tape is not damaged during removal of the old crops. Also, considerable time must be spent checking the system during the first year or two of operation to ensure proper functioning (Burt et al., 2000).

The International Arid Lands Consortium has been involved in a demonstration project in Artesia, New Mexico to determine the benefits of drip irrigation technology for alfalfa. In this study they have estimated a 40 percent water use reduction with the use of drip irrigation compared to traditional sprinkler technology, without a reduction in yield (IALC, 2000).

Microspray systems typically have larger hose diameters than drip because the flow rates of the emissions devices are much higher than for drip. For the same reason, these systems also tend to have smaller hose lengths than drip. Because of the high application rates, a microspray field is often divided into six or more blocks with only one block irrigated at a time, whereas many drip fields are divided into only two blocks. The net result is that microsystems are usually more expensive than drip systems. The exception would be on widely spaced plants such as walnut trees, in which case several drip hoses would be required per tree row compared to only one hose for microspray.

Microspray systems have the advantages of requiring less stringent filtration than drip because of the relatively larger openings and shorter paths of micro-nozzles. In addition, they result in a larger soil wetted volume than a single hose drip system. In situations where frost protection is important, microspray designs offer better climate control than do emitters.

Disadvantages of microspray as compared to drip include the higher cost of some designs, the higher evaporation losses (especially if the water extends past the canopy), higher humidity, and inability to easily restrict the wetted area during certain times of the year. Also, some microspray systems have high sprayer flow rates (10.5 to 15.8 gph) and could be classified as low-flow permanent sprinklers rather than micro-irrigation systems (Burt et al., 2000).

8.3.1.1.3 Laser Leveling. For fields that are flood irrigated, laser leveling involves grading and earthmoving to eliminate variation in field gradient, that is, smoothing the field surface and often reducing field slope. Laser leveling helps to control water advance and improve uniformity of soil saturation under gravity-flow systems, allowing the grower to apply only the water needed to refill the root zone. For this method to work properly, the volume of water needed for irrigation must be applied as rapidly as possible in order to allow the same time for infiltration throughout the entire field. In 1999 more than 60,000 acres in the Northeast Region were flood irrigated; this acreage could benefit from laser leveling (Wilson et al., 2003).

Laser-leveling works only for relatively short runs. If the border lengths are too long, it is better to use graded border irrigation. Border distances for laser-level irrigation will depend upon soil type and water quantity, but 300 to 500 feet in length is usually recommended. Laser-level irrigation needs a minimum of 3 inches per application. If a high water flow is used with a laser-leveled field, an erosion control device may be needed at the turnout.

Evidence suggests that laser-level irrigation can increase on-farm efficiency by 25 percent and reduce diversion time to 25 percent of that previously required to irrigate the same acreage. Irrigation efficiencies for laser-level irrigation can be as high as 75 to 85 percent, as opposed to irrigation efficiencies for normal flood irrigation, which run about 40 to 50 percent (Vickers, 2001).

8.3.1.1.4 Surge Valves. Surge valves can be added to increase application efficiencies and reduce deep percolation of irrigation water of some fields that use furrow irrigation. The principle behind surge irrigation is to switch the water back and forth between irrigation sets in an alternating pattern using an automated valve. The valve may be set for different lengths of out-times (times when water is applied to advance water through the length of row). If the out-times and cutback are set correctly, this method of irrigation advances the water more quickly and efficiently through the field than continuous irrigation, thereby minimizing runoff (tailwater) and deep percolation. Surge valves typically improve furrow irrigation efficiency by an average of 10 to 40 percent, depending on soil type, land slope, and the lengths of the runs; some growers have cut irrigation amounts by as much as 50 percent (Vickers, 2001).

Surge irrigation is relatively inexpensive to implement, given its benefits of increased uniform water distribution, reduced deep percolation, reduced tailwater, and reduced total irrigation. Although surge valves cost approximately $1,000 to 1,500 per valve, the same surge valve may be used on several fields. However, the use of surge valves requires daily adjustment and thus more labor. Laser-leveled fields are also usually required, as the principle behind surge irrigation is to allow water applied uniformly over a given area to percolate before the next application is applied. Thus, irregular topography, which can be covered by flood irrigation, is not compatible with surge techniques.

8.3.1.1.5 Gated Piping. Pipeline conveyance systems are often installed to reduce labor and maintenance costs, as well as water losses to seepage, evaporation, spills, and non-crop vegetative consumption. Permanently installed underground pipeline is constructed of steel, plastic, or concrete, while aboveground pipeline generally consists of lightweight, portable aluminum, plastic, or flexible rubber-based hose that can be moved.

Gated pipe, a form of aboveground pipeline, distributes water to gravity-flow systems from individual gates (valves) along the pipe. One irrigation method (commonly called “cablegation”) that uses gated piping employs a moveable plug that passes slowly through a long section of gated pipe, with the rate of movement controlled by a cable and brake. Because the pipe is both oversized and sloped, water will gradually cease flowing into the first rows irrigated as the plug progresses down the pipe. Improved water management is achieved by varying the speed of the plug, which controls of the length of time water flows into each furrow.

8.3.1.2 Soil Treatments

The amount of water available to plants depends not only on the amount of rainfall and/or irrigation, but also on the physical, chemical, and biological properties of the soil. Soil acts as an absorbent for water from precipitation and irrigation and serves as a reservoir of water for plants in the interval between water applications.

Soil structure is an important physical parameter to consider when trying to increase on-farm efficiency, as soil sealing and soil crusting decrease the rate of water infiltration into the soil. Structureless soil can severely restrict the downward percolation of water. A common constraint to both water filtration and root penetration in the soil is the degree of soil compactness or density. Other soil characteristics that affect water availability to plants include the extent of organic matter in the soil and the types and density of soil organisms present. In addition, soil characteristics can determine how easily runoff occurs; in situ moisture conservation is a means of conserving all rainfall where it falls and allowing no runoff.

Measures that can be adopted by farmers to optimize the physical, chemical, and biological soil parameters with a view to increasing the water efficiency include the following:

- *Covers or mulches laid down on the surface of the soil and along rows*. This practice is important for water and soil conservation as well as for organic matter preservation. Mulches protect soil structure by reducing the mechanical action of raindrops on soil aggregates, thus preventing runoff and erosion. Mulching dramatically decreases evaporation and improves soil moisture retention capacity; as a result, soil water content is increased. Soil temperature, soil strength, and soil aeration are also improved, thus increasing soil productivity and crop yield.

- *Tilling or physically (manually or mechanically) breaking up the plough layer*. This is a common agronomic practice that can improve the infiltration rate of rainwater, thus conserving soil moisture. Tilling also helps to control soil pests and weeds. The pests are brought up to the surface where they are then killed by radiation and/or predators. This approach therefore reduces the need for pesticides and their attendant use of fairly large quantities of water.

- *Use of soil additives called polyacrylamides that bind the soil together so that water spreads more evenly and percolates less rapidly*. Polyacrylamides are soil additives that are applied to the surface and then mixed into the top soil. They generally have a more beneficial effect in sandy soils. Polyacrylamides are sold under many different trade names: Terra-Sorb, Hydrosource, Hydro-mulch, PAM, Moist Soil, Aquasorb, Agrosoke, Smart Soil, Aquacrystals, Bioplex, Agro-diamonds, and others.

- *Planting in small depressions, known as planting pits*. This practice is common in arid areas. Planting pits conserve and concentrate both water and nutrients.

- *Contour cultivation*. This technique slows down the movement of water across the soil surface and also helps to conserve water. Contour cultivation can be achieved by constructing physical barriers such as ridges across the contours to prevent runoff and soil erosion. Runoff from the higher elevations is then trapped in furrows in the contours, thereby increasing infiltration into the soil.

- *Terracing fields*. Different types of terraces can be constructed (e.g., stone terraces, earth banks, bench terraces, and contour stone) to conserve soil moisture as well as to collect water.

8.3.1.3 Crop Management

Crop management provides an extra means of reducing water losses and optimizing water use in any farming system. Crop management considerations include crop water requirements, timing of irrigation, crop selection, crop configuration (plant density, crop mix), and cropping calendar (planting dates, rotation). When used along with properly programmed automatic irrigation systems, crop management techniques can increase on-farm irrigation efficiencies to 85 to 90 percent (Vickers, 2001).

Planting density and crop mix affect the hydrologic characteristics of the system. Increased plant density increases the soil cover by crops and can lead to a decrease in evaporation losses; however, higher planting density can also increase water uptake from the soil. Annual crops and some perennials obtain moisture mainly from the top layer of soil, whereas deep-rooted plants such as trees tap deeper soil moisture that is beyond the reach of the annuals. Additionally, some trees shed their leaves in winter, thereby covering the soil and creating mulch. A synergistic planting may yield more abundant crop production while protecting critical top soils. In addition, mixed cropping systems in particular combinations can help to significantly reduce pest damage. For instance, cabbages grown in alternate rows with either tomatoes or garlic or carrots have been shown to suffer fewer insect attacks, thus improving yield.

8.3.1.4 Off-Farm Conveyance Systems

The conveyance system is a major component of a surface water diversion system; it is the means by which water is moved from the water source to the farm for irrigation purposes. Typically, water is conveyed in an open or closed conduit such as a channel, tunnel, canal, or pipe, and is moved by some driver, typically gravity and/or an energized pump. In Arch Hurley, which diverts surface water from Conchas Reservoir through 110 miles of canals, 5.8 miles of tunnels, and 171 miles of laterals, (USBR, 2006), only 42.7 percent of the diversions are conveyed to the farm. Seepage from the canals recharges the groundwater and ultimately returns to the Canadian River several miles north of the canal system or recharges local wells. Seepage from the 83 miles of unlined ditches in the Dry Cimarron River Basin likely returns directly to the Dry Cimarron, based on the proximity of the canals to the stream.

Surface water delivery systems that use unlined ditches are often inefficient in terms of water use. Improvements to these delivery systems could potentially reduce diversion demands and improve the systems' ability to meet demand during drought years. However, improving the delivery efficiency of unlined ditches often results in a reduced amount of return flow, which can have undesirable consequences such as reducing stream or ditch flow to downstream users (on the Dry Cimarron River) and reducing recharge to shallow wells (in Arch Hurley). Lining canals and ditches can also cut off the water supply to phreatophytes, such as cottonwood trees, that depend on leakage from ditches.

When in use, conveyance facilities and systems are often a source of water loss, primarily through evapotranspiration and leakage. To the extent desired or required, leakage and evapotranspiration can be minimized in man-made or modified natural conveyance structures and systems through appropriate facility planning, design, construction, and operation/maintenance activities. Lining a diversion ditch, for instance, may improve the delivery of water to end users on a ditch, which is particularly crucial during periods of low flow. However, reduced seepage from the diversion ditch does not mean that more water is available for new uses (Section 8.3.2).

Irrigation conveyance systems can be broken down into three classes: main, distributory, and field canals, with each conveying a correspondingly smaller flow. *Main canals* take water for entire irrigated command areas from some source and carry it to *distributory canals;* these, in turn, issue water to *field canals,* which deposit water onto agricultural fields. Each of these canal types lends itself to lining or piping of some sort. The canal lining and pipe replacement necessary to reduce water loss is well understood and practiced worldwide. Available technology includes linings made from compacted impervious earthen material, gunite, soil-cement, concrete, and plastics and various types of pipe materials and systems.

The issue is complicated by the effects of canal lining or piping, such as reduction or elimination of useful and aesthetic vegetation and trees that grew along canal alignments where seepage water was previously available. Seepage water from unlined canals may also contribute to shallow groundwater recharge, and this potential is lost once the canal is lined. Also, the installation of canal lining must be planned and implemented thoughtfully to minimize future damage that could be caused by farmers who might want to install or change the location of farm turn-outs, for example.

Pipe conveyance systems can save even more water than lined canals, as piping water virtually eliminates evaporation. When using pipes in irrigation water conveyance, however, other operational issues are introduced, including increased potential for system clogging, reduced infrastructure flexibility, and increased headworks infrastructure (bars, screens) and associated maintenance.

8.3.1.5 Metering

Due to increasing demands on surface water and groundwater, many states and water districts are considering or have begun installing water meters on groundwater wells, especially wells used for agricultural irrigation, and on surface water diversion structures. The new management information that metering provides to the farmer can help conserve farm water resources, reduce pumping costs for groundwater, improve efficiency, and enhance profitability. In particular, metering can increase the cost-effectiveness of an agricultural business by detecting pump inefficiencies for groundwater and by providing a more accurate view of the actual water use, which can help lead to more water-efficient irrigation practices. Metering can also be used as a crop diagnostic tool.

For water managers at the state and local levels, metering provides information to better estimate surface water and groundwater availability and to help improve water management throughout the state. This aspect raises concerns regarding the potential onset of water use restrictions. Such concerns are valid, as water managers on state and local levels may use the information to establish pumping limits. However, water managers will more likely use this information to ensure sufficient water availability in the area, setting water restrictions only when and where there is due cause, such as part of severe drought mitigation.

Water metering can be used as an effective tool to mange water supplies. Research in the Lower Rio Grande Valley in Texas found that water metering by itself reduced usage by 10 percent, and metering combined with training farmers in irrigation management reduced water use by 20 percent to 40 percent (Sanger, 2005).

8.3.1.6 Strategy Crops and Greenhouse Hydroponics

In the Northeast Region, 80 percent of water depletions are used for agriculture, and more than half of that is for production of livestock forage. Sandia National Laboratories (SNL) has been conducting tests elsewhere in New Mexico to determine the efficacy of using hydroponic greenhouses to grow forage for livestock, a technique that may potentially be applied in the Northeast Region. According to SNL, this method uses approximately 1 percent of the amount of fresh water traditionally used to grow livestock forage. Preliminary results from SNL's studies at a test greenhouse located near the New Mexico-Mexico border indicate that land currently required to grow alfalfa in New Mexico (approximately 260,000 acres) could be reduced to less than 1,000 acres, and fresh water required to grow the forage crop (currently approximately 800,000 acre-feet in New Mexico) could be reduced to 11,000 ac-ft/yr (Southwest Hydrology, 2005).

Hydroponically grown plants do not draw nourishment from the soil, but rather from the nutrition present in the germinating seed. Thus more seed is required to grow forage hydroponically relative to traditional methods; however, far less water is required. In the greenhouse, sensors are placed to monitor light, temperature, relative humidity, and air pressure. By monitoring these environmental properties, the researchers are able to determine the needs of the plants and adjust the conditions in the greenhouse accordingly (SNL, 2004).

Although hydroponic greenhouses will use much less water than currently required to produce forage, costs to implement this technology are very high and research into this method is not complete. Nevertheless, while this technology may not be feasible at the current time, it may be feasible in the future as technology costs decrease and water demand in the state increases.

8.3.2 Hydrological Impacts

Improved irrigation efficiency would decrease demands on surface water, lower diversion costs, and potentially leave more water in surface water bodies when supply is adequate. When supply is low, particularly during drought periods, it could increase the amount of water available for other beneficial uses in the planning region. For groundwater supplies, any decreases in consumptive uses would prolong the life of declining aquifers.

For most techniques, the savings in depletions, or consumptive use, will not be as high as the savings in diversions, but may be more significant. The greatest decrease in consumptive use is associated with converting to lower-water-use crops or switching to drip/micro irrigation systems, which have negligible incidental depletions. Currently, only 345 acres of land in the planning region are irrigated with drip/micro irrigation. Tables 8-7 through 8-11 summarize estimated water savings associated with applicable on-farm water conservation measures for irrigated agriculture for each county in the region; Table 8-12 summarizes the estimated water savings for the entire region.

To estimate the potential gains from improvements in on-farm irrigation efficiency, the on-farm diversions for existing irrigation techniques (flood, sprinkler, and drip) must be identified. The potential improvement from one technique to another is then calculated as the difference in irrigation efficiencies between the two methods. For example, in Quay County, 27,406 acres are currently flood irrigated. Wilson et al. (2003) estimates that 39,463 acre-feet of on-farm diversions are required for these 27,406 acres. If this land were converted from flood to LEPA irrigation, the on-farm efficiency could increase from 60 to 98 percent. This 38 percent increase in efficiency would reduce the amount of diversion water required by almost 15,000 acre-feet.

Table 8-7. Estimated Diversion Savings for Irrigated Agriculture, Union County

Conservation Technique	Potential Reduction in Diversions from Existing Irrigation Methods							Estimated Cost to Implement [a] ($/acre)
	Non-Improved Flood		Sprinkler Irrigation		Micro-Irrigation		Total (ac-ft/yr)	
	%	ac-ft/yr	%	ac-ft/yr	%	ac-ft/yr		
Current irrigated acreage (acres) [b]	*3,017*		*52,233*		*15*		*55,265*	*NA*
Current on-farm diversion amounts [b] *(ac-ft/yr)*	*9,175*		*74,356*		*39*		*83,570*	*NA*
Current on-farm irrigation efficiencies [b] *(%)*	*55-60*		*65*		*85*		*NA*	*NA*
Micro-irrigation (80-95% EF [a])	35	3,211	30	22,307	10	4	25,522	850-1,000
Low-energy precision application (90-98% EF [a])	38	3,487	33	24,537	13	5	28,029	250-281
Laser leveling (75-85% EF [a])	25	2,294	20	14,871	0	0	17,165	40
Installation of surge valves (65-80% EF [a])	20	1,835	15	11,153	0	0	12,988	12-50
Gated piping irrigation [c] (65% EF assumed)	5	459	0	0	0	0	459	NE
Soil treatments [d] (65% EF assumed)	5	459	0	0	0	0	459	NE
Crop management (85-90% EF [a, d])	30	2,753	25	18,589	5	2	21,344	NE
Maximum total potential reduction in diversions	NA	3,487	NA	24,537	NA	5	28,029	NA

[a] Vickers, 2001
[b] Wilson et al., 2003 (efficiency ranges from 55 to 60 percent for flood irrigated lands)
[c] No estimate available for efficiency with gated piping
[d] Highly dependent on type of crop grown and/or current soil conditions

ac-ft/yr = Acre-feet per year
NA = Not applicable
EF = Efficiency
NE = Not estimated, highly variable

Table 8-8. Estimated Diversion Savings for Irrigated Agriculture, Harding County

Conservation Technique	Potential Reduction in Diversions from Existing Irrigation Methods: Non-Improved Flood %	Non-Improved Flood ac-ft/yr	Sprinkler Irrigation %	Sprinkler Irrigation ac-ft/yr	Micro-Irrigation %	Micro-Irrigation ac-ft/yr	Total (ac-ft/yr)	Estimated Cost to Implement [a] ($/acre)
Current irrigated acreage (acres) [b]	*20*		*2,280*		*0*		*2,300*	*NA*
Current on-farm diversion amounts [b] *(ac-ft/yr)*	*38*		*3,616*		*0*		*3,654*	*NA*
Current on-farm irrigation efficiencies [b] *(%)*	*55-60*		*65*		*NA*		*NA*	*NA*
Micro-irrigation (80-95% EF [a])	40	15	30	1,085	NA	0	1,100	850-1,000
Low-energy precision application (90-98% EF [a])	43	16	33	1,193	NA	0	1,209	250-281
Laser leveling (75-85% EF [a])	30	11	20	723	NA	0	734	40
Installation of surge valves (65-80% EF [a])	25	10	15	542	NA	0	552	12-50
Gated piping irrigation [c] (65% EF assumed)	10	4	0	0	NA	0	4	NE
Soil treatments [d] (65% EF assumed)	10	4	0	0	NA	0	4	NE
Crop management (85-90% EF [a, d])	35	13	25	904	NA	0	917	NE
Maximum total potential reduction in diversions	NA	16	NA	1,193	NA	0	1,209	NA

[a] Vickers, 2001
[b] Wilson et al., 2003 (efficiency ranges from 55 to 60 percent for flood irrigated lands)
[c] No estimate available for efficiency with gated piping
[d] Highly dependent on type of crop grown and/or current soil conditions

ac-ft/yr = Acre-feet per year
NA = Not applicable
EF = Efficiency
NE = Not estimated, highly variable

Table 8-9. Estimated Diversion Savings for Irrigated Agriculture, Quay County

Conservation Technique	Potential Reduction in Diversions from Existing Irrigation Methods							Estimated Cost to Implement [a] ($/acre)
	Non-Improved Flood		Sprinkler Irrigation		Micro-Irrigation		Total (ac-ft/yr)	
	%	ac-ft/yr	%	ac-ft/yr	%	ac-ft/yr		
Current irrigated acreage (acres) [b]	*27,406*		*8,794*		*17*		*36,217*	*NA*
Current on-farm diversion amounts [b] (ac-ft/yr)	*91,555*		*22,910*		*35*		*114,500*	*NA*
Current on-farm irrigation efficiencies [b] (%)	*55-60*		*65*		*85*		*NA*	*NA*
Micro-irrigation (80-95% EF [a])	35	32,044	30	6,873	10	4	38,921	850-1,000
Low-energy precision application (90-98% EF [a])	38	34,791	33	7,560	13	5	42,356	250-281
Laser leveling (75-85% EF [a])	25	22,889	20	4,582	0	0	27,471	40
Installation of surge valves (65-80% EF [a])	20	18,311	15	3,437	0	0	21,748	12-50
Gated piping irrigation [c] (65% EF assumed)	5	4,578	0	0	0	0	4,578	NE
Soil treatments [d] (65% EF assumed)	5	4,578	0	0	0	0	4,578	NE
Crop management (85-90% EF [a, d])	30	27,467	25	5,728	5	2	33,197	NE
Maximum total potential reduction in diversions	NA	32,044	NA	7,560	NA	5	42,356	NA

[a] Vickers, 2001
[b] Wilson et al., 2003 (efficiency ranges from 55 to 60 percent for flood irrigated lands)
[c] No estimate available for efficiency with gated piping
[d] Highly dependent on type of crop grown and/or current soil conditions

ac-ft/yr = Acre-feet per year
NA = Not applicable
EF = Efficiency
NE = Not estimated, highly variable

Table 8-10. Estimated Diversion Savings for Irrigated Agriculture, Curry County

Conservation Technique	Potential Reduction in Diversions from Existing Irrigation Methods: Non-Improved Flood %	Non-Improved Flood ac-ft/yr	Sprinkler Irrigation %	Sprinkler Irrigation ac-ft/yr	Micro-Irrigation %	Micro-Irrigation ac-ft/yr	Total (ac-ft/yr)	Estimated Cost to Implement [a] ($/acre)
Current irrigated acreage (acres) [b]	*25,620*		*119,610*		*190*		*145,420*	*NA*
Current on-farm diversion amounts [b] *(ac-ft/yr)*	*39,237*		*156,434*		*215*		*195,886*	*NA*
Current on-farm irrigation efficiencies [b] *(%)*	*55-60*		*80*		*85*		*NA*	*NA*
Micro-irrigation (80-95% EF [a])	35	13,733	15	23,465	10	22	37,220	850-1,000
Low-energy precision application (90-98% EF [a])	38	14,910	18	28,158	13	28	43,096	250-281
Laser leveling (75-85% EF [a])	25	9,809	5	7,822	0	0	17,631	40
Installation of surge valves (65-80% EF [a])	20	7,847	0	0	0	0	7,847	12-50
Gated piping irrigation [c] (65% EF assumed)	5	1,962	0	0	0	0	1,962	NE
Soil treatments [d] (65% EF assumed)	5	1,962	0	0	0	0	1,962	NE
Crop management (85-90% EF [a, d])	30	11,771	10	15,643	5	11	27,425	NE
Maximum total potential reduction in diversions	NA	14,910	NA	28,158	NA	28	43,096	NA

[a] Vickers, 2001
[b] Wilson et al., 2003 (efficiency ranges from 55 to 60 percent for flood irrigated lands)
[c] No estimate available for efficiency with gated piping
[d] Highly dependent on type of crop grown and/or current soil conditions

ac-ft/yr = Acre-feet per year
NA = Not applicable
EF = Efficiency
NE = Not estimated, highly variable

Table 8-11. Estimated Diversion Savings for Irrigated Agriculture, Roosevelt County

Conservation Technique	Potential Reduction in Diversions from Existing Irrigation Methods							Estimated Cost to Implement [a] ($/acre)
	Non-Improved Flood		Sprinkler Irrigation		Micro-Irrigation		Total (ac-ft/yr)	
	%	ac-ft/yr	%	ac-ft/yr	%	ac-ft/yr		
Current irrigated acreage (acres) [b]	*4,631*		*82,138*		*123*		*86,892*	*NA*
Current on-farm diversion amounts [b] *(ac-ft/yr)*	*8,316*		*140,235*		*163*		*148,714*	*NA*
Current on-farm irrigation efficiencies [b] *(%)*	*55-60*		*70*		*85*		*NA*	*NA*
Micro-irrigation (80-95% EF [a])	35	2,911	25	35,059	10	16	37,986	850-1,000
Low-energy precision application (90-98% EF [a])	38	3,160	28	39,266	13	21	42,447	250-281
Laser leveling (75-85% EF [a])	25	2,079	15	21,035	0	0	23,114	40
Installation of surge valves (65-80% EF [a])	20	1,663	10	14,024	0	0	15,687	12-50
Gated piping irrigation [c] (65% EF assumed)	5	416	0	0	0	0	416	NE
Soil treatments [d] (65% EF assumed)	5	416	0	0	0	0	416	NE
Crop management (85-90% EF [a, d])	30	2,495	20	28,047	5	8	30,550	NE
Maximum total potential reduction in diversions	NA	3,160	NA	39,266	NA	21	42,447	NA

[a] Vickers, 2001
[b] Wilson et al., 2003 (efficiency ranges from 55 to 60 percent for flood irrigated lands)
[c] No estimate available for efficiency with gated piping
[d] Highly dependent on type of crop grown and/or current soil conditions

ac-ft/yr = Acre-feet per year
NA = Not applicable
EF = Efficiency
NE = Not estimated, highly variable

Table 8-12. Estimated Diversion Savings for Irrigated Agriculture Northeast New Mexico Water Planning Region

Conservation Technique	Potential Reduction in Diversions from Existing Irrigation Methods				Estimated Cost to Implement [a] ($/acre)
	Non-Improved Flood ac-ft/yr	Sprinkler Irrigation ac-ft/yr	Micro-Irrigation ac-ft/yr	Total (ac-ft/yr)	
Current irrigated acreage (acres) [b]	*60,694*	*265,055*	*345*	*326,094*	*NA*
Current on-farm diversion amounts [b] *(ac-ft/yr)*	*148,321*	*397,551*	*452*	*546,324*	*NA*
Current on-farm irrigation efficiencies [b] *(%)*	*55-60*	*65-80*	*85*	*NA*	*NA*
Micro-irrigation (80-95% EF [a])	51,914	88,789	46	140,749	850-1,000
Low-energy precision application (90-98% EF [a])	56,364	100,714	59	157,137	250-281
Laser leveling (75-85% EF [a])	37,082	49,033	0	86,115	40
Installation of surge valves (65-80% EF [a])	29,666	29,156	0	58,822	12-50
Gated piping irrigation [c] (65% EF assumed)	7,419	0	0	7,419	NE
Soil treatments [d] (65% EF assumed)	7,419	0	0	7,419	NE
Crop management (85-90% EF [a, d])	44,499	68,911	23	113,433	NE
Maximum total potential reduction in diversions	56,364	100,714	59	157,137	NA

[a] Vickers, 2001
[b] Wilson et al., 2003 (efficiency ranges from 55 to 60 percent for flood irrigated lands)
[c] No estimate available for efficiency with gated piping
[d] Highly dependent on type of crop grown and/or current soil conditions

ac-ft/yr = Acre-feet per year
NA = Not applicable
EF = Efficiency
NE = Not estimated, highly variable

The estimates shown in Table 8-12 indicate the maximum possible savings that could be achieved if all of the land currently in production were converted to more efficient on-farm irrigation and management techniques. In actuality, because of financial and logistical constraints, achieving this amount of savings may be difficult. Also, these potential savings represent reduced diversions (as opposed to depletions). Conversion to LEPA represents the greatest potential savings. For the approximately 61,000 acres that are flood irrigated in the Northeast Region, water demands at the farm could be reduced approximately 56,300 ac-ft/yr, from 148,300 ac-ft/yr to 92,000 ac-ft/yr. For the 265,000 acres that are currently irrigated with sprinkler systems, conversion to LEPA could reduce diversion demands approximately 100,700 ac-ft/yr, from 397,600 ac-ft/yr to 296,900 ac-ft/yr.

The savings in total consumptive use from reducing incidental depletions are summarized in Table 8-13. The incidental depletions for each agricultural area in each county are estimated by Wilson et al. (2003) depending on the method of irrigation (flood, sprinkler or drip).

For lands that are flood irrigated, the depletion rate is estimated to be 5 percent of the water that reaches the farm in all counties. For lands that are irrigated with sprinkler systems, the incidental depletion rate ranges from 6.5 percent to 33.8 percent. Lands that use drip irrigation have no incidental depletions. To estimate the potential savings by reducing incidental depletions, the total amount of water delivered to the farm is multiplied by the depletion rate if the lands were converted to a drip/micro irrigation method, where incidental depletions are zero, or to a LEPA sprinkler method, where incidental depletion is 1 percent. If all the lands in the Northeast Region could be converted to drip/micro irrigation, 85,500 ac-ft of water could be saved each year. Conversion of all lands to LEPA irrigation method would save 80,000 ac-ft of water each year.

In 1999, approximately 114,340 acre-feet of surface water was used for irrigation within the limits of the planning region. Surface water for irrigation is conveyed to agricultural fields through canals, ditches, and pipes, and some portion of that water is lost by these conveyance systems through evapotranspiration and infiltration.

**Table 8-13. Potential Savings in Consumptive Use Through Reduced Incidental Depletions
Northeast New Mexico Water Planning Region
Page 1 of 2**

Locale	Type of Irrigation [a]	Diversions [b] (ac-ft/yr)	ID Rate [b] (%)	Current Incidental Depletions [c] (ac-ft/yr)	Consumptive Use Savings (ac-ft/yr)	
					Conversion to Micro-Irrigation (ID = 0%)	Conversion to LEPA [d] (ID = 1%)
Union County						
Clayton & vicinity	D (GW)	39	0	0	0	0
	F (GW)	870	5	44	44	35
	S (GW)	71,254	33.8	24,084	24,084	23,371
Dry Cimarron	F (SW / GW)	7,609	5	380	380	304
	S (GW)	3,102	26.2	813	813	782
Tramperos Creek	F (SW / GW)	696	5	35	35	28
Total Union County		83,570	NA	25,356	25,356	24,520
Harding County						
Scattered	F (GW)	38	5	2	2	2
	S (GW)	3,616	33.8	1,222	1,222	1,186
Total Harding County		3,654	NA	1,224	1,224	1,188
Quay County						
AHCD	F (SW)	90,975	5	4,549	4,549	3,639
	S (SW)	16,979	33.8	5,739	5,739	5,569
Inside AHCD but exclusive of AHCD	D (GW)	35	0	0	0	0
Outside AHCD	S (GW)	1,694	33.8	573	573	556
House & vicinity	F (GW)	580	5	29	29	23
	S (GW)	4,237	33.8	1,432	1,432	1,390
Total Quay County		114,500	NA	12,322	12,322	11,177
Curry County						
Scattered	D (GW)	215	0	0	0	0
	F (GW)	5,717	5	286	286	229
	S (GW)	5,526	6.5	359	359	304
	S (GW)	1,365	6.5	89	89	75
	F (GW)	33,520	5	1,676	1,676	1,341
	S (GW)	149,543	6.5	9,720	9,720	8,225
Total Curry County		195,886	NA	12,130	12,130	10,174

[a] D = Drip
F = Flood irrigation
GW = Groundwater
S = Sprinkler (high-pressure center pivot)
SW = Surface water
[b] Wilson et al., 2003
[c] Diversion x ID rate
[d] The spigot is 18 inches above ground surface.

ac-ft/yr = Acre-feet per year
ID = Incidental depletions
LEPA = Low-energy precision application
NA = Not applicable
AHCD = Arch Hurley Conservancy District

Table 8-13. Potential Savings in Consumptive Use Through Reduced Incidental Depletions Northeast New Mexico Water Planning Region Page 2 of 2

Locale	Type of Irrigation [a]	Diversions [b] (ac-ft/yr)	ID Rate [b] (%)	Current Incidental Depletions [c] (ac-ft/yr)	Consumptive Use Savings (ac-ft/yr)	
					Conversion to Micro-Irrigation (ID = 0%)	Conversion to LEPA [d] (ID = 1%)
Roosevelt County						
Scattered	S (GW)	725	24.3	176	176	169
Causey-Lingo	F (GW)	1,203	5	60	60	48
	S (GW)	3,870	24.3	940	940	902
Portales Basin	D (GW)	163	0	0	0	0
	F (GW)	7,113	5	356	356	285
	S (GW)	135,640	24.3	32,961	32,961	31,604
Total Roosevelt County		148,714	NA	34,493	34,493	33,008
Total Planning Region		546,324	NA	85,525	85,525	80,067

[a] D = Drip
F = Flood irrigation
GW = Groundwater
S = Sprinkler (high-pressure center pivot)
SW = Surface water

[b] Wilson et al., 2003

[c] Diversion x ID rate

[d] The spigot is 18 inches above ground surface.

ac-ft/yr = Acre-feet per year
ID = Incidental depletions
LEPA = Low-energy precision application
NA = Not applicable
AHCD = Arch Hurley Conservancy District

In 1999, conveyance losses in canals and laterals in the planning region ranged from 30 to 57 percent of the total surface withdrawals for irrigation (Wilson et al., 2003). Table 8-14 shows the reductions in diversions potentially achievable by reducing water seepage from conveyance channels in the region. The water in the Dry Cimarron and Tramperos Creek would not actually be saved in the sense that it would free up additional water for other uses, because the seepage water from unlined canals typically returns to the river system to be rediverted downstream. However, a recent study by WRRI (King et al., 2006) indicated that the estimated 56,400 ac-ft/yr of seepage losses from the canals and laterals in Arch Hurley could be reduced by 20,000 to 25,000 ac-ft/yr by lining the very leaky reaches of the main Conchas Canal and laterals.

8.3.3 Financial Feasibility

Financial considerations for on-farm and off-farm conservation measures, including possible sources of funding, are discussed in Sections 8.3.3.1 and 8.3.3.2.

8.3.3.1 On-Farm Conservation Costs

In addition to showing the potential reduction in diversions for this strategy, Tables 8-7 through 8-12 summarize estimated costs associated with applicable on-farm water conservation measures in the planning region. These part-time operations do not generate cash flows sufficient to justify investments in water delivery system improvements, and funding from other sources is therefore likely to be necessary.

Both federal and state funding assistance should be available for the on-farm conservation measures described under this strategy. Federal funding sources are available for capital costs and generally do not cover operation and maintenance costs. Potential funding sources for on-farm improvements include the following:

- The most applicable federal program for funding on-farm activities is the Natural Resources Conservation Service (NRCS) Environmental Quality Incentives Program. However, this program is understaffed, which could increase the time needed to process applications and disburse funding.

Table 8-14. Potential Reduction in Seepage Losses from Off-Farm Conveyance Systems Northeast New Mexico Water Planning Region

Locale [a]	Irrigation Method [b]	Total Surface Water Diversions (ac-ft/yr)	Conveyance Efficiency		Potential Savings from Lined Canals (ac-ft/yr)
			Current (%)	Ideal [c] (%)	
Union County					
AWR Clayton & vicinity	D	0	NA	NA	0
	F	0	NA	NA	0
	S	0	NA	NA	0
AWR Dry Cimarron	F	5,809	70	95	1,452
	S	0	NA	NA	0
AWR Tramperos Creek	F	576	70	95	144
Total Union County		6,385	70	95	1,596
Quay County					
AWR AHCD	F	90,975	42.74	95	47,544
	S	16,979	42.74	95	8,873
AWR inside AHCD but exclusive of AHC	D	0	NA	NA	0
AWR outside AHCD	S	0	NA	NA	0
House & vicinity	F	0	NA	NA	0
House & vicinity	S	0	NA	NA	0
Total Quay County		107,954	42.74	95	56,417
Total Planning Region		114,339			58,013

Source: Wilson et al., 2003, unless otherwise noted

ac-ft/yr = Acre-feet per year
AHCD = Arch Hurley Conservancy District
AWR = Arkansas-White-Red
NA = Not applicable

[a] No unlined conveyance systems exist in Harding, Curry, and Roosevelt Counties
[b] D = Drip
F = Flood irrigation
S = Sprinkler (high-pressure center pivot)
[c] "A well operated, lined conveyance system can reduce network losses to less than 5 to 10%." (Vickers, 2001)

- The Farm Security and Rural Investment Act of 2002 provides for the Conservation Security Program. This is a national incentive program that allows farmers who are implementing conservation technologies in fiscal years 2003 through 2007 to receive reimbursements (SWCS, 2003).

- The New Mexico ISC, through its Agricultural Conservation Funds program, will grant low-interest loans to irrigation entities, who in turn can re-loan to farmers for various farming improvements, including water conservation related actions (NM ISC/OSE, 2006).

- The New Mexico State Legislature has considered and may at some point initiate programs to provide funding for agricultural conservation measures.

Another on-farm conservation measure is the installation of water meters on groundwater wells used for irrigation and on surface water diversions. The cost of a meter can range from $600 to $2,500, not including the additional cost of installation and maintenance. Maintenance costs are estimated at approximately $200 per year per meter (Sanger, 2005). To help farmers off-set these costs, a cost-share program (50 percent) can be set up with the state, local water managers, or irrigation districts.

8.3.3.2 Off-Farm Conservation Costs

As shown in Table 8-14, if all of the canals that divert surface water in the planning region were lined, canal seepage could be reduced by a total of 116,000 acre-feet of water. The cost of lining the approximately 12.6 miles of the Conchas Canal with the highest rate of leakage was estimated to cost $25,000,000 based on 2005 prices (King et al., 2006). Lining the canals would save an estimated 12,000 to 13,000 acre-feet of water per year or about $2,000 per acre-foot. The cost to line the 60 percent of currently unlined laterals in Arch Hurley is estimated to be $500 to $1,000 per acre-foot (King et al., 2006)

This cost does not include annual recurring maintenance or any other costs for planning and managing such a program. Additional capital costs would also be necessary to address non-channel construction required to improve irrigation delivery systems under such a program.

The costs for planning, designing, and installing a piped irrigation system would be generally comparable in magnitude to those for installing canal linings. However, additional water would be saved because of the lack of evaporation.

8.3.4 Environmental Impacts

Implementing canal lining or pipelines could affect the environment by reducing the recharge to groundwater. Currently, the unlined canals and laterals in Arch Hurley act as an artificial aquifer recharge project, reducing the rate of aquifer decline. Similar recharge likely occurs along the Dry Cimarron in areas where surface water is used for irrigation.

8.3.5 Political Feasibility and Social/Cultural Impacts

The bulk of water in the Northeast Region is used for irrigating agriculture, and the greatest opportunity for savings is the implementation of the practices included in this strategy. There is public support for ditch lining as a means to minimize evaporative loss, and the potential reduction of recharge is not seen as a deterrent. LEPA systems were discussed at multiple steering committee and public meetings, and there is consensus that these systems are both efficient and practical, providing a great benefit at low cost. Implementation of irrigation improvements, such as replacing cement pipes with polyvinyl chloride (PVC), and development of lower-water-use crops are also supported.

Based on discussions at multiple meetings, there is not a regional consensus in favor of metering agriculture wells. Most people feel that irrigators use the least amount of water possible and are particularly driven to do so because of the expense of pumping wells. There is widespread opposition to metering livestock wells in the region, and stakeholders want the difference between agricultural and livestock use stressed, as much less water is used for livestock than for irrigating agriculture.

Livestock conservation measures that were supported included providing incentives for cattle growers to reduce evaporation from stockponds and implementing conservation stewardship awards on the local level.

Implementation of water conservation measures (including water reuse) at dairies is widely supported, and the reuse of graywater on farms and ranches is also seen as a viable conservation measure. Hydroponic crops are not viewed as being feasible on a large scale, due to the area that would need to be enclosed and the high cost of implementation. Meeting participants felt that education should be an important part of the agricultural conservation strategy and have identified Future Farmers of America outreach as an important focus, as these students will be the future of farming.

8.4 Groundwater Management

Of the eight states in which the Ogallala aquifer is present, New Mexico has the least amount of water in storage, and portions of the aquifer in New Mexico will not be productive beyond the next 10 to 20 years. To carefully track and monitor the rates of decline throughout the aquifer, extensive groundwater monitoring is necessary, but the federal and state agencies that conduct groundwater level and quality monitoring do not have a coordinated or comprehensive monitoring program to gather data throughout the region, and the information that is collected is not compiled into a unified summary. Thus while the existing programs are valuable to the region, the resulting information cannot be readily accessed by local governments and decision makers.

In addition, counties and municipalities in the planning region area lack an integrated approach to prioritizing and implementing groundwater protection programs. Even in Quay County, which relies on the productive Entrada sandstone aquifer instead of the Ogallala, such groundwater monitoring programs and intergovernmental cooperation would be a key component of long-term groundwater protection.

This strategy examines various groundwater management and reporting activities that would assist the region to better monitor and interpret changes to groundwater levels, discusses potential strategies for development of groundwater administration policies, and discusses options to protect and enhance the quality of all groundwater resources in the planning region. Specific strategies presented include data collection such as measuring groundwater levels, preparation of reports summarizing groundwater level data, development of administrative criteria for groundwater management, sampling water quality in rural areas near septic tanks, and development of wellhead and source water protection initiatives.

8.4.1 Ongoing Monitoring Efforts

The following subsections summarize existing monitoring efforts to indicate which areas currently have metering and measuring data and to highlight data gaps.

8.4.1.1 Municipal Well Metering

The OSE sends questionnaires out to municipalities and, based on the responses, summarizes public water supply use in reports published every five years. While some of the municipalities in the region meter their wells, others respond to the OSE questionnaires with production data or with the amount of water sold. This information is generally a reliable source for estimating water use for public supply. Domestic wells are not metered, and so diversions from domestic wells are estimated based on a calculation for the population not served by public water supply systems and an assumed average per capita demand (Section 6.1.2).

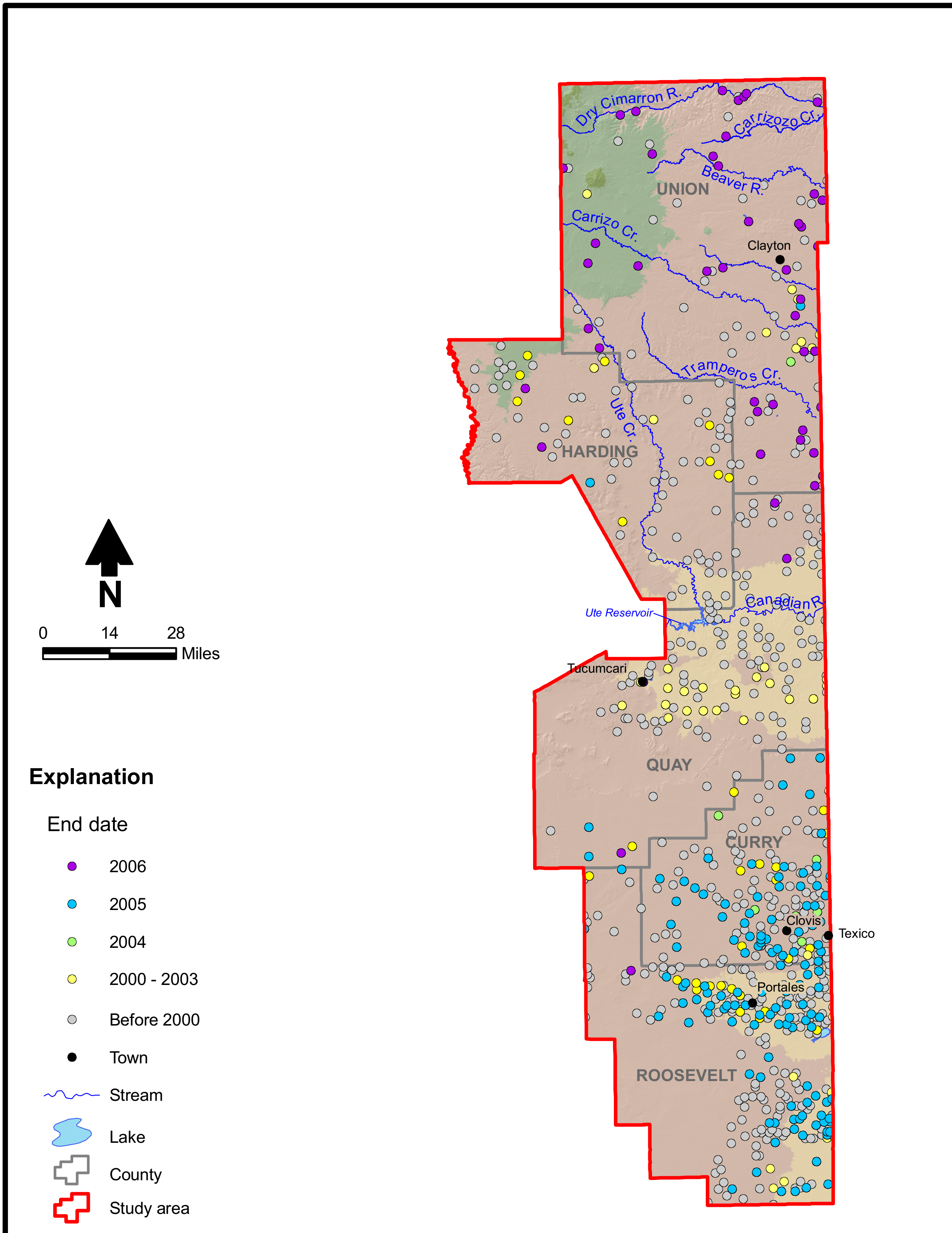
8.4.1.2 Groundwater Level Gaging

The USGS monitors water levels in many wells in the region (Section 5.3.5); however, the number of measurements collected has declined significantly in recent years and is dependent on available funding. Historical groundwater level data are available on the USGS web site for 713 wells in the region. Locations of wells and latest monitoring dates are shown on Figure 8-2.

Some of the communities in the planning region monitor water levels in their municipal wells:

- None of the municipalities in Union (Clayton, Grenville, Des Moines) or Harding Counties (Roy, Mosquero) measure water levels.

- In Quay County, the Village of House measures water levels annually. The Village of San Jon measured water levels every three months before they started using Logan water as their source of supply (supplied through the Logan-San Jon pipeline), but as they are now supplied entirely by water from the Village of Logan, measuring water



NORTHEAST NEW MEXICO REGIONAL WATER PLAN

USGS Well Locations

Daniel B. Stephens & Associates, Inc.

03/22/2007 WR04.0147

Figure 8-2

M:/PROJECTS/WR04.0147_NE_NM_REGIONAL_WATER_PLAN/GIS/MXDS/REPORT_FINAL/FIG8-2_USGS_WELL_LOCATIONS_DATE.MXD 702230 levels is not a high priority. The City of Tucumcari measures water levels monthly, and the Village of Logan does not measure water levels.

- In Curry County, the City of Clovis measures water levels quarterly, while Melrose, Grady, and Texico do not monitor water levels.

- In Roosevelt County, the City of Portales measures water levels annually in the winter, the Village of Elida collects water level measurements infrequently, the Village of Dora has measured water levels twice in the last 20 years, and the Village of Causey does not measure water levels.

Domestic well permits and declaration forms filed with the OSE include water levels of wells at the time of drilling, although there is no electronic summary of this information. A survey of newly permitted domestic wells could provide additional water level data.

8.4.1.3 Water Quality Monitoring

Public water systems sample public supply wells for contaminants of concern based on the U.S. EPA's standardized monitoring framework, with oversight from the NMED Drinking Water Bureau. Public systems test for a variety of constituents on a frequency that is appropriate for each constituent. For instance, turbidity is tested every four hours in surface water systems, whereas volatile organic compounds are tested once every five years in wells in which concentrations have previously been below detection. The Safe Drinking Water Act regulations apply to both privately and publicly owned systems that serve at least 25 people or have 15 service connections (e.g., homes and businesses), for at least 60 days per year. Table 8-15 lists the number of water systems in each county that are monitored by the NMED Drinking Water Bureau.

The NMED Ground Water Quality Bureau monitors water quality at sites with groundwater discharge plan permits. Most of the sites are monitored for nitrate in groundwater originating from municipal and domestic wastewater. Table 8-16 lists the number of groundwater discharge plans by facility type for each county.

Table 8-15. Number of Regularly Sampled Community Water Systems in Northeast Region

County	Number of Water Supply Systems Sampled
Union	12
Harding	2
Quay	17
Curry	29
Roosevelt	9
Total	69

Source: NMED, 2006b

Table 8-16. Number of Groundwater Discharge Plans in Northeast Region

County	Facility Type	Number of Groundwater Discharge Plans
Union	Municipal/domestic wastewater	4
	Agricultural	1
Harding	Municipal/domestic wastewater	2
Quay	Municipal/domestic wastewater	2
	Agricultural	4
	Industrial	2
Curry	Municipal/domestic wastewater	10
	Agricultural	47
	Industrial	7
Roosevelt	Municipal/domestic wastewater	7
	Agricultural	58
	Industrial	1
	Total	145

Source: NMED, 2005b

8.4.1.4 Summary of Data Collection Gaps

Data collection gaps include groundwater level gaging for some areas, summaries of the water level data that is collected, and monitoring the impacts of septic tanks to groundwater in rural areas. In addition, local water quality protection programs to ensure source water and wellhead protection are lacking.

Currently, data are collected by a number of different organizations. Additionally, even when valuable information is collected, it is not routinely evaluated and presented in a manner that allows for timely evaluation of trends by local officials and/or residents. Because each type of data is collected for a specific purpose, development of a single monitoring plan is unlikely. However, improved integration of the data from these different programs would be possible through cooperative groundwater management programs (Section 8.4.2.5).

8.4.2 Technical Feasibility

This strategy includes programs and projects that could reduce the number of data gaps and improve existing data collection and information sharing for the following types of information:

- Continued water level measurements, under the jurisdiction of the counties, OSE, or USGS

- Focused water level measurements along the New Mexico-Texas border, under the jurisdiction of the counties, OSE, or USGS

- Monitoring of groundwater quality in rural areas, in the vicinity of septic tanks, under the jurisdiction of the counties or NMED

- Water quality protection through wellhead and source water protection under the jurisdiction of counties or municipal governments

- Preparation of annual reports that clearly summarize the data collected and provide maps and graphs to indicate changes in water levels and groundwater quality

- Regional participation in development of OSE administrative criteria for groundwater in the area, so that as OSE moves forward with developing groundwater management policies, those policies will reflect the interests of the region.

8.4.2.1 Water Level Measurements

Water level measurement data provide information about the changes in the depth to groundwater, the direction of groundwater flow, and the saturated thickness of the aquifer. Water levels can be analyzed over time for either a single well or for multiple wells. Water level data are most useful when:

- The data are collected when the well and any nearby wells are not being pumped.
- Water levels are measured at the same time of year for extensive periods
- The aquifer the well is completed in is known.

Analysis of depth to water information for many wells completed in the same aquifer can yield flow direction, and most importantly, depth to water trends over time indicate when and where an aquifer is being mined.

Although existing data are adequate for gaining a general understanding of groundwater levels, coverage of the region with regularly monitored wells is incomplete, especially due to decreased funding of the agencies that collect these data. This strategy evaluates a two-phased approach to expand water level data collection throughout the Northeast Region with a focus on the New Mexico-Texas border area. Specific details for individual studies will need to be developed. Oversight by individual counties or the OSE would be appropriate.

8.4.2.1.1 Establish a Water Level Monitoring Network. Development of a comprehensive monitoring network can be accomplished in two phases:

- *Phase 1:* This phase would involve expanding the network of monitored wells and installing monitoring wells where necessary to better define trends in water levels. Areas where additional data collection efforts would be valuable but monitoring has ceased due to decreased funding or wells going dry should be identified, and existing wells that are no longer used should be reinserted in the monitoring program. In some locations, it may be valuable to drill additional monitor wells to better define critical areas.

- *Phase 2:* This phase involves measuring a network of wells established in Phase 1 on a regular basis. An annual program of groundwater monitoring could monitor water level changes over time.

8.4.2.1.2 Monitor Groundwater Elevations Along the Texas-New Mexico Border. To address concerns regarding groundwater near the border, the water level monitoring network could include a higher density of wells in this area. Stakeholders in the Northeast Region have raised concerns over the increase in hydraulic gradient caused by pumping in Texas (Section 7.2.1.2; Chudnoff, 1998). Although studies have indicated that total flow across the state line has decreased due to the saturated thickness reduction caused by pumping on both sides of the state line (Shomaker, 1998), some amount of water does move from New Mexico into Texas. Concentrated water level monitoring along the state line could be used to further address this concern.

8.4.2.1.3 Obtain Water Level Data from Domestic Well Files at the OSE. Domestic well permits and declaration forms submitted to the OSE list water levels of drilled wells associated with the domestic permit. A survey of newly permitted domestic wells could provide additional water level data in rural areas where monitor wells are not present. A copy of the actual well log, which describes in detail the well structure and includes a depth to water measurement, would be the most reliable source of information.

The OSE maintains the files for all of the Northeast groundwater basins in its district office in Santa Fe. However, identifying recently filed domestic well applications could take a significant amount of time. A streamlined approach to obtain data for specific areas of concern, such as the New Mexico-Texas border area, could be feasible if existing personnel could contribute staff time or develop funding to carry out such a project. For example, all domestic well files could be reviewed for a particular area to identify recently drilled wells, and water level data associated with these files could be tabulated.

8.4.2.1.4 Summarize Existing Water Level Data. Depth to water data exist, but they are difficult to obtain or evaluate for purposes of understanding regional trends. Whether or not the region is successful in implementing additional groundwater level monitoring programs, it is important that existing data be evaluated and made available in an accessible format.

Published annual reports that synthesize information on water level declines and remaining saturated thicknesses in the region would be valuable.

8.4.2.2 Monitoring of Rural Groundwater Quality

Septic systems are generally spread out in rural areas and are often located near private domestic wells that are not routinely monitored for water quality. Collectively, septic tanks and other on-site domestic wastewater disposal systems constitute the single largest known source of groundwater contamination in New Mexico (NMED, 2004c). As discussed in Section 5.4.2.2.5, septic tanks are of particular concern in the area near Ute Reservoir, where they have the potential to impact both surface water and groundwater supplies. Ideally, county governments would conduct an assessment of the areas where septic tanks are impacting water quality to help prioritize areas that need changes to the land use codes. Groundwater in wells near septic tanks should be tested for nitrate, TDS, chloride, manganese, sulfide, and total coliforms. County governments, working in cooperation with the NMED, could be responsible for these types of monitoring programs.

8.4.2.3 Administrative Criteria for Groundwater Management

The OSE is currently preparing draft rules and regulations for those groundwater basins that include the Ogallala aquifer, and these regulations will affect seven of the eight groundwater basins present in the Northeast Region. In addition, criteria are being developed for the recently declared expansion areas of existing basins. Public participation is encouraged in the drafting of new OSE regulations, and affected individuals should review and comment on the OSE draft criteria when they become available.

8.4.2.4 Implementation of Wellhead Protection Programs

The Federal Safe Drinking Water Act (SDWA) was enacted in 1974 to ensure that public drinking water is safe and to protect the sources of drinking water from contaminants. In 1986, amendments to the SDWA strengthened provisions for protecting groundwater by requiring each state to develop and implement state wellhead protection programs (WHPP). Information about the New Mexico WHPP can be found at <http://www.nmenv.state.nm.us/dwb/whpp.html.>

Wellhead protection is one way in which communities can protect their current and future drinking water supplies. A WHPP minimizes the potential for contamination by identifying and protecting areas that contribute water to water supply wells and can help to avoid costly groundwater cleanups. A general guidance to develop a WHPP is outlined below.

- Form a community planning team.

- Delineate the protection area(s) by identifying the recharge area and the zone of influence for the well(s).

- Assess the susceptibility of the source water. This can be done by making an inventory of existing potential sources of contamination around the well and within the recharge area of the well.

- Establish a wellhead protection area (WHPA) for the well. The WHPA may be determined by a hydrogeologic investigation.

- Start a public education program for wellhead protection.

- Develop a contingency plan for providing safe water in the event of any contamination incident.

- Based on the assessment of alternatives for addressing potential sources of contamination, develop a management plan describing the local ordinances, zoning requirements, monitoring program, and other local initiatives proposed for the delineated WHPA.

An additional resource to the region is the New Mexico Source Water Assessment and Protection Program (SWAPP), which can be used to address monitoring and control of potential sources of contamination near public water supplies. This is a federally funded program overseen by the U.S. EPA that assists communities in protecting their drinking water supplies. Specifically, 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

8.4.2.5 Organizational Structure for Implementation

An organizational structure for better coordinating and evaluating existing programs and data and for adding to the existing monitoring network has been discussed at multiple Northeast Region water planning meetings. Discussion has included the creation of special water and sanitation districts expansion of OSE groundwater management activities, and use of existing municipal and county authorities to implement cooperative groundwater management programs. Each of these organizational structures is discussed below.

8.4.2.5.1 Creation of Special Water and Sanitation Districts. Water and sanitation districts, created under the Water and Sanitation District Act (NMSA 1978, §§73-21-1 through 73-21-54, 1943, as amended through 2005), are governmental subdivisions of the state with quasi-municipal powers, including the power to levy and collect *ad valorem* taxes (imposed at a rate percentage value), and the right to issue general obligation and revenue bonds. This type of special district can be created for several different purposes (NMSA 1978, §73-21-3A):

- Water supply for domestic, commercial and industrial use
- Sewer services
- Street improvement
- Park and recreational improvements
- Public facilities or economic development

Water and sanitation districts can function as utilities, which are regulated by the Public Regulation Commission (http://www.nmprc.state.nm.us/regent.htm).

Water and sanitation districts can be created by petition and referendum: 25 percent of registered voters within the service area of the district must sign a petition and then approval is sought through a referendum. If successful, the district is formally created when the District Court enters an order declaring the district's existence pursuant to NMSA 1978, §§73-21-5 to 73-21-10.

It is unclear whether a water and sanitation district could be created for the sole purpose of coordinating groundwater measuring and monitoring programs. Also, the size of the district is limited by the geographical area the district serves. Therefore, such an organization would not be regional in nature. Given the high cost to develop such an organization, it is not a feasible approach for increasing measuring and monitoring data in the region.

8.4.2.5.2 Expansion of OSE Groundwater Management Activities. As mentioned in Section 5.3.5, the OSE currently conducts groundwater level monitoring activities in cooperation with the USGS. The region could lobby to increase funding for these programs to continue and potentially expand the amount of groundwater monitoring that takes place, particularly along the New Mexico-Texas border. The budget for these activities should include funding for the OSE to develop water level maps and annual data summary reports, making data readily available and accessible to the region.

The OSE clearly recognizes the need for additional services in the Northeast Region and recently supported an unsuccessful bill requesting $300,000 for a local district office in northeast New Mexico (HB 398), for the purpose of administering the Clayton and Canadian River groundwater basins, as well as surface water in northeast New Mexico. Should the OSE pursue this initiative in the next legislative session, it may be possible to include funding for a staff position dedicated to groundwater level monitoring and reporting, who would work out of the proposed northeast New Mexico district office. This approach presents no legal or technical impediments, but it is uncertain whether it will have sufficient local and OSE political backing to succeed.

The fact that the OSE already conducts this type of activity and has in-house technical expertise is an advantage of this approach. However, the OSE does not conduct water quality testing nor could it assist with wellhead protection.

8.4.2.5.3 Municipal and County Cooperation on Groundwater Management Programs. Another approach would be to rely on municipal and county statutory authority to develop and implement cooperative projects that benefit the local region and address data gaps. A model for this type of municipal and county cooperation was established between Bernalillo County and the City of Albuquerque. Recognizing the need for groundwater management programs, the Bernalillo County Board of Commissioners and the Albuquerque City Council passed resolutions calling for a comprehensive Groundwater Protection Policy and Action Plan (GPPAP) to address groundwater supply protection and cleanup for future use. The Bernalillo County Commission adopted the GPPAP in 1993 and the Albuquerque City Council adopted it in 1994. The goals of the Albuquerque-Bernalillo GPPAP are to protect groundwater, locate and remediate contaminated groundwater, and promote the coordinated protection and prudent use of the groundwater resource throughout the Albuquerque area.

Counties and municipalities in the Northeast Region could develop a similar type of initiative to address local groundwater management priorities and develop cooperative programs to ensure that the necessary information is collected and synthesized. Through cooperative efforts, the counties and municipal governments could pool resources and might be better able to secure additional funding, especially as many funding sources focus on regional projects.

8.4.3 Hydrological Impacts

Water levels and water quality monitoring and implementation of WHPPs are not expected to have direct hydrologic impacts; however, the data collected could ultimately help improve the water resources management. Potential monitor well installation and continued groundwater monitoring and data synthesis could help to ensure that future groundwater development is optimized and does not adversely affect existing users. Rural water quality monitoring can help protect the quality of rural drinking water supplies. Development of WHPPs can help protect groundwater quality from various potential sources of contamination.

8.4.4 Financial Feasibility

The following subsections address the financial feasibility of each proposed component of this strategy.

8.4.4.1 Water Level Measurements

Continued water level monitoring of existing municipal, domestic, stock, or irrigation wells (preferably in the winter, when pumping is at a minimum) is estimated to cost from $50,000 to $200,000. Installation of addition monitor wells can range from $5,000 to $20,000 for each shallow well (about 100 feet deep) or $150,000 for a well about 1,000 feet deep. However, due to the large network of wells present, minimal new well installation is expected.

8.4.4.2 Monitoring of Groundwater Elevations Along the Texas/New Mexico Border

Costs for adding additional wells to the existing monitoring network will vary depending on the number of wells added and the distance between them. The USGS currently estimates a cost of about $160 per measurement on an existing 500-foot-deep well (Garcia, 2005).

8.4.4.3 Development of Water Level and Water Quality Summary Reports

Anticipated costs for preparing annual water level and water quality summary reports are expected to range between $20,000 and 50,000, depending on their level of detail. Reports are anticipated to cost more the first year than in subsequent years.

8.4.4.4 Obtain Water Level Data from Domestic Well Files at the OSE

The number of domestic well files to be evaluated will determine the cost of tabulating water level data from domestic well files; a range of costs is presented in Table 8-17.

Table 8-17. Estimated Cost of Obtaining and Evaluating Domestic Well Water Level Data

Task	Cost ($)		
	File Review	Other [a]	Total
Consult all water rights files in the region to identify recently drilled wells with water level data	40,000-50,000	10,000	50,000-60,000
Consult water rights files in the 44 township and ranges located along the border to identify recently drilled wells with water level data	7,000-10,000	10,000	17,000-27,000

[a] Develop maps, create database, coordinate with local governments

8.4.4.5 Monitoring of Groundwater Quality in Rural Areas

The estimated costs for a program to test 10 percent of the approximately 5,000 groundwater wells in the region (500 wells) for possible impacts from septic tanks are provided in Table 8-18.

Total costs to collect and analyze water quality samples could range from $100,000 to $200,000. County governments could get grants from the U.S. EPA for nonpoint source pollution assessment to help fund this type of program. If impacts from septic tanks are observed, additional testing for organic compounds would be recommended.

Table 8-18. Estimated Analytical Costs for Program to Test Domestic Wells Near Septic Tanks

Constituent	Cost ($)	
	Per Sample	Total (500 Wells)
Nitrate	15	7,500
Chloride	15	7,500
Manganese	20	10,000
Hydrogen sulfide (test is for sulfide)	40	20,000
Iron (ferrous)	20	10,000
Total dissolved solids	15	7,500
Coliforms, total / fecal	41 / 48 [a]	20,500 / 24,000 [a]
Total	166 / 173 [a]	83,000 / 86,500 [a]

Source: 2005 fee schedule for Hall Environmental Analysis Laboratory
[a] Difference in cost reflects the type of coliform test used.

Alternatively, domestic well owners can have their wells tested by NMED for fluoride, iron, nitrate, and electrical conductivity at no cost. Instructions for well testing are provided at the NMED web site (http:/www.nmenv.state.nm.us/fod/LiquidWaste/).

8.4.4.6 Implementation of WHPPs

The cost to develop and implement a WHPP is generally much less than the cost to restore water quality after contamination has occurred. The actual cost to implement a WHPP will depend on the methodology used to determine the protection area and the number of staff needed to administer a proposed program. These costs can be split into development and annual management costs. Delineating the protection area is generally the most expensive portion of the development costs due to the need for groundwater modeling. Costs for development and implementation of WHPPs for various municipalities can vary significantly (from $50,000 to several hundred thousand dollars) based on the needs and specific issues facing the individual community.

Program costs for source water protection programs are similar to those of wellhead protection. Typical costs include program administration, staffing, construction of physical barriers, and materials for public education. NMED would be an important resource and could assist the region in developing this type of program.

8.4.4.7 Water and Sanitation District Development

Creating a water and sanitation district involves numerous startup costs as well as the cost to hire staff and fund the different water measuring and monitoring programs.

Startup costs include the campaign costs to create the district. Assuming an ongoing public education and lobbying effort to obtain signatures followed by the referendum, this activity is likely to cost between $25,000 and $50,000, including consultant and attorney fees.

Operating and managing the district would entail costs for at least one full-time employee, which could cost anywhere from $60,000 to 100,000 per year (including benefits). Additional costs for facilities and equipment could range from $25,000 to 75,000. Water sampling analyses could cost an additional $70,000 to 80,000.

Thus, costs for creating and operating a water and sanitation district would be more than $180,000.

8.4.4.8 Continuation and Potential Expansion of OSE Groundwater Management Activities

Costs associated with the strategy are primarily personnel costs. Assuming a $75 hourly rate (including benefits), these costs would be:

- *Program development:* Identifying additional wells to measure and contacting well owners to obtain their permission is estimated to cost $6,000 per year.

- *Well measurements:* Measuring water levels in 80 wells over a 3 week period is estimated to cost $9,000 per year.

8.4.4.9 Municipal and County Cooperation to Implement Groundwater Management

This strategy could use existing staff from the county and municipal governments, although it would be advisable to hire an additional staff person to take responsibility for this task. This activity is not expected to require full-time work, and so a part-time person could be hired to reduce costs; however, finding a sufficiently qualified person at a part-time level is unlikely. This person could potentially be tasked to carry out other water-related activities (e.g., conservation or public education). The estimated cost for a full-time employee including benefits is $50,000 to $70,000 per year.

8.4.5 Environmental Impacts

Temporary environmental impacts from improved measurement and data collection efforts could result from the installation of wells, but the overall environmental impacts are expected to be minimal.

8.4.6 Political Feasibility and Social/Cultural Impacts

The anticipated political feasibility and social/cultural impacts for each of the activities associated with this strategy are provided in Sections 8.4.6.1 through 8.4.6.3.

8.4.6.1 Water Level Measurements

The groundwater monitoring and management strategy was discussed at multiple meetings and scored high during the strategy selection process. During public meetings, stakeholders agreed that increasing the number of wells that are monitored is viable and that monitoring could be more intense throughout the region. At the last round of public meetings in April 2006, however, concern was expressed over this alternative. Some individuals stated that it seems to be too late to implement a groundwater protection policy in an effort to keep the resource from being depleted. As a whole, people in the region are not in favor of more regulation and its associated costs. In addition to regional reservations, development of these types of monitoring programs may not be considered a priority for the use of limited State funds.

8.4.6.2 Monitoring of Groundwater Quality in Rural Areas

During public meetings, stakeholders agreed that identifying areas vulnerable to contamination is important; however, at the last round of public meetings in April 2006, some individuals expressed the opinion that groundwater is already well regulated by the State Engineer and monitored by communities as required by NMED, making further water level monitoring and water quality sampling unnecessary. Existing water quality monitoring does not cover those individuals supplied by domestic wells; those individuals are responsible for having their own water tested. In light of the concern for the protection of private property rights in the region, this type of program may not receive the necessary support for implementation. More specifically, if additional groundwater monitoring were funded, many landowners may not be willing to allow local government or OSE or NMED staff onto their property to gage or sample private wells.

8.4.6.3 Implementation of WHPPs

Implementing wellhead protection plans in areas near municipal supply wells should be politically feasible, particularly if the program begins by targeting high priority areas. Funding could potentially be obtained from U.S. EPA WHPP grants. No negative impacts of WHPPs are anticipated.

8.5 Rangeland and Watershed Management

Rangeland conservation and watershed management activities can include a variety of practices that can contribute to the health of a watershed. These activities may include those that protect or improve water quality, enhance water supply, and/or enhance ecosystem health. Ideally, rangeland conservation and watershed management activities will proceed in a manner that will optimize the benefits in all of these areas.

Development of watershed groups is helpful in identifying rangeland conservation and watershed management projects (as well as funding for them), although these types of projects can be executed without creating formal groups. In developing rangeland conservation and watershed management plans, the first step involves bringing together individuals and entities with interests in the watershed, including local, state, and federal agencies and private landowners. The key to maintaining this type of group is to make sure that it is well coordinated and facilitated, which may involve hiring facilitators or involving employees of land management agencies, if they are available. Numerous resources for watershed groups (and private citizens) are available from the NRCS and associated soil and water conservation districts (SWCDs), NMED, the Quivira Coalition, and the U.S. EPA, as well as on the internet.

Examples of rangeland conservation and management strategies that could be developed in the Northeast Region by watershed groups or by other means include:

- Management practices for roads, culverts, or other construction projects that minimize erosion and protect water quality from increased sedimentation

- Projects that address water quality issues such as elevated stream temperatures, suspended sediment loads, and impacts from septic systems, mining, or potential contaminant sources

- Grazing practices that minimize water quality degradation, riparian impacts, and impacts to upland watersheds

- Restoration of riparian areas involving the removal of non-native vegetation (e.g., salt cedar) followed by management to prevent regrowth

Rangeland conservation and watershed restoration projects may be identified and implemented through full watershed restoration action strategy (WRAS) document development, or they can be individually identified and implemented in order to address particular areas of concern. Many activities are already being carried out by the NRCS and SWCDs, NMED, and other agencies and individuals in the planning region. For example, the Ute Creek SWCD is involved in an ongoing project to remove salt cedar from the Canadian River watershed.

8.5.1 Technical Feasibility

Ideally, rangeland conservation and watershed restoration programs integrate projects that improve water quality, water yields, and ecological health. The following subsections describe some key restoration efforts that can potentially help to reduce erosion, restore water quality, and enhance yields through reducing riparian depletions. The rangeland management techniques described in this section should be used as a general guide that can be adapted to meet the needs of specific sites and conditions. Acreage where rangeland management techniques are being used in the Northeast Region is summarized in Table 8-19.

8.5.1.1 Grazing Management

Grazing management is the management activity with the greatest potential to improve water quality. Planning region land use is dominated by rangeland, which is grazed by cattle and also serves as wildlife habitat. Rangelands in New Mexico are arid to semiarid, receiving only 16 inches of precipitation (Simanton, 1991). Grazing impacts watersheds by changing soil and vegetation conditions, and grazing management can control the grazing habits of animals on rangelands. Poor grazing management can lead to reduced plant and animal production, as well as adverse runoff effects that lead to erosion (Weltz and Wood, 1986).

Grazing effects on forage and livestock production are dependent on the timing and intensity of grazing. Timing should allow plants to recover between grazing events, preventing them from being weakened and their root depths from being lowered. The length of the recovery period required will vary depending on plant type, grazing intensity, and soil and weather conditions. Grazing intensity also affects how well plants can recover and impacts individual plant species differently. For example, some grasses store energy in the lower leaf stem, and close grazing can remove this stem, removing the source of energy for regrowth. Other plants have older leaves located at the base of the plant, which tend to be less photosynthetically efficient, so close grazing removes the old leaves and allows new, more efficient leaves to grow (Rayburn, 1992).

Riparian areas within the region are important to livestock producers because they serve as a source of water for livestock and there is greater quantity and quality of vegetation in riparian

Table 8-19. Rangeland Management Technique Usage in 2005 in the Northeast Region

County	Management Technique Usage Area (acres, unless otherwise noted)									
	Brush Management [a]	Fence [b] (feet)	Forage Harvest Management [c]	Grazing Land Mechanical Treatment [d]	Pasture and Hay Planting [e]	Prescribed Grazing	Prescribed Grazing for Vegetation Control [f]	Range Planting [g]	Use Exclusion [h]	Pipeline [i] (feet)
New Mexico	*70,230*	*690,481*	*1,715*	*921*	*748*	*137,963*	*756,721*	*6,255*	*17,206*	*670,354*
Curry	602	9,530	---	921	---	1,839	7,082	1,260	1,617	11,045
Harding	5,083	105,168	---	---	---	18,390	11,257	100	931	61,291
Quay	6,359	35,571	190	---	146	8,502	76,114	299	731	36,380
Roosevelt	2,873	100,369	---	---	---	35,155	19,921	3,144	11,801	34,119
Union	317	25,259	---	---	---	11,896	3,147	---	---	58,649
NE Region Total	15,234	275,897	190	921	146	75,782	117,521	4,803	15,080	201,484

Source: http://ias.sc.egov.usda.gov/prsreport2005/report.aspx?report_id=205

--- = No data available

[a] Removal, reduction, or manipulation of non-herbaceous plants
[b] A constructed barrier to animals or people
[c] The timely cutting and removal of forages from the field as hay, green-chop, or ensilage
[d] Modifying physical soil and/or plant conditions with mechanical tools
[e] Establishing native or introduced forage species
[f] Managing the controlled harvest of vegetation with grazing animals
[g] Establishment of adapted perennial vegetation such as grasses, forbs, legumes, shrubs, and trees
[h] Excluding animals, people, or vehicles from an area
[i] Pipeline having an inside diameter of 8 inches or less

areas than in adjacent upland areas. Riparian areas are also ecologically important because they function as filters for sediments and pollutants, slow water during high-flow events, recharge groundwater, reduce erosion and maintain streambank stability, all the while providing a valuable resource for wildlife (Rayburn, 1992). Many management strategies are developed that protect riparian areas and improve forage supplies for livestock. Generally, site-specific measures that focus on soil conditions, hydrology, and vegetation are recommended, and several general strategies detailed below (Baker et al., 2001; Rayburn, 1992; Howery et al., 2000).

- *Season-long grazing*. In season-long grazing, livestock are released into an area in the early spring and allowed to graze in the allotment until fall. With this strategy, cattle will tend to congregate in the riparian areas during the hot summer months, overusing the riparian forage and possibly also eating woody vegetation such as willows and other trees. Important tools for this grazing system include distribution tools and periodic rest of the area.

- *Dormant season grazing*. Dormant season grazing occurs during the winter months and is one of the grazing strategies with the least detrimental impacts to riparian areas. Livestock distribution may be improved using this strategy since herbaceous vegetation may not be very palatable during the winter and riparian areas tend to be colder than the surrounding uplands. However, some research indicates increased foraging on woody species by livestock with dormant season grazing since these species retain more nutrition than herbaceous species during dormancy. This can cause selective pressure on one or more species and may eventually lead to species decline.

- *Early growing season and late growing season strategies*. This strategy allows for a short period of grazing in the early spring and in the fall, with livestock being moved to summer grazing pastures or winter grazing areas in between these periods. For this strategy to be effective, close monitoring of the forage is necessary, especially for the woody riparian species such as willows and cottonwoods. This system of grazing works well in healthy riparian zones where woody vegetation has matured beyond the reach of the cattle and if cattle are removed before the critical growing period.

- *Corridor fencing*. In areas where riparian habitats are severely degraded, selected portions can be fenced off, restricting access of both cattle and wildlife.

- *Deferred-rotation and rest-rotation*. Deferred-rotation has been used as a management strategy to address seasonal preferences of livestock for riparian plant species. Seasonal deferment can help sustain a balance of herbaceous and woody plants by alternating grazing. Early season deferment can be used to reduce stress on herbaceous plants, and summer and late season deferment can be used to reduce stress on shrubs and trees. Rest-rotation allows grazing areas at least one full season of rest to allow riparian area vegetation to recover between grazing events. Additionally, rested areas can serve as emergency use forage areas during severe drought years. Any grazing systems that exclude livestock may also exclude elk, deer, and other wild herbivores from the riparian area, which can assist in recovery but may have a negative impact on wildlife.

- *Best pasture*. In the Southwest, summer rainfall is irregular and spotty due to the isolated and intense thunderstorms during the monsoon season. Different areas may receive copious amounts of rain while others remain relatively dry in a single season. For this reason, the best pasture method attempts to match livestock movement with irregular precipitation patterns and the associated forage production. Livestock can be moved to areas where a localized rain event causes a flush of annual vegetation in one pasture. If a pasture that is scheduled to be used has not received much or any precipitation while other pastures have received several localized rain showers, the rotation schedule can be swapped between the two pastures.

The impact of grazing in riparian areas is largely affected by grazing management practices. There is no single method of grazing management, since each area is different and will require site-specific management (NMDGF, 2004). Pastures that include both riparian and upland areas can be grazed and rested in rotation based on their conditions. Riparian areas where rainfall and snowmelt have made the bank soft should be avoided, as trampling by livestock can increase erosion and compact soils. Use of riparian areas during summer months can lead to overuse. To mitigate this problem, water and shade structures can be made available in the upland areas, and fencing between pastures can be used to control exposure of sensitive areas to overgrazing (Baker et al., 2001).

For any rangeland management technique to be successful, it must be flexible to account for changes in precipitation and forage production. For example, if forage production decreases, dates for livestock movement may need to be adjusted to avoid overgrazing a stressed area. It is also important to monitor rangeland in order to document successes and failures of the grazing systems and management activities in use (Howery et al., 2000).

8.5.1.2 Removal of Invasive Species

The management activity with the greatest potential to increase water yields is the removal of non-native vegetation from riparian areas, followed by management to prevent regrowth. Such management may include revegetating an area with native species. The main invasive species targeted for removal in the Northeast Region is salt cedar. Although evapotranspiration varies depending on vegetation type and density, soil types, and depth to water, in most cases exotic vegetation (such as salt cedar) consumes more water than native vegetation.

Salt cedar, or tamarisk, is common along rivers and their tributaries within the planning region. This plant, native to the Middle East, was introduced to Texas in the late 1800s and has since spread throughout the Southwest. Its rapid growth and reproduction, combined with its ability to replace native vegetation and tap groundwater, has earned it the classification of noxious weed. Approximately 4,365 acres are invaded with salt cedar and/or Russian olive along the main stem of the Canadian River within the Canadian River and Mesa SWCD jurisdictions (CRRRP, 2004).

Salt cedar removal projects have been ongoing in New Mexico for many years. From 1967 to 1971 as a part of the Pecos River Basin Water Salvage Project, the USBR cleared 53,950 acres of salt cedar along 370 miles of the Pecos River between Fort Sumner, New Mexico, and Pecos, Texas (USBR, 2005). Plowing, tree crushing, mowing, bulldozing, chaining, and herbicide applications were the main methods of removal. Regrowth was managed mainly by periodic root plowing in which heavy equipment cut and removed roots 10 to 18 inches below the surface. Though the program was temporarily discontinued, salt cedar clearing by the

USBR on the Pecos River has continued since resumption of the program in 1995, but is limited to about 30,000 acres in New Mexico. Other recent salt cedar removal efforts in and around New Mexico include:

- *Mechanical removal*. Phreatophytes may be removed by bulldozers, mulchers, digging (root-ball extraction), and/or axes, machetes, and chainsaws, all of which cut, destroy, and/or remove the plant itself. The most effective methods are those that affect the plant roots, which can re-sprout even after the plant stem or trunk is destroyed. In addition to current USBR efforts, the USFWS is mechanically removing salt cedar at Bitter Lake National Wildlife Refuge near Roswell and replacing it with native cottonwood and willow (USFWS, 2005). The Santa Fe and Carson National Forests have recently completed an environmental impact statement for invasive plant control (USFS, 2004b) through mechanical as well as other methods. Of the invasive plants targeted, 28 percent are salt cedar and Siberian elm.

- *Aerial herbicide application*. To date, 9,100 acres along 185 river miles from Guadalupe County to the New Mexico-Texas state line have been treated using funding from the New Mexico State Legislature (U.S. SCENR, 2003). The Socorro SWCD has been actively involved in aerial spraying along the Middle Rio Grande. Additionally, New Mexico State University (NMSU) has partnered with the U.S. Department of Agriculture (USDA) to spray salt cedar on the Canadian River in Quay County (NMSU, 2004). Once dead, vegetation sprayed with herbicides may remain in place or may be mechanically removed or burned.

- *Cut stump treatment*. This method involves (1) mechanical removal of phreatophytes and (2) immediate application of herbicide directly to the freshly exposed stump, usually by hand. The timing of herbicide application can have a significant effect on its success. Leaving the cut stump for more than two days before herbicide treatment reduces the success rate. Additional herbicides may be effective when applied to the stump in the autumn, as the plant will then draw its fluids downward, carrying the herbicide to the roots and effectively killing it.

- *Biocontrol*. Though salt cedar has no natural predators in the Southwest, several species have been targeted as possible rapid consumers of the plant. A leaf beetle that preys upon salt cedar in its native Asia has been used to control the species in Nevada (Bryan, 2003). The local success of the leaf beetle is currently being tested on the Pecos River near Artesia, where about 600 leaf beetles were released in August 2003 by NMSU in cooperation with the USDA and USFWS. Goats are being used to control phreatophyte growth on the Canadian River in Quay County (NMSU, 2004). Goats are not necessarily able to remove salt cedar, but can reduce the cost of mechanical removal by clearing thinner branches and new growth and stripping bark from plants (USDA, 2004).

- *Fire*. Outside of New Mexico, controlled burns have been used to clear areas heavily infested with salt cedar (Deuser, 1996; NPS, 2003). Salt cedar is relatively fire resistant; however, and tends to re-sprout following fires (Muzika and Swearingen, 1999).

- *Flooding*. Flooding can be used to control salt cedar, though root crowns must remain submerged for three months in order to kill the plant (Muzika and Swearingen, 1999).

- *Replacement with native vegetation*. Once non-native phreatophytes are removed, native vegetation may naturally take over a treated area. However, this process may be slow and may not favor the desired species (e.g., grasses rather than forbs/weeds), due to interference from root plowing or other continuing management practices to hinder salt cedar regrowth (Welder, 1988). To ensure that salt cedar does not quickly revegetate a cleared area, optimally native vegetation should be established through pole planting or other means, and ongoing maintenance of the cleared site should occur.

As this list of ongoing activities shows, many methods of salt cedar removal have been developed, tested, and executed with varying levels of success in New Mexico during the past four decades. Ongoing phreatophyte removal projects in the region include the Canadian River Riparian Restoration Project work, which plans to address salt cedar along the full length of the Canadian River. Technical feasibility is not anticipated to be an issue based on the number of salt cedar removal projects successfully implemented elsewhere in New Mexico and the Southwest.

8.5.2 Political Feasibility and Social/Cultural Impacts

The adoption of any grazing practice regulations is not favored in the Northeast Region. The protection of private property rights is a concern, and stakeholders feel that governmental supervision of rangeland would neither be desirable or feasible. With respect to grazing, it is believed that best management practices are already in place and that ranchers already have incentive to manage grazing regardless of whether they own or lease the land where their animals graze. Education is favored as the best method for rangeland management, and there is a regional preference for localized policies over regional or state regulations.

There is both widespread support for removal of non-native vegetation in the region and consensus that salt cedar eradication programs are a priority. A large portion of the area where the Canadian River Riparian Restoration Project is active falls within the planning region, and residents want this work to be funded, supported, and successful.

8.5.3 Financial Feasibility

Grazing management techniques include livestock pasture/grazing land rotation and, at some locations, fencing to limit exposure of sensitive areas to overgrazing and construction of shade and water features to minimize impacts to riparian areas. The costs associated with these methods are related to moving livestock and building fences, shade, and water structures. Although the costs for some of these alternatives may initially be high, benefits such as increased forage and livestock production may be worth the cost.

The NRCS New Mexico Environmental Quality Incentives Program (EQIP) assists ranchers with technical information and financial cost-sharing in implementing grazing management techniques. The costs of some of these techniques are summarized in Table 8-20.

Costs for successful phreatophyte removal and native vegetation planting include initial costs as well as costs for long-term maintenance. Welder (1988) observed that salt cedar regrowth on 19,000 acres between Acme and Artesia, New Mexico was halted after an initial clearing and two root plowing events in the Pecos Basin Water Salvage Project, requiring 9 years of

Table 8-20. Summary of 2004 New Mexico Environmental Quality Incentives Program (EQIP) Cost Docket for Range Land Practices in Northeast Region

Practice Name [a]	Selected Components	Unit Type	Unit Cost ($)	Cost Share Rate (%)
Brush management	Salt cedar control – hand application	acre	14	65
	Salt cedar control – helicopter application	acre	75	65
	Salt cedar control – mechanical with or without chemical followup	acre	890	65
Fence	Fencing 4 wire, 3 wire, or net wire	LF	0.18–1.14	50
Grazing land mechanical treatment	Mechanical treatment/rangeland	acre	6.66	50
Pasture and hay planting	Comp pasture and hayland planting	acre	60	50
Pipeline	Various water conveyance systems	Variable	Variable	50
Prescribed burning	Prescribed burning general (or up to 1,000 acres if others defined)	acre	11.57–21	50
	Prescribed burning more than 1,000 acres (and up to 2,000 acres if others defined)	acre	16–18	50
	Prescribed burning, 3,001 acres or more	acre	10–13	50
Prescribed grazing	Incentive prescribed or deferred grazing 1 [b]	acre	7.5-8.5	100
	Incentive prescribed or deferred grazing 2 [b]	acre	4.00	100
	Incentive prescribed or deferred grazing 3 [b]	acre	2.00	100
Range planting	Comp cover crop	acre	24.03–50.00	50
	Comp range planting	acre	10	50
	Herbicides controlling competition/1st year	acre	10.68–22.00	50
	Mechanical competition control/1st year	acre	8.9–12	50
	Range interseeding	acre	5.25–22	50
	Seed, high priced (native)	acre	44.00–39.16	50
	Seed, low priced	acre	17.8–20.0	50
Use exclusion	Excluding animals, people, or vehicles from an area	NA	NA	NA

Source: EQIP, 2004

[a] Detailed definitions provided in Table 8-19.
[b] Locally designated objectives

LF = Linear foot
NA = Not applicable

maintenance. In 2002, The New Mexico State Legislature appropriated $2.5 million to local SWCDs for non-native phreatophyte removal on the Pecos River, indicating the level of funding necessary to undertake phreatophyte removal activities (NMACD, 2003). Typical project costs are summarized in Table 8-21. In the region as in all of New Mexico, phreatophtyte removal will be limited by the amount of funding available, not by treatable acreage.

Table 8-21. Estimated Cost and Effectiveness of Salt Cedar Treatments

Control Treatment	Cost per Acre ($)	Percent Control
Individual Plant Treatments		
Manual removal (immature plants)	0–5,000	95–100
Mechanical grubbing	40–300	97–99
Low-volume herbicide application	30–60	80–95
Cut-stump herbicide application	1,600–2,500 [a]	60–80
Ground-based foliar herbicide	40–300	97–99
Large-Scale Control		
Mechanical	700	97–99
Airplane herbicide-burn	300	93
Helicopter herbicide-burn	240	89
Airplane herbicide-shred [b]	400	97–99
Helicopter herbicide-shred	510	97–99
Airplane herbicide-burn-mechanical	380	97–99
Helicopter herbicide-burn-mechanical	490	97–99

Source: USFS, 2004a (Table 3)
[a] Most of the cost is for tree cutting and removal or chipping; the herbicide cost varies from $20 to $60 per acre.
[b] Includes two years of followup using ground-based herbicide treatment

The General Appropriation Act of 2006 (House Bill 2) included $4 million in funding for non-native phreatophyte removal, monitoring, revegetation, and rehabilitation; however, this line-item was vetoed (NML, 2006). The Canadian River Riparian Restoration Project would have been funded by some portion of these funds, had they gone through.

8.5.4 Hydrological Impacts

Hydrological impacts in the region due to grazing are site-specific and depend on site conditions and grazing management techniques. In general, riparian areas are able to withstand high runoff when enough vegetation remains. The effect of overgrazing for all grazing areas, and especially in riparian areas, includes increased erosion, loss of organic matter, and reduced water retention. Increased erosion control can contribute to improved water quality and ecosystem health in riparian areas.

Historically, reduced water consumption resulting from salt cedar removal has been difficult to measure. In New Mexico, two studies of water savings were conducted in the late 1980s based on data from the area between Acme and Artesia that was mechanically cleared of salt cedar under the Pecos Basin Water Salvage Project:

- Weeks (1987) noted that an early unpublished base-flow analysis based on Pecos River gaging data could not reliably attribute a gain in river base-flow to salt cedar removal. However, Weeks explained that this base-flow gain could have been due to potentially large variations in groundwater recharge (based on precipitation) and metered pumping in the years immediately following salt cedar removal. In an attempt to quantify water salvage by directly measuring phreatophyte water consumption, Weeks used the eddy-correlation and energy budget methods to compare the evapotranspiration of various stages of salt cedar regrowth after clearing (old growth, burned, and mowed) to replacement vegetation from 1980 to 1982, estimating that salt cedar consumed 2 to 3.6 ft/yr and the replacement vegetation (forbs and grasses) consumed 1.3 to 2.3 ft/yr. Thus, he estimated that salt cedar removal resulted in a water savings of 0.66 to 1.3 ft/yr. Though the rates differ, this savings estimate is comparable to savings estimated for the Middle Rio Grande (Cleverly, 2003) of about 1 ac-ft/yr difference in evapotranspiration between dense salt cedar stands and cottonwood-willow bosque.

- Welder (1988) performed an extensive base-flow analysis based on 34 years of Pecos River gaging data and pumping records that spanned the removal of salt cedar on 19,000 acres. He observed a slight decrease in base-flow to the river immediately after the salt cedar removal, followed by a moderate increase that leveled off within a range of 15,850 to 24,700 ac-ft/yr for the 19,000-acre area. This corresponds to a base-flow gain of about 1 ac-ft/yr per acre of salt cedar cleared. An unquantified rise in the water table was also observed after salt cedar removal, suggesting a reduction in evapotranspirative consumption. However, Welder cautions that the change in base-flow conditions could be partially accounted for by other concurrent events, including an observed reduction in metered groundwater pumping and a measured increase in precipitation from the drought in the 1950s to a wetter period at the end of the study.

Though both the Weeks (1987) and Welder (1988) studies acknowledge the inherent difficulties in measuring water savings under transient precipitation and groundwater development conditions, both researchers suggest consumptive reduction of about 1 ac-ft/yr per acre of salt cedar removal on the lower Pecos River in New Mexico. In areas of the planning region, where the climate is more mild, total evapotranspiration by all types of vegetation is anticipated to be less than in the cited studies. Whether the difference in evapotranspiration rates between salt cedar and shallowly rooted replacement vegetation will have the same magnitude in the planning region as in the study areas is unclear. Unfortunately, no evapotranspiration studies applicable to phreatophyte removal projects have been conducted in the planning region, so anticipated hydrologic impacts from this alternative must be extrapolated from the Weeks and Welder studies.

To develop an accurate estimate of savings due to phreatophyte removal, the following factors need to be considered:

- If the area is not revegetated with native riparian species, (1) non-natives will recolonize the area, resulting in no long-term water savings, or (2) the water table may rise, resulting in saturated soils or increased bare soil evaporation, which can negate the effects of the reduced evapotranspiration.

- In some areas, the water table may decline with the addition of drainage such that the area ceases to serve as riparian habitat (i.e., once vegetation is removed and drainage installed, the area will become scrub or grassland with little or no direct evaporative loss). In such cases, the evaporative savings will be on the order of 4 acre-feet per acre, the average evapotranspiration loss from salt-cedar (King and Bawazir, 2000). However, adding this type of drainage is infeasible in many cases.

Assuming that following phreatophyte removal the water table does not decline, causing the area to return to scrub or grassland, and that native vegetation is successfully established and maintained, a savings rate of 1 acre-foot for each treated acre can be estimated. This type of savings can only be realized if projects are carefully designed and executed to ensure water table control and maintenance. Total water savings will depend on the area in the region that is phreatophyte infested and on how effectively that vegetation is removed and maintained.

A recent study completed in west-central Texas (Upper Colorado River Authority [UCRA] et al., 2006) showed a positive hydrological response to brush thinning, even during drought years. The UCRA study involved treatment of 300,000 acres by removal of phreatophytes (mostly honey mesquite and juniper). Response monitoring included measurement of groundwater levels, base flows, and the timing duration and distribution of flood flows. Even though the monitoring has occurred during a dry period, groundwater levels have increased, and numerous previously dry springs and seeps have begun to flow (UCRA et al., 2006).

8.5.5 Environmental Impacts

The impact of livestock grazing to riparian and upland areas depends on the grazing management techniques that are used. As discussed in Section 8.5.1.1, each situation is different and requires a site-specific management system. Site-specific variances include hydrology, soil moisture, soil permeability, plant species composition, weather conditions, forage palatability, and plant regrowth potential. Knowledge about these conditions as well as information about the livestock and grazing season can help determine appropriate management practices. Without proper management, plant community structure and distribution, as well as habitat and ecosystem health, can be negatively affected. Adaptive management techniques can allow for the use of riparian forage as a resource while at the same time preserving the integrity of the ecosystem (Baker et al., 2001).

8.5.5.1 Removal of Invasive Species

Phreatophyte removal activities can have both positive and negative ecosystem impacts. Following phreatophytes removal, ecosystems may benefit from a reduced risk of forest fire in riparian areas due to reduction in understory density. Salinization of soil and water has also been attributed to salt cedar, so its removal is thought to improve soil and water quality. Flood risk may also be reduced with phreatophyte removal, as less armored streambanks allow for higher streamflows. In addition, the removal of non-native and re-establishment of native vegetation species can provide habitat for wildlife.

No long term negative environmental impacts are expected due to invasive species removal. Increased mobility of bank sediments may result in increased sedimentation rates following riparian vegetation removal, and increased river turbidity may also occur with the increased sediment. Following salt cedar removal, those species using it as habitat will either adapt to the replacement vegetation or will move to other areas. The method of removal, however, can adversely affect the environment:

- Mechanical methods of phreatophyte removal may have short-term environmental impacts

- Use of herbicides will kill all species in the area of application. In addition, because herbicides for killing phreatophytes are applied along waterways, the selected herbicides must be chosen with care and be registered for aquatic application (Muzika and Swearingen, 1999).

- The cut stump method of application, which applies the herbicide directly on the salt cedar stump, will have less impact than aerial spraying.

8.6 Water Rights Protection

In 1987, the New Mexico legislature amended a number of water statutes to give the State Engineer authority to deny an application for a new water right or a water right transfer if it is contrary to conservation of water or detrimental to the public welfare of the state. The public welfare consideration is intended to protect New Mexico water resources. A definition of public welfare, adopted by a region, is a potential mechanism for ensuring that what the population of the region values is not lost. The Northeast New Mexico Regional Water Planning Steering Committee has developed a public welfare statement (Section 2.2) that defines the values for the region.

In the Northeast Region, most water rights are used in the agricultural sector, and municipal supply could potentially be supplemented by transferring water out of the agricultural sector. Due to decreasing availability of groundwater, protecting existing water rights and preventing out-of-region transfers are extremely important to the Northeast Region, and these issues were highlighted in the public welfare statement. While the steering committee does not aim to prevent all transfers between sectors, it strongly opposes any large-scale transfers out of the Northeast Region.

8.6.1 Technical Feasibility

Potential methods for protecting water rights and preventing out-of-region transfers include efforts to influence water rights transactions, developing area-of-origin protections, adopting conservation easements, and transferring development rights. These approaches are discussed in the following subsections.

8.6.1.1 Efforts to Influence Water Rights Transactions

State of New Mexico Water Code Water governs water right transfers taking place outside an acéquia or community ditch and allows transfers unless the transfer will impair existing water rights or is contrary to conservation or public welfare. These same criteria apply to out-of-state and out-of-region transfers. New Mexico water law provides individuals with the opportunity to protest water rights transactions; however, the OSE will not deny an application or condition a permit unless the protestant makes a compelling case that the transaction will impair his or her existing water right. Even declines in existing well groundwater levels do not necessarily substantiate an impairment claim (*City of Roswell v. Berry*, 80 NM 110 (1969)).

Most transfers are intra-basin transfers, but out-of-basin and out-of-state transfers are also contemplated in the transfer statutes. In particular, out-of-state transfers are significant in the region, due to its proximity to Texas. Water can be transferred from basin to basin, subject to interstate compacts and federal law (NMSA 1978, §§72-5-23, 72-12-7(A)). Transfers are based on the amount of water consumptively used. The amount that can be transferred is limited to the prior consumptive use, and out-of-basin transfers cannot make the basin hydrologically worse off than it was. Further, the State Engineer can deny an out-of-basin transfer if the transfer would be contrary to the public welfare, or contrary to conservation (NMSA 1978, §72-5-23, 72-12-7(A)).

Similarly, out-of-state water transfers would likely be prohibited by the State Engineer. New Mexico policy is to maintain adequate water supplies for the State's water requirements (NMSA, §72-12B-1(A)). The State Engineer will only allow water rights to be transferred out of New Mexico if the transfer will not impair existing water rights or be detrimental to the public welfare (NMSA, §72-12B-1(C)). In reviewing out-of-state water transfers, the State Engineer considers New Mexico water supply, demand, and water shortages, as well as the supply of water in the state where the applicant intends to use the water (NMSA, §72-12B-1(D)). Accordingly, regional public welfare criteria and water budgets will assist the State Engineer in determining whether an out-of-state transfer request should be granted. Due to water shortages in New Mexico, it is highly unlikely that an out-of-state water transfer would be approved. In fact, the out-of-state transfer issue contributed to the origination of the New Mexico regional water planning program, which was initiated in response to a 1987 Supreme Court ruling that New Mexico could not prohibit the transfer of water out of state unless New Mexico had a plan for that water.

The OSE has developed administrative criteria for several groundwater basins outside of the planning region that are designed to protect critical areas, protect hydrologically connected stream systems, and prevent excessive drawdown. The Northeast Region could encourage or even lobby the OSE to develop a set of criteria for those groundwater basins present in the region. If criteria were developed, they could be used to assist in preventing transfers that could impair existing water rights and resources.

Another approach would be to use the existing authority of county or other local governmental entities, such as water user associations, to develop ordinances designed to protect groundwater and prevent transfers that would be harmful to the health and welfare of citizens. These types of ordinances could also encourage conservation activities or further define conservation so that the OSE would have more specific criteria to apply when evaluating water rights transfers under the statutory criteria mentioned above.

8.6.1.2 Area of Origin Protections

Out-of-region water transfers can have negative impacts on the local economy and way of life (Howe, 2000), and legislating area-of-origin protections may provide some regional benefits, even if the water is transferred elsewhere.

In 2002, a study addressing interbasin transfers proposed a set of 22 criteria for consideration by state agencies granting water rights transfers, prior to granting a permit for interbasin transfer (Georgia Water Coalition, 2005). Many of these provisions are applicable to interregional transfers and are relevant in the implementation of the water rights protection strategy. The following subset from the 22 proposed criteria would be most appropriate for inclusion in the development of area-of-origin legislation for northeast New Mexico:

- Available water supply
- Protection of the present uses
- Ensuring that current and projected future water demands are met
- Surface water and groundwater interaction, and the impact of a proposed transfer on either source of supply
- Economic feasibility
- Consultation with local governments affected by a proposed transfer

To implement area-of-origin legislation, northeast New Mexico would need legislators to draft legislation adopting these or similar permit review criteria.

8.6.1.3 Conservation Easements

Land use easements are permanent restrictions on use or development and are thus a mechanism to keep land use as agricultural. Since most of the water used in the Northeast Region is for irrigated agriculture, protecting the agricultural sector is one means of keeping water within the region. Under the New Mexico Land Use Easement Act, a conservation easement is defined as "a holder's non-possessory interest in real property imposing any limitation or affirmative obligation, the purpose of which includes retaining or protecting the natural or open space values of real property, assuring the availability of real property for agricultural, forest, recreational or open space use, or protecting natural resources"

(NMSA 47-12-2(B)). New Mexico state law allows the granting of land use easements to "preserve the availability of real property for agriculture" as well as for "the protection of natural resources" (NMSA 47-12-2(A)).

Conservation easements are useful for farmers who wish to protect the future use of their agricultural lands. If a willing buyer of the easement can be found, the farmer will obtain compensation without having to sell his or her land or water rights. There are many non-profit organizations in the western United States that are dedicated to the protection of farmland (e.g., American Farmland Trust, Rio Grande Agricultural Land Trust), and these organizations advocate the use of conservation easements to keep agricultural land in production. These regional (e.g., the Taos Land Trust), statewide (e.g., New Mexico Land Conservation Collaborative), and national (e.g., American Farmland Trust) land trusts have many resources to assist farmers.

Conservation easements are valid only if an owner willingly grants the easement (NMSA 47-12-3(E)). In many parts of the United States, farmers are compensated for granting these easements through local, state, and federal programs; however, in New Mexico, the only program currently available to compensate farmers for creating conservation easements is the federal Farmland Protection Program, created as part of the 1996 Farm Bill. An alternative to selling conservation easements is to donate them. Donation of an easement to a qualifying land trust can provide the donor with significant tax benefits.

Whether an easement can be granted that restricts the transfer of water rights between sectors is unclear. The New Mexico Constitution requires that water be used beneficially, and agriculture is considered a beneficial use; however, the Land Use Easement Act specifies that "no application or permit for a change in point of diversion, place, or purpose of use of a water right at any time shall be impaired, invalidated or in any way adversely affected by reason of any provision of that act" (NMSA 47-12-6(C)). It appears that this provision allows a property owner with a valid land use easement to transfer their water rights. Attempting to block a water rights transfer by claiming that the transfer will violate an existing conservation easement appears to be contrary to this provision. There is no New Mexican case law that addresses this provision of the Land Use Easement Act.

8.6.1.4 Transfer of Development Rights

Development rights may be transferred from one parcel of land to another, and this type of transfer is generally implemented through local zoning ordinances. The transfer of development rights can be made from agricultural land to other non-agricultural land, preventing any future conversion of agricultural land to residential or commercial developments. The agricultural land owner derives financial gain from selling the development potential of his/her land, without removing the land from agricultural production.

New Mexico enacted Transfer of Development right legislation in 2003 to specifically allow this type of transaction. NMSA §5-8-43 provides counties and municipalities with guidelines to regulate the transfer of development rights in accordance with comprehensive land planning and encourage the conservation of ecological, agricultural, and historical land.

8.6.2 Hydrologic Impacts

Keeping water within the region can have several hydrologic benefits. In areas where surface water is used for irrigation, continuing to use surface water for irrigation can help retain flows and seepage, contributing to local hydrology. Seepage from ditch systems helps maintain shallow groundwater levels. If seepage is reduced because of decreased diversion to the ditch system, the domestic wells drawing from this part of the aquifer may be impacted. In addition, maintaining water rights within the region will help to ensure that water uses support the local economy. In complex hydrologic systems, the movement of one water right generally has a more significant impact in the move-to location (the location where the water right is transferred to), where pumping from a proposed new well is likely to affect existing well owners or a proposed surface water diversion may affect other surface water users. However, if a surface water right is transferred further upstream, the downstream reach (i.e., the move-from location) will have less water.

In the Ogallala aquifer, the saturated thickness of the aquifer is only a fraction of what it used to be and it continues to decline. Given the limited supply remaining for existing water rights, any out-of-basin water transfer would accelerate the rate of decline as opposed to those rights being retired rather than transferred. Therefore, it is imperative to prohibit any transfer of water rights from the Ogallala aquifer. The pumping of the Ogallala aquifer in Texas in effect results in a transfer of physical groundwater out of New Mexico.

8.6.3 Financial Feasibility

The OSE would bear the cost to develop administrative criteria for regional groundwater basins in northeast New Mexico. The OSE would likely need to further refine existing models to identify specific locations (or cells within the model) where transfers would be limited, and a budget increase would be required to cover these activities.

Costs to develop ordinances governing groundwater extraction would include staff time to develop draft ordinances as well as public education costs to gain support for the initiative. Anticipated costs without contracting consulting and legal assistance would be $10,000. Consulting with an attorney and technical expert in developing the ordinances could range from $20,000 to $40,000, depending on the scope of work.

Several federal programs, many of which are managed by the NRCS, indirectly support the preservation of agricultural land and retention of water rights by providing funding to farmers for a variety of projects. These projects range from granting conservation easements to improving and protecting wetlands and wildlife habitat on private land. In many cases, demand for these programs outweighs the supply of funds available. These programs generally involve a cost-sharing component, and so farmers must also have private financing in order to take advantage of the federal funding.

In the private sector, there are more people interested in selling conservation easements than people who are interested in buying them. Buyers for conservation easements usually include private land trusts or organizations like the Nature Conservancy, which use donations to purchase land and easements. These nonprofit organizations have limited resources, and so the financial feasibility of this strategy is limited.

When a conservation easement has been donated or sold, the landowner can take advantage of fiscal benefits offered through state and federal tax law. Donated conservation easements may be treated as a charitable gift under the federal tax code (IRS 170(h)), and donors can deduct an amount equal to 30 percent of their taxable income the year of the gift. Donations valued in excess of that amount can be carried forward and applied against taxable income for up to six years. The New Mexico Land Conservation Incentive Tax Credit Act allows donors of land for conservation easements to qualified nonprofit conservation organizations and government open space programs to deduct up to half of the appraised value of their donation, not to exceed $100,000. For estate tax purposes, land with a conservation easement will have a lower property tax value and thus a lower estate tax. Federal legislation passed in 1997 created an estate tax incentive for landowners to grant conservation easements. Executors can exclude 40 percent of the value of land subject to a donated qualified conservation easement from the taxable estate (I.R.C. §2031(c)).

8.6.4 Environmental Impacts

Retaining land and water rights in agricultural use can provide environmental benefits for the Northeast Region, as retaining land in agriculture will ensure continued availability of habitat for local and migrating wildlife, and in cases where surface water is used for irrigation, groundwater seepage from irrigation canals will continue to recharge the shallow aquifer and help sustain local riparian habitat.

8.6.5 Political Feasibility and Social/Cultural Impacts

The water rights protection strategy was discussed at multiple steering committee and public meetings, and stakeholders feel that water rights protection is important. Residents of the Northeast Region are interested in maintaining local control over water and are not in favor of out-of-region transfers. While there is interest in keeping water in the region, however, people are not in favor of adding regulations to mandate this. Stakeholders feel that it is the role of the OSE to protect water rights, and water rights holders want the freedom to buy and sell their rights without any additional regulation.

8.7 Eastern New Mexico Rural Water System

As discussed in Section 4.7.1, the 1952 Canadian River Compact allows New Mexico “the free and unrestricted use of all waters originating in the Canadian drainage above Conchas Dam,” and of all waters in the Canadian drainage originating below Conchas Dam provided that the amount of conservation storage of water originating below Conchas Dam, including any water that spills from Conchas Reservoir, does not exceed 200,000 acre-feet (NM ISC, 2000). Ute Reservoir, downstream from Conchas Reservoir, was completed in 1962 to capture Canadian River water that New Mexico is entitled to for the purpose of municipal and industrial use in eastern New Mexico.

Originally constructed with a spillway crest elevation of 3,760 feet and a total capacity of 110,000 acre-feet (NM ISC, 2000), the spillway elevation of Ute Dam was raised in 1984 from 3,760 to 3,787 feet (NM ISC, 2000), and the reservoir had a storage capacity of 244,957 acre-feet in 1992. Storage capacity is reduced each year with the accumulation of additional sediment, and Ute Reservoir is expected to have a storage capacity of 181,700 acre-feet in 2045.

In March 1997, the ISC and Ute Water Commission entered into an agreement that provides for the reservation by several municipalities and counties of 24,000 acre-feet of Ute Reservoir water for a 40-year purchase period through 2046, with a possible renewal through 2086, and the ISC extended the period for reserving such purchases from December 2006 until December 2008 (NM ISC, 2000). Payments of $1.50 per acre-foot per year are made annually to the ISC (NM ISC, 2000). A 1994 yield study that analyzed data from 1942 through 1992 indicated that the reservoir would be unable to satisfy the 24,000-acre-foot demand for only 1 year in 50 (NM ISC, 2000). The reservation agreement includes a shared shortage provision, holding the State of New Mexico harmless in the event that water is unavailable for delivery (NM ISC, 2000).

The purpose of this alternative is to evaluate the proposed Eastern New Mexico Rural Water Supply (ENMRWS) project (also referred to as the Ute Pipeline), which would distribute a total of 16,450 acre-feet of water (Verhines, 2005) to the eight Eastern New Mexico Rural Water Authority (ENMRWA) members, including (along with their reservation amounts):

- City of Clovis (12,292 acre-feet) (including Cannon AFB, which has a long-term lease agreement with the City of Clovis for a portion of the City's reservation)
- Curry County (100 acre-feet)
- Village of Elida (50 acre-feet)

- Village of Grady (75 acre-feet)
- Village of Melrose (250 acre-feet)
- City of Portales (3,333 acre-feet)
- Roosevelt County (100 acre-feet)
- Village of Texico (250 acre-feet)

Tucumcari, Logan, San Jon, and Quay County also have Ute Reservoir water reserved; however, these entities will draw their water through other means (CH2M Hill, 2005e).

8.7.1 Technical Feasibility

The feasibility of this project has been the focus of a series of studies conducted from 1965 to 1998 by the USBR, ISC, and Eastern Plains Council of Government (EPCOG). These studies evaluated the Ute Reservoir water supply feasibility, infrastructure conceptual design, environmental impact, wind resources, and watershed yield (ENMRWA, 2005). In the 1998 and 1999 fiscal years, Congress appropriated $500,000 to refine the 1989 USBR preliminary project design (NM ISC, 2000), and the EPCOG entered into an engineering services agreement with Smith Engineering in 1999. In other studies funded under the federal appropriations, engineers at CH2M Hill determined that the pipeline project, delivering a planned 30 million gallons per day (mgd) of raw water to a regional treatment plant in Curry County and using a combination of existing and newly constructed storage, is the best technical alternative (CH2M Hill, 2005e). A preliminary engineering report on this alternative, including 10 percent design has been completed (Verhines, 2006).

Results of water quality sampling done in 2005 by CH2MHill indicate that Ute Reservoir water will have high levels of turbidity, total organic carbon, and dissolved organic carbon. In addition, the raw water has high levels of bromide. This will make the use of a chloramine (as opposed to free chlorine) disinfectant necessary to prevent the formation of brominated trihalomethanes (CH2M Hill, 2005f).

8.7.2 Hydrological Impacts

The net hydrologic impact of the ENRWS is to contribute an additional 24,000 ac-ft/yr of renewable water supply to portions of the Northeast Region. As discussed above, the ISC determined that Ute Reservoir would have been able to satisfy the total 24,000-acre-foot demand (including both ENMRWS member and Quay County reservations) for all but 1 of the 50 years analyzed (NM ISC, 2000).

Other hydrologic impacts from building the ENMRWS pipeline are centered on the effects that withdrawing water would have on lake level. While Ute Reservoir was built to impound surface water for municipal and industrial use, its recreational function is an important secondary use (NM ISC, 2000). As part of Ute Lake State Park, which is operated by the New Mexico State Park division under agreements with the ISC (NM ISC, 2000), Ute Reservoir is a major recreational area, and Quay County reaps considerable economic benefit from the reservoir. Decreases in the lake's level can impact its recreational value.

When the reservoir was completed in 1962, the New Mexico Department of Game and Fish and ISC agreed upon a minimum fisheries and recreation pool at an elevation of 3,741.6 feet (NM ISC, 2000). The water level in the reservoir has remained relatively stable since it was built, with the lake level fluctuating within a 10-foot elevation range, except when the reservoir level was lowered for reservoir construction and since the spillway elevation was increased (Gates, 2006a).

The 1994 ISC study also determined that, while supplying the full demand, reservoir levels would remain above the minimum 3,741.6-foot fisheries and recreation pool in most years (NM ISC, 2000):

- Above 3,760 feet for 46 of the 50 years (86 percent of the time)
- Above 3,775 feet for 37 of the 50 years (65 percent of the time)
- Above 3,780 feet for 17 of the 50 years (33 percent of the time)

Similarly, the Ute Reservoir model simulating raw water delivery at peak day flow (Gates, 2006a) estimates that the volume of water in Ute Reservoir has been sufficient to both supply the 16,450 ac-ft/yr (ENMRWS only) demand every year since its construction and maintain the minimum 3,741.6-foot elevation.

The Village of Logan has requested that the Ute Reservoir minimum pool elevation be raised from 3,741.6 to 3,765 feet, and the Ute Water Commission has voted to support the request (Wallin, 2005). In order to maintain this higher elevation, however, preliminary review of the Ute Reservoir model data suggests that the 16,450-ac-ft/yr demand would not be met 17 percent of the time (Gates, 2006a). Data analyzed for this calculation covers 1964 to 2006, a period that should not be assumed to represent future conditions because it includes a time when the lake level was reduced for construction purposes. In addition, climatic conditions during this period may not be representative of future climatic conditions. Nevertheless, the available data suggest that adopting the proposed higher minimum recreational pool could significantly impact the ability of the ENMRWS to supply water to its users.

ISC approval would be necessary for the new minimum pool elevation to be adopted. The ISC Chairman and the State Engineer have stated that Ute Reservoir was built specifically to provide communities in eastern New Mexico with a renewable water supply for municipal and industrial use, and that the ISC fully supports the efforts of the ENMRWA to have the pipeline funded and built (NM ISC/OSE, 2005). Discussion of the State of New Mexico's position on the minimum pool issue with ISC personnel indicates that, at this time, the State does not plan to adopt the proposed minimum pool elevation of 3,765 feet (Murray, 2006).

8.7.3 Financial Feasibility

The local, state, and federal agencies involved in developing the ENMRWS project (including ISC, NMED, ENMRWA members, and USBR) evaluated six alternatives for supplying water to the ENMRWA members in Curry and Roosevelt Counties. These included four pipeline alternatives, a "no project" alternative, and a brackish groundwater alternative. The "best technical alternative" that resulted from the decision process is the project as currently proposed. Based on a horizon year of 2060, this project represents the highest benefit relative to cost and the lowest net present value project of all the alternatives.

The project represents the major source of economic benefit and stability to the entities in Curry and Roosevelt Counties over the next 100 years or more. The two-county region has recently lost several significant economic opportunities because of the uncertainty of sustainable water supplies (unless the ENMRWS project is implemented).

CH2M Hill estimates that the ENMRWS pipeline project will cost approximately $470 million for the favored project alternative (CH2M Hill, 2005e), and the most current ENMRWA estimate is for a total capital cost of $384 million (Verhines, 2006). The ENMRWA has secured $2.25 million in state funds and $200,000 in local funds; an ENMRWA request for $3 million in federal funding is pending (Verhines, 2006). The Water Trust and Water Project Funds, created by the New Mexico Legislature in 2001, are another potential source of funding. The New Mexico Water Trust Board ranked the ENMRWS as the highest rated project in the state in 2005 and as the second highest rated project in 2006. As part of his 2007 Year of Water Initiatives, Governor Bill Richardson has proposed a $5 million state investment to further the design of the project, and the Water Trust Board has recommended an additional $2.3 million appropriation for the project to the 2007 Legislature.

ENMRWA estimates that a total of $3.6 million has been spent on the project to date, including $500,000 in local reservation fees paid to the ISC, $700,000 in federal appropriations, $2 million in state funds, and $400,000 in local funds (Verhines, 2006). In addition to the financial assistance obtained by ENMRWA for ENMRWS construction, ENMRWS members will need to raise water rates and taxes and issue bonds either to fund the project or to expand existing facilities to meet demand (CH2M Hill, 2005c).

The cost of not building the pipeline would likely be higher, as up to 419 new wells would need to be drilled to supply the ENMRWA members over the next 50 years, costing an estimated $500 million (CH2M Hill, 2005e). In such an event, increased treatment of groundwater will also become necessary, as these communities will be tapping the bottom of the Ogallala aquifer, which yields water of poorer quality (CH2M Hill, 2005e).

8.7.4 Environmental Impacts

The water level in Ute Reservoir has remained relatively stable since it was constructed, and any large lake level fluctuations would have significant impacts on the surrounding wetlands and on wildlife. As part of ENMRWA planning, ERO Resources Corporation will be preparing an environmental impact statement to address in detail the environmental impacts of the proposed project.

The Arkansas River shiner, which is found downstream of Ute Reservoir (SWCA, 2004), is classified as a threatened species in New Mexico. The USFWS issued a final rule designating critical habitat for the Arkansas River shiner on October 13, 2005 (70 Fed. Reg. 59808, 59823 (2005)), although no area within New Mexico was included in this designation because the USFWS felt that the implementation of the *Arkansas River Shiner Management Plan* (authored by the Canadian River Municipal Water Authority (CRMWA) and its Federal, State, and private partners) will effectively manage this habitat (70 Fed. Reg. 59808, 59823 (2005)).

The goals of the *Arkansas River Shiner Management Plan* include conserving and protecting the existing Arkansas River shiner population, maintaining the existing ecological functions that support this population, maintaining and improving habitat integrity, encouraging good land management practices on land adjacent to the Canadian River, and contributing to the eventual delisting of the species (CRMWA, 2005). Management actions outlined in the plan focus on hydrology, geomorphology, and water quality:

- Managing the volume and timing of Ute Dam releases to benefit Arkansas River shiner spawning

- Maintaining the existing 3- to 5-cfs baseflow from Ute Dam

- Minimizing riparian zone disturbance for erosion control and protection of habitat

- Developing best management practices (BMPs) that minimize erosion and harm from off-road vehicles

- Spearheading salt cedar eradication efforts
- Promoting restoration of uplands to grasses and control of brush species (such as mesquite)
- Minimizing nonpoint source water quality impacts to streams
- Monitoring water quality
- Promoting public outreach and education programs

8.7.5 Political Feasibility and Social/Cultural Impacts

Based on discussion of this project at multiple regional water planning meetings, ENMRWA members strongly support this project. Concern has been raised over the rising total project cost, as well as the operation and maintenance expense that each participating community will be responsible for. Some stakeholders from Harding County oppose this project, as much of the water in Ute Reservoir originates in Harding County and they would like to see some of this water used in Harding County, but others from Harding County are in favor of the project. Additionally, as discussed in Section 8.7.2, there is concern that full project build-out will have a negative impact on recreation. Overall, however, there is regional support for this strategy and its implementation in conjunction with conservation strategies.

8.8 Infrastructure Upgrades

Community water and sewer facilities are built to provide safe drinking water, treat effluent waste, and reduce related health risks. Many communities upgrade their water and/or sewer infrastructure in order to meet federal, state, and local regulations or as a way to encourage economic growth. A study by the USDA Economic Research Service found that rural communities derived sizeable economic benefits from water and sewer projects, including an increase in available jobs, more private investments, and increasing property tax bases (Bagi, 2002).

The Northeast Region received approximately $6 million from the New Mexico Legislature under the 2006 Severance Tax Bond Projects Bill (House Bill 622), with an additional $5 million earmarked for Cannon AFB contingent on the base receiving a new mission (which it did on June 20, 2006 [Brunt, 2006]). This funding was divided among the various counties and communities as follows:

- Union County:
  - $210,000 to plan, design, construct, purchase, equip, and install a water system in Des Moines
  - $1,300,000 to plan, design, and construct water leakage repairs to the water system in Clayton
  - $75,000 to plan, design, construct, and provide water line hookups to the main water system in Clayton
  - $1,000,000 to plan, design, and make improvements to address water leakage at Clayton Lake dam and surrounding areas

- Harding County:
  - $200,000 to plan, design, and construct wastewater system improvements, including purchase and installation of equipment, in Mosquero
  - $200,000 to plan, design, and construct a water system, including storage and distribution, in Roy
- Quay County:
  - $250,000 to plan, design, and construct water and wastewater system improvements in Tucumcari
  - $75,000 to plan, design, and construct a sewer system, including purchase and installation of equipment, in Logan
  - $50,000 to plan, design, and construct water and wastewater system improvements, including purchase and installation of equipment, in San Jon
  - $50,000 to purchase and install equipment for Arch Hurley
  - $25,000 to plan, design, and construct a sewer system, including purchase and installation of equipment, in Logan
  - $25,000 to plan, design, and construct improvements to the water and wastewater system in Logan

- $250,000 to plan, design, and construct water and wastewater system improvements, including purchase and installation of equipment, in San Jon

- Curry County:
  - $400,000 to plan, design, construct, and equip water system improvements, including replacing the water tank, lines and fire hydrants, in Melrose
  - $50,000 to plan, design, and construct wastewater system improvements in Melrose
  - $400,000 to purchase a wastewater pretreatment plant, acquire land, make improvements, and design, equip and construct wastewater system infrastructure for economic development projects in Curry County
  - $5,000,000 to acquire land and water rights and to plan, design, and construct infrastructure for Cannon AFB (contingent upon the base being selected for a new mission)
  - $1,000,000 to purchase a wastewater pretreatment plant, to acquire land, make improvements, and design, equip and construct wastewater system infrastructure for economic development projects in Clovis
  - $140,000 to purchase water conservation research equipment for the New Mexico State University Agriculture Science Center in Clovis

- Roosevelt County:
  - $50,000 to plan, design, construct, acquire, equip, and install city wastewater improvements in Portales
  - $200,000 to plan, design, and construct improvements to the water system in Portales
  - $40,000 to design and construct improvements to the water system, including replacing the water storage tank, in Elida

Additional projects needed but not currently funded include:

- Logan wastewater system extension and septic system retirement
- Extension of the Logan-San Jon pipeline to serve additional customers
- Construction of a Harding County Water System
- Construction of a new water supply well for the Village of Des Moines

- Connection of recently acquired wells into the Clayton water distribution system
- Continued replacement of old lines in all communities
- Funding of the ENMRWS (Section 8.7)

Additionally, there is a continuing need for adequate staff and resources to provide high-quality operation and maintenance. Greater regional cooperation that could potentially include emergency support between systems, equipment sharing, or other cooperative efforts will help the region be better prepared to meet future needs.

This section focuses on the technical and financial feasibility, as well as the hydrologic, environmental, and political and social/cultural impacts, of implementing the non-funded projects listed above.

8.8.1 Technical Feasibility

Infrastructure upgrades are routinely completed and are technically feasible. Technical issues pertaining to some of the key identified water projects in the area are discussed in the following subsections. However, infrastructure needs other than those discussed here will also be needed over the 40-year planning horizon. Technical issues pertaining to any specific project that may be identified can generally be overcome with sufficient funding.

8.8.1.1 Logan Wastewater System Extension and Septic System Retirement

Residents near Ute Reservoir are currently served by septic systems, and there is concern over the potential water quality impacts, particularly to Ute Reservoir water, of these septic systems. Water quality in Ute Reservoir will be especially important when the ENMRWS comes on line; however, protection of water quality also benefits the recreational uses that currently thrive. Under the 2006 capital outlay bill Logan received $100,000 to design and construct a new sewer system and $25,000 for water and wastewater system improvements. This funding will be used for design and to hire engineers to begin work on a sewer and wastewater collection system to serve residences near Ute Reservoir. The preliminary engineering report for this project is complete (Wallin, 2006).

8.8.1.2 Logan-San Jon Pipeline Extension

The Logan-San Jon pipeline was built following a 40 percent decrease in production from Village of San Jon wells (Village of San Jon, 2004). The Village is now completely supplied by groundwater from Logan, transported approximately 20 miles through the pipeline, with the Village's existing well field serving as backup. A pipeline extension is needed to supply water to new customers and to supply water for fire control. Anticipated costs have not been projected for this extension.

8.8.1.3 Harding County Water System Construction

There is interest in constructing a regional water system in Harding County to serve the towns of Roy and Mosquero and potentially to supply water for agricultural irrigation. Construction of such a project would involve diverting water from the Canadian River, Ute Creek, Conchas Reservoir, or Ute Reservoir.

The Canadian River is fully appropriated, and water rights would need to be purchased and transferred before any water could be diverted for a Harding water system. Water from Ute Creek, a tributary of the Canadian River that drains into the Canadian River at Ute Reservoir, downstream of Conchas Dam, could be diverted if water rights were obtained. Similarly, Ute Reservoir water could be used for a Harding County water supply project if water rights were obtained. Additional discussion of the Canadian River Compact and potential storage rights is included in Section 4.7.1 and 8.10.1.

Agreements have been made with the ISC for the reservation of 24,000 acre-feet of Ute Reservoir water per year (Sections 4.7.1, 8.7). Reservation holders include Tucumcari, Logan, San Jon, Quay County, and those communities and counties that are participating in the ENMRWS project (Clovis, Elida, Grady, Melrose, Portales, Texico, and Curry and Roosevelt Counties). Harding County does not have any water reserved in Ute Reservoir; however an agreement to lease water from one of the communities or counties with a reservation could possibly be reached, eliminating the need to obtain water rights. ENMRWS members will each be responsible for covering a portion of the pipeline operation and maintenance (O&M) costs; however, Tucumcari, Logan, San Jon, and Quay County are not ENMRWS members and will not be responsible for any ENMRWS O&M fees. The possibility of diverting water from the Canadian River or Ute Creek before it reaches Ute Reservoir and taking it as a portion of the water reserved could be further explored.

8.8.1.4 Village of Des Moines Water System

The Village of Des Moines has seven wells, three of which have been taken offline due to nitrate contamination. Of the other four wells, three are producing and the fourth cavitates (ceases to produce water) within a few minutes of being turned on. There is also concern regarding the main well, as it is within ½ mile of the cavitating well and was drilled at the same time as that well. In addition to nitrate contamination, Village of Des Moines wells have elevated radon levels (Bray, 2006b). Groundwater elevation levels for the Village of Des Moines are declining, with one supply well effectively dry.

The Village of Des Moines is in need of a new water supply well and plans to approach Folsom, Capulin, and Grenville about the possibility of putting in a regional system (Bray, 2006b). While the Village of Grenville has a water system, consisting of two wells serving a population of 28 people, Folsom and Capulin do not currently have water systems. Depth to groundwater in domestic wells ranges from 40 to 120 feet in Folsom and 50 to 80 feet in Capulin (Bray, 2006a).

The 2006 capital outlay funding that the Village of Des Moines received is being used to address leaks in approximately one-third of the water system, which have resulted in an average water loss rate of 32 percent for the past two years (Bray, 2006b). These funds are being used to replace some of the distribution system lines, main lines, and connections (replace cast-iron pipe with PVC), and to add additional shut-off valves throughout the system (Bray, 2006b).

The Village of Des Moines would like to drill test wells and install a water supply well in the Capulin Basin. However, the NMED Construction Programs Bureau will not provide funding for well installation until the water loss is minimized (Bray, 2006b). Similarly, the OSE does not want communities to receive funding for well installation without bringing the amount of water lost down (Watkins, 2006).

To address their immediate water supply needs, the Village of Des Moines has evaluated the possibility of leasing water from the City of Raton. The City of Raton is willing to enter into a 25- to 30-year lease on Capulin Basin groundwater rights they hold; however, the Village of Des Moines would have to pay for the necessary infrastructure to bring water from Raton. This option may not be feasible due to the expense (Bray, 2006a).

8.8.1.5 Connection of Recently Acquired Wells into the Clayton Water Distribution System

Clayton has recently purchased land that includes several irrigation wells. In order to tie these wells into the distribution system, Clayton will need to install additional infrastructure, including new distribution and service lines. Upgrades to older sections of the system may also be necessary in order to tie in the new lines.

8.8.1.6 Replacement of Old Lines in all Communities

Continued update and improvement of existing water supply infrastructure will be necessary in all communities in the region, to replace aging and leaking pipelines and aging mechanical devices. In order to optimize operation and maintenance resources (equipment and staff) and to address water quality requirements and emergency planning issues, regional cooperation among water systems is recommended.

8.8.2 Hydrological Impacts

In most areas within the Northeast Region, completing infrastructure upgrades will not have a direct hydrologic impact. Infrastructure upgrades could however ultimately help improve water resource management, and upgrading water delivery systems will help conserve water by reducing system losses.

8.8.2.1 Logan Wastewater System Extension and Septic System Retirement

Transitioning septic system users onto a wastewater system near Ute Reservoir in Logan would contribute to improved water quality. No hydrologic impacts are anticipated as a result of this transition.

8.8.2.2 Logan-San Jon Pipeline Extension

Adding an extension to the existing Logan-San Jon pipeline would not have hydrological impacts as long as Logan has an adequate supply of water and water rights and is able to sell additional water to San Jon. This pipeline will have a positive hydrologic impact to San Jon, where additional water will be delivered.

8.8.2.3 Harding County Water System Construction

Construction of a Harding County water system would first necessitate either the purchase of water rights or a water leasing agreement with one of the Ute Reservoir water reservation holders. Development of a water system could have hydrologic impacts if water were to be withdrawn at a point on the Canadian River or Ute Creek where water is not currently being withdrawn. Impacts would depend on the amount of water to be withdrawn, as well as the location of the diversion.

8.8.2.4 Village of Des Moines Water System

Development of additional groundwater supplies for the Village of Des Moines would potentially provide more water to meet future demands. The Village of Des Moines would have to file an application with the OSE for a permit to drill a well, and the OSE would evaluate the impacts of the proposed groundwater pumping on senior water rights holders before approving the permit. Approval of a Village of Des Moines permit would indicate that the State Engineer did not anticipate the requested well to have hydrologic impacts.

8.8.2.5 Connection of Recently Acquired Wells into the Clayton Water Distribution System

The addition of pre-existing wells into the Clayton water distribution system would provide more water to meet future demands in the Town of Clayton. The existing wells were previously used for irrigation, and while they are not currently pumping, transferring their method of use to municipal supply would use significantly less water than was previously pumped for irrigation.

8.8.2.6 Replacement of Old Lines in All Communities

Continued replacement of water system lines will conserve water by reducing system losses, improving water resource management. This upgrade is expected to have a positive hydrologic impact to the extent that losses are reduced.

8.8.3 Financial Feasibility

8.8.3.1 Logan Wastewater System Extension and Septic System Retirement

The total anticipated cost for the Logan wastewater system project is approximately $8 million (Wallin, 2006). The $125,000 2006 capital outlay funding received from the New Mexico legislature is being used for design and engineering, and additional funding is being sought from multiple sources (Wallin, 2006).

8.8.3.2 Logan-San Jon Pipeline Extension

Anticipated costs have not been projected for the Logan-San Jon pipeline extension.

8.8.3.3 Harding County Water System Construction

Projected costs for a Harding County water system will depend on whether a diversion or dam is built, where it is built, and the size of the system to be built. In addition, costs will be incurred for the water rights or a water leasing agreement that need to be in place prior to constructing a system. Costs can be estimated following a preliminary design of the project and definition of its size. Building a diversion would cost much less than a dam; however, ample funding will be necessary either way.

8.8.3.4 Village of Des Moines Water System

The cost of installing a regional system to serve the Villages of Des Moines, Capulin, Folsom, and Grenville has not been estimated. However, the Village of Des Moines anticipates that it would cost approximately $2.5 million to drill a water supply well and pipe water 10 miles from Capulin to Des Moines. The $210,000 in 2006 capital outlay funding received by the Village is being spent in an effort to minimize existing water system losses, which likely must be reduced in order to receive funding to drill a new well (Bray, 2006b). Des Moines plans to seek funding from the State of New Mexico emergency water funds or from the legislature in 2007.

8.8.3.5 Connection of Recently Acquired Wells into the Clayton Water Distribution System

The cost to connect the recently acquired irrigation wells to the Town of Clayton's distribution system has not been estimated.

8.8.3.6 Replacement of Old Lines in All Communities

Costs of replacing old water system lines will vary depending upon each system, the quantity of lines to be replaced, and the materials used.

8.8.4 Environmental Impacts

Temporary environmental impacts could result from construction of infrastructure upgrades, but no significant environmental impacts are expected to occur. Depending on the project and funding source, environmental assessments might be necessary to ensure that projects have no unintended consequences, particularly with the construction of large projects such as the Harding County water system.

8.8.5 Political Feasibility and Social/Cultural Impacts

The Harding County water system is expected to have wide support in the County. However there may be some concern, depending on where the water comes from and how it is diverted and/or stored. All of the other infrastructure upgrade projects proposed here are expected to have full public support and no adverse social or cultural impacts.

8.9 Planning for Growth

As discussed in Sections 5, 6, and 7, the Northeast Region is experiencing declining groundwater supplies over much of the region, yet could potentially realize significant growth over the long-term planning period. Because of the projected shortfalls, it is important that new development proceed in a manner to ensure that adequate supplies are secured prior to residential, commercial, or other new development.

Although the State of New Mexico recognizes the need to provide adequate water supplies for new development (NMSA 47-6-11(F)), the responsibility of developing and implementing ordinances that require proof of available water supply and/or address related issues such as conservation in new development, lie with counties and municipalities. However, this approach results in varying degrees of water supply protection related to new development due to the lack of a technical definition of a long-term water supply, insufficient staff, resources and data to evaluate cumulative impacts of development and to determine if adequate long term supplies exist, inconsistent standards among counties, and insufficient requirements for municipalities. The purpose of this strategy is to evaluate the potential for improved water resource management by requiring that adequate water supplies are available before development can proceed and ensuring that growth proceeds in a manner that supports wise use of water resources.

8.9.1 Technical Feasibility

Issues related to growth planning are relevant at both the County level (8.9.1.1) and at the municipal level (8.9.1.2).

8.9.1.1 County Subdivision Regulation

The New Mexico Subdivision Act mandates that counties pass subdivision ordinances requiring developers to demonstrate that a proposed subdivision will have water supplies of sufficient quantity and quality to meet demand (NMSA 47-6-11(F)). Each county within the planning region has approved subdivision requirements that address water supply availability (Table 8-22). In Curry, Harding, Quay, and Roosevelt Counties, subdivision regulations require proof of a 40-year water supply and the counties rely on the OSE to determine whether that condition has been met. In Union County a hydrologic report demonstrating water availability is required. NMED generally reviews issues relating to wastewater disposal.

The Subdivision Act includes numerous exemptions. For example, the Act excludes 13 types of land divisions from the definition of subdivision (NMSA 47-6-2). No proof of water availability is required for development on lands that fall under these exemptions. Two examples of exemptions include bequests of land to family members and parcels donated to not-for-profit corporations including schools, universities, and religious organizations. Two other aspects of the Subdivision Act hamper comprehensive planning for water availability: (1) developers can avoid compliance with county subdivision regulations, and (2) domestic wells are exempt from the regulations.

The existence of county regulations does not necessarily mean that subdivisions will be required to comply with the water availability requirements. Cases have occurred in which the OSE has issued a negative opinion about the water supply availability for a proposed subdivision, yet the county commission has nevertheless approved the subdivision (Drennan, 1997). Additionally, developers can take advantage of lax municipal water supply requirements. In cases where the county commission has denied a permit, developers have convinced nearby municipalities to annex the subdivision in order to allow the subdivision to move forward. Efforts to protect water supplies for future use will require the cooperation of informed county commissions, municipalities, and other planning agencies.

Table 8–22. Northeast Region Subdivision Requirements Pertaining To Water
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County	Water Availability Requirements	Annual water Requirements per Parcel	Water Conservation Requirements	Water Permit Requirements	Other Requirements
Union	Requires water supply plan, including geohydrological or hydrological evaluation, references OSE guidelines, but does state that applicant must demonstrate water availability over a specific time frame. (Appendix B Water Quantity, Water Availability and Water Supply Plan)	Water demand analysis is based on 0.5 acre-foot per year per lot. Appendix B (Water Availability Sec. A).	• Water saving fixtures • Insulation of hot water pipes • Metering of all uses • Water pressure at 80 psi or less (Appendix B (Water Conservation Measures))	None. Requires only a water supply plan (Sec.5.7.1)	• Terrain Management Plan including erosion and drainage plan, landscaping and revegetation • Storm Drainage Plan, water quality requirements • Liquid waste disposal requirements
Harding	Water supply plan including conservation. Adopts OSE guidelines for County Subdivision Regulations governing water supply requirement, which require water for 40 years	• Adopts OSE guidelines • Water demand analysis is based on 0.5 acre-foot per year per lot.	• Adopts OSE guidelines • Water saving fixtures • Insulation of hot water pipes • Water pressure at 80 psi or less	• Applicant must have an OSE water rights permit in sufficient amount to fulfill the maximum water requirements for the subdivision • Required for final plat approval for subdivisions with 20 or more parcels of 2 acre or less size (Sec. 5.7)	• Terrain Management Plan including erosion and drainage plan, landscaping and revegetation • Storm Drainage Plan, water quality requirements • Liquid waste disposal requirements
Quay	Water availability plan showing sustainable water supply for 40 years (Sec. 8.7.4)	1 acre-foot per parcel (Sec. 8.7.3(a))	• Water saving fixtures • Insulation of hot water pipes (Sec. 8.7.2(a) and (b))	None. Requires only a water availability plan (Sec. 8.7)	NMED approval for development involving a public water supply or liquid waste disposal system, water quality requirements, Terrain Management Plan including erosion and drainage plan

Table 8–22. Northeast Region Subdivision Requirements Pertaining To Water
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County	Water Availability Requirements	Annual water Requirements per Parcel	Water Conservation Requirements	Water Permit Requirements	Other Requirements
Curry	Requires demonstration of available water supply for 40 years (Attachment 2, Sec. 4)	2.0 acre-feet per parcel or alternate water demand projection using OSE guidance	• Water saving fixtures • Insulation of hot water pipes • Water pressure at 80 psi or less (Attachment 2 Section (C)(3)(A))	None. Sets out water conservation and availability requirements for subdivisions in Attachment 2. Requires application be submitted to OSE for review.	• Terrain Management Plan, water quality requirements, • Liquid waste disposal requirements
Roosevelt	Requires demonstration of available water supply for 40 years (Sec. 16.3.5(C)(1))	0.6 acre-feet per parcel unless a detailed demand analysis approved by OSE justifies the use of a different figure (Sec. 16.3.2 (A))	• New construction shall conform to administrative building and plumbing codes (Section 16.3.1(A)) • Low water use landscaping techniques are encouraged (Sec. 16.3.1(B))	Applicant must have a sufficient amount of OSE water rights permit to fulfill the maximum water requirements for the subdivision. Required for final plat approval for subdivisions with 20 or more parcels of 2 acre or less size (Sec. 5.7.1)	• Terrain Management Plan, Storm Drainage Plan, water quality requirements, • Liquid waste disposal requirements

Domestic wells are exempt from the Subdivision Act, and neither the immediate or cumulative impacts of these wells are considered in determining available water supply. Even when agricultural water rights are transferred to another location, the land may be developed for housing using domestic wells. This practice allows for increased withdrawals that could impair other water users, yet there is no opportunity for protest or evaluation of impairment. New domestic well regulations (Section 4.1.2) may affect future subdivision development using domestic wells in critical management areas.

8.9.1.2 Municipal Water Suppliers

The Subdivision Act does not apply to municipalities, although they do have the power to adopt city ordinances governing land platting, planning, and zoning (NMSA 3-19-1 through 12; 3-20-1 through 3-20-16). Specifically, municipal subdivision regulations may govern the extent and manner in which water will be provided to the subdivision as a requirement of subdivision approval.

New subdivisions within municipalities are typically served by a municipal system, and a municipality could include consideration of system capacity in its land use regulations. For example, a municipality could require, for any proposed development project, a written statement of water and sewer availability for building permits, site plan, or subdivision approval. Again, a jurisdiction that ties approvals to system capacity should have a sound technical basis for evaluating development and implementing such regulations.

In areas where an existing water system will supply new subdivisions, infrastructure development requirements can be established to tie development approvals to existing or planned system capacity. Local governments could better link capital improvements to the timing of new development by identifying growth areas in advance and providing new publicly funded infrastructure to serve these areas in a timely manner. Alternately, some local governments have established concurrency ordinances which require that new development is restricted to areas where infrastructure capacity exists or will be available within a specified period of time. This approach may not alter the type or cost of improvements, but would affect the timing of construction.

As discussed previously, many of the municipal suppliers in the Northeast region intend to rely on ENMRWS water. Once pipeline construction begins and the renewable water supply is more assured, it would be prudent for the communities that will receive ENMRWS water to link subdivision approvals to the amount water that the community has reserved. Each community should also make sure that drought conservation measures can be instituted during years when the full ENMRWS allotment is unavailable, in accordance with the shared shortage provision of the reservation/purchase agreement, prior to approving new subdivisions.

8.9.1.3 Water Conservation During Development

In addition to assuring that water supply is available to support new development, an important component of new development is conservation measures. Both municipal and county subdivision policies and policies relating to industrial or commercial development should ideally incorporate conservation. It can be difficult to ask existing residents to conserve water if they see new development going in without conservation measures. Additionally, it is easiest to install low water use appliances, xeriscaping, rain water harvesting, gray water reuse, and other conservation features during construction, rather than retrofitting them later. Additional detail and recommendations for implementing conservation measures in the region is provided in Section 8.2.

8.9.1.4 Summary of Technical Feasibility

The greatest technical challenge regarding this strategy is the ability to define specific criteria that can be used to assess the long term viability of groundwater supplies considering the cumulative impacts of agricultural and municipal pumping within a given aquifer. This is an issue at both the county and municipal level. Specifically, while it is relatively easy to pass a regulation stipulating that a 40-year (or other time period) water supply must be available for subdivision approval, it is more difficult technically to quantitatively determine if a given amount of water will be available for a long period. The best method for doing this is through groundwater modeling, but models must be kept up to date to account for cumulative withdrawals accurately. Since groundwater models do not currently exist for all areas in the region, technical resources would be required to develop them.

In some cases where models exist, the OSE may evaluate cumulative impacts of development. However, in more rural areas, the OSE typically reviews pump tests for the proposed well to determine whether that well has sufficient water to continue pumping during the length of time specified in the county subdivision act. This process does not take into consideration the cumulative impacts on the entire groundwater basin of the proposed additional pumping, and the OSE often does not have the data to make that determination because they receive individual permit requests rather than a comprehensive development plan. Furthermore, the effects of long-term drought may not be considered unless a model is in use that can be adjusted to simulate lower recharge. For implementation of this strategy to be technically feasible, the counties need to have sufficient financial resources to hire technical staff that can develop models and thoroughly evaluate applications for water use.

To implement this activity in the planning region, it would be helpful to have new legislation at the state level that better defines terminology such as “adequate” water supplies, and the region may wish to support statewide legislation. In the absence of statewide definitions and criteria, counties within the region may consider clarifying their regulations to more specifically define how a determination of water supply availability will be made. Such clarification may help prevent developers from circumnavigating compliance with county regulations, but only if (1) regulations are adequately enforced and (2) counties and municipalities cooperate to protect water supplies from overdevelopment.

If the higher growth projected scenarios (Section 6.4) are realized, this strategy may become very important to ensure optimal use of water resources in the region. Some counties in New Mexico have chosen to require proof of water for up to 70 years. Outside New Mexico, some counties or states require proof of water availability for up to 100 years or more. Depending on existing and projected cumulative use and local hydrology, the 40-year time frame may not be sufficient, and Counties may consider lengthening the planning time frame.

8.9.2 Hydrological Impacts

No new water would be made available to the region as a result of this strategy, but senior water rights would be better protected. Instituting more protections regarding water supply will protect the region from development that is faced with future water shortages. As the objective of this strategy is to make sure that development proceeds responsibly, rather than to stop or slow development, the overall impacts to the regional water demand will likely not be significant.

If this strategy is not implemented and growth occurs without adequate water supplies, there may be long-term effects such as depletion of groundwater, as indicated by falling water levels, and wells eventually going dry. For surface water supplies, the long-term effect could be extremely severe water restrictions during drought, when supplies are insufficient to supply all of the new development. This could potentially be an issue if development causes demands to exceed contracted water on communities served by the ENMRWS.

8.9.3 Financial Feasibility

If wide-scale development is allowed to occur without ensuring that adequate water supply is available, costly projects will be required to locate alternative water supplies that would potentially need to be imported from great distances. Costs for ensuring water supply availability for new development are low in comparison to costs of addressing significant water problems later.

The cost of developing new legislation at the state level or regulations at the county level to further refine the technical aspects of proof of water availability vary depending on how much can be accomplished by in-house staff. In general, a county could likely hire a consultant to help develop new, more explicit regulations for approximately $50,000 to $100,000.

The greatest expense for requiring proof of adequate water supplies is likely to be the technical evaluations required for a rigorous analysis of cumulative impacts of water supply development. None of the five counties in the planning region currently has the resources and staff needed to evaluate the adequacies of water supplies. If the counties were to implement this strategy, they could (1) hire additional staff to help with technical evaluations or (2) contract with technical experts to help with these evaluations. Hiring new staff is a viable option if the amount of work justifies the position; the cost would depend on the expertise and experience of the staff but might be in the range of $75,000 to $100,000 per year. The cost of contracting with a consultant would vary depending on whether or not existing models are available. If existing models can be used, evaluations could be in the $20,000 to $30,000 range, though there would be efficiencies if several developments in one area are considered at the same time.

8.9.4 Environmental Impacts

This strategy is not expected to create any environmental impacts. By ensuring that development proceeds only when adequate water supplies have been secured, it should protect against potential undesirable impacts to the environment that may result from groundwater overdraft, especially during drought conditions. Additionally, consideration of measures such as water conservation with new development will contribute to environmental protection by preserving the region's limited water resources.

8.9.5 Political Feasibility and Social/Cultural Impacts

Ensuring sufficient water supplies for new development while taking into account existing demand would benefit all residents in the region by protecting their water supplies. However, initiatives that are perceived to slow growth and development or provide added regulation tend to generate significant political opposition. Public opinion expressed at numerous steering committee and public meetings was generally supportive of growth and development and supported individuals' rights to do as they choose with their own property. Additionally, developers will likely oppose any attempts to limit their ability to construct new developments at will, and their financial resources to fight proposed legislation are usually greater than those of the local governments, nonprofit groups, and other interested parties who would support increased proof of water availability. However, there was also considerable public opinion indicating that stakeholders in the region support responsible use of water resources when new development occurs.

8.10 Dam Construction

In 2000, surface water supplied 16 percent of total depletions in the Northeast Region. Surface water is concentrated in the northern three counties, where it supplied 5 percent (Union), 2 percent (Harding), and 90 percent (Quay) of total depletions in 2000. No surface water features are present in Curry and Roosevelt Counties, and surface water thus supplied less than 1 percent of depletions in these counties in 2000.

As the volume of available groundwater decreases, the counties in northeast New Mexico are beginning to look for alternative sources of supply. The communities that are not slated to be served by the ENMRWS could benefit from renewable surface water supplies. In particular, the proposed Harding County water system will need a source of water, and impounding or diverting surface water is the most likely option. The purpose of this strategy is to provide a legal analysis of whether any of the surface water in the Northeast Region could be impounded by a new dam without adversely impairing other water users in the region; accordingly, this strategy discusses the feasibility, costs, and other impacts associated with building new reservoirs in the region. As the analysis identified large hurdles to dam construction, diverting water directly to a water system, in place of impoundment, is also discussed.

The region's surface water supply is provided by two stream systems and their tributaries: the Dry Cimarron River and the Canadian River. Existing dams in the area include Conchas, Ute, and Clayton Dams:

- Conchas Dam was built in 1939 and is outside the planning region; however it impounds Canadian River water for use in Quay County.

- Ute Dam was completed in 1962, and while no water is currently being withdrawn from Ute Reservoir, the ENMRWS project (Section 8.7) plans to supply communities in Curry and Roosevelt Counties with water for municipal and industrial use, and Quay County has water reserved in Ute Reservoir that will be withdrawn by other means.

- Clayton Dam was built in the 1970s on a tributary to the Dry Cimarron River and is operated by the New Mexico Department of Game and Fish as a recreational pool.

Numerous other small lakes exist in the planning region, as summarized in Section 5.2.3.

8.10.1 Technical Feasibility

The Canadian River Compact provides free and unrestricted use of water upstream of Conchas Dam and free and unrestricted use of all waters originating in the Canadian River Basin below Conchas Dam (Section 4.7.1). However, the Canadian River Compact limits storage in New Mexico below Conchas Reservoir to 200,000 acre-feet, and if a new reservoir were built in the Canadian system below Conchas Reservoir, storage in Ute Reservoir would have to be reduced in order to keep the total amount of storage in the two reservoirs below the 200,000-acre-foot maximum. Adding a diversion would not impact the amount of water in storage, and construction of a diversion to supply a Harding County water system would not violate the Canadian River Compact. However, designing a diversion without storage would mean that supplies would be limited during low-flow periods unless alternate groundwater supplies are used. Additionally, ENMRWA members that will be relying on supplies from Ute Reservoir are concerned about potential upstream diversions and would need to be assured that their supplies would not be negatively impacted.

If new storage were to result in increased depletions, water rights would either have to be transferred to offset the new depletions or an OSE permit would have to be obtained to appropriate water in the amount of the new depletions. Because Canadian River Basin surface water is considered to be fully appropriated, the OSE is not likely to issue a permit to appropriate additional water, except for potentially available flood flows. Therefore, the most likely avenue would be to transfer (i.e., change the point of diversion and/or place and/or purpose or use of) a water right. Transfer of a water right requires that an applicant show that the transfer (1) will not impair other water rights, (2) is not contrary to conservation, and (3) is not detrimental to public welfare (§§72-5-23, 72-12-7 NMSA 1978 (1997 Repl.)).

Agreements have been made with the ISC for the reservation of 24,000 acre-feet of Ute Reservoir water per year (Section 8.7). Entering into an agreement with one of the communities or counties with a Ute Reservoir water reservation would eliminate the need to obtain water rights on the Canadian River or Ute Creek. The possibility of diverting water before it reaches Ute Reservoir and taking it as a portion of the water reserved is another option that Harding County or other communities in the Northeast Region could explore.

Construction of dams is also regulated by the State Engineer (§72-5-32 NMSA 1978 (1997 Repl.)), and before a dam is constructed, a permit must be obtained from the OSE. The proposed dam must meet the same statutory criteria as a water right transfer: not cause impairment of any existing water right, not be detrimental to the public welfare, and not be contrary to the conservation of water (§72-5-6 NMSA 1978 (1997 Repl.)). Until 1997, no dams that were less than 10 feet in height and that impounded fewer than 10 acre-feet were subject to OSE regulation. However, in 1997, the legislature amended §72-5-32 NMSA to greatly restrict that exemption, and the only dams that are currently exempted from OSE permitting are ". . . erosion control structures whose maximum storage capacity does not exceed ten acre-feet and are constructed for the sole purpose of sediment control. An erosion control structure shall not impound surface water in any amount for fishing, fish propagation, recreation, or aesthetic purpose, which shall require a permit pursuant to Section 72-5-1 NMSA 1978" (NMSA 72-5-32).

From an engineering standpoint, new reservoirs can be constructed wherever ample supplies of surface water are available and site conditions are favorable. There are inevitable technological challenges to constructing new reservoirs, but few absolute barriers that cannot be overcome with the investment of additional funds. The engineering barriers to any given dam site are dictated by geologic conditions such as the lack of stable abutments and footings for the dam, high seismic risk, or unfavorable geology that would result in excessive seepage losses.

A new or expanded reservoir would require authorization from the affected landowner. In addition, other federal laws would apply including NEPA (42 U.S.C. §4321 *et seq.*), the CWA (33 U.S.C. §1251 *et seq.*), the ESA (16 U.S.C. §1531 *et seq.*), and possibly the National Historic Preservation Act (NHPA) (16 U.S.C. §470 *et seq.*). Most of the constraints placed by these laws relate to process, studies, and planning that must be done before any significant surface-disturbing work can begin. There will, however, also be substantive constraints on how much earthmoving and road-building is allowed. For instance:

- The ESA may limit new storage where species listed as threatened or endangered are located.

- Any diversions that are constructed in arroyos or streams, which are considered "waters of the United States," are subject to CWA jurisdiction and will require a permit from the

U.S. Army Corps of Engineers (USACE) under §404 (33 U.S.C. §1344). The greater the land disturbance, the more onerous the permit conditions will be.

- The American Indian Religious Freedom Act and NFMA may limit land disturbance near sites of religious, cultural, or historical significance.

8.10.2 Hydrological Impacts

As discussed in Section 8.10.1, the OSE is not likely to issue a permit to appropriate additional surface water on either the Canadian or Dry Cimarron systems, except for potentially available flood flows, although water could be diverted from these systems if existing water rights were transferred. A new water diversion would not have hydrologic impacts as long as water rights were secured for the project.

The construction of new reservoirs would be effective in increasing storage space to hold existing water rights, but would not create new water. However, storage could lessen the impacts of seasonal and annual variability in the surface water supply. Since the total storage on the Canadian River system is limited to 200,000 acre-feet and Ute Reservoir has a capacity of 245,000 acre-feet (although some portion of that amount is taken up by sediment), no new storage would be available. The storage of additional water would be limited to those periods when spring runoff or precipitation events generated water in excess of current storage capacity and when such storage would not negatively impact downstream water rights users or conflict with Compact requirements. Given those limitations, the time frame of storage could be seasonal (for annual needs such as irrigation) or multiyear (for drought cycle water supplies.) A "water cost" would be incurred through evaporation, associated evapotranspiration by vegetation, and seepage of the stored water. Thus water rights sufficient to cover new uses as well as losses would need to be transferred.

Two USGS stream gages were formerly located on the Dry Cimarron River, near Guy and near Folsom; however, use of both gages has been discontinued. The periods of record for these gages are October 1, 1942 through December 31, 1973 for the gage near Guy and October 1, 1927 through September 30, 1933 for the gage near Folsom (Table 5-4). As no other gages are located on the Dry Cimarron River, its flow has been ungaged since 1973. During the Guy and

Folsom gages' periods of record, average flows were approximately 7,000 ac-ft/yr; however, these historical data do not provide an adequate basis on which to predict how much water would be available for storage. Alternatively, water could be diverted from the Dry Cimarron River if water rights were secured in advance.

Ute Creek is gaged near Logan, upstream of where Ute Creek drains into Ute Reservoir. This stream gage is active, and its period of record extends back to January 1942 (the gage continues to be in operation, but the dataset available for use in this report goes only through July 2005). Average flow past this gage for its period of record has been approximately 15,000 ac-ft/yr, with a minimum flow of less than 200 ac-ft/yr and a maximum flow of almost 63,000 ac-ft/yr. For comparison, in 2000 total withdrawals in Harding County were 4,225 acre-feet, 98 percent of which were supplied by groundwater (Wilson et al., 2003).

8.10.3 Financial Feasibility

Because the construction costs for dams and diversions are determined by their proposed sites and sizes, it is not possible to estimate the costs of constructing new dams or diversions in unspecified areas. Dam construction costs can vary widely. For example, a proposed dam in Sebastian Canyon was estimated to cost $7.2 million, indexed to Year 2005 dollars (Romero, 1994), while original construction costs of Nambe Falls Dam and Reservoir in Santa Fe County and Heron Dam and Reservoir in Rio Arriba County, indexed to Year 2002 dollars, were about $34 million and $57 million, respectively (Leutheuser et al., 2002).

8.10.4 Environmental Impacts

A wide range of environmental issues are associated with the construction of new dams or diversions. Beyond the immediate effects of a dam and reservoir or diversion on the environment, these projects would affect downstream conditions such as hydrography, sediment, water temperature, water quality, and river morphology. The cost of mitigating adverse environmental impacts would be included in the construction and operation and maintenance costs.

Large construction projects (such as dam and/or diversion construction) would become subject to NEPA requirements under Section 7 of the ESA if they were to receive federal funding, if they would require USACE §404 permits, or if it appeared that the project would harm a threatened or endangered species. Under ESA Section 7, Environmental Impact Statements, Environmental Assessments, and Categorical Exclusions would be required before a project could proceed. In a case where a project is subject to NEPA requirements, compliance with the USFWS and the NHPA Section 106 process would also be invoked. If federal funding were not involved, USACE §404 permits were not required, and no harm would come to a threatened or endangered species, only Section 9 of the ESA (regulating the taking of any endangered species) would apply.

8.10.5 Political Feasibility and Social/Cultural Impacts

Constructing new reservoirs could impact downstream water users by creating a larger water surface area that would increase evaporative losses and reduce downstream flow. Local communities are likely to resist the building of a new reservoir unless they reap a direct benefit in the form of more water. New diversions are also likely to be protested if there is a perceived impact to existing water rights holders; however, a proposed diversion project would probably face much less opposition than a new dam.

In addition to opposition from potentially affected water rights holders, growing environmental sensibilities among the public would likely give rise to significant public opinion hurdles and potential opposition to new large reservoirs. Again, construction of a new diversion would be a smaller project with fewer impacts and, therefore, probably less opposition.

Finally, public financing for new dams and/or diversions may be difficult to obtain, and the cost of these new structures would likely be passed on to consumers, increasing the cost of water and again generating political opposition.

8.11 Summary Recommendations and Implementation Schedule

As discussed in Section 8.1, a list of potential strategies was developed at steering committee meetings, which were open to the public, and at a series of community meetings held in Clovis, Logan, Clayton, and Mosquero. The list of potential strategies was prioritized based on input from the public meetings, and the priority strategies are analyzed in Sections 8.2 through 8.10. Other strategies on the comprehensive list are part of the long-term planning strategy for the Northeast Region.

A draft implementation schedule that identifies responsible parties and the relative time frame to begin implementation of each strategy has been developed and is included as Table 8-23.

Union, Harding, Quay, Curry, and Roosevelt Counties should develop memorandums of understanding (MOUs) to use among themselves as well as among all incorporated municipalities in the region. Having MOUs in place will aid in coordinating between municipalities and/or counties for project implementation and funding requests.

Funding for projects is expected to be most successful if funding requests involve multiple communities and/or counties, taking advantage of regional project funding mechanisms such as CWA Section 319 grants, Water Trust Board grants, CFRP grants, and others. Potential funding sources for strategy implementation are included in Table 8-24.

The larger the projected gap between demand and supply is, the greater the need for implementing strategies. While all communities will benefit from strategies that protect and restore water supplies, communities in Curry and Roosevelt Counties are projected to face the largest gap between existing supply and future demand for the high growth scenario. These communities in particular need to plan for future growth.

Table 8-25 shows the projected demand for all sectors by county for the low and high growth projections (Section 6.4). As shown in this table, the gap (i.e., projected new water use that is not currently associated with a water right or specified source) under the high growth projection is approximately 10,000 acre-feet in Quay County, 21,000 acre-feet in Curry County, and 15,000 acre-feet in Roosevelt County. The low projection gap reflects declines in irrigated agriculture and associated reductions in water use. However, the region fully intends to support economic growth as shown in the high projection and needs to prepare for that scenario.

Table 8-23. Preliminary Implementation Schedule and Recommended Actions for Strategies to Meet Future Supply Needs
Page 1 of 4

Strategy	Implementation Priority [a]	Action	Responsible Party [b]
Water conservation			
Agricultural conservation / delivery system efficiencies (i.e., line ditches, install pipes) (Section 8.2)	1	• Determine where lining is beneficial and not detrimental • Support state legislation for agricultural conservation programs • Obtain funding to assist farmers in implementing on-farm conservation measures • Continue replacing old sprinkler systems with LEPA systems	Arch Hurley Conservancy District, SWCDs, NRCS
Municipal conservation / education (Section 8.1)	1	• Develop and implement education programs • Implement rate structures and other incentives to reduce water use • Implement community-specific recommendations (Table 8-1)	Municipalities [c]
Treat and reuse wastewater	1	• Expand the number of and continue to implement wastewater treatment and reuse programs	Municipalities [c]
Encourage the use of gray water	2	• Consider including gray water reuse infrastructure in building codes • Consider implementing green-building codes • Conduct education program	Municipalities [c]
Develop drought contingency plans	1	• Develop plans at the community level	Municipalities [c], counties
Complete 40-year water plans	1	• Provide funding and technical assistance for plan completion	Municipalities [c], counties
Water plan implementation (Section 8.2)	1	• Continue to meet and pursue implementation	Municipalities [c], counties
Groundwater management			
Participate in development of OSE administrative criteria	1	• Monitor and participate in OSE criteria development	OSE

[a] 1 = Begin implementing immediately (within 1 to 3 years)
2 = Begin implementing in 4 to 10 years
[b] Primary responsible parties; others may also be involved.
[c] Municipalities of Clayton, Des Moines, Grenville, Roy, Mosquero, Tucumcari, Logan, San Jon, House, Clovis, Grady, Melrose, Texico, Portales, Dora, Causey, Elida.

ENMRWA = Eastern New Mexico Rural Water Authority
LEPA = Low energy precision application
NMRWA = New Mexico Rural Water Association
NRCS = Natural Resources Conservation Service
OSE = Office of the State Engineer
SWCD = Soil and water conservation district
USGS = U.S. Geological Survey
WWTP = Wastewater treatment plant

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Table 8-23. Preliminary Implementation Schedule and Recommended Actions for Strategies to Meet Future Supply Needs
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Strategy	Implementation Priority [a]	Action	Responsible Party [b]
Data collection, metering, measuring, monitoring (Section 8.3)	1	• Develop detailed monitoring/metering plan • Educate legislature on need to fund data collection	OSE, legislators, USGS, municipalities [c], individuals
Prepare summary report on groundwater declines	1	• Seek funding for reporting • Synthesize data and publish clear report	Counties, municipalities [c], OSE, NMRWA
Rangeland conservation and watershed management			
Salt cedar removal (Section 8.4)	1	• Work with the Canadian River Riparian Restoration Project to continue salt cedar removal efforts • Collect quantitative data regarding the benefits of salt cedar removal	SWCDs; municipalities [c]; counties, U.S. Forest Service, OSE, USGS
Watershed management (Section 8.4)	1	• Continue and expand existing watershed programs • Conduct public education regarding watershed activities	SWCDs; municipalities [c]; counties, U.S. Forest Service
Water rights protection			
Support and become involved in the existing OSE process (Section 8.5)	1	• Monitor published notices announcing OSE applications for new appropriations or transfer of existing water rights • File written protest or objection with the OSE if any applications are contrary to the conservation of water, detrimental to public welfare, and/or will substantially or specifically affect the objector if approved	Individuals, municipalities [c], counties
Infrastructure upgrades, dam construction, and Eastern New Mexico Rural Water System			
Logan wastewater system extension (Section 8.7)	1	• Continue to seek additional funding	Logan

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Table 8-23. Preliminary Implementation Schedule and Recommended Actions for Strategies to Meet Future Supply Needs
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Strategy	Implementation Priority [a]	Action	Responsible Party [b]
Logan-San Jon pipeline extension	2	• Construct expansion plans • Enter a lease agreement for additional water • Seek funding for construction	San Jon and Logan
Harding County water system (Section 8.9)	2	• Obtain water rights or enter into a Ute Reservoir water leasing agreement • Plan proposed diversion or dam • Seek funding for construction	Harding County, Roy, Mosquero, individuals
Village of Des Moines water system (Section 8.7)	1	• Approach Folsom, Capulin, and Grenville regarding construction of a regional water system • Continue addressing water loss, replacing lines • Apply for OSE permit and drill test holes in Capulin basin • Seek funding for construction • Seek funding for wastewater improvements	Des Moines
Clayton well connection	2	• Plan water system expansion • Seek funding for construction	Clayton
Continued water line replacement (Section 8.7)	1	• Apply for additional funding	Municipalities [c]
Eastern New Mexico Rural Water System (Section 8.6)	1	• Support ENMRWA in moving forward • Continue to seek funding	ENMRWA, member municipalities and counties
Tucumcari WWTP	1	• Seek funding for WWTP improvements	Tucumcari
Portales WWTP	1	• Seek funding for WWTP improvements	Portales
Clovis reuse infrastructure	1	• Seek funding to expand reuse infrastructure	Clovis

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[b] Primary responsible parties; others may also be involved.
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Table 8-23. Preliminary Implementation Schedule and Recommended Actions for Strategies to Meet Future Supply Needs
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Strategy	Implementation Priority [a]	Action	Responsible Party [b]
Planning for growth			
Ensure that growth proceeds in a manner that supports wise use of water resources (Section 8.8)	1 2	• Develop/update groundwater models to evaluate cumulative impacts of withdrawals • Seek funding for staff to evaluate sustainability issues associated with growth.	Municipalities [c], counties, OSE

[a] 1 = Begin implementing immediately (within 1 to 3 years)
2 = Begin implementing in 4 to 10 years
[b] Primary responsible parties; others may also be involved.
[c] Municipalities of Clayton, Des Moines, Grenville, Roy, Mosquero, Tucumcari, Logan, San Jon, House, Clovis, Grady, Melrose, Texico, Portales, Dora, Causey, Elida.

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Table 8-24. State and Federal Funding Sources
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Program Title / *Agency* / Web Site or Contact [a]	Funding Area: Water Supply Conservation	Funding Area: Development and Infrastructure	Funding Area: Water Supply Protection	Funding Area: Water Resources Management	Description
General Information					
Catalog of Federal Domestic Assistance http://www.cfda.gov/	■	■	■	■	Good information about funding sources, grant writing, etc.
Federal Grants Search www.grants.gov	■	■	■	■	Searches all federal agency sources for grant information
Federal Drought Programs http://www.iwr.usace.army.mil/iwr/drought/feddrghtprogs.htm	■	■	■	■	Summary of federal funding sources available for drought programs.
Catalog of Federal Funding Sources for Watershed Protection http://cfpub.epa.gov/fedfund/			■		Topical listing of funding sources related to watershed protection.
Links to private funding sources http://www.epa.gov/owow/nps/capacity/funding.htm	■	■	■	■	List of links for private funding sources for various areas.
Funding Programs					
New Mexico Clean Water State Revolving Fund *New Mexico Environment Department*, *Construction Programs Bureau* Santa Fe: 505-827-2806 http://www.nmenv.state.nm.us/cpb/cpbtop.html http://www.nmenv.state.nm.us *New Mexico Water Trust Board* Contact New Mexico Finance Authority (NMFA) U.S. *Environmental Protection Agency (EPA)* http://www.epa.gov/owm/cwfinance/cwsrf/	■	■	■	■	Eligible projects include water supply development, conservation, watershed management, and infrastructure. Water quality protection projects for wastewater treatment, nonpoint source pollution control, and watershed and estuary management.

Web site address as of June 2006; address and information found there is subject to change.

Table 8-24. State and Federal Funding Sources
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Program Title / *Agency* / Web Site or Contact [a]	Funding Area: Water Supply Conservation	Funding Area: Development and Infrastructure	Funding Area: Water Supply Protection	Funding Area: Water Resources Management	Description
Community Development Block Grants *Department of Housing and Urban Development* http://www.state.nm.us/clients/dfa/Files/LGD/CDB/index.html				■	Funding source for 40-year plans.
Community Facilities (CF) Direct Loans and Grants *U.S. Department of Agriculture (USDA)* http://www.rurdev.usda.gov/rhs/cf/cp_dir_grant.htm		■			Provides loans for the development of essential community facilities for public use in rural areas and towns with a population of 20,000 or less.
Emergency Community Water Assistance Grants *USDA Rural Utility Services (RUS)* Albuquerque: 505-761-4955 http://www.rurdev.usda.gov/nm/ http://www.usda.gov/rus/water/programs.htm#EMERGENCY http://www.usda.gov/rus/water/		■	■		Assists rural communities that have had a significant decline in quantity or quality of drinking water.
Irrigation Works Construction Loan Fund *New Mexico Interstate Stream Commission* Santa Fe: 505-827-6134 Fax 505-827-6188 http://www.ose.state.nm.us/isc_acequias_construction_loan.html		■			Makes loans to entities such as irrigation districts, community ditch associations, and municipalities for engineering and design, construction, or rehabilitation of irrigation works.
Acequia Restoration and Rehabilitation Program *U.S. Army Corps of Engineers, Albuquerque office* *New Mexico Interstate Stream Commission* Santa Fe: 505-827-6160 Fax 505-827-6188		■			Joint program with U.S. Army Corps of Engineers (COE); provides eligible acequias with COE grants that fund up to 75% of a project's cost with 25% acequia funding. Matching requirements may be met through state grants (17.5%) and loans (7.5%).

Web site address as of June 2006; address and information found there is subject to change.

Table 8-24. State and Federal Funding Sources
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Program Title / *Agency* / Web Site or Contact [a]	Funding Area: Water Supply Conservation	Funding Area: Development and Infrastructure	Funding Area: Water Supply Protection	Funding Area: Water Resources Management	Description
Ditch Rehabilitation Grant Program *Office of the State Engineer* Santa Fe: 505-827-6191 Fax 505-827-6188		■			Joint program with U.S. Soil Conservation Service; provides grants to community ditches for construction, repair, and improvement of ditches, dams, reservoirs, flumes, and appurtenances.
Planning Assistance to States *U.S. Army Corps of Engineers* Albuquerque*: (505) 342-3109* http://www.spa.usace.army.mil	■	■	■	■	Assists in planning for the development, utilization, and conservation of water and related land resources and ecosystems.
Reclamation States Emergency Drought Relief Act of 1991 - Title II *U.S. Bureau of Reclamation* Albuquerque Area Office: 505-248-5323 http://www.usbr.gov/uc/progact/waterconsv/wtr_wmp.html	■	■	■	■	Assistance in the construction and planning of projects that mitigate effects of drought.
Conservation Technical Assistance *USDA Natural Resource Conservation Service* Albuquerque Office: 761-4407; 1-800-410-2067 http://www.nrcs.usda.gov/programs/cta/			■	■	Planning and implementation of solutions to natural resource concerns, including drought.
Safe Drinking Water Act Revolving Loan Program *New Mexico Environment Department, Construction Programs Bureau* Santa Fe: 505-827-2806 http://www.nmenv.state.nm.us/cpb/cpbtop.html http://www.nmenv.state.nm.us *U.S. EPA* http://www.epa.gov/safewater/dwsrf.html		■	■		Water infrastructure improvements, for small and disadvantaged communities and for pollution prevention to ensure safe drinking water.

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Table 8-24. State and Federal Funding Sources
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Program Title / *Agency* / Web Site or Contact [a]	Funding Area: Water Supply Conservation	Funding Area: Development and Infrastructure	Funding Area: Water Supply Protection	Funding Area: Water Resources Management	Description
Water and Waste Loans and Grants *USDA Rural Development* Albuquerque: 505-761-4955 http://www.rurdev.usda.gov/nm/ http://www.usda.gov/rus/water/programs.htm		■	■		Development or improvement of water or wastewater disposal systems in rural areas.
Snow Survey and Water Supply Forecasting Program *USDA Natural Resources Conservation Service* Albuquerque: 505-761-4407; 1-800-410-2067 http://www.nrcs.usda.gov. http://www.nrcs.usda.gov/programs/snowsurvey/				■	Monitoring of climatic and hydrologic elements necessary to produce water supply forecasts.
Reclamation Water Reclamation and Reuse Program *U.S. Bureau of Reclamation* Albuquerque: 505-248-5323 http://www.cfda.gov (Search using keyword: groundwater or wastewater) http://www.usbr.gov/pmts/writing/guidelines/	■	■			Appraisal and feasibility studies on water reclamation and reuse projects.
Small Watershed Program *USDA Natural Resources Conservation Service* Albuquerque: 505-761-4407; 1-800-410-2067 http://www.nrcs.usda.gov/programs/watershed/	■		■	■	Agricultural water management, municipal and industrial water supply, groundwater recharge, and watershed protection projects.
Conservation Partnership Initiative *USDA Natural Resources Conservation Service* Albuquerque: 505-761-4407; 1-800-410-2067 http://www.nrcs.usda.gov/programs/cpi/			■		Funds projects that promote terrestrial and freshwater aquatic wildlife habitat and address invasive species (such as noxious weeds). (See guidance for additional non-watershed related project eligibility)

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Table 8-24. State and Federal Funding Sources
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Program Title / *Agency* / Web Site or Contact [a]	Funding Area: Water Supply Conservation	Funding Area: Development and Infrastructure	Funding Area: Water Supply Protection	Funding Area: Water Resources Management	Description
Environmental Quality Incentives Program (EQIP) *USDA Natural Resources Conservation Service* Albuquerque: 505-761-4407; 1-800-410-2067 http://www.nrcs.usda.gov/programs/eqip/	■		■		Practices to address soil, water, and related natural resource concerns on farm and ranch lands.
Emergency Water Supplies *USDA Rural Development* Santa Fe: 505-476-9600 http://www.dps.nm.org/emergency/index.htm	■		■		Provision of emergency water supplies to communities that may run out of adequate drinking water.
Finance Authority Emergency Funding and Water and Wastewater Grant Program *NMFA* Contact: NMFA at (505) 984-1454 toll free, 1-877-ask-nmfa		■			Provision of emergency water supplies.
Emergency Conservation Program *USDA Farm Services* Albuquerque *:* 505-761-4407; 1-800-410-2067 http://disaster.fsa.usda.gov/ecp.htm	■				Rehabilitation of farm lands and conservation facilities.
Public Assistance /Emergency Measures Program *New Mexico Emergency Management Center* Regional Office Main Number (940) 898-5399 Santa Fe: 505-476-9600 http://www.dps.nm.org/emergency/index.htm http://www.fema.gov/about/contact/regions.shtm		■		■	Activities to alleviate consequences of the subject of a Presidential Emergency or Major Disaster Declaration (such as drought).
Economic Adjustment Program: Sudden and Severe Economic Dislocation Components *U.S. Department of Commerce EDA* http://www.osec.doc.gov/eda/				■	Prevention of serious economic dislocations or reestablishment of employment opportunities after a sudden and significant dislocation.

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Table 8-24. State and Federal Funding Sources
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Program Title / *Agency* / Web Site or Contact [a]	Funding Area: Water Supply Conservation	Funding Area: Development and Infrastructure	Funding Area: Water Supply Protection	Funding Area: Water Resources Management	Description
Conservation Reserve Program *USDA Natural Resources Conservation Service* http://www.nrcs.usda.gov/programs/crp/	■				Helps farmers and ranchers address water resource concerns on their lands.
Emergency Watershed Protection *USDA Natural Resources Conservation Service* http://www.nrcs.usda.gov/programs/ewp/			■	■	Emergency recovery measures to relieve imminent hazards to life and property as a result of natural disasters.
Emergency Well Construction and Water Transport *USACE* *U.S. Army Corps of Engineers Albuquerque District Office* Albuquerque: 505-342-3109 http://www.spa.usace.army.mil		■	■		Construction of wells or transport of water drought-distressed areas.
Water Quality Program *USDA CSREES* http://www.csrees.usda.gov/nea/nre/in_focus/ water_if_waterquality.html			■		Provide watershed- based information for assessing and improving sources of water quality impairment in targeted watersheds.
Unsolicited proposals *U.S. Geological Survey* http://www.usgs.gov/contracts/grants/unsolbk.html	■			■	Research proposals in many earth science areas, including hydrology and conservation.
State-EPA NPS Partnership *U.S. Environmental Protection Agency* http://www.epa.gov/owow/nps/partnership.html			■		Focus on nonpoint source topic-specific needs including: watershed planning and implementation.

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Table 8-24. State and Federal Funding Sources
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Program Title / *Agency* / Web Site or Contact [a]	Funding Area: Water Supply Conservation	Funding Area: Development and Infrastructure	Funding Area: Water Supply Protection	Funding Area: Water Resources Management	Description
Land and Water Conservation Fund Grants to States *National Park Service* http://www.nps.gov/ncrc/programs/lwcf/			■		Matching grants to states and local governments for the acquisition and development of public outdoor recreation areas and facilities.
Water Reclamation and Reuse Program *U.S. Bureau of Reclamation* http://www.usbr.gov/pmts/writing/guidelines/		■			Projects for reclamation and reuse of municipal and other wastewaters and naturally impaired waters.

[a] Web site address as of June 2006; address and information found there is subject to change.

Table 8-25. Projected Water Use

County	2000 Diversion [a] (ac-ft/yr)	Projection	Projected Diversions [a] (ac-ft) 2010	2020	2030	2040	2050	Gap in 2050 [b] (ac-ft)
Union	86,500	Low	81,300	76,600	72,200	68,000	64,100	–22,400
		High	86,600	86,800	86,900	87,100	87,200	700
Harding	4,200	Low	4,000	3,800	3,600	3,400	3,200	–1,000
		High	4,300	4,300	4,400	4,500	4,600	400
Quay	150,600	Low	137,400	130,900	124,800	119,000	113,600	–37,000
		High	155,800	156,300	156,900	156,900	157,700	7,100
Curry	209,600	Low	197,900	188,100	179,100	170,800	163,400	–46,200
		High	210,900	212,800	214,600	214,600	219,200	9,600
Roosevelt	158,300	Low	148,700	141,300	134,600	128,700	123,500	–34,800
		High	159,000	160,700	162,600	162,600	168,200	9,900
Total	609,300	Low	569,400	540,700	514,300	490,000	467,800	–141,500
		High	616,600	620,900	625,400	630,600	636,900	27,600

[a] Includes diversions for all sectors

[b] Difference between projected water use in 2050 and year 2000 water use (signifies gap only due to new water uses; additional gaps may occur due to drought conditions). Negative numbers indicate that less water use is projected in 2050 than in 2000 as a result of declines in irrigated agriculture.

ac-ft = Acre-feet

As discussed in Section 8-2, significant water savings could be realized through the implementation and/or continuation of municipal conservation programs, with total reduction in demand of up to 45 percent in 2050 (Table 8-4). Comparing potential savings to projected gaps between supply and demand under the high growth projections for the counties with the most significant imbalance between supply and projected demand indicates that these gaps could be reduced by almost 1,000 acre-feet in Quay County, more than 3,000 acre-feet in Curry County, and almost 1,400 acre-feet in Roosevelt County. However, even if these maximum savings are achieved, Quay, Curry, and Roosevelt Counties will have significant supply shortfalls if the high growth population projections are realized.

Even without additional growth, water problems exist because of the region's large dependence on mined groundwater. The severity of the water problems can be reduced by pursuing some of the strategies described in Sections 8.2 through 8.10.

Some of the actions identified in this plan can be carried out by individual water providers (Table 8-23). Other actions, such as watershed management and ENMRWS construction, are best pursued on a regional level. The ongoing cooperation of the counties and/or municipalities in the region will be necessary in order to oversee implementation of these strategies and will be the key to successfully moving forward with this plan and the protection of the region's resources.