Exhibit 39A: Detailed Discussion of Alternative 39—Desalination

Acknowledgements: This discussion, which follows the same basic format as the fact sheet it accompanies, provides additional details and information that support the conclusions presented in the fact sheet. It was written by Mark Miller of Daniel B. Stephens & Associates, Inc. as part of the "Evaluation of Alternative Actions for Technical, Physical, Hydrological, Environmental, Economic, Social, Cultural, and Legal Feasibility and Water Quality Issues and Legal Overview" contracted to Daniel B. Stephens & Associates, Inc.

1. Definition of Alternative

Utilize technological advances for treating deep saline and brackish water for potable or non-potable use in the region.

2. Summary of the Alternative Analysis

Desalination of brackish or saline water can potentially provide a new source of water to the Middle Rio Grande (MRG) planning region (region) by using highly mineralized water that would otherwise have little practical use. Supplies of brackish and saline groundwater within the MRG region have the potential used to yield potable fresh water through desalination.

The terminology used for classification of water quality based on the total dissolved solids is presented in Todd (1980).

Table 1. Classification of Saline Groundwater

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

Desalination is a water treatment process that converts brackish or saline water to fresh water by removing dissolved minerals (e.g., sodium and chloride ions) from the water. Where supplies of brackish or saline water exist, desalination can be used to yield potable fresh water.

However, because of its relatively high cost, desalination is generally only chosen when supplies of fresher water are limited. Desalination is further complicated by issues of environmentally acceptable disposal of reject brines, especially in inland areas. Desalination is proven technology that has been used for many years, and is increasingly common, in areas with scarce water supplies.

The analysis of the desalination feasibility for the region included the following:

- Determination of potential water sources of brackish and saline water that currently are not used for water supply.

- Consideration of how to protect the water quality of fresh water sources from potential degradation due to pumping saline groundwater or brine disposal.

- An examination of successes and lessons learned from existing desalination projects and plans for similar projects in the western U.S.

- An analysis of how desalination technologies could be applied to variously size communities in the MRG planning region. This included preliminary scenarios for:

  - Small-scale reverse osmosis (RO) units to serve individual users and small, particularly rural, communities
  - Large-scale municipal systems

- Energy requirements for desalination plants, including variable energy costs associated with increasing source water salinity.

- A preliminary cost assessment using cost data from comparable projects. Costs were derived from:

  - Published costs for comparable desalination projects
  - City of Albuquerque standard construction cost data

3. Alternative Evaluation

3.1 Technical Feasibility

Enabling New Technologies and Status

Desalination Processes

Desalination is being increasingly used in the U.S. and world-wide, indicating that it is a technically feasible alternative. Approximately 13,600 desalination units in 120 different countries currently produce 26 million cubic meters of fresh water each day (Reuters ENN, 2001). The Middle East region has approximately 50 percent of the desalination capacity because fresh water supplies are scarce in that region (Gleick, 1998; Buros, 1999). The U.S. has approximately 16 percent of world desalination capacity (Burros, 1999).

Energy Requirements

Desalination processes require large amounts of thermal or electric energy, as the process to separate pure water from a saline solution is energy-intensive. For seawater (total dissolved solids of 35,000 milligrams per liter [mg/L]), this minimum energy needed for this process is approximately 2.65 kilowatt hours (KWH) per 1,000 gallons of fresh water produced (Cordes and Shaeffer, 1973). However, because of inefficiencies that exist in desalination processes, the actual energy requirements for desalination systems are substantially higher than this theoretical minimum value. Advances in desalination technology continue to improve energy efficiency.

Recent investigations have focused on the use of renewable energy to provide the required power for the desalination process, with the most popular renewable source being solar energy. Other alternative, renewable energy sources available for desalination are wind-turbines, geothermal, biogas, and landfill gas-to-energy systems. The International Desalination Association has inventoried 100 small-scale, alternative energy source desalination systems in 25 countries around the world (Buros, 1999). Dual-purpose plants, where the desalination plant is connected to a conventional electric power generating station, can use the waste heat from the station as an energy source (Buros, 1999; Goosen et al., 2000).

Infrastructure Development Requirements

Two main types of desalination processes are currently in use: (1) membrane methods and (2) thermal methods. Membrane technologies are improving and membrane processes are gaining a larger share or the new desalination plants being constructed, particularly in the U.S. An early thermal desalination plant using vacuum distillation was constructed and operated in Roswell, New Mexico, during the early 1960s, under a U.S. Department of Interior funded pilot project.

Membrane processes consist of various types, with the most effective membrane selected depending primarily on the level of source water salinity and the potential for supersaturation and precipitation of silica, carbonates, or other less soluble constituents in the reject brine.

- The most common membrane process is reverse osmosis (RO), in which pure water passes through a semipermeable membrane under pressure, leaving the dissolved salts (minerals) behind in a more concentrated brine solution.

- A related technology, nanofiltration membranes, also has a demonstrated ability to remove salts, though not as completely as RO.

- Electrodialysis (ED) uses charged electrodes to cause dissolved ions to pass through semipermeable membranes, leaving behind water of lower salinity.

The most well-known thermal process is distillation, in which saline water is heated to increase its vapor pressure, and subsequent condensation of the resulting water vapor yields fresh water. Thermal processes are applied most often to water with high salinity; more than half of the world's sea water desalination takes uses thermal processes (Buros, 1999). Thermal processes include (Buros, 1999):

- Multi-stage flash (MSF) distillation, in which water is initially boiled to produce steam, then passed through a series of vessels, each with a lower pressure and correspondingly lower boiling point, causing the water to immediately boil as it passes into each vessel.

- Multi-effect distillation (MED), which also uses a series of vessels with successively lower pressures to produce steam. The MED process uses a variety of designs of misters or water films to enhance the evaporation process.

- Vapor compression (VC) distillation uses an electric or diesel powered compressor to condense steam produced by spraying water on a heated surface. VC systems are reliable to operate and have been used most commonly for small-scale applications such as industries and resorts.

Most existing desalination plants use RO and MSF processes (Ettouney, et al., 2002). Membrane processes (RO or ED) are generally the preferred technologies for desalination where brackish water containing less than 10,000 parts per million (ppm) dissolved salts is available. ED tends to be more economical at salinities less than about 3,000 ppm, whereas RO may be more appropriate at salinities between 5,000 and 10,000 ppm (U.S. Congress, 1988). The decision between ED and RO is also influence by the individual water chemistry and potential for precipitation in highly concentrated RO reject streams and the possible need for the positive contaminant barrier provided by RO. Treatment of brackish water by RO is the most commonly used desalination technology in the U.S. (Buros, 1999). In New Mexico, the preferred treatment would vary depending on the degree of source water salinity, with RO or ED most favorable for brackish water and thermal methods more favorable for highly saline water.

An emerging technology for smaller scale desalination systems is solar humidification. This process uses a solar “still” that consists of a clear glass or plastic roof covering a pool of saline water, thereby using natural solar energy to evaporate fresh water, which is condensed on a cool surface and collected. Solar desalination requires large land areas for the amount of water produced. For a large-scale 1-million gallons per day (gpd) plant, approximately 250 acres of land is required (Buros, 1999). In locations with abundant sunshine, such as New Mexico, solar desalination is a potentially viable option, especially for small-scale plants in remote locations. Solar desalination systems are simple and easy to operate and maintain. They are also environmentally friendly because they do not require fossil fuels (Voivontas et al., 1999; Chaibi, 2000).

Additional infrastructure required for a desalination project includes:

- Production wells in saline or brackish aquifers
- Pipelines from a supply well or well network to the treatment plant and to connect into existing water distribution network(s)
- Brine disposal systems (discussed in “Impacts to Water Quality,” below)

The specific characteristics of these infrastructure components will depend on the size and location of the desalination project. Two potential project scenarios are described below in Section 3.2, Financial Feasibility.

Total Time to Implement

The time needed to implement a desalination project is highly variable depending on the nature and scale of the project.

- Small-scale projects involving the installation of commercially available RO equipment or solar humidification could be implemented in 1 to 2 years.
- Large-scale projects involving plant construction, bringing new power supplies on-line, and drilling new wells could require 5 to 10 years.

Additional time may be needed to implement large-scale projects that require the investigation of saline aquifers, energy supply development, public involvement, regulatory permitting, or other issues.

3.1.1 Physical and Hydrological Impacts

Effect on Water Demand

In general, desalination will not affect water demand, except for possible minor reductions related to the relatively high cost for treatment.

Effect on Water Supply (surface and ground water)

Sources of brackish and saline groundwater are available within the MRG planning region, and desalination can provide for use of this new water source that is currently unused. The ability to develop these sources depends largely on whether pumping the brackish or saline groundwater will affect existing freshwater sources within the central Rio Grande Basin. Withdrawal of groundwater from Santa Fe Group sediments within the basin may ultimately lead to increased water level declines in the basin-fill aquifer and contribute to reduced flows in the Rio Grande. Therefore, this analysis focuses on identifying brackish and saline groundwater resources that are sufficiently isolated from the central basin to effectively provide new water sources that are currently unused.

The occurrence of saline and brackish groundwater generally indicates that these waters are not receiving significant recharge and salt concentrations have increased over a long period of time. Pumping this water for desalination will constitute mining of this finite resource, although sufficient quantities of saline and brackish water may be available such that the depletions are considered acceptable. Most importantly, the New Mexico Office of the State Engineer (OSE) will have authority over pumping of saline and brackish groundwater to prevent impairment of existing users of fresh water supplies that may be in connection with the groundwater pumped for desalination.

Pumping of brackish or saline groundwater has the potential to alter conditions in an aquifer in a manner that could lead to adverse impacts on fresh water resources. Brackish and saline groundwater exists in the lower Santa Fe Group sediments of the Middle Rio Grande Basin, below approximately 3,000 feet below ground surface (U.S. Department of the Interior, 1970). Pumping this deep groundwater within the basin could draw shallow groundwater of good quality into deeper portions of the aquifer, adversely impacting the fresh water quality and contributing to water level declines in the upper fresh water aquifer.

Potential source waters must be sufficiently disconnected from the Middle Rio Grande surface water and aquifer system so that groundwater pumping will not deplete the central basin. Favorable source waters are located outside the Middle Rio Grande Administrative Area (MRGAA), which was designated by the OSE for compliance with the Rio Grande Compact (OSE, 2000). The defined boundaries of the MRGAA include the areal extent of the alluvial aquifer known to be in hydrologic connection with the Rio Grande in the Middle Rio Grande Basin.

Most of the suitable brackish and saline aquifers that are sufficiently disconnected from the MRGAA are located in the western part of the MRG region, including portions of Sandoval, Bernalillo, and Valencia Counties. The following contain brackish and saline groundwater:

- Middle Rio Grande Basin; Santa Fe Group aquifer (Bexfield, 2001)
  - Rio Puerco drainage basin
  - Laguna Bench
  - Sierra Ladrones Formation Piedmont
- Glorieta Sandstone (Geoscience Consultants, 1986)
- San Andres Limestone (Geoscience Consultants, 1986)

This analysis focuses on the feasibility of desalination within the MRG planning region. Importation of water from saline or brackish aquifers outside the region could also be considered; with costs escalating as water conveyance distances increase.

Water Saved/Lost (consumption and depletions)

Desalination has the potential to produce new water supplies by making use of water that is currently unappropriated to other water rights holders. Brackish and saline groundwater resources may exist that are currently unappropriated, and an application to appropriate this water for beneficial use may be filed with the OSE, if it can be shown that other water rights will not be impaired by the new appropriation. Development of new water sources should be performed in a manner that will not impair existing groundwater users or reduce flow in the Rio Grande.

Water rights are not required by the OSE for saline groundwater (total dissolved solids [TDS] concentration exceeding 10,000 mg/L) in deep aquifers more than 2,500 feet below ground surface (NMSA 1978, §72-12-25). However, brackish groundwater (TDS of 1,000 to 10,000 mg/L) is subject to the same New Mexico water law that governs the use of fresh water. The

Glorieta Sandstone and San Andres Limestone are important aquifers in some parts of New Mexico, but within the MRG planning region they contain saline groundwater. The deep, saline portions of the Glorieta Sandstone and San Andres Limestone exceed 2,500 feet below ground surface; however, portions of these formations further west are at shallower depths, where they are used for water supply. The OSE requirements will need to be explored to develop brackish or saline groundwater.

Impacts to Water Quality (and mitigations)

The major environmental concern for desalination is the disposal of brine, which is a byproduct of all desalination processes. Brine disposal must be conducted in a manner that protects water quality. Alternatives for disposal of brine include (1) deep subsurface injection, (2) discharge to sanitary sewer, (3) disposal of brine in evaporation ponds, and (4) evaporation, crystallization, and disposal of solid salt in a solid waste landfill (Winter et al., 2000).

- Deep subsurface injection wells require permitting as either Class I (non-hazardous industrial wastewater) or Class V (other non-hazardous wastewater) wells under the New Mexico Environment Department's (NMED) Underground Injection Control (UIC) Program. Obtaining permits for such wells is a cost consideration and would require a hydrogeologic study to ensure that the proposed injection well(s) would not impact freshwater aquifers.

- Brine disposal to sanitary sewers is permissible if flow is small enough to not cause a significant salinity change in the total flow to the wastewater treatment plant. For small desalination plants in communities served by sewers, this could prove the most economical option for brine disposal.

- Lined evaporation ponds are a relatively simple approach to brine disposal where sufficient land is available. Depending on the site's hydrogeologic conditions, a groundwater discharge plan will most likely be required from NMED to address protection of underlying groundwater from potential brine seepage.

- Crystallization and disposal of desalination salts in an approved landfill has become increasingly popular nationwide, in part due to the high technical and regulatory costs of surface or subsurface brine disposal.

A unique brine management approach used for some desalination projects in Texas is to mix the brine with irrigation water (Burkstaller, 2003). To be successful, the blend of brine and irrigation water must be of suitable quality and irrigation managed to avoid negative effects on crop production or soil salinity.

An additional brine disposal option that may be feasible is discharging brine to one of the permitted and lined solid waste landfills in the region. This approach would use an emerging technology known as a "bioreactor landfill," in which water is added to degrade the solid waste, increasing methane production for a landfill gas-to-energy project. Development of a cogeneration desalination/gas-to-energy project would combine two emerging technologies and would use landfill gas to meet the energy requirements of desalination and groundwater pumping. This approach may prove feasible for the City of Albuquerque Cerro Colorado Landfill, which is currently developing a landfill gas collection system and also has brackish water resources available in the area.

Watershed/Geologic Impacts

A well planned desalination project should not cause any watershed or geologic impacts.

3.1.2 Environmental Impacts

Impact to Ecosystems

Local ecosystems will not be affected, aside from the immediate effects resulting from facility construction. Indirectly, the energy requirements for desalination could have an effect on ecosystems due to the associated power generation impacts, including the use of fossil fuel and air emissions.

Implications to Endangered Species

Desalination will not affect endangered species.

3.2 Financial Feasibility

3.2.1 Initial Cost to Implement

Several considerations influence the cost of desalination per volume of fresh water produced, including: (1) feed water salinity, (2) energy costs, and (3) economies of scale. The major categories are capital costs and operation and maintenance (O&M) costs. In addition, any economic evaluation of the total cost of water delivered to a customer must include costs for water distribution and costs for compliance with environmental regulations.

Costs rise significantly with increasing salinity of the feed water; the cost of desalting seawater (TDS of 35,000 mg/L) is three to five times higher than the cost of desalting lower-salinity brackish water from the same size plant (Buros, 1999). It is advantageous to make use of the freshest feed water available; with brackish water aquifers providing lower cost treatment than saline water sources.

Economies of scale arise when increases in the plant size (gallons of water produced per day) bring decreases in the unit fresh water cost. Economies of scale are evident in all desalination processes, but to different extents. RO exhibits the smallest economies due to scale, and RO facilities for small communities, such as the mid-size RO project implemented in Grand Junction, Colorado, can be cost-effective. Distillation processes show the greatest economies of size, as is seen in the large-scale desalination/power generation dual-use projects in the Middle East.

RO plants are generally the preferred choice for desalting brackish water in most small to medium-size communities in the U.S. RO plants offer simpler operation, lower energy consumption, and resultant lower fresh water unit costs as compared with other desalination methods (Glueckstern, 1999). The overall cost of fresh water from an RO plant is often less than half of that produced by means of distillation, although the process has higher up-front investment costs compared to thermal processes. As technical advancements provide improved cost and efficiency, membrane technologies will continue to be the preferred choice for new desalination plants.

RO of brackish water (if available) using solar energy is potentially the cheapest way to provide new fresh water resources in remote areas (McCarthy & Leigh, 1979; Voivontas et al., 1999). At present, solar desalination worldwide is restricted to remote areas needing smaller desalination systems.

Costs for desalination processes typically fall in the range of $1.90 to $4.43 per 1,000 gallons of water produced ($620 to $1,440 per ac-ft) (Ettouney, et. al., 2002). Costs reported for sea water desalination plants in Florida and California are in the range of $2.00 to $2.40 per 1,000 gallons (Krishna, 2002). These costs do not typically include pipeline costs of the magnitude that may be required for the MRG planning region, where saline and brackish water sources are located at considerable distance from the areas of water demand.

At present, costs for traditional water supplies generally remain lower than the cost of desalination. However, the gap between the two might narrow with (1) reductions in the cost of desalination (e.g., through reduced energy costs or increased energy efficiency) and/or (2) increases in the cost of traditional water sources.

3.2.2 Potential Funding Source

Potential funding sources for desalination projects include:

- New Mexico Legislative appropriation
- New Mexico Finance Authority loan
- NMED Construction Programs Bureau loan
- U.S. Department of Agriculture Rural Utilities Service
- Local financing (revenue bonds)
- Public private partnerships

The U.S. EPA is providing $7 to $21 million to help fund the Hueco Bolson desalination project to serve El Paso, Texas. Funding for this project is also being provided by the U.S. Department of Defense, in return for additional capacity to serve Fort Bliss, an adjacent military installation (Burkstaller, 2003).

3.2.3 Ongoing Cost for Operation and Maintenance

Operation and maintenance (O&M) costs are directly affected by the quality of the feed water (Morin, 1999). In practice, energy costs often represent 50 to 75 percent of operating costs (Mesa et al., 1996), and energy costs are directly linked to feed water quality. Membrane processes are often more attractive than distillation because they typically have the lowest energy requirements (Sackinger, 1982; Glueckstern, 1999), and rising energy prices tend to increasingly favor RO or ED.

Ongoing costs for brine disposal are a significant component of desalination O&M costs. Disposal of brine in lined evaporation ponds can be relatively inexpensive in arid regions where land is readily available. Brine evaporation ponds in Texas add costs of $0.05 to $0.25 per 1,000 gallons of fresh water (U.S. Congress, 1988). Brine disposal using deep injection wells is often more expensive, and the feasibility of injection wells depends on whether existing geologic conditions can confine the brine. Salt crystallization and solid waste disposal can result in additional costs of $1.15 to $1.85 per 1,000 gallons of fresh water produced (U.S. Congress, 1988). Brine disposal using deep injection wells is often more expensive, and the feasibility of injection wells is highly dependent on the geologic conditions at the site providing confinement of the injected brine. Drilling and maintenance of deep injection wells is costly, if very deep wells are needed at a site, and regulatory costs associated with permitting injection wells is a further consideration. Salt crystallization and solid waste disposal can result in additional costs of $1.15 to $1.85 per 1,000 gallons of fresh water produced (U.S. Congress, 1988).

Increasing demands for fresh water worldwide should result in continued improvements in desalination technology. Improved desalination technologies will increase the performance ratio (the ratio of fresh water to the amount of energy consumed) and hence lower the unit costs of producing potable water. Reduced energy costs would likewise make desalination relatively more attractive.

3.2.4 Cost Evaluation Scenarios

To provide a preliminary cost feasibility analysis for desalination projects in the region, two representative cost evaluation scenarios were developed. These cost scenarios are based on hypothetical small- to large-scale projects that may be used to augment water supplies for communities in the region. The cost evaluation scenarios are intended to provide a preliminary examination of the expected costs for water production through desalination. However, the cost evaluation completed for this analysis does not represent an analysis of actual project plans and is not intended as a complete feasibility analysis.

Small-Scale Project

The cost evaluation scenario for a small-scale desalination project is based on an RO system that is intended to supplement the water supply available to a small community. The community is assumed to be experiencing growth and additional connections are needed to the community operated water system. The desalination system would add an additional capacity of 100,000 gpd (112 acre-feet per year [ac-ft/yr]), enough to serve approximately 300 additional households.

The small-scale scenario includes costs for the following project components:

- *Supply Well:* A brackish water supply well assumed to be 1,000 feet deep would be drilled into an aquifer containing water with a TDS concentration of 5,000 mg/L. It is assumed that this aquifer is present locally, but is not being used because of the poor water quality.

- *RO Treatment Plant:* A commercially available RO treatment plant would be purchased and set up, with all ancillary facilities constructed (building, roadways, electric connections, system controls, chlorination facilities, storage tank, connection to existing supply system, etc.).

- *Evaporation Ponds:* Evaporation ponds would be constructed for brine disposal. The ponds are assumed to be 5 acres in size and lined with high-density polyethylene (HDPE).

- *Land Purchase:* A 40-acre tract of land for the treatment plant would be purchased on the outskirts of the local community for a cost assumed to be $5,000 per acre.

- *Design and Permitting:* The engineering design for the RO plant is assumed to be 10 percent of construction cost and permitting is assumed to be 5 percent of construction cost.

- *Operation and Maintenance:* A 40-year operating life for the desalination plant is assumed for O&M of the facility. O&M costs would include: electric power for plant operation and groundwater pumping, as well as labor, parts, chemicals, equipment, and other expenses.

Large-Scale Project

The cost evaluation scenario for a large-scale desalination project considers a major infrastructure project, assumed to provide 20 million gpd of treated water to the region's urban corridor. This water supply rate is equivalent to 22,400 acre-feet per year (ac-ft/yr) or approximately 20 percent of the City of Albuquerque's total annual water use of 120,000 ac-ft/yr.

The treated water would go to urban uses rather than agriculture, because of the relatively high cost of the new water supply.

The large- scale scenario considers costs for the following project components:

- *Supply Wells:* A well field assumed to consist of 30 supply wells would be drilled into a saline aquifer to a depth of 3,000 feet. The well field would be located in the western part of the region, with wells penetrating the Glorieta Sandstone and San Andres Limestone, at depths below 2,500 feet, producing water with a TDS concentration of 25,000 mg/L. Wells are assumed to be capable of producing in excess of 500 gallons per minute.

- *RO Treatment Plant*: An RO treatment plant would be designed and constructed, using a series of commercially available RO treatment units. Construction would include all ancillary facilities such as a building, roadways, system controls, chlorination facilities, storage tanks, etc. A new electric power supply line would be needed to serve the plant, and a power network would be needed to all of the wells.

- *Evaporation Ponds:* Evaporation ponds would be constructed for brine disposal. The ponds are assumed to be 320 acres in size and lined with high-density polyethylene (HDPE). Evaporation rates are assumed to be tripled by using a misting sprayer system.

- *Pipeline:* A conveyance pipeline would be constructed from the western part of the region to the central region urban corridor. The pipeline is assumed to be 30 miles long and constructed of 36-inch diameter pipe with two pump stations.

- *Land Purchase*: A 640 acre tract of land would be purchased for the treatment plant site and evaporation ponds, and lease agreements are assumed to be established for the well field and pipelines. Water could be made available to local land owners as an incentive to promote economic development in the area.

- *Design and Permitting:* The engineering design for the RO plant is assumed to be 5 percent of construction cost and permitting is assumed to be 5 percent of construction cost.

- *Operation and Maintenance*: A 40-year operating life is assumed for O&M of the desalination facility. O&M costs would include electric power for plant operation and pumping of groundwater and treated water as well as labor, parts, chemicals, equipment, and other expenses.

3.2.5 Cost Summary

The cost evaluation scenarios are summarized in Table 39-2. This preliminary evaluation of the costs for desalination projects provides an initial estimate of the range of costs that may be expected. The cost estimates are preliminary and intended for planning purposes only; therefore, the cost estimates for each alternative are based on 2003 costs for comparison, and adjustments for present worth have not been considered.

The preliminary cost evaluation for desalination projects provides costs in the range of $9.76 per 1,000 gallons ($3,180 per ac-ft) for a small-scale project to $3.98 per 1,000 galllons ($1,300 per ac-ft) for a large-scale project. These costs are relatively high as compared to reported costs for sea water desalination because the latter does not include the added costs for well installations, groundwater pumping, evaporation ponds, and pipelines. Desalination costs are much higher than current water prices; augmenting existing water supplies with desalinated water would be costly.

The cost estimates are intended only for the purpose of a preliminary evaluation of the desalination option as compared to other water supply alternatives considered. Therefore, the cost estimates for each alternative are for 2003 costs, and adjustments for present worth have not been considered. Much additional study is needed to develop desalination plans more fully before a complete feasibility analysis can be made for specific projects.

References/Bibliography

Bexfield, L.M., 2001. Occurrence and sources of arsenic in ground water of the Middle Rio Grande Basin, Central New Mexico. Master of Science in Hydrology Thesis B4680, New Mexico Institute of Mining and Technology, Socorro, New Mexico. December. 2001.

Burkstaller, J. 2002. Personal communication between John Burkstaller (former El Paso Water Utilities Chief Technical Officer, now with DBS&A) and Mark Miller (DBS&A). January 2003.

Buros, O.K. 1999. *The ABCs of desalting*. International Desalination Association, New York, Massachusetts, USA.

Chaibi, M.T. 2000. An overview of solar desalination for domestic and agriculture water needs in remote arid areas. *In Desalination* 127:119-133.

Cordes, E.H., and R. Schaeffer. 1973. *Chemistry*. Harper and Row, New York.

Ettouney, H.M., H.T. El-Dessouky, R.S. Faibish, and P.J. Gowin, 2002. Evaluating the Economics of Desalination. In Chemical Engineering Progress Vol. 98, No. 12:32-39, December 2002.

Geoscience Consultants, Ltd., 1986. Hydrogeochemistry of deep aquifers on the Acoma and Laguna Indian Reservations, New Mexico: progress report and preliminary data analysis. prepared for U.S. Department of Interior, Bureau of Indian Affairs, February 4, 1986.

Glueckstern, P. 1999. Design and operation of medium- and small-size desalination plants in remote areas: New perspective for improved reliability, durability and lower costs. *In Desalination* 122:123-140.

Goosen, M.F.A., S.S. Sablani, W.H. Shayya, C. Paton, and H. Al-Hinai. 2000. Thermodynamic and economic considerations of solar desalination. *In Desalination* 129:63-89.

Krishna, H. 2002. State of Texas considers augmenting supplies with desalinated water. *In U.S. Water News* 19(7).

McCarthy, J.V. and J.M. Leigh. 1979. *The prospects of desalination using solar energy*. BHP Melbourne Research Laboratories, Australia.

Mesa, A.A., C.M. Gómez, and R.U. Azpitarte. 1996. Energy saving and desalination of water. *In Desalination* 108:43-50.

Morin, P.E. 1999. *Desalting plant cost update: 2000*. International Desalination Association.

New Mexico Office of the New Mexico State Engineer (NM OSE). 2000. *Middle Rio Grande Administrative Area guidelines for review of water right applications*. September 13, 2000.

Reuters Environmental News Network (ENN). 2001. Thirst for water drives desalination boom. <http://www.enn.com/news>. March 21, 2001.

Sackinger, C.T. 1982. Energy advantages of reverse osmosis in seawater desalination. *In Desalination* 40:271-281.

Todd, D.K. 1980. *Groundwater hydrology*. John Wiley & Sons, Inc., New York, 535 pp.

U.S. Congress, Office of Technology Assessment. 1988. *Using desalination technologies for water treatment*. OTA-BP-O-46. Washington, DC: U.S. Government Printing Office. March 1988.

U.S. Department of the Interior. 1970. *Saline ground-water resources of the Rio Grande Drainage Basin, a pilot study*. Office of Saline Water, Research and Development Progress Report No. 560. May 1970.

Voivontas, D., K. Yannopoulas, K. Rados, A. Zervos, and D. Assimacopoulos. 1999. Market potential of renewable energy powered desalination systems in Greece. *In Desalination* 121:159-172.

Winter, Tennille, D.J. Pannell, and Laura McCann. 2000. The economics of desalination and its potential application in Australia. SEA Working Paper 01/02, Agricultural and Resource Economics Department, University of Western Australia, Perth. <http://www.general.uwa.edu.au/-u/-dpannell/dpap0102.htm>.