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ALAMOGORDO
REGIONAL WATER SUPPLY PROJECT
FINAL ENVIRONMENTAL IMPACT STATEMENT

VOLUME 2 --APPENDICIES

US DEPARTMENT OF THE INTERIOR
Bureau of Land Management
Las Cruces District Office
1800 Marquess Street
Las Cruces NM 88005

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

MAY 2012

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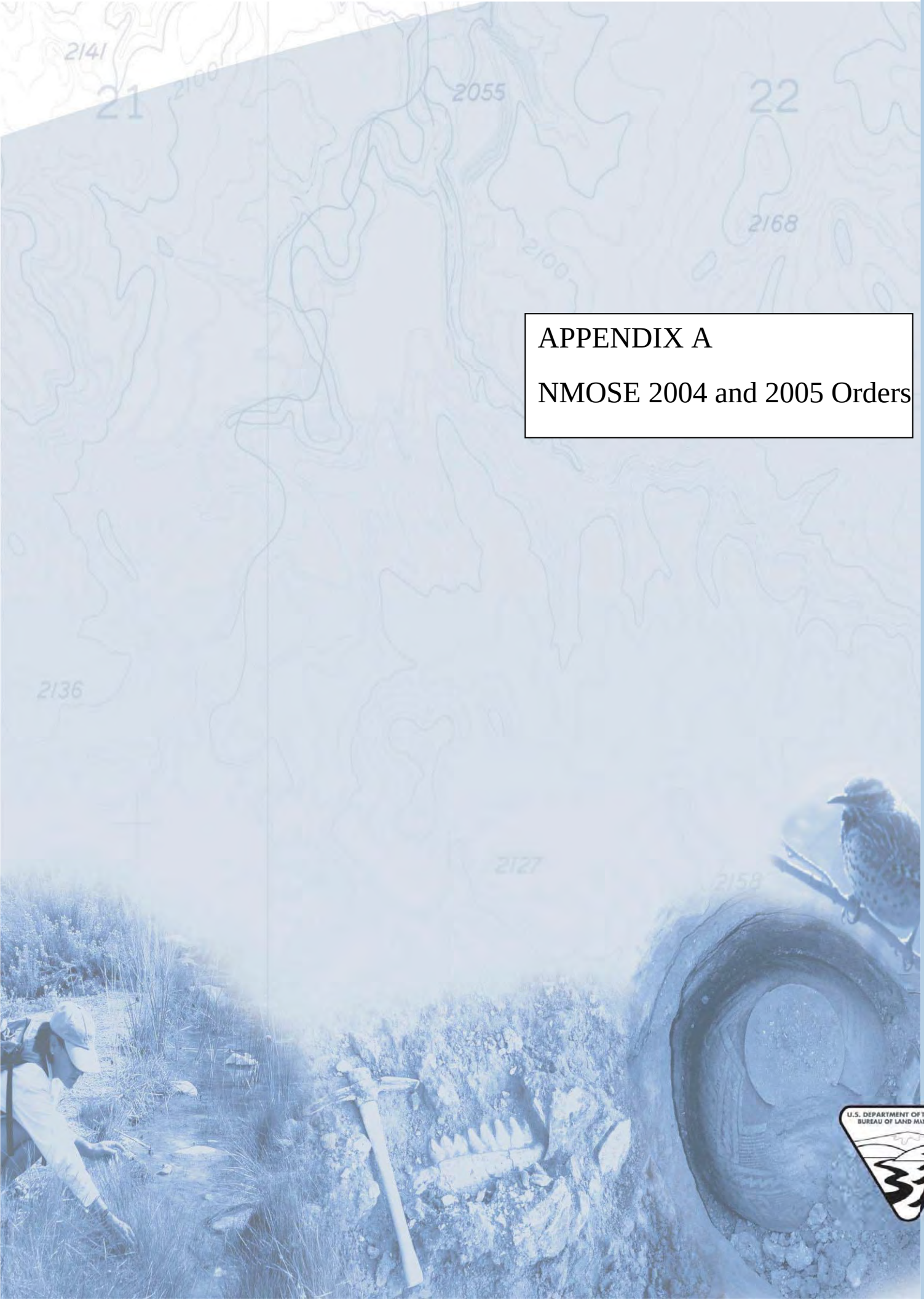
APPENDIX A

NMOSE 2004 and 2005 Orders



BEFORE THE NEW MEXICO STATE ENGINEER

IN THE MATTER OF THE APPLICATION BY) CITY OF ALAMOGORDO FOR PERMIT TO) APPROPRIATE UNDERGROUND WATERS) FROM THE SHALLOW AQUIFER LOCATED) IN THE TULAROSA BASIN OF NEW MEXICO)	**Hearing No. 02-035** **OSE File No. T-3825 thru T-3825-S-9**

REPORT AND RECOMMENDATION OF THE HEARING EXAMINER

This matter came on for hearing before Victor Kovach, the State Engineer's designated Hearing Examiner, on October 14 through 17 and October 20 through 24, 2003, in Alamogordo, New Mexico. The parties appeared as follows: James C. Brockmann, Esq., and Jay F. Stein, Esq., represented Applicant City of Alamogordo; Jeffrey L. Fornaciari, Esq., and Paula M. Buchwald, Esq., represented Protestants HFR Corporation (HFR) and Three Rivers Cattle Ltd Co. (Three Rivers); A. J. Olsen, Esq., represented Protestants David & Julia M. Christopher (Christophers); Peter T. White, Esq., represented Protestants Dan C. Abercrombie, Elsie I. Bailey, David Rankin, Laymon Hightower (Tularosa Farms), Allen "Bill" Trammell, Tularosa Community Ditch Corporation, and Cates Farms (referred to collectively as "Tularosa Protestants"); and William D. Teel, Esq., represented the Water Resources Allocation Program (a.k.a. Water Rights Division) of the Office of the State Engineer (OSE). Jefferson R. Rhodes, Esq., appeared on behalf of the Village of Tularosa on October 14, 2003, and, prior to the presentation of witnesses, the protest of the Village of Tularosa was voluntarily withdrawn and it was dismissed from the proceedings. Having considered the evidence and pleadings submitted in this matter, the Hearing Examiner recommends the following findings and order.

FINDINGS OF FACT

1. The State Engineer has jurisdiction of the parties and subject matter.

2. On September 6, 2000, and in January 2002, the City of Alamogordo (hereinafter "City") filed ten Applications numbered T-3825 thru T-3825-S-9 with the State

Engineer for Permit to Appropriate the Underground Waters of the Tularosa Underground Water Basin of New Mexico. Notice for Publication of the Applications was issued on February 1, 2002. The Applications and Legal Notice filed in this matter, reflect that the City proposes to drill ten wells for a diversion of 1,500 acre-feet per year (afy) per well, with the combined diversion from all ten wells not to exceed 13,450 afy, and to desalinate and treat the water for use for municipal, industrial or commercial purposes in Otero County, New Mexico, by all water systems or operations in the County that wish to participate in the program and purchase bulk water. The proposed well-field would be located on property owned by the United States Department of the Interior, Bureau of Land Management, approximately 8.5 to 11 miles north of Tularosa, New Mexico and east of Highway 54 at sites described by New Mexico Principle Meridian (NMPM) coordinates, as follows:

Well No.	Subdivision	Section	Township	Range
T-3825	NW ¼ SE ¼ SW ¼	1	13 South	9 East
T-3825-S	SW ¼ SW ¼ NW ¼	31	12 South	10 East
T-3825-S-2	SW ¼ SW ¼ SW ¼	31	12 South	10 East
T-3825-S-3	SW ¼ NW ¼ NE ¼	35	12 South	9 East
T-3825-S-4	SE ¼ SW ¼ SE ¼	35	12 South	9 East
T-3825-S-5	NW ¼ SE ¼ NW ¼	6	13 South	10 East
T-3825-S-6	NE ¼ NW ¼ NE ¼	7	13 South	10 East
T-3825-S-7	SE ¼ SW ¼ NW ¼	7	13 South	10 East
T-3825-S-8	NE ¼ NW ¼ SE ¼	1	13 South	9 East
T-3825-S-9	NW ¼ SW ¼ NE ¼	1	13 South	9 East

An Affidavit of Publication was filed on March 11, 2002.

3. Protests objecting to the granting of the Application were filed by HFR Corporation, Three Rivers Cattle Ltd Co., Cates Farm, David & Julia Christopher, Dan C. Abercrombie, Robert Baca, Elsie I. Bailey, David Rankin, Tularosa Farms, Sacramento Mountains Watershed Restoration Corporation (SMWRC), Village of Tularosa, Allen "Bill" Trammell, and the Tularosa Community Ditch Corporation.

4. The protest of Robert Baca was dismissed by order entered in this matter on August 23, 2002.

5. The protest of SMWRC was dismissed by order entered on April 17, 2003. By Order Adopting Stipulation, Rick Warnock, in his capacity as President of SMWRC, appeared as a fact witness testifying to SMWRC's concerns with the Application.

6. By order entered in this matter on April 22, 2003, the City was granted leave to amend its Application to reduce the total amount of water applied for from 13,450 afy to 10,000 afy.

7. Pursuant to NMSA 1978 § 72-1-9 (2003), municipalities are authorized and allowed "a water use planning period not to exceed forty years." Water rights for municipalities must be based upon "a water development plan . . . for reasonably projected additional needs within forty years." *Id.* Additional need is determined by comparing projected future water demand to available supply.

8. The City's 40-Year Water Development Plan, City Exhibit 10, contains population and water use projections to the year 2040. Using the University of New Mexico Bureau of Business and Economic Research (BBER) medium growth methodology, the City estimates that its population will increase to approximately 56,137 by the year 2040 as follows:

Year	Projection
2010	41,168
2020	46,366
2030	51,252
2040	56,137

The BBER methodology incorporates economic, demographic and migration trends and is a widely accepted method for forecasting population. The City's population projection is reasonable.

9. Assuming an average water use of 165 gallons per capita per day (gpcpd), which is equivalent to an annual per capita use of 0.1848237 afy (165 gpcpd x 365 days = 60,225 gallons ÷ 325,851 gallons per acre foot = 0.1848237 afy), the City estimates its water demand (rounded off to the nearest whole number) through the year 2040

as follows:

Year	Population Projection		Per Capita Use		Demand
2010	41,168	x	0.1848237 afy	=	7,609 afy
2020	46,366	x	0.1848237 afy	=	8,570 afy
2030	51,252	x	0.1848237 afy	=	9,473 afy
2040	56,137	x	0.1848237 afy	=	10,375 afy

The City's demand estimate through 2040 is reasonable.

10. OSE records reflect that the City of Alamogordo has existing surface and ground water rights and permits to divert 23,458.79 afy from its wells and surface diversions, as follows:

Surface Diversions	OSE File No.	Diversion Amount
Bonito Lake	SP-13	1,449.02 afy (2.26867 cfs)
La Luz – Fresnal	SP-01110 thru 01115	
	01118 thru 01121	
	01342 thru 01346	
	01383, 01411, 01412	
	01455, 01456, 01562	
	2886 and 1122	891.20 afy + 16 cfs
		+ (11,583.43 afy)
Alamo Canyon	SP-06037 and 2176	3,078.00 afy
	SUBTOTAL	17,001.65 afy
Ground Water Diversions		
La Luz Wells	T-32	4,572.88 afy
Prather Wells	T-33	1,354.00 afy
Golf Course Well	T-814	269.935 afy
Landfill Well	T-2408	100.00 afy
Cemetery Irrigation	T-3489	160.33 afy
	SUBTOTAL	6,457.145 afy
	TOTAL	23,458.795 afy

11. The City currently holds water rights and permits that exceed its projected water demand for the forty-year planning period.

12. Approximately 72% of the City's water rights (17,001.65 afy out of 23,458.79 afy) are surface water rights. The ability to fully exercise those rights is susceptible to drought conditions.

13. The City contends that the supply of surface water that is actually available for use is far less than its surface water rights and that it is unable to fully develop and utilize the 6,457.145 afy of ground water under its existing permits.

14. In determining the additional needs of a municipality over the forty-year planning period, it is reasonable to consider historic diversions and historic water supply, as well as the amount of vested water rights and permits held by the municipality.

15. Table 2 of City Exhibit 15 reflects that for the years 1967 through 2001, the City's surface water diversions from La Luz-Fresnal flume, Alamo Canyon, and Bonito Lake (receival) averaged 3,614 afy, 1,372 afy and 1,400 afy respectively. The City shares Bonito Lake diversions equally with Holloman Air Force Base. The average historical surface water diversion for the City, combined, for the period of 1967 through 2001, is 5,686 afy (3,614 afy + 1,372 afy + 700 afy).

16. Protestant HFR and Three Rivers Exhibit 34, Attachment A, reflects that the City's groundwater diversions for the last five (5) years have averaged approximately 2,088 afy. The City has failed to establish, by credible evidence, that it would be unable to sustain production from its current wells at this level. A groundwater supply of 2,088 may be considered in supply calculations for purposes of this Application, provided that conditions limit the City's actual combined annual groundwater diversions to the sum of the amount of groundwater considered to be available (2,088) and the amount permitted under T-3825 thru T-3825-S-9, or require that the City files Proof of Beneficial Use consistent with that figure.

17. The City projects that its water demand will be 10,375 afy, in the year 2040, based upon its assumption that water use in the year 2040 will be equal to its current approximate annual average use level of 165 gpcpd. It is similarly appropriate to consider that the City's available supply of water in the year 2040 will be at least

equal to the average amount of water that the City has historically diverted from its surface and groundwater sources. A short-term drought or temporary loss of surface supply can be addressed, in part, by provisions that allow for temporary increase in annual groundwater diversions from the subject wells and averaging of the increase over five years. During long-term drought conditions, good conservation practice requires implementation of drought management plans that include tiered or increased water rate structures, reductions in water use and, if necessary, rationing.

18. The average water supply that has been historically available to and diverted by the City from both surface and groundwater sources is 7,774 afy (5,686 afy surface water + 2,088 groundwater). Accordingly, the City's unmet water demand through the 40-year planning period, is no more than 2,601 afy (10,375 afy – 7,774 afy).

19. Section 4.3.2 of City Exhibit 11 reflects that the City expects 84% recovery of potable water from the desalinization process. A diversion of 3,096.43 afy would be required to produce 2,601 afy of potable water.

20. The City proposes to divert the water applied for in accordance with the following pumping schedule: diversion of 5,000 afy through 2009; diversion of 6,500 afy from 2010-2020; diversion of 8,000 afy from 2020-2030; and, diversion of 10,000 afy for 2030 and beyond. There was considerable and significant disagreement among the experts as to the projected effects of the proposed scheduled pumping and the reliability of the models constructed and employed to predict those effects.

21. Simulations of the effects of diversions under the City's proposed pumping schedule for forty years were conducted using modified versions of the Morrison groundwater flow model for the Tularosa Underground Water Basin (Morrison 1989) and a model of the Basin constructed by John Shomaker and Associates (JSAI).

22. Protestants HFR and Three Rivers expert hydrologists, Maryann Wasiolek and Michael P. Spinks, of Hydroscience Associates, Inc., (hereinafter "Hydroscience") estimated hydraulic effects of the subject applications utilizing a modified version of the Morrison model wherein the model boundaries are extended three miles north of

the City's proposed well field and the model grid is refined for the areas north of the Tularosa Underground Water Basin Administrative Area.

23. WRD's technical expert, Eric Keyes, utilized the Hydroscience refined grid of the Morrison Model and further modified the model by changing transmissivity values to match higher transmissivities observed during a recent aquifer test of Exploratory Well No. T-3825. The results of simulations of pumping the City's proposed wells for forty years, in accordance with the City's pumping schedule, using the refined and modified Morrison model, as reflected in a March 2003 report submitted into evidence as WRD Exhibit 1, indicate that the largest impacts to other wells occur at HFR Corporation wells where water columns are reduced by as much as 81 feet with one well T-1797-S-4 going dry. The results reported in WRD Exhibit 1 were derived based upon the static water columns in nearby wells and did not consider the effect of self induced drawdown in the water columns of irrigation wells, referred to as 'irrigation dynamic drawdown' or 'pumping drawdown'.

24. Mr. Keyes subsequently performed a hydraulic analysis of the subject Applications using the refined and modified Morrison model with consideration given to the effect of 'irrigation dynamic drawdown'. WRD Exhibit 1-A and Amended Exhibit 1-A reflect that after 40 years of pumping the proposed wells under the City's proposed pumping schedule, eighteen (18) nearby wells of other ownership would go dry or be significantly impacted.

25. The Hydrology Bureau of the OSE considers a well to be significantly impacted when its available water column is reduced by more than 70% or there is less than 10 feet of water above and below the pump.

26. The City's technical experts, John Shomaker and Associates, developed a separate groundwater flow model for evaluating the effects of pumping the proposed wells (JSAI Model). The JSAI model, described in City Exhibit No. 14, was prepared by Steven T. Finch under the direction of Dr. John W. Shomaker. The model differs from the Morrison model in several ways including the following: it is a three-dimensional model that includes the mountain block east of the basin fill as an active part of the model and considers additional recharge from the mountain block; all of

the boundaries are no flow boundaries with the western boundary considered an evaporation boundary, wherein the groundwater discharges through evapotranspiration and does not flow westward and across the boundary; and the calculated discharge by evapotranspiration in the western boundary is approximately equal to the mountain-block recharge.

27. JSAI model simulations reflect that the Protestant Christophers' domestic well T-4316 and another domestic well of other ownership, T-2911, will go dry or be significantly impacted as a result of pumping the proposed wells for forty years under the City's pumping schedule. The results are derived based upon static water levels in nearby wells and do not consider the effect of 'irrigation dynamic drawdown' or 'pumping drawdown'.

28. The predicted effects under both the JSAI model and the refined and modified Morrison model are based upon a comparison of baseline effects from a forty-year projection of continued historic pumping, without the proposed pumping, to a forty-year projection of those baseline effects with the proposed pumping done in accordance with the City's pumping schedule. The baseline does not necessarily consider permits as being fully exercised and, as emphasized by Protestants, the effect of pumping the full diversion amount requested by the subject application, 10,000 afy, was only considered for ten years. Expansion of the modeling efforts to include the full exercise of permitted rights in the base line and to simulate pumping the proposed wells at 10,000 afy for forty years would result in an expansion and acceleration of effects.

29. Evidence concerning the effects of diverting less than the full amount requested, although limited, was credible.

30. The nearest wells of other ownership include permitted and declared wells of Protestants HFR and the Christophers.

31. Protestants HFR and Three Rivers expert hydrologist, Michael P. Spinks, testified that groundwater diversion of 2,500 to 3,000 afy from the proposed well field would not impair or adversely impact the production of Protestant HFR or 3 Rivers' wells.

32. Protestant Christophers are the owners of the High Nogal Ranch. They claim ownership of the following declared wells located within the ranch boundaries and within the vicinity of the proposed well field:

Well No.	Location T	R	S	SD	Declared Amount	Declared Use	Declared Priority
T-4311	13S	10E	18	413	3 afy	Livestock	Pre 07/1982
T-4312	12S	10E	15	123	3 afy	Livestock	Pre 07/1982
T-4313	13S	10E	9	1412	3 afy	Livestock	Pre 07/1982
T-4314	12S	10E	30	234	3 afy	Livestock	Pre 07/1982
T-4315	12S	9E	25	421	3 afy	Livestock	Pre 07/1982
T-4316	13S	10E	6	334	3 afy	Domestic & Livestock	1940

The Declarations for the above wells were filed in 2003, after the City filed the subject Application. The Christophers also claim ownership of livestock well No. T-3845, located in the Section 3, Township 12 South, Range 10 East, NMPM, completed March 1, 2001.

33. Protestant Christophers' Exhibit 16 includes reports of a field check conducted on April 30, 2003, by OSE staff David Bernadone and Sheldon Dorman. The Field Reports contain the following entry for each of Well Nos. T-4312, T-4313, T-4314 and T-4315: "well is not equipped and is an abandoned open hole." The Field Report for Well No. T-4316 reflects that it was "equipped and in use."

34. Table 3 of Protestant Christophers' Exhibit 22 reflects that the water level in well Nos. T-4311 and T-4314 is at or below the well depth.

35. Well T-3845 is located approximately seven (7) miles north and east of the proposed well field. OSE records reflect that Well T-3845 has a static water column of approximately 298 feet. Well No. T-3845 will not be adversely affected by ongoing groundwater diversions of at least 3,000 afy from the City's proposed well field.

36. Table 3 of Protestant Christophers' Exhibit 22 reflects that Well No. T-4316 has a

well depth of 290 feet and a static water level of 278 feet. Well No. T-4316 is within the City's proposed well field and will lose its water column as a result of diversion of 3,000 afy from the proposed well field.

37. Protestant Christophers' Exhibit 22 reflects that Well No. T-4316 is located less than 5,000 feet east of the City's test Well No. T-3825 which was drilled to a depth of 710 feet. Expert witnesses Eric Keyes and Michael Spinks testified that Well No. T-4316 is located in the Basin Fill.

38. The evidence reflects that Well No. T-4316 can be deepened or replaced to recover production. The ability to deepen wells to recover production is considered a factor in determining whether a proposed appropriation of groundwater will impair an existing right.

39. The City of Alamogordo has agreed to pay for the cost of deepening or replacing Well No. T-4316 or to replace the water.

40. Given the indication that Well No. T-4316 can be deepened to recover production and that the City has offered to assume the cost for deepening or replacement, granting of the proposed application for a diversion of at least 3,000 afy will not impair Well No. T-4316.

41. In February 2003, Protestant Christophers also filed Declarations of Ownership of Water Right concerning a number of springs located within the boundaries of the High Nogal Ranch, as follows:

OSE File No.	Location				Amount	Use
	T	R	S	SD		
SD-05221	12S	10E	8	333	3 afy	Stk
SD-05222	12S	10E	19	213	3 afy	Stk
SD-05223	12S	10E	15	132	3 afy	Stk
SD-05224	12S	10E	15	223	3 afy	Stk
SD-05225	12S	10E	12	243	3 afy	Stk
SD-05226	12S	10E	1	223	3 afy	Stk
SD-05278	12S	10E	17	344	3 afy	Stk
SD-05279	12S	10E	11	343	3 afy	Stk

Maxwell Spring	13S	10E	2	333	12 afy	Dom & Stk
(no file no.)	13S	10E	11	112		
So. Aguilar Spring	13S	10E	20	423	3 afy	Stk

The above locations are described by township (T), range (R), Section (S) and subdivision (SD).

42. The springs on High Nogal Ranch are generally located in the mountain front recharge area up gradient from the proposed well field.

43. The weight of the evidence presented reflects that Maxwell Spring is located at the contact of the San Andres Limestone with the underlying lower-conductivity Yeso Formation, which impedes downward flow. The springs identified as File Nos. SD-05222 (Kitty Spring), SD-05278 (Crosby Spring) and SD-05221 (Aguilar Spring) are located in an area where water is moving downward in the Santa Rosa Sandstone to the lower-conductivity beds in the Artesia group, and where igneous dykes impede groundwater flow causing water to appear at the surface.

44. The weight of the evidence presented reflects that the springs on the High Nogal Ranch that are nearest to the proposed well field are contact or perched springs that would not be significantly affected by the ongoing diversion of at least 3,000 afy from the well field. The other springs on the High Nogal Ranch are farther removed from the proposed well field and are not likely to be effected by diversions from the well field.

45. The weight of the evidence presented reflects that ongoing diversion of at least 3,000 afy from the proposed well field will not dry up or adversely affect the springs on the High Nogal Ranch.

46. The point of diversion for the Tularosa Community Ditch is located in the SW ¼ of Section 15, Township 14 South, Range 10 East. The Tularosa Community Ditch provides irrigation water to 55 farmers and about 190 residents in the Village of Tularosa.

47. WRD's hydrologic expert, Eric Keyes, modified the JSAI model by adding constant-

head cells to represent the Rio Tularosa as being in connection with the water table and estimated that diversion of 10,000 afy in accordance with the proposed diversion schedule, could cause induced base flow loss to Tularosa Creek of approximately 16 afy at the end of forty years.

48. The Rio Tularosa does not appear to be in direct connection with the regional water table in the area of interest. In the mountain block, water levels in wells close to the river appear to be in the range of 20 feet to about 100 feet below land surface. The depth to water in wells near the river, where it flows out across the basin fill, varies from 80 feet to over 100 feet.

49. The WRD's addition of constant-head cells to the JSAI model results in over-estimation of effects to the Rio Tularosa.

50. Diversion of at least 3,000 afy from the proposed well field should not result in reduction of available flow in the Rio Tularosa at the point of diversion for the Tularosa Community Ditch.

51. Concerns were raised as to the propagation of effects from the proposed pumping within the Tularosa Basin Administrative Area. The State Engineer's Tularosa Underground Water Basin Administrative Criteria (TUWBAC) for the Alamogordo-Tularosa Area became effective on May 19, 1997. The TUWBAC provide guidelines for OSE staff to apply in evaluating applications within the Alamogordo-Tularosa administrative area, which is a sub-area of the Tularosa Underground Water Basin. The TUWBAC include certain water level decline standards and limits for prescribed areas, or blocks, within the administrative area. The TUWBAC limit the average annual groundwater level decline rate within any administrative block, caused by existing and proposed uses, to no more than 2.5 feet per year, unless the portion of the decline rate attributed to the proposed pumping is not greater than 0.05 feet per year.

52. The administrative area covered by the TUWBAC extends approximately 6 ½ miles north of the Village of Tularosa. The City's proposed well field is located approximately 8 ½ to 11 miles north of the Village of Tularosa and approximately 2 to 5 miles outside the northeast boundary of the administrative area. The TUWBAC

provide that wells outside of the administrative area will be evaluated on a case-by-case basis.

53. Generally, evaluation of applications for diversions from wells located outside, but near, an administrative area, includes consideration of the resulting effects or drawdowns within the administrative area and whether those drawdowns exceed limits for the administrative area.

54. Simulations performed using the modified Morrison model reflect that diversion of 10,000 afy from the proposed wells would result in induced drawdowns in excess of permissible levels under the guidelines.

55. WRD contends that the TUWBAC should not be strictly applied to this application because the ambient drawdowns anticipated under the criteria have not occurred in the application area. The inference to be drawn is that there is more water available in the specific area of interest than had been originally projected.

56. The evidence presented suggests that ongoing diversion of 3,000 afy from the proposed well field may not result in actual induced drawdowns in excess of permissible levels under the guidelines. If the subject Applications are approved, the City's authority to continue diverting water should be conditioned upon monitoring of appropriate wells, and filing of reports establishing, to the satisfaction of the State Engineer, that the TUWBAC limits on annual groundwater decline rates are not exceeded.

57. Estimates of salinity migration resulting from diversion of 10,000 afy in accordance with the proposed diversion schedule, calculated using the modified Morrison model coupled with the United States Army Corps of Engineers transport model MT3DMS (Zheng 1999), show very small induced salinity variations. The largest increase in induced TDS concentration at any well was 24 mg/l after 40 years. Diversion of 3,000 afy would have significantly less effect. The diversion of 3,000 afy from the proposed well field would not impair water quality.

58. The ongoing diversion of 3,000 afy from the proposed well field, subject to conditions, will not impair existing water rights or result in significant degradation of water quality. A temporary increase in annual diversions, up to 4,500 acre-feet, will

not impair existing water rights provided that the sum of annual diversions for any consecutive five-year period does not exceed 15,000 acre-feet.

59. The diversion of unappropriated brackish groundwater and conversion of that brackish water into potable water, through desalination, would be beneficial to the public welfare of the state. Desalinated water is a potential resource for providing a reliable supply of potable water in other areas of the Tularosa Basin. In that regard, the Tularosa Basin has been chosen as the site for a national desalination research and development facility.

60. If the City's desalination project proves to be successful, and monitoring shows limited effect to ground and surface water sources in the region, the City and other public governmental entities covered under NMSA 1978 § 72-1-9 could, as co-applicants or a regional water authority, file an application for permit to increase diversion based upon regional demand. Alternatively, the City could apply for permit to transfer its valid existing rights into the well field.

61. The City has reduced its per capita water use rate since 1990 by 37% through adoption and implementation of a successful water conservation program. Records reflect that in 1990 the City's gpcpd was 245.54. The City's gpcpd since 1998 is as follows: 173 gpcpd in 1999; 184 gpcpd in 2000; 155 gpcpd in 2001; and 134 gpcpd in 2002.

62. The City's water conservation program addresses elements of the State Engineer's Water Conservation Guidelines for Public Water Supply Systems and it includes repair and replacement of pipelines and meters, tiered structuring of water rates, rationing in times of drought, use of reclaimed water, public outreach and education.

63. Approval of the subject application would not be contrary to the conservation of water within the state.

64. The Applications should be approved for a diversion of 3,000 afy, subject to conditions of approval including, but not limited to, a condition that the diversion in any year may be increased up to 4,500 acre-feet provided that the sum of annual diversions for any consecutive five-year period does not exceed 15,000 acre-feet.

ORDER

THEREFORE, Application Nos. T-3825 thru T-3825-S-9 filed by the City of Alamogordo are partially approved for the diversion of up to 3,000 afy, subject to conditions, as follows:

Permittee: City of Alamogordo

Permit No.: T-3825 thru T-3825-S-9

Date of Application: September 6, 2000

Source of Water: Tularosa Underground Water Basin

Points of Diversion:

Well No.	Subdivision	Section	Township	Range
T-3825	NW ¼ SE ¼ SW ¼	1	13 South	9 East
T-3825-S	SW ¼ SW ¼ NW ¼	31	12 South	10 East
T-3825-S-2	SW ¼ SW ¼ SW ¼	31	12 South	10 East
T-3825-S-3	SW ¼ NW ¼ NE ¼	35	12 South	9 East
T-3825-S-4	SE ¼ SW ¼ SE ¼	35	12 South	9 East
T-3825-S-5	NW ¼ SE ¼ NW ¼	6	13 South	10 East
T-3825-S-6	NE ¼ NW ¼ NE ¼	7	13 South	10 East
T-3825-S-7	SE ¼ SW ¼ NW ¼	7	13 South	10 East
T-3825-S-8	NE ¼ NW ¼ SE ¼	1	13 South	9 East
T-3825-S-9	NW ¼ SW ¼ NE ¼	1	13 South	9 East

Amount of Water: Up to 3,000 afy. The diversion for any calendar year may be increased up to 4,500 acre-feet, provided that the sum of annual diversions for any consecutive five-year period does not exceed 15,000 acre-feet.

Purpose of Use: Municipal, Industrial, Commercial or Irrigation

Place of Use: Service area of the City of Alamogordo water system

CONDITIONS OF APPROVAL

1. Permit No. T-3825 thru T-3825-S-9 shall not be exercised to the detriment of valid existing water rights or in a manner that is contrary to the conservation of water within the state or detrimental to the public welfare of the State of New Mexico.

2. The total annual combined diversion of groundwater from Well Nos. T-3825 thru T-3825-S-9 under this permit shall not exceed 3,000 afy, except that the City may increase the total annual combined diversion of groundwater from said wells during any calendar year up to 4,500 acre-feet, provided that the sum of annual diversions for any consecutive five-year period does not exceed 15,000 acre-feet.

3. During any year in which groundwater is diverted from Well Nos. T-3825 thru T-3825-S-9 under this permit, the City's total annual groundwater diversions from said wells and wells under OSE File Nos. T-32 (La Luz Wells), T-33 (Prather Wells), T-814 (Golf Course Well), T-2408 (Landfill Well) and T-3489 (Cemetery Irrigation Well) combined shall not exceed 5,088 afy (2,088 + 3,000), or 6,588 (2,088 + 4,500) during a year in which the Applicant increases its diversions under Condition of Approval 2.

4. Prior to the drilling of Well Nos. RG-3825 thru RG-3825-S-9 under this permit, the City shall submit to the State Engineer an acknowledged statement, executed by the owner of the land upon which the wells are to be drilled, establishing that the permittee has permission to occupy such portion of the owners land as is necessary to drill and operate the wells.

5. Well Nos. RG-3825 thru RG-3825-S-9 shall be equipped with totalizing meters of a type and at locations approved by and installed in a manner acceptable to the State Engineer. The City shall provide in writing, the make, model, serial number, date of installation, initial reading, units, and dates of recalibration of each meter and any replacement meter used to measure the diversion of water under this permit. At a minimum, all meters shall be calibrated in accordance with industry standards annually and the results shall be submitted to the Office of the State Engineer.

6. Records of the amount of water diverted from Wells T-3825 through 3825-S-9 shall be submitted to the State Engineer on or before the 10th day of January, April, July and October for the preceding three (3) month period.

7. Prior to diversion of water under this permit, the permittee shall furnish to the State Engineer, such documents as the State Engineer may find necessary to establish that the City has assumed financial responsibility for deepening or replacement of Well No. T-4316 as necessary to sustain production of 3 afy from said well for forty years, or that the owner of Well No. T-4316 has waived or released any claim of liability against the permittee for injury resulting to such well from operations under this permit, or that the permittee has acquired the rights of such persons in such wells, or that the permittee and the owner of Well No. T-4316 have reached other mutually acceptable agreement concerning replacement of water from said well.

8. Prior to diversion of water under this permit, the permittee shall propose and implement a monitoring plan and system, acceptable to the State Engineer, involving the monitoring of water levels in wells and surface water flows. In July and January of each calendar year, the permittee shall measure water levels and total dissolved solids within the monitoring wells and surface flows. The permittee shall report the data to the State Engineer, in writing, on or before January 31 and July 31 of each calendar year.

9. The State Engineer may order the temporary suspension of all or a part of groundwater diversions under this permit if the water levels, total dissolved solids or surface water flows reported pursuant to Condition of Approval 8 above, indicate that impairment to valid existing senior rights to divert water is likely to occur or that groundwater decline rates within the Tularosa Underground Water Basin Administrative Area are likely to exceed those allowed by the TUBWAC as a result of the continued operation of Well Nos. RG-3825 thru RG-3825-S-9 at then current diversion levels.

10. Issuance of this permit is predicated upon the expectation that the permittee's annual water use will not exceed the product of the population within its service area for each year times 0.1848237 (165 gpcpd converted to afy). The permittee is

expected to reduce its water use during periods of extended drought consistent with appropriate drought management plans. Additionally, the permittee shall utilize the highest and best technology available to ensure ongoing conservation of water to the maximum extent practical. The permittee shall submit progress reports on its Water Conservation Plan on or before February 1st of every fifth year, commencing five years after the date of approval of this permit.

11. Proof of Completion of Work(s) shall be filed on or before May 15, 2009.

12. The permittee shall file Proof of Application of Water to Beneficial Use under this permit on or before May 15th of the fourth year after the permittee first puts water to beneficial use under this permit and shall file additional Proofs on or before May 15th of every fourth year thereafter for additional amounts of water put to beneficial use.

13. The State Engineer shall retain jurisdiction over this permit for the purpose of ensuring that exercise of the permit does not violate the forgoing conditions.

Respectfully submitted,

_____
Victor Kovach
Hearing Examiner

I ACCEPT AND ADOPT THE REPORT AND RECOMMENDATION OF THE HEARING EXAMINER THIS _____ DAY OF _____ 2004.

_____
JOHN R. D'ANTONIO, JR., P.E.
NEW MEXICO STATE ENGINEER

BEFORE THE NEW MEXICO STATE ENGINEER

2004 DEC 29 AM 9:35

IN THE MATTER OF THE APPLICATION BY) CITY OF ALAMOGORDO FOR PERMIT TO) APPROPRIATE UNDERGROUND WATERS) FROM THE SHALLOW AQUIFER LOCATED) IN THE TULAROSA BASIN OF NEW MEXICO)	Hearing No. 02-035 OSE File No. T-3825 thru T-3825-S-9

OFFICE OF THE STATE ENGINEER HEARINGS UNIT SANTA FE, NM

REPORT AND RECOMMENDATION OF THE HEARING EXAMINER

This matter came on for hearing before Victor Kovach, the State Engineer's designated Hearing Examiner, on October 14 through 17 and October 20 through 24, 2003, in Alamogordo, New Mexico. The parties appeared as follows: James C. Brockmann, Esq., and Jay F. Stein, Esq., represented Applicant City of Alamogordo; Jeffrey L. Fornacjari, Esq., and Paula M. Buchwald, Esq., represented Protestants HFR Corporation (HFR) and Three Rivers Cattle Ltd Co. (Three Rivers); A. J. Olsen, Esq., represented Protestants David & Julia M. Christopher (Christophers); Peter T. White, Esq., represented Protestants Dan C. Abercrombie, Elsie I. Bailey, David Rankin, Laymon Hightower (Tularosa Farms), Allen "Bill" Trammell, Tularosa Community Ditch Corporation, and Cates Farms (referred to collectively as "Tularosa Protestants"); and William D. Teel, Esq., represented the Water Resources Allocation Program (a.k.a. Water Rights Division) of the Office of the State Engineer (OSE). Jefferson R. Rhodes, Esq., appeared on behalf of the Village of Tularosa on October 14, 2003, and, prior to the presentation of witnesses, the protest of the Village of Tularosa was voluntarily withdrawn and it was dismissed from the proceedings. Having considered the evidence and pleadings submitted in this matter, the Hearing Examiner recommends the following findings and order.

FINDINGS OF FACT

1. The State Engineer has jurisdiction of the parties and subject matter.
2. On September 6, 2000, and in January 2002, the City of Alamogordo (hereinafter "City") filed ten Applications numbered T-3825 thru T-3825-S-9 with the State

Alamogordo Exhibit 7

Engineer for Permit to Appropriate the Underground Waters of the Tularosa Underground Water Basin of New Mexico. Notice for Publication of the Applications was issued on February 1, 2002. The Applications and Legal Notice filed in this matter, reflect that the City proposes to drill ten wells for a diversion of 1,500 acre-feet per year (afy) per well, with the combined diversion from all ten wells not to exceed 13,450 afy, and to desalinate and treat the water for use for municipal, industrial or commercial purposes in Otero County, New Mexico, by all water systems or operations in the County that wish to participate in the program and purchase bulk water. The proposed well-field would be located on property owned by the United States Department of the Interior, Bureau of Land Management, approximately 8.5 to 11 miles north of Tularosa, New Mexico and east of Highway 54 at sites described by New Mexico Principle Meridian (NMPM) coordinates, as follows:

Well No.	Subdivision	Section	Township	Range
T-3825	NW ¼ SE ¼ SW ¼	1	13 South	9 East
T-3825-S	SW ¼ SW ¼ NW ¼	31	12 South	10 East
T-3825-S-2	SW ¼ SW ¼ SW ¼	31	12 South	10 East
T-3825-S-3	SW ¼ NW ¼ NE ¼	35	12 South	9 East
T-3825-S-4	SE ¼ SW ¼ SE ¼	35	12 South	9 East
T-3825-S-5	NW ¼ SE ¼ NW ¼	6	13 South	10 East
T-3825-S-6	NE ¼ NW ¼ NE ¼	7	13 South	10 East
T-3825-S-7	SE ¼ SW ¼ NW ¼	7	13 South	10 East
T-3825-S-8	NE ¼ NW ¼ SE ¼	1	13 South	9 East
T-3825-S-9	NW ¼ SW ¼ NE ¼	1	13 South	9 East

An Affidavit of Publication was filed on March 11, 2002.

3. Protests objecting to the granting of the Application were filed by HFR Corporation, Three Rivers Cattle Ltd Co., Cates Farm, David & Julia Christopher, Dan C. Abercrombie, Robert Baca, Elsie I. Bailey, David Rankin, Tularosa Farms, Sacramento Mountains Watershed Restoration Corporation (SMWRC), Village of Tularosa, Allen "Bill" Trammell, and the Tularosa Community Ditch Corporation.

4. The protest of Robert Baca was dismissed by order entered in this matter on August 23, 2002.

5. The protest of SMWRC was dismissed by order entered on April 17, 2003. By Order Adopting Stipulation, Rick Warnock, in his capacity as President of SMWRC, appeared as a fact witness testifying to SMWRC's concerns with the Application.

6. By order entered in this matter on April 22, 2003, the City was granted leave to amend its Application to reduce the total amount of water applied for from 13,450 afy to 10,000 afy.

7. Pursuant to NMSA 1978 § 72-1-9 (2003), municipalities are authorized and allowed "a water use planning period not to exceed forty years." Water rights for municipalities must be based upon "a water development plan . . . for reasonably projected additional needs within forty years." *Id.* Additional need is determined by comparing projected future water demand to available supply.

8. The City's 40-Year Water Development Plan, City Exhibit 10, contains population and water use projections to the year 2040. Using the University of New Mexico Bureau of Business and Economic Research (BBER) medium growth methodology, the City estimates that its population will increase to approximately 56,137 by the year 2040 as follows:

Year	Projection
2010	41,168
2020	46,366
2030	51,252
2040	56,137

The BBER methodology incorporates economic, demographic and migration trends and is a widely accepted method for forecasting population. The City's population projection is reasonable.

9. Assuming an average water use of 165 gallons per capita per day (gpcpd), which is equivalent to an annual per capita use of 0.1848237 afy (165 gpcpd x 365 days = 60,225 gallons ÷ 325,851 gallons per acre foot = 0.1848237 afy), the City estimates its water demand (rounded off to the nearest whole number) through the year 2040

as follows:

Year	Population Projection		Per Capita Use		Demand
2010	41,168	x	0.1848237 afy	=	7,609 afy
2020	46,366	x	0.1848237 afy	=	8,570 afy
2030	51,252	x	0.1848237 afy	=	9,473 afy
2040	56,137	x	0.1848237 afy	=	10,375 afy

The City's demand estimate through 2040 is reasonable.

10. OSE records reflect that the City of Alamogordo has existing surface and ground water rights and permits to divert 23,458.79 afy from its wells and surface diversions, as follows:

Surface Diversions	OSE File No.	Diversion Amount
Bonito Lake	SP-13	1,449.02 afy (2.26867 cfs)
La Luz – Fresnal	SP-01110 thru 01115	
	01118 thru 01121	
	01342 thru 01346	
	01383, 01411, 01412	
	01455, 01456, 01562	
	2886 and 1122	891.20 afy + 16 cfs
		+ (11,583.43 afy)
Alamo Canyon	SP-06037 and 2176	3,078.00 afy
	SUBTOTAL	17,001.65 afy
Ground Water Diversions		
La Luz Wells	T-32	4,572.88 afy
Prather Wells	T-33	1,354.00 afy
Golf Course Well	T-814	269.935 afy
Landfill Well	T-2408	100.00 afy
Cemetery Irrigation	T-3489	160.33 afy
	SUBTOTAL	6,457.145 afy
	TOTAL	23,458.795 afy

11. The City currently holds water rights and permits that exceed its projected water demand for the forty-year planning period.

12. Approximately 72% of the City's water rights (17,001.65 afy out of 23,458.79 afy) are surface water rights. The ability to fully exercise those rights is susceptible to drought conditions.

13. The City contends that the supply of surface water that is actually available for use is far less than its surface water rights and that it is unable to fully develop and utilize the 6,457.145 afy of ground water under its existing permits.

14. In determining the additional needs of a municipality over the forty-year planning period, it is reasonable to consider historic diversions and historic water supply, as well as the amount of vested water rights and permits held by the municipality.

15. Table 2 of City Exhibit 15 reflects that for the years 1967 through 2001, the City's surface water diversions from La Luz-Fresnal flume, Alamo Canyon, and Bonito Lake (receival) averaged 3,614 afy, 1,372 afy and 1,400 afy respectively. The City shares Bonito Lake diversions equally with Holloman Air Force Base. The average historical surface water diversion for the City, combined, for the period of 1967 through 2001, is 5,686 afy (3,614 afy + 1,372 afy + 700 afy).

16. Protestant HFR and Three Rivers Exhibit 34, Attachment A, reflects that the City's groundwater diversions for the last five (5) years have averaged approximately 2,088 afy. The City has failed to establish, by credible evidence, that it would be unable to sustain production from its current wells at this level. A groundwater supply of 2,088 may be considered in supply calculations for purposes of this Application, provided that conditions limit the City's actual combined annual groundwater diversions to the sum of the amount of groundwater considered to be available (2,088) and the amount permitted under T-3825 thru T-3825-S-9, or require that the City files Proof of Beneficial Use consistent with that figure.

17. The City projects that its water demand will be 10,375 afy, in the year 2040, based upon its assumption that water use in the year 2040 will be equal to its current approximate annual average use level of 165 gpcpd. It is similarly appropriate to consider that the City's available supply of water in the year 2040 will be at least

equal to the average amount of water that the City has historically diverted from its surface and groundwater sources. A short-term drought or temporary loss of surface supply can be addressed, in part, by provisions that allow for temporary increase in annual groundwater diversions from the subject wells and averaging of the increase over five years. During long-term drought conditions, good conservation practice requires implementation of drought management plans that include tiered or increased water rate structures, reductions in water use and, if necessary, rationing.

18. The average water supply that has been historically available to and diverted by the City from both surface and groundwater sources is 7,774 afy (5,686 afy surface water + 2,088 groundwater). Accordingly, the City's unmet water demand through the 40-year planning period, is no more than 2,601 afy (10,375 afy – 7,774 afy).

19. Section 4.3.2 of City Exhibit 11 reflects that the City expects 84% recovery of potable water from the desalinization process. A diversion of 3,096.43 afy would be required to produce 2,601 afy of potable water.

20. The City proposes to divert the water applied for in accordance with the following pumping schedule: diversion of 5,000 afy through 2009; diversion of 6,500 afy from 2010-2020; diversion of 8,000 afy from 2020-2030; and, diversion of 10,000 afy for 2030 and beyond. There was considerable and significant disagreement among the experts as to the projected effects of the proposed scheduled pumping and the reliability of the models constructed and employed to predict those effects.

21. Simulations of the effects of diversions under the City's proposed pumping schedule for forty years were conducted using modified versions of the Morrison groundwater flow model for the Tularosa Underground Water Basin (Morrison 1989) and a model of the Basin constructed by John Shomaker and Associates (JSAI).

22. Protestants HFR and Three Rivers expert hydrologists, Maryann Wasiolek and Michael P. Spinks, of Hydroscience Associates, Inc., (hereinafter "Hydroscience") estimated hydraulic effects of the subject applications utilizing a modified version of the Morrison model wherein the model boundaries are extended three miles north of

the City's proposed well field and the model grid is refined for the areas north of the Tularosa Underground Water Basin Administrative Area.

23. WRD's technical expert, Eric Keyes, utilized the Hydroscience refined grid of the Morrison Model and further modified the model by changing transmissivity values to match higher transmissivities observed during a recent aquifer test of Exploratory Well No. T-3825. The results of simulations of pumping the City's proposed wells for forty years, in accordance with the City's pumping schedule, using the refined and modified Morrison model, as reflected in a March 2003 report submitted into evidence as WRD Exhibit 1, indicate that the largest impacts to other wells occur at HFR Corporation wells where water columns are reduced by as much as 81 feet with one well T-1797-S-4 going dry. The results reported in WRD Exhibit 1 were derived based upon the static water columns in nearby wells and did not consider the effect of self induced drawdown in the water columns of irrigation wells, referred to as 'irrigation dynamic drawdown' or 'pumping drawdown'.

24. Mr. Keyes subsequently performed a hydraulic analysis of the subject Applications using the refined and modified Morrison model with consideration given to the effect of 'irrigation dynamic drawdown'. WRD Exhibit 1-A and Amended Exhibit 1-A reflect that after 40 years of pumping the proposed wells under the City's proposed pumping schedule, eighteen (18) nearby wells of other ownership would go dry or be significantly impacted.

25. The Hydrology Bureau of the OSE considers a well to be significantly impacted when its available water column is reduced by more than 70% or there is less than 10 feet of water above and below the pump.

26. The City's technical experts, John Shomaker and Associates, developed a separate groundwater flow model for evaluating the effects of pumping the proposed wells (JSAI Model). The JSAI model, described in City Exhibit No. 14, was prepared by Steven T. Finch under the direction of Dr. John W. Shomaker. The model differs from the Morrison model in several ways including the following: it is a three-dimensional model that includes the mountain block east of the basin fill as an active part of the model and considers additional recharge from the mountain block;

all of the boundaries are no flow boundaries with the western boundary considered an evaporation boundary, wherein the groundwater discharges through evapotranspiration and does not flow westward and across the boundary; and the calculated discharge by evapotranspiration in the western boundary is approximately equal to the mountain-block recharge.

27. JSAI model simulations reflect that the Protestant Christophers' domestic well T-4316 and another domestic well of other ownership, T-2911, will go dry or be significantly impacted as a result of pumping the proposed wells for forty years under the City's pumping schedule. The results are derived based upon static water levels in nearby wells and do not consider the effect of 'irrigation dynamic drawdown' or 'pumping drawdown'.

28. The predicted effects under both the JSAI model and the refined and modified Morrison model are based upon a comparison of baseline effects from a forty-year projection of continued historic pumping, without the proposed pumping, to a forty-year projection of those baseline effects with the proposed pumping done in accordance with the City's pumping schedule. The baseline does not necessarily consider permits as being fully exercised and, as emphasized by Protestants, the effect of pumping the full diversion amount requested by the subject application, 10,000 afy, was only considered for ten years. Expansion of the modeling efforts to include the full exercise of permitted rights in the base line and to simulate pumping the proposed wells at 10,000 afy for forty years would result in an expansion and acceleration of effects.

29. Evidence concerning the effects of diverting less than the full amount requested, although limited, was credible.

30. The nearest wells of other ownership include permitted and declared wells of Protestants HFR and the Christophers.

31. Protestants HFR and Three Rivers expert hydrologist, Michael P. Spinks, testified that groundwater diversion of 2,500 to 3,000 afy from the proposed well field would not impair or adversely impact the production of Protestant HFR or 3 Rivers' wells.

32. Protestant Christophers are the owners of the High Nogal Ranch. They claim ownership of the following declared wells located within the ranch boundaries and within the vicinity of the proposed well field:

Well No.	Location T	R	S	SD	Declared Amount	Declared Use	Declared Priority
T-4311	13S	10E	18	413	3 afy	Livestock	Pre 07/1982
T-4312	12S	10E	15	123	3 afy	Livestock	Pre 07/1982
T-4313	13S	10E	9	1412	3 afy	Livestock	Pre 07/1982
T-4314	12S	10E	30	234	3 afy	Livestock	Pre 07/1982
T-4315	12S	9E	25	421	3 afy	Livestock	Pre 07/1982
T-4316	13S	10E	6	334	3 afy	Domestic & Livestock	1940

The Declarations for the above wells were filed in 2003, after the City filed the subject Application. The Christophers also claim ownership of livestock well No. T-3845, located in the Section 3, Township 12 South, Range 10 East, NMPM, completed March 1, 2001.

33. Protestant Christophers' Exhibit 16 includes reports of a field check conducted on April 30, 2003, by OSE staff David Bernadone and Sheldon Dorman. The Field Reports contain the following entry for each of Well Nos. T-4312, T-4313, T-4314 and T-4315: "well is not equipped and is an abandoned open hole." The Field Report for Well No. T-4316 reflects that it was "equipped and in use."

34. Table 3 of Protestant Christophers' Exhibit 22 reflects that the water level in well Nos. T-4311 and T-4314 is at or below the well depth.

35. Well T-3845 is located approximately seven (7) miles north and east of the proposed well field. OSE records reflect that Well T-3845 has a static water column of approximately 298 feet. Well No. T-3845 will not be adversely affected by ongoing groundwater diversions of at least 3,000 afy from the City's proposed well field.

36. Table 3 of Protestant Christophers' Exhibit 22 reflects that Well No. T-4316 has a well depth of 290 feet and a static water level of 278 feet. Well No. T-4316 is within the City's proposed well field and will lose its water column as a result of diversion of 3,000 afy from the proposed well field.

37. Protestant Christophers' Exhibit 22 reflects that Well No. T-4316 is located less than 5,000 feet east of the City's test Well No. T-3825 which was drilled to a depth of 710 feet. Expert witnesses Eric Keyes and Michael Spinks testified that Well No. T-4316 is located in the Basin Fill.

38. The evidence reflects that Well No. T-4316 can be deepened or replaced to recover production. The ability to deepen wells to recover production is considered a factor in determining whether a proposed appropriation of groundwater will impair an existing right.

39. The City of Alamogordo has agreed to pay for the cost of deepening or replacing Well No. T-4316 or to replace the water.

40. Given the indication that Well No. T-4316 can be deepened to recover production and that the City has offered to assume the cost for deepening or replacement, granting of the proposed application for a diversion of at least 3,000 afy will not impair Well No. T-4316.

41. In February 2003, Protestant Christophers also filed Declarations of Ownership of Water Right concerning a number of springs located within the boundaries of the High Nogal Ranch, as follows:

OSE File No.	Location				Amount	Use
	T	R	S	SD		
SD-05221	12S	10E	8	333	3 afy	Stk
SD-05222	12S	10E	19	213	3 afy	Stk
SD-05223	12S	10E	15	132	3 afy	Stk
SD-05224	12S	10E	15	223	3 afy	Stk
SD-05225	12S	10E	12	243	3 afy	Stk
SD-05226	12S	10E	1	223	3 afy	Stk
SD-05278	12S	10E	17	344	3 afy	Stk

SD-05279	12S	10E	11	343	3 afy	Stk
Maxwell Spring	13S	10E	2	333	12 afy	Dom & Stk
(no file no.)	13S	10E	11	112		
So. Aguilar Spring	13S	10E	20	423	3 afy	Stk

The above locations are described by township (T), range (R), Section (S) and subdivision (SD).

42. The springs on High Nogal Ranch are generally located in the mountain front recharge area up gradient from the proposed well field.

43. The weight of the evidence presented reflects that Maxwell Spring is located at the contact of the San Andres Limestone with the underlying lower-conductivity Yeso Formation, which impedes downward flow. The springs identified as File Nos. SD-05222 (Kitty Spring), SD-05278 (Crosby Spring) and SD-05221 (Aguilar Spring) are located in an area where water is moving downward in the Santa Rosa Sandstone to the lower-conductivity beds in the Artesia group, and where igneous dykes impede groundwater flow causing water to appear at the surface.

44. The weight of the evidence presented reflects that the springs on the High Nogal Ranch that are nearest to the proposed well field are contact or perched springs that would not be significantly affected by the ongoing diversion of at least 3,000 afy from the well field. The other springs on the High Nogal Ranch are farther removed from the proposed well field and are not likely to be effected by diversions from the well field.

45. The weight of the evidence presented reflects that ongoing diversion of at least 3,000 afy from the proposed well field will not dry up or adversely affect the springs on the High Nogal Ranch.

46. The point of diversion for the Tularosa Community Ditch is located in the SW ¼ of Section 15, Township 14 South, Range 10 East. The Tularosa Community Ditch provides irrigation water to 55 farmers and about 190 residents in the Village of Tularosa.

47. WRD's hydrologic expert, Eric Keyes, modified the JSAI model by adding constant-head cells to represent the Rio Tularosa as being in connection with the water table and estimated that diversion of 10,000 afy in accordance with the proposed diversion schedule, could cause induced base flow loss to Tularosa Creek of approximately 16 afy at the end of forty years.

48. The Rio Tularosa does not appear to be in direct connection with the regional water table in the area of interest. In the mountain block, water levels in wells close to the river appear to be in the range of 20 feet to about 100 feet below land surface. The depth to water in wells near the river, where it flows out across the basin fill, varies from 80 feet to over 100 feet.

49. The WRD's addition of constant-head cells to the JSAI model results in over-estimation of effects to the Rio Tularosa.

50. Diversion of at least 3,000 afy from the proposed well field should not result in reduction of available flow in the Rio Tularosa at the point of diversion for the Tularosa Community Ditch.

51. Concerns were raised as to the propagation of effects from the proposed pumping within the Tularosa Basin Administrative Area. The State Engineer's Tularosa Underground Water Basin Administrative Criteria (TUWBAC) for the Alamogordo-Tularosa Area became effective on May 19, 1997. The TUWBAC provide guidelines for OSE staff to apply in evaluating applications within the Alamogordo-Tularosa administrative area, which is a sub-area of the Tularosa Underground Water Basin. The TUWBAC include certain water level decline standards and limits for prescribed areas, or blocks, within the administrative area. The TUWBAC limit the average annual groundwater level decline rate within any administrative block, caused by existing and proposed uses, to no more than 2.5 feet per year, unless the portion of the decline rate attributed to the proposed pumping is not greater than 0.05 feet per year.

52. The administrative area covered by the TUWBAC extends approximately 6 ½ miles north of the Village of Tularosa. The City's proposed well field is located approximately 8 ½ to 11 miles north of the Village of Tularosa and approximately 2

to 5 miles outside the northeast boundary of the administrative area. The TUWBAC provide that wells outside of the administrative area will be evaluated on a case-by-case basis.

53. Generally, evaluation of applications for diversions from wells located outside, but near, an administrative area, includes consideration of the resulting effects or drawdowns within the administrative area and whether those drawdowns exceed limits for the administrative area.

54. Simulations performed using the modified Morrison model reflect that diversion of 10,000 afy from the proposed wells would result in induced drawdowns in excess of permissible levels under the guidelines.

55. WRD contends that the TUWBAC should not be strictly applied to this application because the ambient drawdowns anticipated under the criteria have not occurred in the application area. The inference to be drawn is that there is more water available in the specific area of interest than had been originally projected.

56. The evidence presented suggests that ongoing diversion of 3,000 afy from the proposed well field may not result in actual induced drawdowns in excess of permissible levels under the guidelines. If the subject Applications are approved, the City's authority to continue diverting water should be conditioned upon monitoring of appropriate wells, and filing of reports establishing, to the satisfaction of the State Engineer, that the TUWBAC limits on annual groundwater decline rates are not exceeded.

57. Estimates of salinity migration resulting from diversion of 10,000 afy in accordance with the proposed diversion schedule, calculated using the modified Morrison model coupled with the United States Army Corps of Engineers transport model MT3DMS (Zheng 1999), show very small induced salinity variations. The largest increase in induced TDS concentration at any well was 24 mg/l after 40 years. Diversion of 3,000 afy would have significantly less effect. The diversion of 3,000 afy from the proposed well field would not impair water quality.

58. The ongoing diversion of 3,000 afy from the proposed well field, subject to conditions, will not impair existing water rights or result in significant degradation of

water quality. A temporary increase in annual diversions, up to 4,500 acre-feet, will not impair existing water rights provided that the sum of annual diversions for any consecutive five-year period does not exceed 15,000 acre-feet.

59. The diversion of unappropriated brackish groundwater and conversion of that brackish water into potable water, through desalination, would be beneficial to the public welfare of the state. Desalinated water is a potential resource for providing a reliable supply of potable water in other areas of the Tularosa Basin. In that regard, the Tularosa Basin has been chosen as the site for a national desalination research and development facility.

60. If the City's desalination project proves to be successful, and monitoring shows limited effect to ground and surface water sources in the region, the City and other public governmental entities covered under NMSA 1978 § 72-1-9 could, as co-applicants or a regional water authority, file an application for permit to increase diversion based upon regional demand. Alternatively, the City could apply for permit to transfer its valid existing rights into the well field.

61. The City has reduced its per capita water use rate since 1990 by 37% through adoption and implementation of a successful water conservation program. Records reflect that in 1990 the City's gpcpd was 245.54. The City's gpcpd since 1998 is as follows: 173 gpcpd in 1999; 184 gpcpd in 2000; 155 gpcpd in 2001; and 134 gpcpd in 2002.

62. The City's water conservation program addresses elements of the State Engineer's Water Conservation Guidelines for Public Water Supply Systems and it includes repair and replacement of pipelines and meters, tiered structuring of water rates, rationing in times of drought, use of reclaimed water, public outreach and education.

63. Approval of the subject application would not be contrary to the conservation of water within the state.

64. The Applications should be approved for a diversion of 3,000 afy, subject to conditions of approval including, but not limited to, a condition that the diversion in any year may be increased up to 4,500 acre-feet provided that the sum of annual diversions for any consecutive five-year period does not exceed 15,000 acre-feet.

ORDER

THEREFORE, Application Nos. T-3825 thru T-3825-S-9 filed by the City of Alamogordo are partially approved for the diversion of up to 3,000 afy, subject to conditions, as follows:

Permittee: City of Alamogordo

Permit No.: T-3825 thru T-3825-S-9

Date of Application: September 6, 2000

Source of Water: Tularosa Underground Water Basin

Points of Diversion:

Well No.	Subdivision	Section	Township	Range
T-3825	NW ¼ SE ¼ SW ¼	1	13 South	9 East
T-3825-S	SW ¼ SW ¼ NW ¼	31	12 South	10 East
T-3825-S-2	SW ¼ SW ¼ SW ¼	31	12 South	10 East
T-3825-S-3	SW ¼ NW ¼ NE ¼	35	12 South	9 East
T-3825-S-4	SE ¼ SW ¼ SE ¼	35	12 South	9 East
T-3825-S-5	NW ¼ SE ¼ NW ¼	6	13 South	10 East
T-3825-S-6	NE ¼ NW ¼ NE ¼	7	13 South	10 East
T-3825-S-7	SE ¼ SW ¼ NW ¼	7	13 South	10 East
T-3825-S-8	NE ¼ NW ¼ SE ¼	1	13 South	9 East
T-3825-S-9	NW ¼ SW ¼ NE ¼	1	13 South	9 East

Amount of Water: Up to 3,000 afy. The diversion for any calendar year may be increased up to 4,500 acre-feet, provided that the sum of annual diversions for any consecutive five-year period does not exceed 15,000 acre-feet.

Purpose of Use: Municipal, Industrial, Commercial or Irrigation

Place of Use: Service area of the City of Alamogordo water system

CONDITIONS OF APPROVAL

1. Permit No. T-3825 thru T-3825-S-9 shall not be exercised to the detriment of valid existing water rights or in a manner that is contrary to the conservation of water within the state or detrimental to the public welfare of the State of New Mexico.
2. The total annual combined diversion of groundwater from Well Nos. T-3825 thru T-3825-S-9 under this permit shall not exceed 3,000 afy, except that the City may increase the total annual combined diversion of groundwater from said wells during any calendar year up to 4,500 acre-feet, provided that the sum of annual diversions for any consecutive five-year period does not exceed 15,000 acre-feet.
3. During any year in which groundwater is diverted from Well Nos. T-3825 thru T-3825-S-9 under this permit, the City's total annual groundwater diversions from said wells and wells under OSE File Nos. T-32 (La Luz Wells), T-33 (Prather Wells), T-814 (Golf Course Well), T-2408 (Landfill Well) and T-3489 (Cemetery Irrigation Well) combined shall not exceed 5,088 afy (2,088 + 3,000), or 6,588 (2,088 + 4,500) during a year in which the Applicant increases its diversions under Condition of Approval 2.
4. Prior to the drilling of Well Nos. RG-3825 thru RG-3825-S-9 under this permit, the City shall submit to the State Engineer an acknowledged statement, executed by the owner of the land upon which the wells are to be drilled, establishing that the permittee has permission to occupy such portion of the owners land as is necessary to drill and operate the wells.
5. Well Nos. RG-3825 thru RG-3825-S-9 shall be equipped with totalizing meters of a type and at locations approved by and installed in a manner acceptable to the State Engineer. The City shall provide in writing, the make, model, serial number, date of installation, initial reading, units, and dates of recalibration of each meter and any replacement meter used to measure the diversion of water under this permit. At a minimum, all meters shall be calibrated in accordance with industry standards annually and the results shall be submitted to the Office of the State Engineer.

6. Records of the amount of water diverted from Wells T-3825 through 3825-S-9 shall be submitted to the State Engineer on or before the 10th day of January, April, July and October for the preceding three (3) month period.

7. Prior to diversion of water under this permit, the permittee shall furnish to the State Engineer, such documents as the State Engineer may find necessary to establish that the City has assumed financial responsibility for deepening or replacement of Well No. T-4316 as necessary to sustain production of 3 afy from said well for forty years, or that the owner of Well No. T-4316 has waived or released any claim of liability against the permittee for injury resulting to such well from operations under this permit, or that the permittee has acquired the rights of such persons in such wells, or that the permittee and the owner of Well No. T-4316 have reached other mutually acceptable agreement concerning replacement of water from said well.

8. Prior to diversion of water under this permit, the permittee shall propose and implement a monitoring plan and system, acceptable to the State Engineer, involving the monitoring of water levels in wells and surface water flows. In July and January of each calendar year, the permittee shall measure water levels and total dissolved solids within the monitoring wells and surface flows. The permittee shall report the data to the State Engineer, in writing, on or before January 31 and July 31 of each calendar year.

9. The State Engineer may order the temporary suspension of all or a part of groundwater diversions under this permit if the water levels, total dissolved solids or surface water flows reported pursuant to Condition of Approval 8 above, indicate that impairment to valid existing senior rights to divert water is likely to occur or that groundwater decline rates within the Tularosa Underground Water Basin Administrative Area are likely to exceed those allowed by the TUBWAC as a result of the continued operation of Well Nos. RG-3825 thru RG-3825-S-9 at then current diversion levels.

10. Issuance of this permit is predicated upon the expectation that the permittee's annual water use will not exceed the product of the population within its service area for each year times 0.1848237 (165 gpcpd converted to afy). The permittee is

expected to reduce its water use during periods of extended drought consistent with appropriate drought management plans. Additionally, the permittee shall utilize the highest and best technology available to ensure ongoing conservation of water to the maximum extent practical. The permittee shall submit progress reports on its Water Conservation Plan on or before February 1st of every fifth year, commencing five years after the date of approval of this permit.

11. Proof of Completion of Work(s) shall be filed on or before May 15, 2009.

12. The permittee shall file Proof of Application of Water to Beneficial Use under this permit on or before May 15th of the fourth year after the permittee first puts water to beneficial use under this permit and shall file additional Proofs on or before May 15th of every fourth year thereafter for additional amounts of water put to beneficial use.

13. The State Engineer shall retain jurisdiction over this permit for the purpose of ensuring that exercise of the permit does not violate the forgoing conditions.

Respectfully submitted,

Victor Kovach
Hearing Examiner

I ACCEPT AND ADOPT THE REPORT AND RECOMMENDATION OF THE HEARING EXAMINER THIS 28th DAY OF December 2004.

JOHN R. D'ANTONIO, JR., P.E.
NEW MEXICO STATE ENGINEER

JOHN R. D'ANTONIO, JR. PE
NEW MEXICO
14846
STATE ENGINEER
REGISTERED PROFESSIONAL ENGINEER

PARTIES ENTITLED TO NOTICE

HU No. 02-035

I certify that a copy of the foregoing Report and Recommendation of the Hearing Examiner was mailed to the following parties on the 29th day of December 2004.

F. Eileen Serna, Administrator

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OFFICE OF THE
STATE ENGINEER
HEARINGS UNIT
SANTA FE, NM

BEFORE THE NEW MEXICO STATE ENGINEER

IN THE MATTER OF THE APPLICATION BY) CITY OF ALAMOGORDO FOR PERMIT TO) APPROPRIATE UNDERGROUND WATERS) FROM THE SHALLOW AQUIFER LOCATED) IN THE TULAROSA BASIN OF NEW MEXICO)	Hearing No. 02-035 OSE File No. T-3825 thru T-3825-S-9

ORDER STRIKING PARENTHETICAL AND DENYING APPLICANT'S MOTION TO SET ASIDE

This matter came before the State Engineer upon a Motion to Set Aside State Engineer's Decision and to Establish a Briefing Schedule for Clarification and/or Reconsideration of Certain Findings of Fact and Conditions of Approval (hereinafter "Motion to Set Aside"), filed by the City of Alamogordo on January 19, 2005. Having considered the matter, the State Engineer finds the following:

1. Clerical errors in Conditions of Approval 4, 5 and 9, on pages 16 and 17 of the State Engineer's Order and Decision Accepting and Adopting the Report and Recommendation of the Hearing Examiner (hereinafter "Decision"), signed on December 28, 2004, have been corrected by substitution made and entered in this matter on January 20, 2005.
2. The numbers in parentheticals in Condition of Approval No. 3 of the Decision, (2,088 + 3,000) and (2,088 + 4,500), were intended to illustrate how the figure for the combined limits immediately preceding the parentheticals was derived, and not intended to establish a separate limit of 2,088 afy on diversions from the City's Wells under OSE File Nos. T-32, T-33, T-814, T-2408 and T-3489 (hereinafter "other wells"), regardless of the amount of water diverted from Well Nos. T-3825 thru T-3825-S-9. For example, if the City were to divert 1,000 acre-feet from Well Nos. T-3825 thru T-3825-S-9 in a given year, pursuant to Condition of Approval No. 3, it could divert up to 4,088 acre-feet from its other wells, combined, in that same year. The City's combined diversions from its other wells would be limited to 2,088 acre-feet during years in which the diversions from Well Nos. T-3285 thru T-3285-S-

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Alamogordo
Exhibit 9

9 equal to or exceed 3,000 afy. The Condition does not apply during any year in which no groundwater is diverted from Well Nos. T-3825 thru T-3825-S-9.

3. To the extent that the first set of numbers in parentheticals in Condition of Approval No. 3 of the Decision may be interpreted to limit the City's annual combined diversions from its other wells to 2,088 acre-feet, during years when the City's groundwater diversions from Well Nos. T-3285 thru T-3285-S-9 are less than 3,000 acre-feet combined, they should be stricken from the State Engineer's Decision in this matter.

4. The City's comments and concerns as to Conditions of Approval No. 8 and 9 relate to a monitoring plan that the City must propose to the State Engineer and the State Engineer's ability to take action based on data reported pursuant to said plan. It would be premature to provide further interpretation, absent such proposal, and outside the context of a review of such proposal.

5. The City's concerns as to Condition of Approval 11 are in the nature of a request for extension of time, which is available under existing statute.

6. The language of Condition of Approval 12 clearly does not require the City to place the full amount of water to beneficial use within four years from the date its first places water to beneficial use under Permit No. T-3825 thru T-3825-S-9, rather the City is required to report that amount of water incrementally placed to beneficial use during a four-year period.

THEREFORE, the parenthetical "(2,088 + 3,000)", in line 5 of Condition of Approval No. 3 of the State Engineer's Decision Accepting and Adopting the Report and Recommendation of the Hearing Examiner in this Matter, signed on December 28, 2004, is hereby stricken and Applicant's Motion to Set Aside, filed on January 19, 2005, is denied.

IT IS SO ORDERED this 28th day of January 2005.

JOHN R. D'ANTONIO, JR., P.E.
NEW MEXICO STATE ENGINEER

PARTIES ENTITLED TO NOTICE

HU No. 02-035

I certify that a copy of the foregoing Order was mailed to the following parties on the 31st day of January, 2005.

F. Eileen Serna, Administrator

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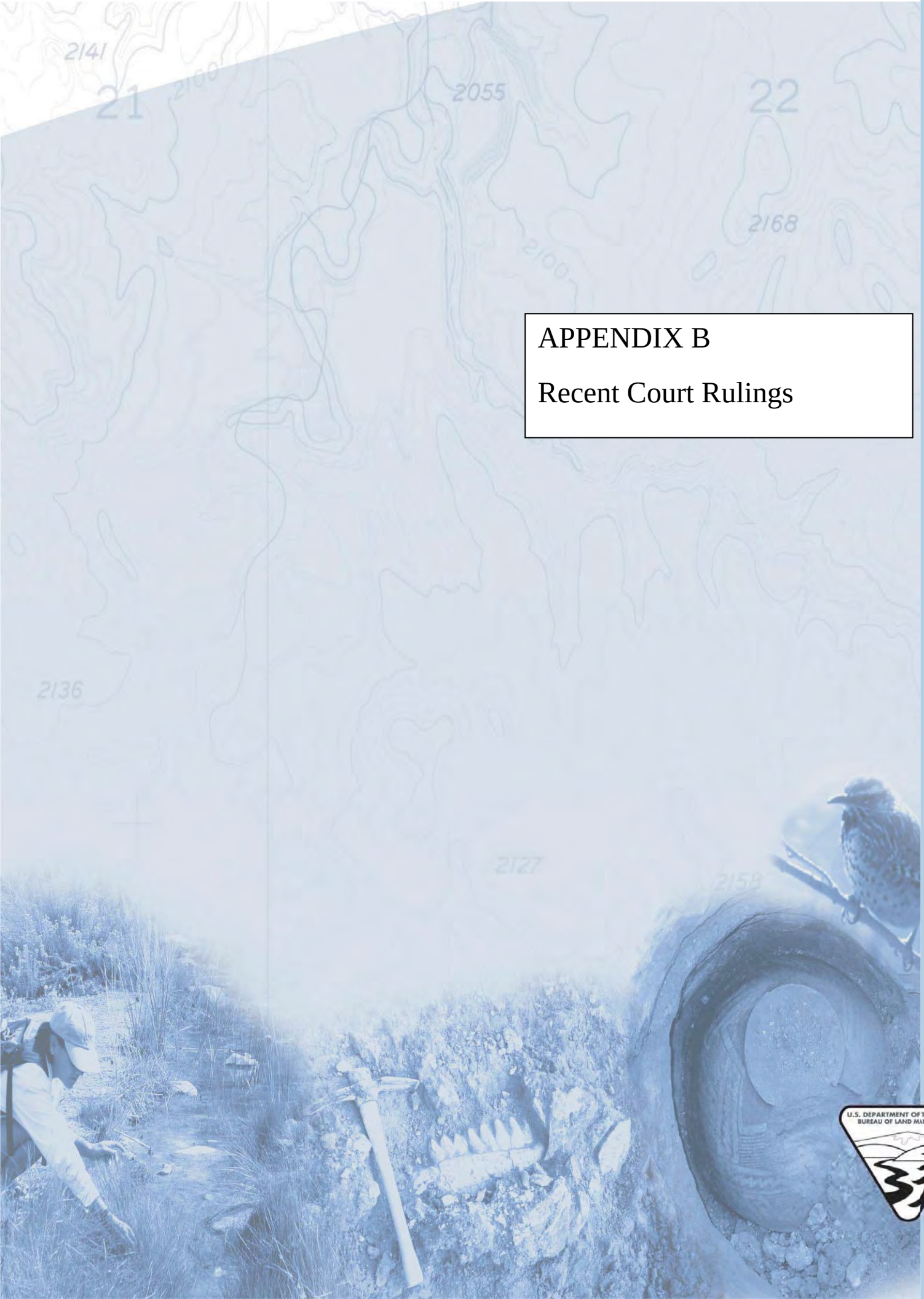
APPENDIX B

Recent Court Rulings



IN THE COURT OF APPEALS OF THE STATE OF NEW MEXICO

CITY OF ALAMOGORDO,

Applicant-Appellee,

and

TULAROSA COMMUNITY DITCH CORPORATION, DAN C. ABERCROMBIE, ELSIE I. BAILEY, LAYMON HIGHTOWER, deceased, and ALLEN (BILL) TRAMMELL,

Protestants-Appellants,

v. **NO. 28,643**

NEW MEXICO STATE ENGINEER, JOHN R. D'ANTONIO, JR.,

Interested Party-Appellee,

APPEAL FROM THE DISTRICT COURT OF OTERO COUNTY
James Waylon Counts, District Judge

Stein & Brockmann, P.A.
James C. Brockmann
Jay F. Stein
Seth R. Fullerton
Santa Fe, NM

Katherine W. Hall, P.C.
Katherine W. Hall
Santa Fe, NM

City of Alamogordo
Steve Thies, City Attorney
Alamogordo, NM

for Applicant-Appellee

Peter Thomas White
Santa Fe, NM

for Protestants-Appellants

DL Sanders, Chief Counsel
Hilary Lamberton, Special Assistant Attorneys General
Office of the State Engineer
Santa Fe, NM

William D. Teel, Special Assistant Attorney General
Albuquerque, NM

for Appellees John R. D'Antonio, Jr. and New Mexico State Engineer

MEMORANDUM OPINION

BUSTAMANTE, Judge.

The Tularosa Community Ditch Corporation, Dan C. Abercrombie, Elsie I. Bailey, Laymon Hightower (deceased), and Allen (Bill) Trammell (Protestants) appeal the decision of the district court approving a permit for the City of Alamogordo (Alamogordo) to appropriate brackish groundwater within the Tularosa Underground Water Basin (Tularosa Basin). At issue on appeal is whether the district court was justified in its ruling that (1) the appropriation is not detrimental to public welfare and will not adversely impact existing water rights, (2) there are appropriable

water rights remaining in the Tularosa Basin, (3) the permit adequately limits the total amount of water that Alamogordo may appropriate, and (4) the appropriation is not contrary to the conservation of water. We find substantial evidence in support of the district court's ruling and affirm its decision to approve Alamogordo's permit to divert brackish water from the Tularosa Basin.

BACKGROUND

In September 2000 Alamogordo filed applications for wells T-3825 through T-3825-S-9 seeking to divert a combined total not to exceed 13,450 acre-feet per year (afy) of brackish water from the Tularosa Basin. These wells are located at the "Snake Tank Well Field" north of the Village of Tularosa and outside of the Tularosa Underground Water Basin Administrative Criteria (TUWBAC) area. The water diverted from these wells will be treated by desalination to produce potable water to be transported via pipeline for beneficial use in Alamogordo's water service area.

The Office of the State Engineer initially issued a permit for the T-3825 wells to allow diversions of up to 3,000 afy, with a provision that up to 4,500 afy could be diverted in any one year, provided that the total diversion over any five-year period did not exceed 15,000 acre-feet. Protestants, along with several other parties, appealed the decision of the OSE to the district court. The other parties ultimately withdrew their protests after entering into settlement agreements with Alamogordo.

Alamogordo itself was also dissatisfied with the permit issued by the OSE and submitted its own appeal to the district court. Alamogordo and the OSE ultimately entered into a settlement agreement resolving their disputes, and a revised permit was issued.

The revised permit would allow Alamogordo to divert up to 4,000 afy from the T-3825 wells with a provision that up to 5,000 afy may be diverted in any one year, provided that the total diversion over any five-year period did not exceed 20,000 acre-feet. The revised permit contains twelve conditions of approval, including requirements that groundwater levels and quality be monitored and reported to the OSE annually and that diversions under the permit be suspended if there are indications that valid senior water rights will likely be impaired or that water levels will fall beneath those acceptable under the TUWBAC. After a de novo review, the district court ordered that the revised permit be approved based on its findings and conclusions that there was unappropriated water within the Tularosa Basin, that existing water rights would not be impaired by granting the permit, and that granting the permit would not be contrary to conservation or public welfare.

STANDARD OF REVIEW

The district court entered 136 findings of fact and twenty-one conclusions of law in support of its order approving the revised permit. Although Protestants argue

for a de novo review, the issues raised on appeal involve only evidentiary challenges. Thus we apply a substantial evidence standard of review. *See Bishop v. Evangelical Good Samaritan Soc'y*, 2009-NMSC-036, ¶ 25, 146 N.M. 473, 212 P.3d 361 (applying a substantial evidence standard where no legal questions remain). "Substantial evidence is such relevant evidence that a reasonable mind would find adequate to support a conclusion." *Landavazo v. Sanchez*, 111 N.M. 137, 138, 802 P.2d 1283, 1284 (1990). In reviewing a substantial evidence claim, "[t]he question is not whether substantial evidence exists to support the opposite result, but rather whether such evidence supports the result reached." *Las Cruces Prof'l Fire Fighters v. City of Las Cruces*, 1997-NMCA-044, ¶ 12, 123 N.M. 329, 940 P.2d 177 (filed 1996). "Additionally we will not reweigh the evidence nor substitute our judgment for that of the fact finder." *Id.* "When the trial court's findings of fact are supported by substantial evidence, . . . refusal to make contrary findings is not error." *Griffin v. Guadalupe Med. Ctr., Inc.*, 1997-NMCA-012, ¶ 22, 123 N.M. 60, 933 P.2d 859.

DISCUSSION

I. Substantial Evidence Supports the District Court's Conclusion That Approval of the Revised Permit is Not Detrimental to Public Welfare and Will Not Adversely Impact Existing Water Rights

Protestants argue that approval of the revised permit is detrimental to public welfare and will impair existing water rights for several reasons. First, Protestants

argue that approving the revised permit may conflict with the desires of existing water rights holders wishing to maintain current supplies. Protestants also argue that the criteria found in TUWBAC provide an insufficient basis for an appropriation when a local jurisdiction has adopted a separate water policy. Specifically, TUWBAC relies on a forty-year water-planning horizon and allows annual drawdowns of up to two-and-a-half feet per year, while Otero County's Comprehensive Plan anticipates expanding to a sixty-year water planning horizon and encourages a reduction in annual drawdown to no more than one foot per year. Protestants assert that instead of relying on the TUWBAC criteria, the district court should have adopted the criteria from the Otero County Comprehensive Plan to guide its analysis.

Several of the district court's findings support the conclusion that approval of the revised permit would not impair existing water rights. The district court found that the Tularosa Community Ditch Association's water rights would not be impaired or reduced. The district court relied on evidence that the Tularosa Community Ditch Association's point of diversion was "located within the mountain block [, which] means that the surface water supply to the ditch, which is derived from precipitation run-off and mountain block aquifer discharge upgradient of the basin fill aquifer, will not be impaired by pumping of water in the basin fill." The Protestants do not challenge any of the evidence supporting this finding.

With respect to well impairment, the district court considered the effects of the revised permit based on the results of the OSE's groundwater flow model. It noted that this model was the most conservative of the three models currently available, in that it likely over-estimates drawdowns and under-estimates recharge. The court noted that the question of impairment may depend on several factors, including the age and depth of a well, its construction characteristics, and the amount of time it would take for the effects of Alamogordo's pumping to reach it. Taking the groundwater model and these factors into consideration, the district court found that approval of the revised permit would not result in impairment of existing rights. It also found that if any signs of impairment were to develop, the conditions of approval for the revised permit would allow the OSE to take action to protect senior rights. Protestants argue that the district court should have accepted or credited other evidence on this issue. Again, we do not reweigh evidence or substitute our own judgment for that of the fact finder. *Las Cruces Prof'l Fire Fighters*, 1997-NMCA-044, ¶ 12.

Furthermore, Protestants' assertion that the revised permit is inconsistent with public welfare as described by the Otero County Comprehensive Plan is somewhat misplaced. Protestants fail to note that the County's plan itself contains statements supporting the revised permit. Specifically, the plan endorses "desalinating the

abundant Tularosa Basin Aquifer." It also states that the County supports the efforts of the OSE and "utilizes its guidelines in making decisions on water use within the County." Finally, we note that approval of the revised permit in no way prevents Otero County from following through with its objectives to "continue to work with State authorities to better understand the aquifer" and to promote water conservation and aquifer management to reduce aquifer depletion rates.

Even assuming that inconsistencies exist, Protestants' evidentiary challenge falls short. The district court recognized that a regional water plan may consider the public welfare of a region, but that the OSE must consider the welfare of the State as a whole. It found that approval of the permit to appropriate brackish groundwater in order to convert it to potable water creates a benefit to the public welfare of New Mexico by reducing demand on existing fresh water supplies. Protestants do not challenge these findings. Absent a more substantial challenge, we cannot conclude that the district court's findings in this area were unsupported. *See* Rule 12-213(A)(4) NMRA.

II. Substantial Evidence Supports the District Court's Conclusion That There are Unappropriated Water Rights Sufficient to Satisfy the Appropriation Under the Revised Permit

Protestants' argument that the district court erred in finding that there is unappropriated water within the Tularosa Basin is unfounded. It relies on assertions

that the district court lacked authority to make such a determination because the basin is rechargeable and the appropriation is more than de minimis. Even assuming that Protestants present a valid legal distinction based on whether or not a basin is rechargeable, Protestants cannot demonstrate that there is no support for the district court's findings of fact that there is appropriable water within the Tularosa Basin.

The district court relied on recent measurements showing that water levels in the Tularosa Basin have not declined to the extent previously predicted. Furthermore, it found that groundwater levels actually rose between 1982, when TUWBAC was initially implemented, and 1995, and that as recently as 2004 water levels still remained higher than those measured in 1982. These findings tending to show the availability of appropriable water are supported by the testimony of Eric Keyes and John Shomaker. Protestants do not challenge these findings, and even assuming that these facts were controverted, we cannot reweigh the evidence on appeal. *Las Cruces Prof'l Fire Fighters*, 1997-NMCA-044, ¶ 12.

III. The District Court's Approval Properly Limits Alamogordo's Appropriation

Protestants argue that "[t]he most significant error in the Revised Permit and condition [nine] in particular is that it does not . . . quantify or limit Alamogordo's total diversion of water from all surface and ground water sources of supply." Condition nine expresses an expectation that Alamogordo's annual water usage will

not exceed 165 gallons per capita per day (gpcpd). Protestants argue that, rather than stating an "expectation," this condition should be phrased as an absolute limit. Otherwise, Protestants assert Alamogordo could pump water in excess of its needs from the Snake Tank Well Field, even in years when it could otherwise satisfy all its needs from other sources.

We find evidence in support of the district court's findings that the revised permit is reasonably limited. Protestants do not acknowledge that condition nine also requires Alamogordo to "utilize the highest and best technology available to ensure ongoing conservation of water to the maximum extent practical." Protestants also fail to acknowledge the limit imposed by condition two of the revised permit:

> The total annual combined diversion of groundwater from Well Nos. T-3825 thru T-3825-S-9 under this permit shall not exceed 4,000 afy, except that the City may increase the total annual combined diversion of groundwater from said wells during any calendar year up to 5,000 acre-feet, provided that the sum of annual diversions for any consecutive five-year period does not exceed 20,000 acre-feet.

Contrary to Protestants' argument, the district court did in fact find adequate safeguards to ensure that Alamogordo actively conserves water by not-over pumping during years where its other water sources produce strong yields. Specifically, in addition to the conditions in the permit, the district court found that Alamogordo has undertaken significant water conservation measures in recent years by using reclaimed water for all of its public green spaces, by passing conservation ordinances

that include restrictions on outdoor watering and a rate system with tiered billing based on use, and by passing an ordinance establishing an emergency plan for heightened conservation measures in times of drought. Finally, based on the expert testimony of Len Stokes, the district court found that Alamogordo would "first use its high quality, limited surface water sources, then phase-in use of its existing lesser quality groundwater sources, and lastly, would phase-in use of the mineralized brackish water from the proposed T-3825 well field." Protestants do not directly challenge any evidence supporting these findings, which tend to show that water under the revised permit will not only be used judiciously, but also only as the last of three sources.

IV. The District Court's Findings That the Revised Permit Will Not be Contrary to Conservation are Supported by Substantial Evidence

Protestants argue that Alamogordo's use of 165 gpcpd in order to project its future water needs is excessive. Protestants argue that Alamogordo's water needs should have instead been projected based on a maximum usage of 143 gpcpd. Protestants assert that this is more reasonable because from 2000-2005, Alamogordo consumed on average only 139 gpcpd.

While Protestants argue that the district court could have imposed a lower usage rate, they fail to acknowledge evidence supporting a usage rate of 165 gpcpd. For example, the district court reviewed the gpcpd consumption of thirteen other

southwestern cities. Alamogordo's benchmark of 165 gpcpd is lower than eight of the other cities, and the field of thirteen is bookended by El Paso, Texas, at the low end consuming 142.6 gpcpd, and Scottsdale, Arizona, at the high end consuming 322.8 gpcpd. The court also noted that 165 gpcpd compared favorably with the Village of Tularosa's 241 gpcpd, Holloman Air Force Base's 300 gpcpd, and Las Cruces' 230 gpcpd (with a goal of 180 gpcpd). Based on this evidence, the district court found that use of 165 gpcpd was reasonable and consistent with usage by other southwestern cities.

Based on reports and testimony by Jim Sizemore about water usage in other cities, the district court found that 165 gpcpd was an effective limit to impose on the city as it grows and that converting brackish water to potable water to meet this demand promotes conservation of potable water. Although Protestants' push for a lower gpcpd is understandable, we cannot conclude that use of the 165 gpcpd standard was unreasonable in light of the evidence of water usage in other cities and Alamogordo's notable conservation efforts.

CONCLUSION

For the foregoing reasons, we affirm the decision of the district court.

IT IS SO ORDERED.

MICHAEL D. BUSTAMANTE, Judge

WE CONCUR:

_____

CYNTHIA A. Fry, Chief Judge

_____

LINDA M. VANZI, Judge

STATE OF NEW MEXICO
COUNTY OF OTERO
TWELFTH JUDICIAL DISTRICT COURT

CITY OF ALAMOGORDO,

Applicant-Appellant,

and

DAVID AND JULIA CHRISTOPHER,

Protestants-Appellants

and

TULAROSA COMMUNITY DITCH CORPORATION, DAN C. ABERCROMBIE, ELSIE I. BAILEY, LAYMON HIGHTOWER, DAVID RANKIN and ALLEN (BILL) TRAMMELL,

Protestants-Appellants,

v.

NEW MEXICO STATE ENGINEER, JOHN R. D'ANTONIO, JR.,

Appellee, and

HFR CORPORATION and THREE RIVERS CATTLE LTD. CO.

Protestants-Appellees.

No. CV-05-019 (Consolidated)
Division II

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MINUTE ORDER

THIS MATTER came before the Court for trial on the merits. Applicant - Appellant, City of Alamogordo, appeared through counsel, James C. Brockmann. Protestants - Appellants, Tularosa Community Ditch Corporation, Dan C. Abercrombie, Elsie I. Bailey, Laymon Hightower, David Rankin, and Allen (Bill) Trammel, appeared through counsel, Peter Thomas White. Appellee, New

Mexico State Engineer, John R. D'Antonio, appeared through Special Attorney General, William Teel. The Court having taken testimony, heard arguments of counsel, and being otherwise fully advised in the premises makes the following findings of fact and conclusions of law,

FINDINGS OF FACT

1. On September 6, 2000, the Applicant, City of Alamogordo filed Applications T-3825 through T-3825-S-9, seeking to appropriate 1,500 acre-feet per year, (afy), per well, of "brackish water" from the Tularosa Underground Basin within the state of New Mexico. Alamogordo Exhibit 4 – Applications.

2. City Applications T-3825, *et al.*, proposed that the wells would be drilled on property owned by the United States Department of the Interior, Bureau of Land Management, and sought permission to divert an amount of water from proposed wells T-3825 through T-3825-S-9, combined, not to exceed 13,450 afy for municipal, industrial, commercial, or irrigation anywhere within Otero County, New Mexico. Alamogordo Exhibit 4 – Applications.

3. The water subject to appropriation is brackish groundwater with total dissolved solids ("TDS") in the range of 2,500 milligrams per liter ("mg/l") that will be treated by desalination to potable water standards and transported via pipeline for beneficial use in the service area of the City of Alamogordo for municipal, industrial, commercial, or irrigation purposes. Alamogordo Exhibit Nos. 4; 7; 14; 21; 25.

4. City Applications T-3825, *et al.*, proposed that the wells would be drilled to an approximate depth of 1000 feet, with a 14 inch outside diameter casing and the water, with total dissolved solids concentration of approximately 2,500 parts per million, would be treated to reduce the concentration of dissolved solids. Alamogordo Exhibit 4 – Applications.

5. On April 22, 2003, a State Engineer Hearing Unit Order was entered approving a Motion to Amend the Alamogordo Applications to request a diversion of 10,000 afy. Alamogordo Exhibit 6.

6. The priority date for Alamogordo Applications T-3825 through T-3825-S-9 is September 6, 2000. State Engineer Exhibit 8 – 12/22/2006 Report of Andrea Mendoza.

7. In October, 2003, an administrative hearing was held on the Alamogordo Applications T-3825, *et al.* by the State Engineer's designated Hearing Examiner. Alamogordo Exhibit 7 – Report and Recommendation and Decision filed December 29, 2004.

8. In his decision of December 28, 2004, the State Engineer partially approved the Alamogordo Applications, but restricted the total annual T-3825 well field diversion to 3,000 acre-feet per year, (afy), with a provision that up to 4,500 afy could be diverted as long as the sum of any consecutive five year period did not exceed 15,000 acre-feet. Alamogordo Exhibit 7 – Report and Recommendation and Decision filed 12/29/04.

9. The State Engineer permit of December 28, 2004 included thirteen Conditions of Approval to insure that the exercise of the permit would not impair existing senior water rights. Alamogordo Exhibit 7 – Report and Recommendation and Decision filed 12/29/04, with attached Order, signed 12/28/04.

10. David and Julia Christopher, owners of land near the City's T-3825 well field, protested the City Applications, but prior to the district court's *de novo* appellate trial of this matter, (Otero County Civil Cause No. CV-05-019 (Consolidated), Division II), the Christophers withdrew their protest and entered into a settlement agreement with the City. Alamogordo Exhibit 20 – Stipulated Agreement between Christophers and Alamogordo.

11. As a result of the settlement agreement between the City and the Christophers, Condition of Approval No. 7 of Permit No. T-3825 *et al.* is no longer applicable. Alamogordo Exhibit 7 at 17, ¶7.

12. In the settlement agreement between the City and the Christophers, the Christophers waived any claim of impairment and waived any and all effects to their water rights that may be caused by the exercise of Permit No. T-3825 *et al.* or any revisions thereto that allow diversions of 10,000 afy or less. Alamogordo Exhibit 20 at 2-3, ¶¶3, 5.

13. Alamogordo and the Village of Tularosa entered into an agreement on July 2, 2003, by which the City would sell bulk water to the Village of Tularosa, "to the extent allowed by Permit No. T-3825 through T-3825-S-9." Alamogordo Exhibit 19 – Agreement between Alamogordo and Village of Tularosa.

14. The State Engineer permit of December 28, 2004, did not allow Alamogordo to sell water to the Village of Tularosa, but, instead, limited the use of water under the permit to the "Service area of the City of Alamogordo water system." Alamogordo Exhibit 7 – Report and Recommendation and Decision filed 12/29/04.

15. HFR Corporation and Three Rivers Cattle Ltd., Co. each protested the City Applications T-3825, *et al.*, but prior to the district court's *de novo* appellate trial of this matter, (Otero County Civil Cause No. CV-05-019 (Consolidated), Division II), each of these protestants withdrew its protest and entered into a joint settlement agreement with the City. Alamogordo Exhibit 22, Settlement Agreement between and among the City, HFR Corporation and Three Rivers Cattle Ltd., Co.

16. The following individuals and entities appealed from the State Engineer's December 28, 2004, Permit and participated in the trial *de novo* appeal to the district court as the

"Tularosa Protestants": Tularosa Community Ditch Corporation, Dan C. Abercrombie, Elsie I. Bailey, Laymon Hightower, and Bill Trammell. Notice of Appeal filed with the Clerk of the Court on January 26, 2005.

17. David Rankin, originally a member of the Tularosa Protestant group withdrew from the group and was dismissed from this action on approximately January 9, 2008. Order dismissing Mr. Rankin from the case filed on approximately January 9, 2008.

18. The City was dissatisfied with the Permit issued by the State Engineer on December 28, 2004, and appealed to the District Court of Otero County pursuant to law. Notice of Appeal filed with the Clerk of the Court on January 21, 2005.

19. During the period of time following the October 2003 Administrative Hearing, the State Engineer and the City entered into settlement negotiations. Testimony of Jim Sizemore.

20. In July, 2007, the State Engineer and the City entered into a Settlement Agreement by which all of the issues relating to City Applications T-3825, *et al.* and the State Engineer Permit were resolved. Alamogordo Exhibit 21 – Settlement Agreement Between State Engineer and City.

21. The Settlement Agreement between the State Engineer and the City includes a "Revised Permit," attached to the Agreement as Exhibit 1. Alamogordo Exhibit 21 – Settlement Agreement Between State Engineer and City.

22. Pursuant to ¶ 21, p. 5, of the Settlement Agreement between the State Engineer and the City, those parties jointly request that the court approve the Revised Permit and remand this matter to the State Engineer for "reissuance of the Permit in a manner consistent with Exhibit No. 1." Alamogordo Exhibit 21 – Settlement Agreement Between State Engineer and City.

23. Water may only be delivered to the Village of Tularosa, under the Revised Permit, if the Village of Tularosa requires emergency bulk water, and an appropriate application is filed with

the State Engineer. Testimony of Jim Sizemore and Alamogordo Exhibit 21 – Settlement Agreement Between State Engineer and City, ¶ 20.

24. If an emergency exists, as set forth in the Revised Stipulation between the City and the Village of Tularosa, and if the necessary State Engineer permits are obtained, the City may deliver water to the Village of Tularosa on a temporary basis. Testimony of Jim Sizemore and Alamogordo Exhibit 21 – Settlement Agreement Between State Engineer and City, ¶ 20.

25. The proposed Revised Permit, (Exhibit 1 to the State Engineer/City Settlement Agreement), (hereafter the Revised Permit), would allow the City to divert up to 4,000 afy of water from the T-3825 well field, with a provision for up to 5,000 afy in any one year, provided the sum of annual diversions for any consecutive five-year period does not exceed 20,000 acre-feet, (hereafter referred to as 4,000 afy). Alamogordo Exhibit 21 – Settlement Agreement Between State Engineer and City, Exhibit 1, Condition of Approval 2.

26. There is unappropriated water available to satisfy the proposed diversion of up to 4,000 afy, pursuant to the terms of the Revised Permit. Testimony of Eric Keyes and John Shomaker.

27. Based on 1983 simulations run using the initial State Engineer groundwater flow model, (the OSE Morrison Model), groundwater levels in the Tularosa Basin were projected to decline. Testimony of Eric Keyes.

28. Recent measurements have shown that groundwater levels in the Tularosa Basin have not declined to the extent predicted by earlier simulations using the Morrison model. Testimony of Eric Keyes.

29. Dan C. Abercrombie owns land in the Tularosa area and has a well on that land in which he reports depth to water in 1992 was 163 feet below measuring point, and depth to water in 2000 was 165 feet below measuring point. Testimony of Dan C. Abercrombie.

30. The Tularosa Community Ditch Corporation provides surface water for irrigation of land to individuals in the Tularosa area. Testimony of Norval Bookout, President Tularosa Community Ditch Corporation.

31. Individuals who use water from the Tularosa Community Ditch must own water right shares from the ditch. Testimony of Norval Bookout, President Tularosa Community Ditch Corporation.

32. Mr. Bookout holds five water right shares on the Tularosa Community Ditch and irrigates 40 acres with that water. Testimony of Norval Bookout, President Tularosa Community Ditch Corporation.

33. The Tularosa Community Ditch has an adequate supply of water to meet the needs of its water right holders. Testimony of Norval Bookout, President Tularosa Community Ditch Corporation.

34. The point of diversion for the Tularosa Community Ditch Association ditch is located on the Rio Tularosa, within the lower mountainous region, bordering the eastern edge of the Tularosa Basin and is within the mountain block. Testimony of Eric Keyes.

35. The point of diversion for the Tularosa Community Ditch Association ditch is located in an area designated as an inactive zone within the current State Engineer groundwater flow model for the Tularosa Basin. Testimony of Eric Keyes.

36. The fact that the point of diversion for the Tularosa Community Ditch Association ditch is located within the mountain block means that the surface water supply to the ditch, which

is derived from precipitation run-off and mountain block aquifer discharge upgradient of the basin fill aquifer, will not be impaired by pumping of water in the basin fill. Testimony of Eric Keyes.

37. The City's requested diversion of up to 4,000 afy from its proposed T-3825 well field would not impair or reduce the supply of water to the Tularosa Community Ditch Association point of diversion. Testimony of Eric Keyes.

38. Pat McCourt is the Alamogordo City Manager and is familiar with the City's water supply and water needs and the City's efforts toward conservation of water. Testimony of Pat McCourt.

39. The City uses water that is "reclaimed" treated effluent from its sewage treatment plant for watering public green spaces. Testimony of Pat McCourt.

40. In recent years, the City has spent seventeen million dollars, ($17,000,000), to improve its water infrastructure, and these improvements include improvements to collection systems in the mountains, construction of an additional covered storage reservoir and replacement of water lines to reduce leakage. Testimony of Pat McCourt.

41. The City has passed conservation ordinances that include restrictions on outdoor watering and a rate system with tiered billing based on use. Testimony of Pat McCourt.

42. The City has passed an ordinance establishing an emergency plan for more severe conservation measures in the time of drought. Testimony of Pat McCourt.

43. The Revised Permit, in Condition of Approval No. 9, requires the City to reduce its water use during periods of extended drought. Alamogordo Exhibit 21 and testimony of Jim Sizemore.

44. The Revised Permit, in Condition of Approval No. 9, requires the City to utilize the highest and best technology available to ensure ongoing conservation of water to the maximum extent practical. Alamogordo Exhibit 21 and testimony of Jim Sizemore.

45. In the mid-1990's, potable water use in the City of Alamogordo was 250 gallons per capita per day, (gpcd). Testimony of Pat McCourt.

46. Since the mid-1990's, the City has substantially reduced its per capita potable water usage. Testimony of Pat McCourt.

47. A per capita usage rate of 165 gpcd for the City of Alamogordo is reasonable. Testimony of Pat McCourt and Jim Sizemore.

48. Potable water use of 165 gpcd by the City of Alamogordo would not be inconsistent with the usages of other Southwestern cities. Testimony of Pat McCourt; testimony and Report of Jim Sizemore, State Engineer Exhibit 2.

49. Len Stokes testified as an expert in water rights and water rights administration. Testimony of Len Stokes.

50. The City has historically relied on a combination of surface water and groundwater to meet its potable water needs. Testimony of Len Stokes.

51. One of the City's surface water rights is the La Luz flow rate right, which is designated as a 16 cubic feet per second right, and which the City could take, if available, 24 hours per day, 7 days per week, for the entirety of any year. Testimony of Len Stokes.

52. The amount of actual water availability via the La Luz flow rate right is very inconsistent and the designated La Luz flow rate is only rarely available. Testimony of Len Stokes.

53. The City has other existing groundwater well fields, but production from those wells is limited, in part, by natural deleterious conditions, including iron bacteria. Testimony of Len Stokes.

54. The City's existing well fields cannot be expanded by drilling wells due to the probability of impairment of existing senior water rights because the wells are located in a critical management area which means that no new appropriations are allowed. Testimony of Len Stokes.

55. The City's current short term water strategy includes conservation, development of reclaimed water, and rationing if necessary. Testimony of Len Stokes.

56. The City's long-term water plan requires a new "independent" source of water, and the use of brackish groundwater will meet that requirement. Testimony of Len Stokes.

57. If the Revised Permit is approved, the City would continue to first use its high quality, limited surface water sources, then phase-in use of its existing lesser quality groundwater sources, and lastly, would phase-in use of the mineralized brackish water from the proposed T-3825 well field. Testimony of Len Stokes.

58. Eddie C. Livingston is a registered Professional Civil Engineer in New Mexico, Arizona and California and testified as an expert in this case. Testimony of Eddie C. Livingston and Alamogordo Exhibit 23, Resume of Eddie C. Livingston.

59. Mr. Livingston engages in a private engineering practice in which he advises municipalities regarding water supply, water demand, population projection, and other water planning issues including the development of 40-Year Water Development Plans. Testimony of Eddie C. Livingston.

60. A municipal potable water demand of 165 gpcd is very conservative and is in accord with A Water Conservation Guide for Public Utilities, a 2001 State Engineer publication authored

by Brian Wilson, the former chief of the Water Use and Conservation Bureau. Testimony of Eddie C. Livingston.

61. A municipal potable water demand of 165 gpcd for the City of Alamogordo compares favorably with other municipalities in the area, including the Village of Tularosa's 241 gpcd, Holloman Air Force Base's 300 gpcd, Las Cruces' 230 gpcd, (with a goal of 180 gpcd), and Tucson's 165 gpcd. Testimony of Eddie C. Livingston.

62. Alternatives to the City's Applications T-3825, *et al.* were explored, including importing water from the Salt Basin, but the desalination project was the only viable solution for the City. Testimony of Eddie C. Livingston.

63. Desalination feasibility studies were conducted and the initial test indicated an 84% efficiency, but a more recent test indicated an 80% efficiency in converting brackish water to fresh water. Testimony of Eddie C. Livingston.

64. An advantage to utilizing the proposed T-3825 brackish well field groundwater source for the City is that it is "drought resistant." Testimony of Eddie C. Livingston.

65. Utilization of brackish groundwater for desalination for municipal use does not waste water, but instead saves water by adding to the usable fresh water supply. Testimony of Eddie C. Livingston.

66. Utilization of brackish groundwater for desalination for municipal use is not contrary to the conservation of water, and creates a benefit to the public welfare of New Mexico by reducing demand on existing fresh water supplies. Testimony of Eddie C. Livingston.

67. Dr. John W. Shomaker holds a B.S. degree in geology, a Masters degree in geology, a Masters degree in hydrogeology and a Ph.D. in hydrogeology. Testimony of Dr. John W. Shomaker and Alamogordo Exhibit 27, Resume of Dr. John W. Shomaker.

68. Dr. Shomaker testified as an expert in hydrogeology and interpretation of pump tests. Testimony of Dr. John W. Shomaker.

69. Dr. Shomaker engages in groundwater modeling and has done about 20 groundwater models. Testimony of Dr. John W. Shomaker.

70. In the Alamogordo project, Dr. Shomaker assisted Eddie C. Livingston in the choice of a location for the proposed T-3825 well field and he and his staff conducted groundwater modeling of the basin and supervised the drilling and test pumping of the test wells and interpretation of those aquifer tests. Testimony of Dr. John W. Shomaker.

71. Of three currently considered groundwater flow models of the Tularosa Basin, (the JSAI, model prepared by John Shomaker & Associates, Inc., the Huff USGS model, and the current State Engineer model), the State Engineer model provides the most conservative simulation of the effects of pumping. Testimony of Dr. John W. Shomaker.

72. A model is considered conservative when it predicts more aquifer drawdown or recognizes lower levels of recharge, resulting in greater simulated aquifer drawdown, or both. Testimony of Dr. John W. Shomaker.

73. In 1982 the State Engineer instituted the Tularosa Underground Water Basin Administrative Criteria, (hereafter the Basin Guidelines), which provide that a maximum of 2.5 feet of drawdown per year in an administrative area cell will be allowed. Testimony of Dr. John W. Shomaker.

74. When the Basin Guidelines were established in 1982, the State Engineer Morrison model simulations predicted drawdowns in the area, but water levels actually rose until 1995, and in 2003 and 2004, water levels were higher than in 1982. Testimony of Dr. John W. Shomaker.

75. In the Tularosa Basin, wells generally can be deepened to restore production of water. Testimony of Dr. John W. Shomaker and Eric Keyes.

76. There will be no impairment to any of the Protestants' wells, or to the diversion point of the Tularosa Community Ditch Association's irrigation ditch, and to the extent any impairment occurs, the thirteen Conditions of Approval in the proposed revised permit will allow the State Engineer to take action to protect senior water rights. Testimony of Dr. John W. Shomaker.

77. Eric J. Keyes holds a Bachelor of Science in Mathematics and a Master of Science in Hydrology and has worked as a hydrologist for the State Engineer, in the Hydrology Bureau, since 1998. Testimony of Eric Keyes, and State Engineer Exhibit 3, Resume of Eric J. Keyes.

78. Within the context of a review by a State Engineer hydrologist of an application for use of water, an evaluation of possible impacts to surface and groundwater is included. Testimony of Eric Keyes.

79. In conducting the evaluation of City Applications T-3825, *et al.*, a groundwater flow model was utilized. Testimony of Eric Keyes.

80. In constructing a groundwater flow model, various elements of the basin characteristics are represented mathematically in the model, including basin recharge, existing basin water depletions, including pumpage and evapotranspiration and water-bearing properties of the aquifer including transmissivity. Testimony of Eric Keyes.

81. A groundwater flow model can be calibrated by checking predicted water levels to actual water levels in wells in the model area. Testimony of Eric Keyes.

82. The State Engineer model is conservative, meaning that it probably over-estimates aquifer drawdowns and may under-estimate recharge to the Tularosa Basin. Testimony of Eric Keyes.

83. The groundwater flow model is used to predict future drawdown in the region, first, without applicant pumping, and second, with applicant pumping. Testimony of Eric Keyes.

84. The State Engineer groundwater flow model was run to simulate City pumping of the T-3825 well field, at amounts of both 3,000 afy and 4,000 afy. Testimony of Eric Keyes.

85. Tables of effects to local wells based on proposed City diversions of 3,000 afy and 4,000 afy were derived from the State Engineer Model output, and are shown in State Engineer Exhibit 5, p. 4. Testimony of Eric Keyes and State Engineer Exhibit 5.

86. In considering whether City pumping will impair existing senior water rights, several factors are considered, which include the age of a well, depth of a well, construction characteristics of a well, and the time it will take for the City pumping effects to reach the well. Testimony of Eric Keyes.

87. The State Engineer model included the area in which the Village of Tularosa is located, and the 4,000 afy analysis showed no applicant-induced impairment to wells in the Tularosa area. Testimony of Eric Keyes.

88. The State Engineer model utilized a transport model component which shows that local groundwater salinity will increase very slightly, if at all, due to the proposed T-3825 well field pumping. Testimony of Eric Keyes.

89. The State Engineer model simulates continuous City diversions of 4,000 afy from the first day the Permit is approved through the end of the 40-year planning period, but this will not happen, as the City's diversions will increase over time, eventually reaching 4,000. Testimony of Eric Keyes.

90. The proposed City T-3825 well field is located outside of the Basin Guidelines area. Testimony of Eric Keyes.

91. Basin Guidelines do not apply to applications to appropriate water appropriated from points of diversion outside of the Guideline area, but according to the Guidelines, any such application is to be considered on a case-by-case basis. Testimony of Eric Keyes, testimony of Jim Sizemore and testimony of John Shomaker.

92. If the Permit is granted for 4,000 afy, or a five-year total diversion not to exceed 20,000 acre-feet, the City's diversions will not impair existing senior water rights in the Tularosa Basin. Testimony of Eric Keyes.

93. Doug Rappuhn holds a Bachelor of Science degree in geology and has work experience in the areas of geology, hydrology and hydrogeology. Testimony of Doug Rappuhn and State Engineer Exhibit 6, Resume of Doug Rappuhn.

94. Doug Rappuhn is presently employed by the State Engineer and works in the Hydrology Bureau and he has extensive background in well construction and the analysis of test pumping of wells. Testimony of Doug Rappuhn and State Engineer Exhibit 6, Resume of Doug Rappuhn.

95. Doug Rappuhn is a licensed professional geologist and a licensed water well contractor in the state of Florida and he has served as an adjunct faculty member at the College of Santa Fe in the Sciences and Conservation Studies Department. Testimony of Doug Rappuhn.

96. Test pumping of wells, which includes the monitoring of pumping rate and well drawdown through time, provides information from which fundamental aquifer properties may be derived, including the property of transmissivity. Testimony of Doug Rappuhn.

97. An aquifer is a geologic stratum or sequence of subsurface strata that are saturated and can yield economic quantities of water. Testimony of Doug Rappuhn.

98. Transmissivity is a numerical value, expressed in units of $ft.^2$/day, that describes the efficiency of the movement of groundwater through an aquifer. Testimony of Doug Rappuhn.

99. Doug Rappuhn reviewed the JSAI Well Report which was entered into evidence as Alamogordo Exhibit 28. Testimony of Doug Rappuhn.

100. Doug Rappuhn's calculations were generally correlative to the JSAI transmissivity estimates on a test specific basis. Testimony of Doug Rappuhn.

101. Once Doug Rappuhn had evaluated test-based transmissivity from the five City well tests, he compared his values with those used in the pertinent areas of the Keyes State Engineer model grid and found that values in the Keyes model were in agreement with his independent assessment of test-derived transmissivity. Testimony of Doug Rappuhn.

102. Jim Sizemore has been employed by the New Mexico State Engineer since October 1998, and presently serves as the manager of the Water Rights Division, which includes management of six district offices and 124 technical and non-technical staff. Testimony of Jim Sizemore.

103. Jim Sizemore has a Bachelor of Science degree in Civil Engineering and is a registered professional engineer in Colorado and New Mexico. Testimony of Jim Sizemore.

104. Jim Sizemore testified as an expert in water rights and water rights administration. Testimony of Jim Sizemore. Ruling of the Court during trial.

105. Jim Sizemore has supervised other State Engineer technical staff in the evaluation of applications for the use of water, he has conducted such evaluations himself, and he conducted an evaluation of City Applications T-3825, *et al.* in the context of settlement negotiations with the City. Testimony of Jim Sizemore.

106. The use of brackish water, for treatment in a desalination plant, and use as potable water promotes both the public welfare and the conservation of water. Testimony of Jim Sizemore.

107. The priority date for Applications T-3825 *et al.* is September 6, 2000. Testimony of Jim Sizemore and State Engineer Exhibit 8, Dec. 22, 2006 Report of Andrea Mendoza.

108. City Applications T-3825, *et al.* were amended on April 22, 2003. Testimony of Jim Sizemore.

109. The Tularosa Underground Water Basin Administrative Criteria were developed by the State Engineer to provide for better management of the area of the Basin with the greatest demands on the water. Testimony of Jim Sizemore.

110. Even though the Basin Guidelines do not apply to this application, the State Engineer has a duty to evaluate the application to insure that if granted, it will not impair water rights within the Guideline area. Testimony of Jim Sizemore.

111. In the Revised Permit, the State Engineer has retained jurisdiction to reduce or curtail City diversions if the groundwater decline rates within the administrative area are likely to exceed those allowed by the administrative criteria. Testimony of Jim Sizemore and Alamogordo Exhibit 21, Condition of Approval No. 7.

112. The City's 40-Year Water Plan includes population projections, a description of current water supply and projected water demand. Testimony of Jim Sizemore and Alamogordo Exhibit 14, City of Alamogordo 40-Year Water Development Plan.

113. Population projections for the City of Alamogordo 40-Year Water Development Plan were made by the UNM Bureau of Business and Economic Research, (BBER), and this is a reasonable method of projecting population. Testimony of Jim Sizemore.

114 The State Engineer has accepted UNM Bureau of Business and Economic Research, (BBER), population projections as reasonable in the evaluation of other municipal applications. Testimony of Jim Sizemore.

115. In the process of evaluating Applications T-3825, *et al.*, the State Engineer evaluated the City's existing surface and groundwater supplies. Testimony of Jim Sizemore.

116. An efficiency rate of 80% for the proposed desalination facility is reasonable. Testimony of Jim Sizemore and Eddie Livingston.

117. Following the October, 2003 Administrative Hearing on City Applications T-3825, *et al.*, the New Mexico State Engineer found that the average historical surface water diversion for the City was 5,686 afy, and this amount was utilized in determining the City's total supply and unmet water demand. Alamogordo Exhibit 7, Report and Recommendation of Hearing Examiner, at p. 5, Finding 15, and p. 6, Finding 18.

118. Use of the mean, or average, of the historical surface water diversions for the City is not a reasonable approach to determining a reliable supply for a municipality because one-half of the time, the diversions will be below that number, and could be significantly below. Testimony of Jim Sizemore.

119. The City's reliable surface water supply was determined to be 3,513 afy, and this amount was approved by the State Engineer. Alamogordo Exhibit 21, Settlement Agreement between State Engineer and City, p. 3, ¶ 6.

120. The determination that the City's reliable surface diversion is 3,513 afy was made by using the lowest surface diversion amount recorded for a historical period of about 20 years. Testimony of Jim Sizemore.

121. Using the lowest diversion amount observed in a 20 year period is reasonable because there is a high probability of that amount of water being available. Testimony of Jim Sizemore.

122. In evaluating whether Applications T-3825, *et al.*, if granted, would be contrary to the conservation of water in New Mexico, the City's conservation measures were considered, and

they included reuse of treated effluent for irrigation of public green spaces, installation of lined and covered water supply reservoirs, use of a graduated water rate structure or tier system, use of public education and outreach programs, passage of conservation and rationing ordinances and a repair and replacement program. Testimony of Jim Sizemore, Eddie Livingston and Pat McCourt.

123. The Revised Permit requires the City to submit a Conservation Plan to the State Engineer. Testimony of Jim Sizemore and Alamogordo Exhibit 21, Revised Permit Condition No. 9.

124. In times of extended drought, the Revised Permit would require the City to reduce its water use by instituting appropriate drought management plans. Testimony of Jim Sizemore and Alamogordo Exhibit 21, Revised Permit Condition No. 9.

125. If approved, the Revised Permit would only provide for water to be used within the City of Alamogordo water service area, and not in the Village of Tularosa. Testimony of Jim Sizemore.

126. Based on the Tularosa Basin Regional Water Plan prepared in May of 2002, the estimated per capita water usage in the Village of Tularosa in 2000 was 240.9 gpcd. Testimony of Jim Sizemore.

127. Condition of Approval No. 9 of the Revised Permit provides an effective limit on diversions by the City by requiring that diversions not exceed the product of the population within the service area times 165 gpcd. Testimony of Jim Sizemore.

128. The City's Conservation Plan and its 40-Year Water Development Plan must be updated every five years, which will provide updated information on population. Testimony of Jim Sizemore.

129. The State Engineer uses groundwater flow models to project drawdowns created by proposed applicant pumping. Testimony of Jim Sizemore.

130. Information regarding regional drawdown, age of wells, depth of wells, water column depth, applicant-induced drawdown, the time it takes applicant-induced drawdown to propagate, and method of well construction are all elements that can be considered in evaluating an application for impairment. Testimony of Jim Sizemore.

131. Generally, the State Engineer considers the economically viable life of a well to be about 40 years, which is reasonable. Testimony of Jim Sizemore.

132. Eluid Martinez is a Professional Engineer and Land Surveyor in New Mexico and is a former New Mexico State Engineer, having held that position from December 1990 through December 1994. Testimony of Eluid Martinez and Alamogordo Exhibit 42, Resume of Eluid Martinez.

133. A Regional Water Plan may consider the welfare of a region of the state, but the State Engineer must consider the welfare of the state as a whole. Testimony of Eluid Martinez.

134. In determining what a municipality has as a reliable water supply, one must look at what water is reasonably expected to be available, and not rely simply on "paper water rights." Testimony of Eluid Martinez.

135. It is within the purview of a city's decision makers to decide what degree of growth is reasonable for a city, and not the State Engineer, through the supervision or control of water. Testimony of Eluid Martinez.

136. The Settlement Agreement entered into between the City of Alamogordo and the State Engineer, and the exhibit thereto, the Revised Permit, (Alamogordo Exhibit 21), are supported by the testimony of the witnesses called by the State Engineer and the City of Alamogordo, are based on sound hydrology, and represent a reasonable approach to satisfying the water planning needs of the City of Alamogordo, which does not cause impairment of other water rights and which is

consistent with the public welfare of the State of New Mexico and would not be detrimental to the conservation of water in the state. Testimony of City and State Engineer witnesses.

CONCLUSIONS OF LAW

1. This matter came before the district pursuant to § 72-7-2 N.M.S.A. 1978, and New Mexico Constitution Article 16, § 5.

2. The district court has jurisdiction of the parties and the subject matter of this action.

3. All parties who protested City Applications T-3825, *et al.* with the State Engineer, except the "Tularosa Protestants," either withdrew from the case, or were properly dismissed.

4. The New Mexico State Engineer, the City of Alamogordo and the Tularosa Protestants were each represented by counsel, and each was given a fair opportunity to present evidence, cross examine witnesses and to be heard by the court.

5. Pursuant to New Mexico law, the State Engineer may issue a permit for the use of groundwater if he makes the following findings: 1) That there is unappropriated water, or that the application can be granted without impairing existing senior water rights; 2) That the granting of the application is not contrary to the conservation of water; and 3) That the granting of the application is not detrimental to the public welfare.

6. Because of the settlement agreement between the City and the Christophers, none of the Christophers' water rights need to be considered in the impairment analysis related to Permit No. T-3825 *et al.* or any revisions thereto that allow diversions of 10,000 afy or less.

6. Granting City of Alamogordo Applications T-3825, *et al.* will not cause impairment to existing senior water rights.

7. Granting City of Alamogordo Applications T-3825, *et al.* will not be contrary to conservation of water within New Mexico.

8. Granting City of Alamogordo Applications T-3825, *et al.* will not be detrimental to the public welfare of the state of New Mexico.

9. The City of Alamogordo is a municipality and falls within the definition of entities entitled to adopt a forty-year water plan and hold water rights for forty years under the terms of § 72-1-9, N.M.S.A.

10. Population projections for the City of Alamogordo, which were prepared by the UNM Bureau of Business and Economic Research, (BBER), are reasonable and meet the requirement of § 72-1-9, N.M.S.A. 2003, as the basis for reasonably projected additional needs within forty years.

11. Potable water use of 165 gpcd by the City of Alamogordo is reasonable and will not be contrary to the conservation of water within New Mexico.

12. Potable water use of 165 gpcd by the City of Alamogordo is reasonable and will not be detrimental to the public welfare of the State of New Mexico.

13. The City of Alamogordo has prepared and adopted a 40-Year Water Development Plan which is fulfills the requirements of § 72-1-9 N.M.S.A. 1978.

14. The conservation of water in New Mexico is enhanced by the conservation practices which have been established by the City of Alamogordo.

15. The conservation of water in New Mexico will be enhanced by the ongoing conservation practices which have been established by the City of Alamogordo, and by the requirement of the Revised Permit that the City prepare a formal Water Conservation Plan with five-year updates to the State Engineer.

16. The use of brackish water for treatment in a desalination process for use as a source of potable water for the City of Alamogordo promotes the conservation of water in the State of New Mexico.

17. The use of brackish water for treatment in a desalination process for use as a source of potable water for the City of Alamogordo promotes the public welfare of the State of New Mexico.

18. The Revised Permit, which is proposed for adoption by the Court by the State Engineer and the City of Alamogordo meets the requirements of § 72-1-9 N.M.S.A. 1978.

19. The City of Alamogordo's water rights, which will be available to it under the Revised Permit, represent a reliable supply to meet its reasonably calculated demand which fulfills the requirements of § 72-1-90 N.M.S.A. 1978.

20. The priority date for Applications T-3825 *et al.* is September 6, 2000.

21. It is reasonable to allow the 40-year planning period to run from the date of the amendment, to wit April 22, 2003.

WHEREFORE, IT IS ORDERED, ADJUDGED, AND DECREED that the Revised Permit is approved, as requested by the State Engineer and the City of Alamogordo.

JAMES WAYLON COUNTS
WATER JUDGE

CC: James C. Brockmann, Esquire
William Teel, Special Assistant Attorney General
Peter Thomas White, Esquire

THE SUPREME COURT OF THE STATE OF NEW MEXICO
January 21, 2010

NO. 32,141

RECEIVED
STEIN & BROCKMANN
JAN 25 2010

TULAROSA COMMUNITY DITCH CORPORATION, DAN C. ABERCROMBIE, ELSIE I. BAILEY, LAYMON HIGHTWOER and ALLEN (BILL) TRAMMELL,

Protestants-Petitioners,

v.

NEW MEXICO STATE ENGINEER, JOHN R. D'ANTONIO, JR.,

Interested Party-Respondent,

and

CITY OF ALAMOGORDO,

Applicant-Respondent.

ORDER

This matter coming on for consideration by the Court upon petition for writ of certiorari, and the Court having considered said petition and responses and being sufficiently advised, Chief Justice Edward L. Chávez, Justice Patricio M. Serna, Justice Petra Jimenez Maes, Justice Richard C. Bosson, and Justice Charles W. Daniels concurring;

NOW, THEREFORE, IT IS ORDERED that the petition for writ of certiorari is denied in Court of Appeals number 28643.

IT IS SO ORDERED.

WITNESS, The Hon. Edward L. Chávez, Chief Justice of the Supreme Court of the State of New Mexico, and the seal of said Court this 21st day of January, 2010.

(SEAL)

Madeline Garcia

Madeline Garcia, Chief Deputy Clerk

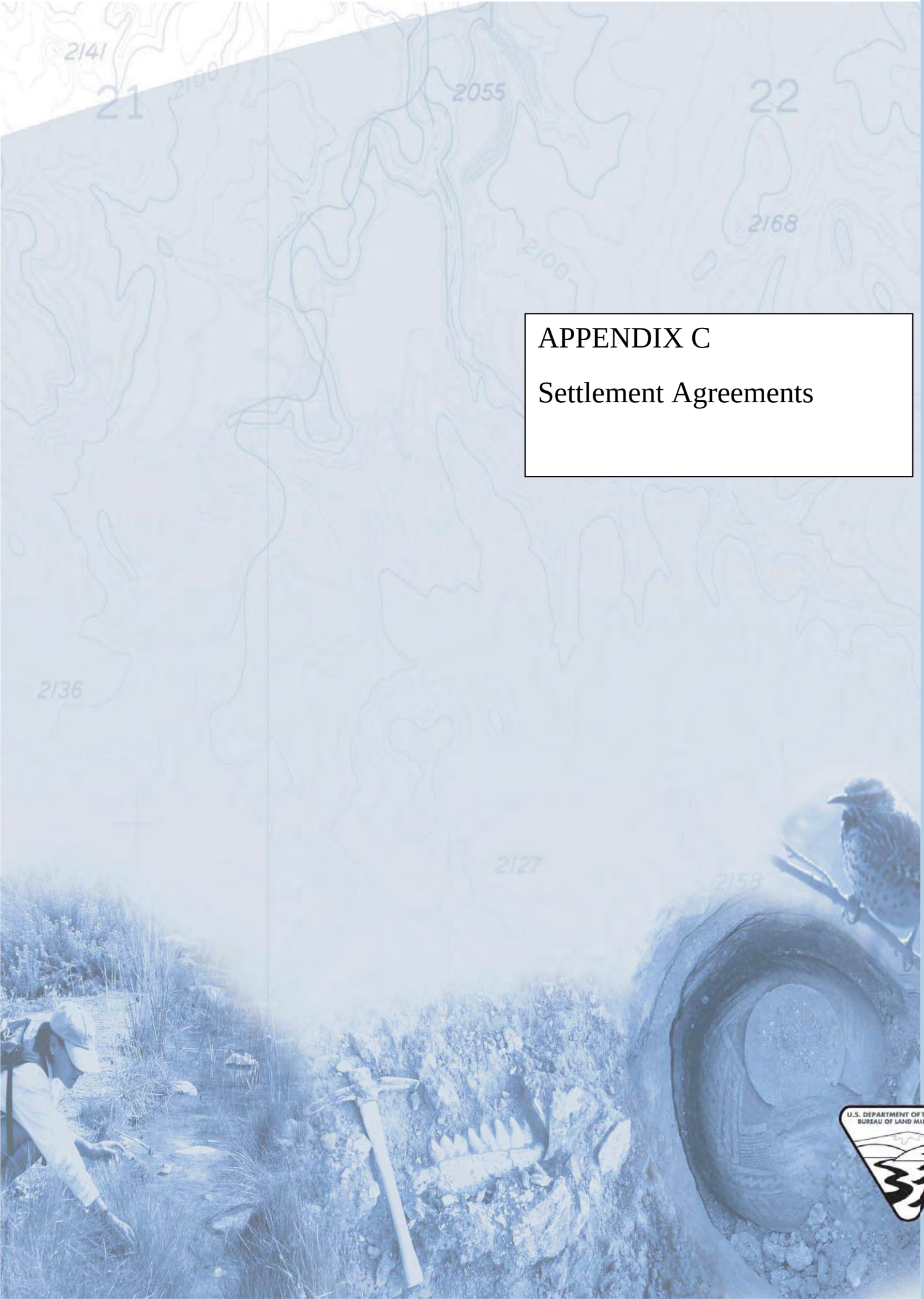
ATTEST: A TRUE COPY

Madeline Garcia

Clerk of the Supreme Court
of the State of New Mexico

APPENDIX C

Settlement Agreements



U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

BEFORE THE NEW MEXICO
STATE ENGINEER

IN THE MATTER OF THE APPLICATION BY	)	Hearing No. 02-035
CITY OF ALAMOGORDO FOR PERMIT TO	)	
APPROPRIATE UNDERGROUND WATERS	)	OSE File Nos. T-3825 thru
FROM THE SHALLOW AQUIFER LOCATED	)	T-3825-S-9
IN THE TULAROSA BASIN OF NEW MEXICO	)	

STIPULATION AMONG
THE CITY OF ALAMOGORDO, THE ABERCROMBIE PROTESTANTS,
THE WATER RESOURCES ALLOCATION PROGRAM,
AND
THE SACRAMENTO WATERSHED RESTORATION CORPORATION

This matter came on to be heard on the Sacramento Mountains Watershed Restoration Corporation's Motion to Set Aside Order and Reinstate Protest. The parties to the Motion are the City of Alamogordo, the Sacramento Mountains Watershed Restoration Corporation, the Abercrombie Protestants, and the Water Resources Allocation Program. These parties stipulate and agree that the Motion To Set Aside Order and Reinstate Protest will be withdrawn and that in the event of a hearing in this matter, Rick Warnock, its President, should be called as a witness under the following terms and conditions:

1. The Motion to Set Aside Order and Reinstate Protest of the Sacramento Mountains Watershed Restoration Corporation will be withdrawn within ten (10) days;

2. Rick Warnock, in his capacity as the President of the Sacramento Mountains Watershed Restoration Corporation, will be called as a witness by the Abercrombie Protestants subject to the following limitations:

   a. Mr. Warnock may appear as a fact witness only and not as an expert witness; and

b. Mr. Warnock can testify only to issues on which he has personal factual knowledge related to Application Nos. T-3825 thru T3825-S-9.

Dated this ____ day of June, 2002.

Respectfully submitted,

_____

James C. Brockmann
Jay F. Stein
STEIN & BROCKMANN, P.A.
P.O. Box 5250
Santa Fe, NM 87502-5250
Telephone: (505) 983-3880
Fax: (505) 986-1028
Attorneys for City of Alamogordo

_____

Gary O'Dea
817 Gold Avenue, SW
Albuquerque, NM 87102
Telephone: (505) 243-8083
Fax:(505) 243-2332
Attorney for Sacramento Mountains Watershed
Restoration Corporation

_____

Arianne Singer
Attorney For The OSE, Administrative Litigation Unit
P.O. Box 25102
Santa Fe, NM 87504-5102
Telephone: (505) 827-3523
Fax: (505) 827-3520

Peter Thomas White
125 E. Palace Ave. #50
Santa Fe, NM 87501-2367
Telephone: (505) 984-2690
Fax: (505) 984-2690
Attorney for Tularosa Community Ditch
Corporation, Tularosa Farms,
Laymon Hightower, Elsie Bailey,
Dan C. Abercrombie, and David Rankin,
And Cates Farms

CERTIFICATE OF SERVICE

It is hereby certified that on the ____ day of June, 2003, a true and correct copy of the foregoing: **Stipulation Among The City Of Alamogordo, The Abercrombie Protestants, The Water Resources Allocation Program, And The Sacramento Watershed Restoration Corporation** was served on the following parties by First Class Mail, postage prepaid

Counsel for Water Resources Allocation Program:
Arianne Singer, Esq.
OSE, Administrative Litigation Unit
P.O. Box 25102
Santa Fe, NM 87504-5102
Phone: (505) 827-1432
Fax: (505) 827-3520

Counsel for Protestant Village of Tularosa:
Jefferson R. Rhodes, Esq.
Burroughs & Rhodes
P.O. Drawer 5008
Alamogordo, NM 88311-5008
Phone: (505) 434-1010
Fax: (505) 434-5805

Counsel for Allen (Bill) Trammell, Tularosa Community Ditch Corporation, Tularosa Farms / Laymon Hightower, Elsie I. Bailey, Dan C. Abercrombie, and David Rankin, and Cates Farms:
Peter Thomas White, Esq.
Sena Plaza, Suite 50
125 E. Palace Avenue
Santa Fe, NM 87501
Phone & Fax: (505) 984-2690

Counsel for Protestant Three Rivers Cattle and HFR Corporation:
Jeffrey L. Fornaciari, Esq.
Hinkle, Hensley, Shanor & Martin, LLP
P.O. Box 2068
Santa Fe, NM 87504-2068
Phone: (505) 982-4554
Fax: (505) 982-8623

Counsel for Protestants David & Julia Christopher:
A. J. Olsen, Esq.
Olsen & Hennighausen
P.O. Box 1415
Roswell, NM 88202
Phone: (505) 624-2463
Fax: (505) 624-2878

Counsel for Sacramento Mountains Watershed Restoration Corporation:
Gary O'Dea
817 Gold Avenue, SW
Albuquerque, NM 87102
Telephone: (505) 243-8083
Fax:(505) 243-2332

_____
James C. Brockmann

STIPULATED AGREEMENT

THIS STIPULATED AGREEMENT is entered into by and between David Christopher and Julia Christopher (Christopher) and the City of Alamogordo (City) on this 24th day of January, 2007.

WHEREAS, City has filed a Complaint in the District Court for Otero County New Mexico appealing the Order entered by the New Mexico Office of the State Engineer pursuant to applications T-3825 through T-3825-S-9, commonly referred to as the Snake Tank Road well field; and,

WHEREAS, Christopher has filed an application with the Office of the New Mexico State Engineer for the appropriation of 1613 acre feet per year in application number HU No. 04-041, OSE File SP-4896; and,

WHEREAS, Christopher has filed a response to City's Petition in District Court, Case No. CV-05-019; and,

WHEREAS, City has filed an objection to the Christopher application for appropriation of water; and,

WHEREAS, the parties hereto have reached an agreement through which each party to this Agreement will withdraw their respective claims against the other party upon the signing of this Agreement; and,

WHEREAS, it is in the best interest of the City to enter into this agreement; and,

WHEREAS, the City Commission for City has voted to approve this Agreement and has authorized the signing of this Agreement by the Mayor of the City of Alamogordo; and,

WHEREAS, David Christopher and Julia Christopher are the authorized persons to be signing this Agreement on behalf of Christopher.

Alamogordo
Exhibit 20

NOW, THEREFORE, IT IS AGREED AS FOLLOWS:

1. Within ten (10) days of the signing of this Agreement by both parties, the respective parties will direct their attorneys to file a Motion for Dismissal with prejudice of their respective claims in the Otero County District Court action and the Office of the State Engineer action, and will direct their counsel to move as quickly as possible to obtain an Order or Judgment dismissing the claims of the respective parties in the District Court action and the State Engineer action.

2. That should either of the attorneys for the respective parties under this Agreement fail or delay in petitioning the Court for an Order of Dismissal, the other party may proceed toward dismissal without the approval of the delaying party.

3. That Christopher will withdraw any and all claims and objections it may have now or in the future against City's request for appropriation of water through City's Applications T-3825 through T-3825-S-9 including any revisions and under the Otero County District Court Cause No. CV-05-0019 (Consolidated). City agrees that it will not increase the amount applied for in Applications T-3825 through T-3825-S-9 and under Otero County District Court Cause No. CV-05-0019 (Consolidated) beyond the 10,000 acre feet per year currently included in the applications.

4. City will withdraw its objections to Christopher's Application No. SP-4896 and will withdraw from New Mexico Office of the State Engineer Hearing HU No. 04-041, OSE File No. SP-4896.

5. Christopher agrees to provide a written statement that they waive any claim of impairment and waive any and all effects to their water rights caused by operation of wells pursuant to City's Permit No. T-3825 through T-3825-S-9, including any revisions that

the City is seeking to Permit No. T-3825 through T-3825-S-9. Christopher waives and releases the City of Alamogordo from any and all claims of liabilities for damages to Christopher resulting from the operations of the wells under Permit No. T-3825 through T-3825-S-9. Should anyone assert any rights to the water purchased by the City or to Christopher's water rights or should the issue arise concerning Christopher's agreement for the sale of water to the City of Alamogordo. Christopher agrees that he will defend the City against any and all such claims at his sole cost and expense.

6. Christopher agrees to take all steps necessary to remove any and all objections or claims it may have under the Environmental Impact Statement proceedings relating to the City's proposed Desalinization Plant and supporting pipeline structure.

7. City agrees to provide a written statement that they waive any and all claims of impairment and waive any and all effects of the Christopher Application No. SP-4896.

8. City will provide a letter of interest to the Office of the State Engineer stating that City is interested in taking water and will take water for municipal and related purposes from the Christopher's Maxwell Spring diversions under State Engineer Application No. SP-4896.

9. When the City of Alamogordo Permit No. T-3825 through T-3825-S-9 is final to the satisfaction of the City and non-appealable, and the City's water production system is constructed, and also if the Christopher application No. SP-4896 is approved to the satisfaction of Christopher, City agrees to purchase up to the permitted amount of Maxwell Spring water provided the permitted amount is 300 acre feet per year or more and Maxwell Spring produces this minimum amount and this taking by City is permitted by the New Mexico Office of the State Engineer. City agrees to pay Christopher the sum of $.56 per

1000 gallons delivered to the High Nogal Ranch House site intersection with City's waterline.

10. City agrees to purchase available Maxwell Springs water up to the extent of available flow before utilizing water pumped from wells in the Snake Tank well field.

11. The cost of pumping will be reviewed every fifth year from the date of this Agreement and the $.56 per 1000 gallons set forth herein will be adjusted accordingly. At the end of the fifth year, City shall adjust the price per thousand gallons based upon the most recent U.S. Bureau of Labor Statistics C.P.I. All Urban Consumers.

12. Christopher agrees to construct a filtration and collection device at the Maxwell Spring area and to construct a security fence around the Spring area to exclude contamination factors including wildlife from entering the Spring.

13. Christopher agrees to construct a pipeline from the Maxwell Spring collection facility to the High Nogal Ranch House site intersection with the City's pipeline area.

14. City will construct all necessary pipelines and transmission systems from the High Nogal Ranch House area to the City's Desalinization Plant for the Snake Tank well field area.

15. City will transfer the T-3837 test well to Christopher within sixty (60) days of the execution of this contract by both parties. Christopher grants City right to use this well for testing and monitoring.

16. Christopher agrees to use water from the T-3837 well only for domestic and livestock purposes up to three (3) acre feet per year. Water used under this paragraph will be based upon Christopher water rights.

17. In the event that all of the livestock spring water currently used by Christopher for livestock use dries up, City agrees to allow Christopher and his successors and assigns access to one or more of its water pipelines providing water to the City Desalinization Plant for the purpose of livestock watering tanks or ponds. Christopher agrees to pay all costs involved in tapping City water lines and to install metering devices on each tap. Christopher agrees to pay City the then applicable per thousand gallon rate to purchase this water that the City is paying Christopher for Maxwell Spring water. Christopher agrees not to utilize more than 434,444 gallons per month. Christopher agrees that any water taken under this paragraph will be used solely for livestock purposes in that it is untreated and non-potable water. Both parties agree that the first 978,000 gallons used by Christopher will be at no charge to Christopher. The next 2,932,000 gallons will be charged at the same rate then being paid by City for Maxwell Springs water. No water will be permitted above 3,910,000 gallons per year.

18. Christopher and City will hold title to all improvements from the Maxwell Springs including the filtration and collecting devices, fencing, and pipeline in joint equal ownership. Both parties agree that neither party may transfer any interest in this joint equal ownership without prior notice to and approval by the other party. Both parties agree that approval of any transfer of interest will not be unreasonably withheld.

19. City agrees to maintain all improvements to the Maxwell Springs area and the pipeline.

20. Christopher agrees to allow City access to all of the improvements in the Maxwell Springs area and the pipeline, including access to all meters to be installed pursuant to this agreement.

21. Christopher agrees to allow City access to the construction process to assure that construction is completed in accordance with plans.

22. Once City and Christopher approve the plans and the cost estimates, Christopher will build the improvements and pipeline. City will pay for materials delivered on site for improvements and pipeline. City will pay for engineering of improvements and pipeline. City will reimburse Christopher for the costs of environmental permits. Christopher will do all construction and installation at $9.00 per linear pipeline foot including fencing, and collection and filtration system.

23. Five years from the date of connection of the Maxwell Springs pipeline to the City's pipeline, City will purchase Christopher's interest in the collection filtration and related structures and the pipeline for a sum equal to his costs of construction based on $9.00 per linear pipeline foot.

24. Christopher agrees to keep City fully apprised of all actions in the State Engineer Application File No. SP-4896. City agrees to keep Christopher fully apprised of all actions relating to Applications T-3825 through T-3825-S-9.

25. Both parties agree that the terms and conditions set forth in this agreement incorporate all of the terms and conditions agreed to by the parties and any changes or alterations must be mutually agreed upon in writing by the parties.

26. Both parties agree that the terms and conditions of this agreement will be valid for a period of forty (40) years from the date of the agreement and can be renewed for successive forty (40) year periods if agreed to by both parties.

27. Both parties agree that should either party breach the terms and conditions of this agreement, the non-breaching party shall give the breaching party a thirty (30) days

notice to cure any breach. Should the breach not be cured and the matter is turned over to an attorney for resolution, the prevailing party shall be entitled to reasonable attorney fees and costs incurred in resolving any breach.

28. Both parties agree to issue any letters or other written documents required under this agreement within thirty (30) days of request by the appropriate party for the production of said document.

29. Both parties agree to cooperate with each other in accomplishing the goals of the respective parties in the District Court action and the Office of the State Engineer application.

30. Christopher agrees that should the City be unable to appropriate sufficient funds for the satisfaction of the City obligations under this agreement, this agreement shall be terminated on the June 30 immediately following this lack of funding. City's determination as to availability of funds shall be final and in the City's sole discretion. City shall give sixty (60) days written notice of this determination of lack of funds.

31. This contract contains all of the terms and agreements of the parties relating to this agreement. Any amendments must be in writing signed by both parties. The terms of this agreement shall be binding upon the parties hereto, their successors and assigns. This agreement shall run with the land affected by this agreement.

32. Immediately upon execution of this document, each party will file the necessary court pleadings and documents to give full effect of their mutual agreements to withdraw from the pending applications of the parties in District Court and before the State Engineer. Immediately upon execution of this document, City will begin transfer of T-3837 to Christopher. The five year period for adjustment of the per-thousand gallon price of

$0.56 will begin immediately upon execution of this document. The five year period following which the City will purchase Christopher's interest in the pipeline will begin running upon the connection of the Maxwell Springs pipeline to the City's pipeline. Neither party is obligated to act pursuant to this contract with regard to the water purchase sections until both the City's and Christopher's applications are finally, unappealably approved.

33. City will pay for water delivered to the City pipeline based on monthly meter readings; payment due thirty (30) days following the meter reading.

Date: 1-24-07

David Christopher

Date: 1-24.07

Julia Christopher by David Christopher
her attorney in fact

Date: 1/24/07

City of Alamogordo, New Mexico

By:

STATE OF NEW MEXICO)
) ss.
COUNTY OF OTERO)

SUBSCRIBED AND SWORN TO before me this 24th day of January 2007, by DAVID CHRISTOPHER.

Dorothy J Murphy
Notary Public

My commission expires:
Nov. 5, 2007

STATE OF NEW MEXICO)
) ss.
COUNTY OF OTERO)

SUBSCRIBED AND SWORN TO before me this 24th day of January 2007, by David Christopher as attorney in fact for JULIA CHRISTOPHER.

Dorothy J Murphy
Notary Public

My commission expires
Nov. 5, 2007

STATE OF NEW MEXICO)
) ss.
COUNTY OF OTERO)

SUBSCRIBED AND SWORN TO before me this 24th day of January 2007, by DONALD E. CARROLL, Mayor of the City of Alamogordo, New Mexico, a New Mexico municipal corporation on behalf of said corporation.

Dorothy J Murphy
Notary Public

My commission expires:
Nov. 5, 2007

LIMITED POWER OF ATTORNEY

Julia M. Christopher whose address is 1616 Leesway Road, Richmond, Texas, 77469, does hereby appoint her husband, David Christopher, as her Attorney-In-Fact to act for her and on her behalf in all matters and to do and perform all acts in things which her Attorney-In-Fact, David Christopher, shall deem necessary or desirable in connection with the sale of the High Nogal Ranch, located in New Mexico, and the settlement of pending water rights litigation with the City of Alamogordo.

I specifically authorize my Attorney-In-Fact to sign all contracts, deeds, and other documents necessary to accomplish the sale of the High Nogal Ranch without limitation, and I further authorize my Attorney-In-Fact to sign all court pleadings and all other documents necessary to accomplish a full and complete resolution of the issues between my husband and myself and the City of Alamogordo and all other parties involved in the on going water rights litigation with the City of Alamogordo.

I hereby ratify and confirm all acts done by my Attorney-In-Fact pursuant to this Limited Power of Attorney.

I execute this Limited Power of Attorney, this 23 day of January 2007, at Richmond, Texas.

FURTHER AFFIANT SAYETH NAUGHT .

Julia M. Christopher

Julia M. Christopher

STATE OF TEXAS)

COUNTY OF Fort Bend)

Before me, the undersigned notary public appeared Julia M. Christopher who did acknowledge her signature to the foregoing Limited Power of Attorney as her free act and deed this 23 day of January _____, 2007.

Donna L Mathews

Notary Public

My Commission Expires:

DONNA LYNN MATHEWS
Notary Public, State of Texas
My Commission Expires
April 03, 2010

SETTLEMENT AGREEMENT
BETWEEN THE
NEW MEXICO STATE ENGINEER
AND THE
CITY OF ALAMOGORDO
REGARDING
PERMIT NO. T-3825 *ET AL.*

THIS SETTLEMENT AGREEMENT BETWEEN THE NEW MEXICO STATE ENGINEER AND THE CITY OF ALAMOGORDO REGARDING PERMIT NO. T-3825 *ET AL.* ("Settlement Agreement") is entered into this 3rd day of July , 2007, by and between the New Mexico State Engineer ("State Engineer"), whose address is New Mexico State Engineer, P.O. Box 25102, Santa Fe, New Mexico, 87504, and the City of Alamogordo ("City"), whose address is City of Alamogordo, c/o City Manager, 1376 E. Ninth Street, Alamogordo, New Mexico, 88310, (collectively the "Parties").

RECITALS

WHEREAS, on September 6, 2000, the City of Alamogordo filed Application Nos. T-3825 through T-3825-S-9 with the State Engineer, which applications were amended in January of 2002, and on April 21, 2003 ("Application No. T-3825 *et al.*");

WHEREAS, there were 13 protests to Application No. T-3825 *et al.*;

WHEREAS, the State Engineer held an Administrative Hearing on Application No. T-3825 *et al.* on October 14 through 17 and October 20 through 24, 2003;

WHEREAS, on December 28, 2004, the State Engineer accepted and adopted the Report and Recommendation of the Hearing Examiner setting forth Findings of Fact and entering an Order partially approving Application No. T-3825 *et al.* subject to certain Conditions of Approval ("Permit No. T-3825 *et al.*");

WHEREAS, the State Engineer's decision was appealed to the Twelfth Judicial District Court for a *de novo* review in *City of Alamogordo and David and Julia Christopher and Tularosa Community Ditch Corporation, Dan C. Abercrombie, Elsie II Bailey, Laymon Hightower, David Rankin, and Allen (Bill) Trammel v. New Mexico State Engineer, John R. D'Antonio, Jr. and HFR Corporation and Three Rivers Cattle Company, Ltd., Co.*, Twelfth Judicial District Court, CV-05-019 (Consolidated) Division II ("*City of Alamogordo v. New Mexico State Engineer*");

WHEREAS, the City of Alamogordo has reached a settlement agreement with David and Julia Christopher dated January 24, 2007, whereby the City has resolved any State Engineer concerns regarding the Christophers' declared groundwater and surface water rights on the High Nogal Ranch, including Well No. T-4316;

Alamogordo Exhibit 21

WHEREAS, the City of Alamogordo and the Village of Tularosa ("Village") entered into a stipulation on July 2, 2003, prior to the administrative hearing, whereby the Village withdrew its protest to Application No. T-3825 *et al.*, and that stipulation is in the process of being revised ("Revised Stipulation");

WHEREAS, there have been additional hydrologic investigations and analyses since the State Engineer issued Permit No. T-3825 *et al.* on December 28, 2004; and

WHEREAS, this Settlement Agreement memorializes the agreement of the Parties to set aside their different positions on legal and factual issues and the Parties believe that it is in their mutual interest to settle their differences though this Settlement Agreement.

COVENANTS

NOW, THEREFORE, in exchange for the mutual covenants, agreements, and consideration described herein, the Parties agree as follows:

1 La Luz Well Field (Office of the State Engineer ("OSE") File No. T-32-S-2 through T-32-S-9).

1.1 The City's present declared groundwater right for OSE File No. T-32-S-2 through T-32-S-9 (La Luz Well Field) is 4,573 acre-feet per year ("AFY"). The La Luz Well Field cannot physically produce the maximum declared groundwater right and the City's maximum historical diversion was 2,750 AFY in 1971. The City agrees to file a Proof of Beneficial Use with the State Engineer for 3,000 AFY for OSE File No. T-32-S-2 through T-32-S-9 (La Luz Well Field), making the City's net reduction in declared groundwater rights 1,573 AFY.

1.2 Within 180 days after the City files the Proof of Beneficial Use described in Paragraph No. 1.1, the State Engineer will review the terms of the Proof of Beneficial Use and, if accepted for filing, will issue a License to the City for 3,000 AFY for OSE File No. T-32-S-2 through T-32-S-9 (La Luz Well Field).

1.3 After a License is issued pursuant to Paragraph No. 1.2, the State Engineer will evaluate future applications considering the City's full licensed water rights for OSE File No. T-32-S-2 through T-32-S-9 (La Luz Well Field).

2 Prather Wells (OSE File No. T-33 and T-33-S).

2.1 The City will file an application to repair and deepen the Prather Wells (OSE File No. T-33 and T-33-S). In addition, the City has provided the State Engineer with current well pumping tests which indicate that the Prather Wells cannot produce the presently permitted water right.

2.2 In reviewing the City's application to repair and deepen the Prather Wells (OSE File No. T-33 and T-33-S) described in Paragraph No. 2.1 and based upon data from the current well pumping tests, the State Engineer has determined that the wells diversion and consumption should not exceed 500 AFY and the City accepts that finding. The permitted diversion from the Prather Wells is 1,354 AFY, making the City's net reduction of permitted groundwater rights from the Prather Wells 854 AFY.

3 The City's Golf Course Wells (OSE File No. T-814 and T-814-S) are permitted for 270 AFY.

4 The City's Mountain View Well (OSE File No. T-3489-repl) is permitted for 161 AFY.

5 For purposes of settlement, the City's reliable groundwater supply is determined to be 3,931 AFY (3,000 AFY from the La Luz Well Field (OSE File No. T-32-S-2 through T-32-S-9) + 500 AFY from Prather Wells (OSE File No. T-33 and T-33-S) + 270 AFY from the Golf Course Wells (OSE File No. T-814 and T-814-S) + 161 AFY from the Mountain View Well (OSE File No. T-3489-Repl)), making the City's net reduction in declared and permitted groundwater rights 2,427 AFY.

6 For purposes of settlement, the City's reliable surface water supply is determined to be 3,513 AFY.

7 For purposes of settlement, the City's total reliable surface water and groundwater supply are determined to be 7,444 AFY.

8 The population projections and per capita demands (165 gpcpd) set forth in the *City of Alamogordo's 40-Year Water Development Plan, 2005-2045 (Table 4.2* at 33*)* are reasonable.

9 The City's future water demands will be calculated through 2043, 40 years from the date of the amendment of Application No. T-3825 *et al.* In 2043, the City's water demands are estimated to be 10,644 AFY.

10 Subtracting the City's total reliable groundwater and surface water supply (7,444 AFY) from the City's estimated water demands in 2043 (10,644 AFY), the City needs an additional 3,200 AFY.

11 The additional hydrologic investigations conducted after the issuance of Permit No. T-3825 *et al.* provided information that indicates that the desalination facility will operate at 80% efficiency.

12 Because the desalination facility is estimated to be 80% efficient, the City will have to divert 4,000 AFY to provide 3,200 AFY of potable water to the City.

13 The City of Alamogordo has reached a settlement agreement with David and Julia Christopher dated January 24, 2007, whereby the City has resolved any State Engineer concerns regarding the Christophers' declared groundwater and surface water rights on the High Nogal Ranch, including Well No. T-4316.

14 Because history and statistics show that the City will not have available in every year what has been determined to be its total reliable groundwater and surface water supply, a condition of approval will be included in Revised Permit No. T-3825 *et al.* that allows the City to increase diversions in any calendar year up to 5,000 AFY, provided that the total annual diversions for any consecutive five-year period does not exceed 20,000 acre-feet.

15 There is unappropriated groundwater available for appropriation which will allow for a new ongoing diversion of 4,000 AFY from the wells associated with Revised Permit No. T-3825 *et al.*, with a temporary increase in annual diversions up to 5,000 AFY provided that the sum of annual diversions for any consecutive five-year period does not exceed 20,000 acre-feet.

16 The ongoing diversion of 4,000 AFY from the wells associated with Revised Permit No. T-3825 *et al.*, with a temporary increase in annual diversions up to 5,000 AFY provided that the sum of annual diversions for any consecutive five-year period does not exceed 20,000 acre-feet, will not impair existing water rights or result in significant degradation of water quality.

17 A Condition of Approval will be included in Revised Permit No. T-3825 *et al.* that requires development and implementation of a monitoring plan acceptable to the State Engineer under which the State Engineer may order the temporary suspension of all or part of groundwater diversions under the Revised Permit if water levels or total dissolved solids indicate that impairment to valid existing senior water rights is likely to occur as a result of the City's exercise of Revised Permit No. T-3825 *et al.*

18 The ongoing diversion of 4,000 AFY from the wells associated with Revised Permit No. T-3825 *et al.*, with a temporary increase in annual diversions up to 5,000 AFY provided that the sum of annual diversions for any consecutive five-year period does not exceed 20,000 acre-feet, is not contrary to the conservation of water within the State. In fact, the use of desalination to convert brackish water to potable water promotes the conservation of water within the State.

19 The ongoing diversion of 4,000 AFY from the wells associated with Revised Permit No. T-3825 *et al.*, with a temporary increase in annual diversions up to 5,000 AFY provided that the sum of annual diversions for any consecutive five-year period does not exceed 20,000 acre-feet, is not detrimental to the public welfare of the State. In fact, the diversion of unappropriated brackish groundwater and conversion of that brackish water into potable water through desalination is beneficial to the public welfare of the State.

20 A Revised Stipulation has been entered between the City of Alamogordo and the Village of Tularosa. As set forth in the Revised Stipulation, if a situation exists in the future in which the Village of Tularosa needs an emergency supply of bulk water, an appropriate application will be filed with the State Engineer. If the necessary State Engineer permits are obtained and if the use is consistent with the Revised Stipulation, the City of Alamogordo may deliver water to the Village of Tularosa.

21 The Parties will jointly pursue revisions to Permit No. T-3825 *et al.* in a manner consistent with Exhibit No. 1, which is incorporated herein by reference and made part of this Settlement Agreement as if set forth fully herein.

21.1 The Parties will attempt to settle with the other parties to *City of Alamogordo v. New Mexico State Engineer* in a manner consistent with Exhibit No. 1.

21.2 If a settlement is not reached with all other parties to *City of Alamogordo v. New Mexico State Engineer*, the Parties to this Settlement Agreement will advocate for a revised permit consistent with Exhibit No. 1, both in District Court and on appeal, if any.

21.3 If the District Court or any appellate court orders that Permit No. T-3825 *et al.* should be revised in a manner consistent with Exhibit No. 1, at the conclusion of *City of Alamogordo v. New Mexico State Engineer*, the Parties will jointly move the District Court to remand Permit No. T-3825 *et al.* to the State Engineer for reissuance of the Permit in a manner consistent with Exhibit No. 1.

22 The Parties agree that any water rights granted pursuant to Revised Permit No. T-3825 *et al.* will be administered in accordance with the Conditions of Approval contained in Exhibit No. 1.

23 The Parties represent that they have carefully read and reviewed the terms of this Settlement Agreement and that they understand it.

24 The Parties further acknowledge that this instrument, including Exhibit No. 1, constitutes the entire agreement of this compromise settlement and all of the terms hereof are contractual and not mere recitals.

25 Because this is a Settlement Agreement, the Parties agree that the terms herein have no precedential effect on either Party. Nothing herein shall be construed as establishing any standard for any future application that the City may file with the State Engineer.

26 The Parties have developed this Settlement Agreement through good faith negotiations for the purpose of resolving legal and factual disputes, including pending litigation. No conduct, statements, offers, or compromises made in the course thereof

shall be construed as admissions against interest or be used in any legal forum or proceeding.

27 Each Party represents and warrants that it is authorized to execute this Settlement Agreement on behalf of the respective Parties hereto and does so freely and voluntarily.

28 Execution of this Settlement Agreement by all institutional entities signifies that all provisions of this Settlement Agreement have been approved by those entities' respective governing bodies and that those entities bind themselves to the obligations and benefits of this Settlement Agreement.

29 This Settlement Agreement shall be construed in accordance with the laws of the State of New Mexico.

30 This Settlement Agreement shall, unless otherwise indicated, be binding on and inure to the benefit of the Parties and their respective successors and assigns.

31 This Settlement Agreement incorporates all attachments included herewith and sets forth the entire agreement of the Parties with respect to the subject matter hereof. This Settlement Agreement may be amended only by written agreement executed by the Parties.

32 The Parties agree that the term of this Settlement Agreement shall be perpetual.

OFFICE OF THE STATE ENGINEER

for John R. D'Antonio
State Engineer
State of New Mexico

CITY OF ALAMOGORDO

Donald E. Carroll
Mayor
City of Alamogordo

JOHN R. D'ANTONIO, JR. PE
NEW MEXICO
14846
STATE ENGINEER
REGISTERED PROFESSIONAL ENGINEER

STATE OF NEW MEXICO)
) ss.
COUNTY OF SANTA FE)

The foregoing instrument was acknowledged before me this 3rd day of July, 2007, by John R. D'Antonio, Jr., New Mexico State Engineer, on behalf of the Office of the State Engineer. Estevan Lopez

Notary Public

My Commission Expires: 10/18/10

STATE OF NEW MEXICO)
) ss.
COUNTY OF OTERO)

The foregoing instrument was acknowledged before me this 11th day of July, 2007, by Donald E. Carroll, Mayor, on behalf of the City of Alamogordo.

Notary Public

My Commission Expires: 7/21/07

Exhibit No. 1

REVISED PERMIT NO. T-3825 *ET AL.*

Application Nos. T-3825 thru T-3825-S-9 filed by the City of Alamogordo are partially approved for the diversion of up to 4,000 acre-feet per year ("afy"), subject to conditions, as follows:

Permittee: City of Alamogordo

Permit No.: T-3825 thru T-3825-S-9

Priority Date: September 6, 2000

Source of Water: Tularosa Underground Water Basin

Points of Diversion:

Well No.	Subdivision	Section	Township	Range
T-3825	NW¼SE¼SW¼	1	13 South	9 East
T-3825-S	SW¼SW¼NW¼	31	12 South	10 East
T-3825-S-2	SW¼SW¼SW¼	31	12 South	10 East
T-3825-S-3	SW¼NW¼NE¼	35	12 South	9 East
T-3825-S-4	SE¼SW¼SE¼	35	12 South	9 East
T-3825-S-5	NW¼SE¼NW¼	6	13 South	10 East
T-3825-S-6	NE¼NW¼NE¼	7	13 South	10 East
T-3825-S-7	SE¼SW¼NW¼	7	13 South	10 East
T-3825-S-8	NE¼NW¼SE¼	1	13 South	9 East
T-3825-S-9	NW¼SW¼NE¼	1	13 South	9 East

Amount of Water: Up to 4,000 afy. The diversion for any calendar year may be increased up to 5,000 acre-feet, provided that the sum of annual diversions for any consecutive five-year period does not exceed 20,000 acre-feet.

Purpose of Use: Municipal, Industrial, Commercial or Irrigation

Place of Use: Service area of the City of Alamogordo water system

CONDITIONS OF APPROVAL

1. Permit No. T-3825 thru T-3825-S-9 shall not be exercised to the detriment of valid existing water rights or in a manner that is contrary to the conservation of water within the state or detrimental to the public welfare of the State of New Mexico.
2. The total annual combined diversion of groundwater from Well Nos. T-3825 thru T-3825-S-9 under this permit shall not exceed 4,000 afy, except that the City may increase the total annual combined diversion of groundwater from said wells during any calendar year up to 5,000 acre-feet, provided that the sum of annual diversions for any consecutive five-year period does not exceed 20,000 acre-feet.
3. Prior to the drilling of Well Nos. T-3825 thru T-3825-S-9 under this permit, the City shall submit to the State Engineer an acknowledged statement, executed by the owner of the land upon which the wells are to be drilled, establishing that the permittee has permission to occupy such portion of the owner's land as is necessary to drill and operate the wells.
4. Prior to any diversions under this permit, Well Nos. T-3825 thru T-3825-S-9 shall be equipped with totalizing meters of a type and at locations approved by and installed in a manner acceptable to the State Engineer. The City shall provide in writing, the make, model, serial number, date of installation, initial reading, units, and dates of recalibration of each meter and any replacement meter used to measure the diversion of water under this permit. At a minimum, all meters shall be calibrated in accordance with industry standards annually and the results shall be submitted to the State Engineer's District 4 Office.
5. Records of the amount of water diverted from Well Nos. T-3825 through 3825-S-9 shall be submitted to the State Engineer on or before the 10th day of each month for the preceding month.
6. Prior to diversion of water under this permit, the permittee shall propose and implement a monitoring plan and system, acceptable to the State Engineer, involving the monitoring of groundwater levels and water quality. In January and July of each calendar year, the permittee shall measure water levels and total dissolved solids within the monitoring wells. The permittee shall report the data to the State Engineer, in writing, on or before January 31, and July 31 of each calendar year.

7. The State Engineer may order the temporary suspension of all or a part of groundwater diversions under this permit if the water levels or total dissolved solids reported pursuant to Condition of Approval No. 6 above, indicate that impairment to valid existing senior rights to divert water is likely to occur or that groundwater decline rates within the Tularosa Underground Water Basin Administrative Area are likely to exceed those allowed by the Tularosa Underground Water Basin Administrative Criteria as a result of the continued operation of Well Nos. T-3825 thru T-3825-S-9 at then-current diversion levels.
8. The permittee shall submit a formal Water Conservation Plan, which will include the reporting frequencies and methodology for determining the average per capita water use, for approval by the State Engineer prior to diversion of any water under this permit. The Water Conservation Plan shall be submitted to:

   Office of the State Engineer
   Water Use and Conservation Bureau
   PO Box 25102
   Santa Fe, NM 87504-5102

9. Issuance of this permit is predicated upon the expectation that the permittee's annual water use will not exceed the product of the population within its service area for each year times 0.1848237 (converts 165 gpcpd to afy). The permittee is expected to reduce its water use during periods of extended drought consistent with appropriate drought management plans. Additionally, the permittee shall utilize the highest and best technology available to ensure ongoing conservation of water to the maximum extent practical.
10. The permittee shall submit progress reports on its 40-year Water Plan and its Water Conservation Plan on or before February 1st of every fifth year, commencing five years after the date of approval of this Revised Permit.
11. Proof of Completion of Work(s) shall be filed on or before August 31, 2011.
12. The State Engineer shall retain jurisdiction over this permit for the purpose of ensuring that exercise of the permit does not violate the foregoing conditions.

JOHN R. D'ANTONIO, JR., P.E.
NEW MEXICO STATE ENGINEER

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SETTLEMENT AGREEMENT BETWEEN AND AMONG THE CITY OF ALAMOGORDO, HFR CORPORATION, AND THREE RIVERS CATTLE LTD., CO.

Alamogordo Exhibit 22

This Settlement Agreement is entered into this 20th day of November, 2007, between and among the City of Alamogordo ("City"), HFR Corporation ("HFR"), and Three Rivers Cattle Ltd., Co. ("Three Rivers") (collectively the "Parties"), which resolves all issues among them related to the pending appeal of the New Mexico State Engineer's acceptance and adoption of the Report and Recommendation of the Hearing Examiner in Hearing No. 02-035, OSE File No. T-3825 through T-3825-S-9, dated December 28, 2004, and any subsequent appeals or other disposition therefrom ("Settlement Agreement").

RECITALS

The following recitals constitute matters that are accepted by the Parties and are incorporated in this Settlement Agreement.

A. On September 6, 2000, the City of Alamogordo filed Application Nos. T-3825 through T-3825-S-9 with the New Mexico State Engineer ("State Engineer" or "OSE"), which applications were amended in January of 2002 and on April 21, 2003 ("Application No. T-3825 *et al.*" or "OSE File No. T-3825 *et al.*").

B. The City has designated its desalination project associated with Application No. T-3825 *et al.* as the Alamogordo Regional Water Supply Project ("Regional Project"). The Parties intend to include in this Settlement Agreement all instrumentalities and entities of the City that may participate in the development, use, and treatment of water associated with Application No. T-3825 *et al.*, including, without limitation, the Regional Project. Therefore, the references to the City in this Settlement Agreement are intended to include the City and such instrumentalities and entities.

C. On February 20, 2002, Three Rivers timely filed a protest with the State Engineer to Application No. T-3825 *et al.* Three Rivers operates a ranch and farm, and it owns and uses water rights identified as OSE File No. 0958, 2635 & T-0442 *et al.* Combined.

D. On February 21, 2002, HFR timely filed a protest with the State Engineer to Application No. T-3825 *et al.* HFR owns the water right identified as OSE File No. T-1797 *et al.* which is currently used on the pecan orchard operated by Sierra Blanca Pecan Ranch.

E. The State Engineer held an administrative hearing on Application No. T-3825 *et al.* on October 14 through 17 and October 20 through 24, 2003. On December 28, 2004, the State Engineer accepted and adopted the Report and Recommendation of the Hearing Examiner, which partially approved Application No. T-3825 *et al.* and authorized a diversion up to 3,000 acre-feet per year ("AFY"), subject to certain conditions of approval ("State Engineer's Decision"). Pursuant to the State Engineer's Decision, the diversion for any calendar year may be increased up to 4,500 AFY, provided that the sum of annual diversions for any consecutive five-year period does not exceed 15,000 acre-feet.

F. The State Engineer's Decision was appealed to the Twelfth Judicial District Court, State of New Mexico ("Court"), by David and Julia Christopher on January 14, 2005, by the City on January 21, 2005, and by Tularosa Community Ditch Corporation, Dan C. Abercrombie, Elsie I. Bailey, Laymon Hightower, David Rankin, and Allen (Bill) Trammel on January 26, 2005, and these appeals were consolidated. The consolidated cases have been captioned as *City of Alamogordo and David and Julia Christopher and Tularosa Community Ditch Corporation, Dan C. Abercrombie, Elsie I. Bailey, Laymon Hightower, David Rankin, and Allen (Bill) Trammel v. New Mexico State Engineer, John R. D'Antonio, Jr. and HFR Corporation and Three Rivers Cattle, Ltd. Co.*, Twelfth Judicial District Court, CV-05-019 (Consolidated) Division II ("Consolidated Appeal").

G. On January 31, 2005, HFR and Three Rivers entered their appearances in the Consolidated Appeal and indicated that they were aligned with the State Engineer in defending the State Engineer's Decision.

H. On July 3, 2007, the City and the State Engineer entered into a stipulation whereby both the City and State Engineer agreed to seek revisions to the State Engineer's Decision which, if approved by the Court, would result in a new permit under OSE File No. T-3825 *et al.* that would allow the City to divert up to 4,000 AFY, with certain conditions of approval ("SE/City Stipulation"). Pursuant to the SE/City Stipulation, the diversion for any calendar year could be increased up to 5,000 AFY, provided that the sum of annual diversions for any consecutive five-year period does not exceed 20,000 acre-feet. HFR and Three Rivers are not parties to the SE/City Stipulation and they are not bound by the terms and conditions of that stipulation.

I. This Settlement Agreement will impose on the City monitoring and remediation requirements in relation to the City's exercise of any permit issued under OSE

File No. T-3825 *et al.*, and this Settlement Agreement will also establish acceptable groundwater level declines and changes in water quality to protect HFR's and Three Rivers' water rights and associated wells from injury/damage that could result from the City's appropriation under any such permit. Further, this Settlement Agreement will establish well setback requirements and water right and water use prohibitions and quantitative restrictions in the Three Rivers area and well setback requirements in the HFR area. These agreements are the basis for HFR's and Three Rivers' decision to enter into this Settlement Agreement and to not oppose the SE/City Stipulation in the Consolidated Appeal.

J. This Settlement Agreement memorializes the agreements of the Parties which the Parties believe will settle their differences related to the Consolidated Appeal.

AGREEMENTS

NOW, THEREFORE, in exchange for the mutual covenants, agreements, and consideration described herein, the Parties agree as follows:

1. The Parties shall take all actions specified in this Settlement Agreement, either individually or collectively as specified herein, to resolve their claims against each other in the Consolidated Appeal. These actions are described in the paragraphs set forth below. The Parties shall fully and promptly comply with the undertakings described below, and each party is relying on and expecting such performance by the other parties as the basis for entering into this Settlement Agreement. Therefore, time is of the essence with respect to each party's performance under and enforcement of this Settlement Agreement.

2. The Parties shall take the following actions within the time frames specified in this Settlement Agreement:

    a. At least two weeks before the trial in this case, HFR and Three Rivers shall inform the Court that they do not oppose the entry of a judgment and decree that accepts the SE/City Stipulation.

    b. At least two weeks before the trial in this case, the Parties shall file a motion with the Court requesting entry of a judgment and decree that accepts and approves the monitoring and remediation provisions and well setback and water right and water use prohibitions and quantitative limitations of this Settlement Agreement, and that orders the Parties to implement and comply with those provisions, and further declares that:

i. Only Parties to this Settlement Agreement have standing to enforce this Settlement Agreement;

ii. Any enforcement proceeding related to the City's alleged violation of Paragraphs 3, 4, 6, or 7 of this Settlement Agreement will be limited to the following issues:

1. Whether the City has complied with the drilling and monitoring requirements set forth in Paragraph 6;

2. Whether the measured groundwater level declines in dedicated monitoring wells M-1, M-2, or M-3 exceed the acceptable groundwater level declines established in Graphs 1, 2, and 3 and Table 1 described in Paragraph 3;

3. Whether the measured water quality changes in dedicated monitoring well M-2 or M-3 exceeds the acceptable level(s) established in Paragraph 3;

4. Whether the City has undertaken the remedial actions required in Paragraph 7 in a timely fashion and in good faith; and

5. Whether the City has complied with the well setback and water right and water use prohibitions and quantitative limitations established in Paragraph 4.a. and the well setback limitations established in Paragraph 4.b.

iii. Any enforcement proceeding related to HFR's and/or Three Rivers' alleged violation of this Settlement Agreement will be determined by the issues raised.

c. In accordance with Paragraph 6, the City shall drill, develop, equip, maintain, and, if necessary, replace the three dedicated monitoring wells, and the City shall conduct monitoring activities at those dedicated monitoring wells.

d. If the City exceeds the standards established in Paragraph 3, the City shall take the remedial actions as required in Paragraph 7.

3. To protect HFR's and Three Rivers' now-existing water rights and wells from injury that could result from the City's appropriation under OSE File No. T-3825 *et al.*, the following standards shall govern groundwater level decline and water quality changes in dedicated monitoring wells M-1, M-2, and M-3 as between the City, HFR, and Three Rivers:

   a. Acceptable Groundwater Level Decline.

      i. Graphs 1, 2, and 3 and Table 1 establish the acceptable groundwater level decline(s) at dedicated monitoring wells M-1, M-2, and M-3. The baseline water level which will represent the starting point on Graphs 1, 2, and 3 and Table 1 will be the average of the water level measurements taken in the dedicated monitoring wells in the year prior to when the City first produces 500 AFY or more for two consecutive years from its wells under OSE File No. T-3825 *et al.* Production of 500 AFY for two years by the City is a predicate for commencement of calculation of groundwater declines using the graphs and table.

      ii. The baseline condition for each dedicated monitoring well shall be the average of the January and July groundwater levels (altitude in feet above sea level) measured in each dedicated monitoring well prior to initiation of City pumping as defined in Paragraph 3.a.i.

      iii. The annual groundwater level decline from the baseline condition in each dedicated monitoring well for each year shall be based upon the average water-level measurements taken in January and July of the same year, both represented in altitude in feet above sea level.

      iv. The annual groundwater level decline in each dedicated monitoring well shall be the mathematical difference between the altitude in feet above sea level of the baseline groundwater level measured in that well as defined in Paragraph 3.a.ii., and the annual groundwater level measured in the same well as defined in Paragraph 3.a.iii.

      v. The annual groundwater level decline in each dedicated monitoring well shall be compared to the acceptable groundwater level decline for that well represented in Graphs 1, 2, and 3 and Table 1 for the appropriate year after commencement of City pumping as defined in Paragraph 3.a.i. to determine whether the acceptable

groundwater level decline in any dedicated monitoring well has been exceeded.

vi. If the annual groundwater level declines in any of the dedicated monitoring wells M-1, M-2, or M-3 exceed the acceptable groundwater level declines represented in the appropriate Graphs 1, 2, and 3 and Table 1 for three consecutive years, the City shall implement one or more of the remedial actions required in Paragraph 7.

vii. Graphs 1, 2, and 3 and Table 1 were generated and agreed to by the Parties by applying the 2007 superposition version of the OSE's Tularosa Basin two-dimensional ground-water flow model as modified by OSE hydrologist Eric Keyes. Graphs 1, 2, and 3 and Table 1 present for each of the dedicated monitoring wells the acceptable simulated groundwater level declines due to existing and future appropriations within the Tularosa Basin over time, which include, among other input and assumptions, the simulated groundwater level declines projected by the model to occur due to the withdrawal by the City of a constant pumping of 3,000 AFY under OSE File No. T-3825 *et al.*

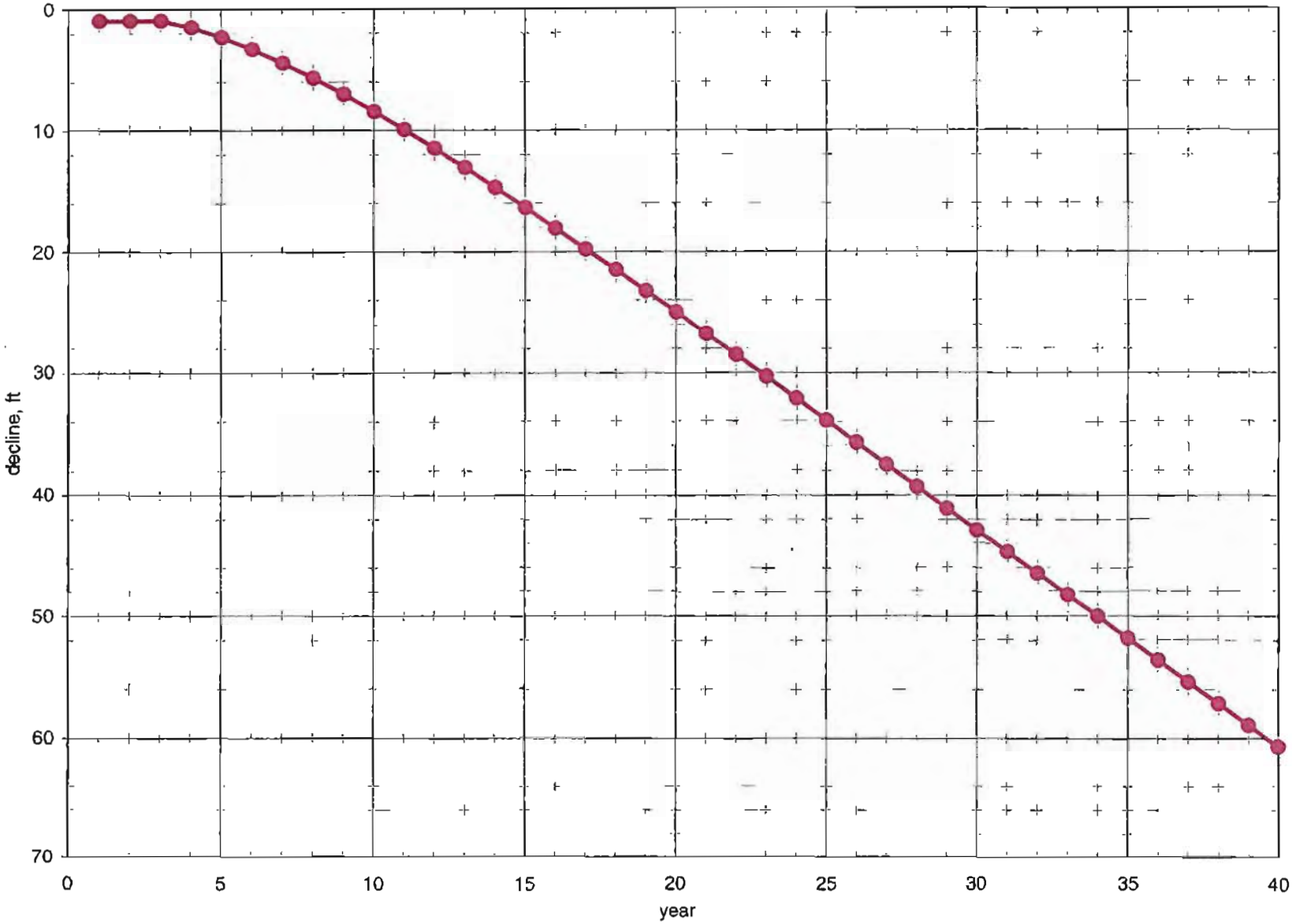
b. Water Quality. The maximum permissible total dissolved solids ("TDS") concentration in dedicated monitoring wells M-2 and M-3 shall not exceed 3,000 mg/L or the highest TDS measured in that well prior to commencement of City pumping as defined in Paragraph 3.a.i. plus 500 mg/L, whichever is higher. If the highest TDS measured in each calendar year in dedicated monitoring wells M-2 or M-3 exceeds the maximum permissible TDS for three consecutive years, the City shall implement one or more of the remedial actions required in Paragraph 7.

c. Dedicated monitoring well M-1 shall govern and only apply to the City's appropriations in relation to impacts on Three Rivers' water rights and wells. Dedicated monitoring wells M-2 and M-3 shall govern and only apply to the City's appropriation under OSE File No. T-3825 *et al.* in relation to impacts on HFR's water rights and wells.

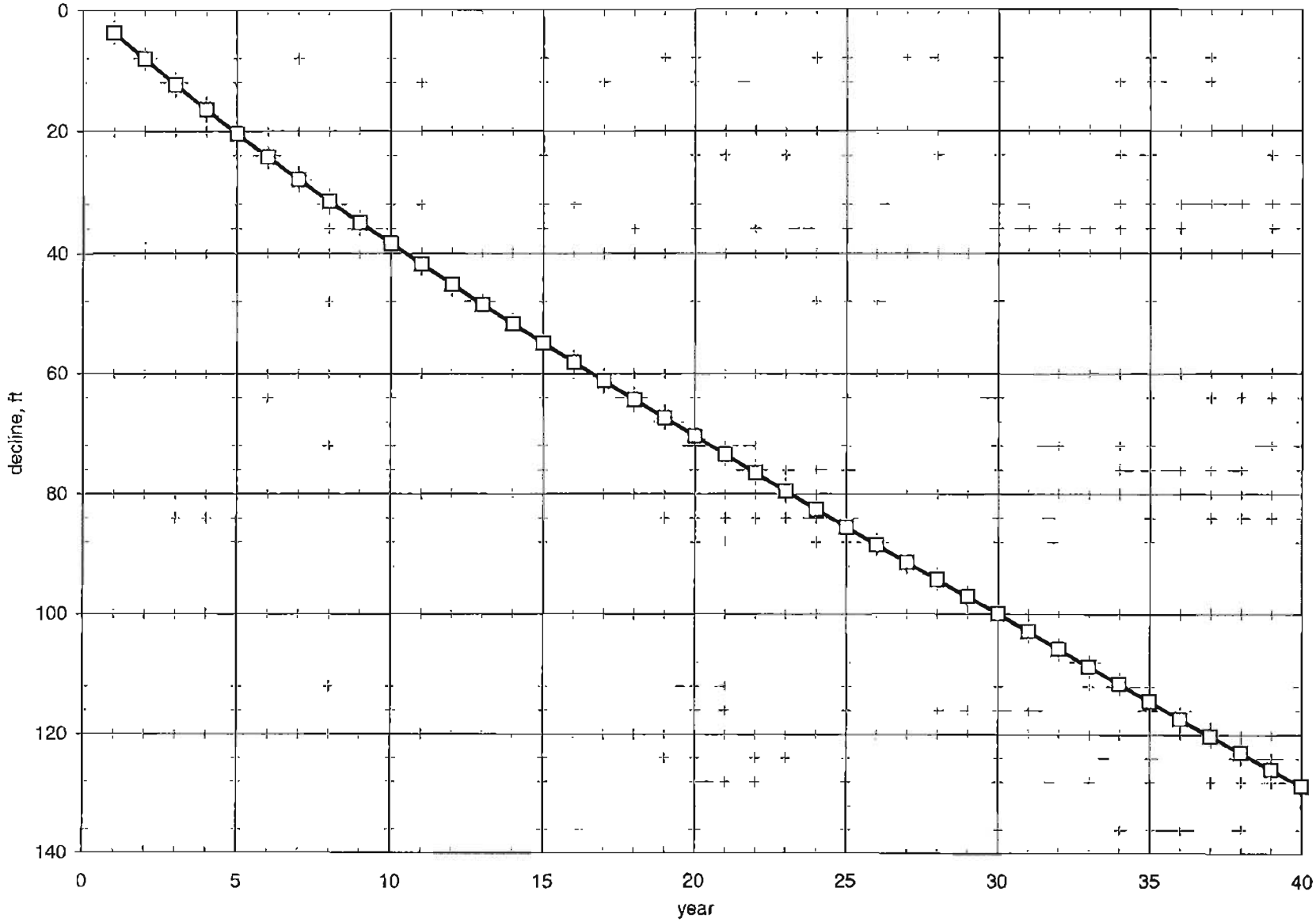
Table 1. Model-simulated groundwater level declines, in feet

Year	M-1 (16,41) acceptable groundwater level decline	M-2 (24,40) acceptable groundwater level decline	M-3 (25,41) acceptable groundwater level decline
1	<1.0	3.7	4.3
2	<1.0	8.0	9.0
3	<1.0	12.3	13.5
4	1.5	16.4	17.9
5	2.3	20.4	22.1
6	3.3	24.2	26.1
7	4.4	27.9	29.9
8	5.7	31.5	33.6
9	7.0	35.0	37.2
10	8.4	38.3	40.7
11	9.9	41.7	44.2
12	11.4	45.1	47.7
13	13.0	48.4	51.1
14	14.7	51.7	54.5
15	16.3	54.9	57.8
16	18.0	58.1	61.0
17	19.7	61.2	64.2
18	21.5	64.3	67.3
19	23.2	67.3	70.4
20	25.0	70.2	73.4
21	26.7	73.3	76.5
22	28.5	76.4	79.6
23	30.3	79.4	82.7
24	32.1	82.4	85.8
25	33.9	85.4	88.8
26	35.7	88.4	91.8
27	37.5	91.3	94.8
28	39.3	94.2	97.7
29	41.1	97.0	100.6
30	42.9	99.9	103.5
31	44.7	102.8	106.5
32	46.5	105.7	109.5
33	48.3	108.7	112.5
34	50.0	111.6	115.4
35	51.8	114.5	118.4
36	53.6	117.4	121.3
37	55.4	120.2	124.2
38	57.1	123.1	127.0
39	58.9	125.9	129.9
40	60.7	128.7	132.7

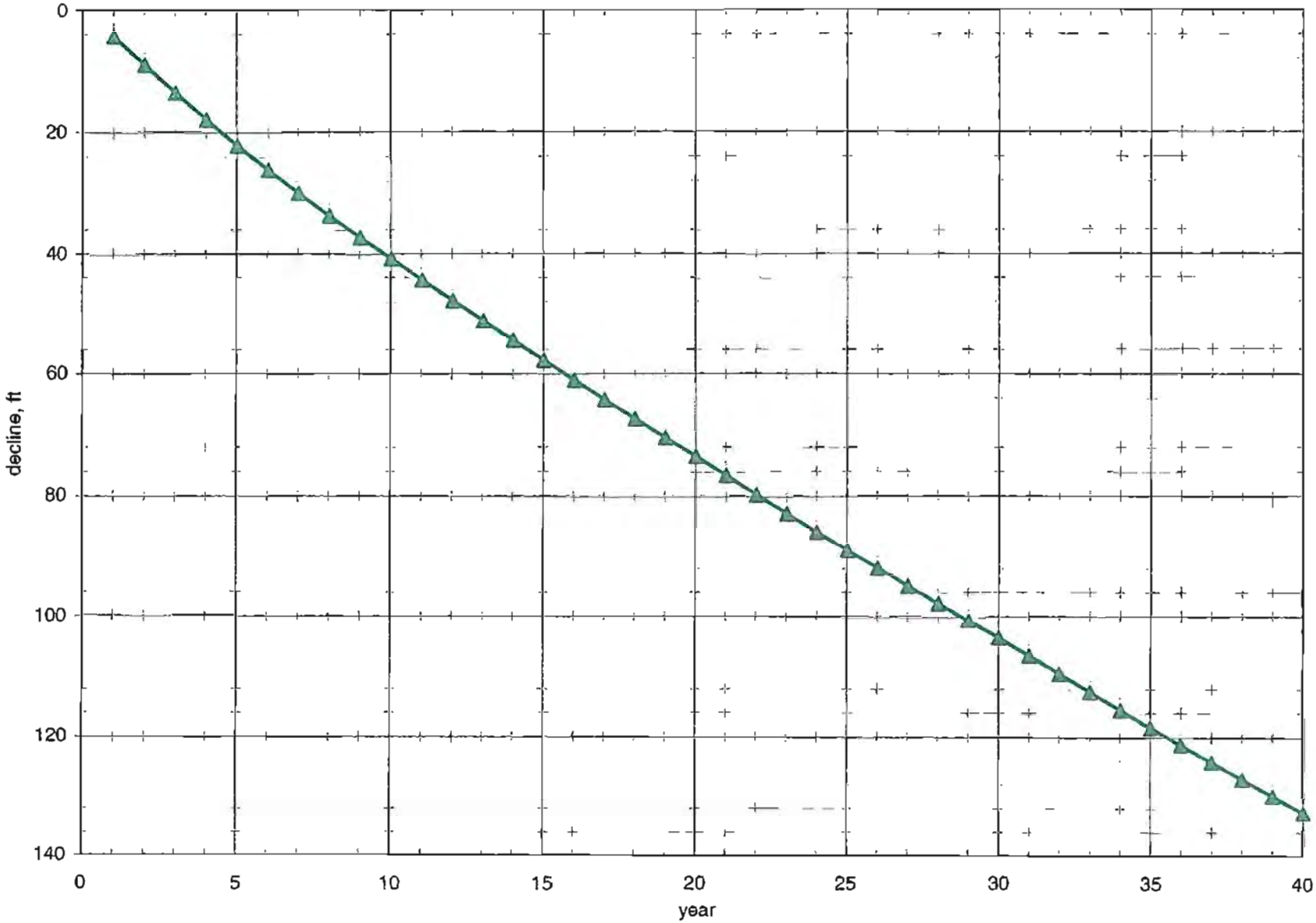
Graph 1. Acceptable Groundwater Level Decline at M-1



Graph 2. Acceptable Groundwater Level Decline at M-2



Graph 3. Acceptable Groundwater Level Decline at M-3



4. The following provisions will protect Three Rivers' and HFR's now-existing water rights and wells from injury that could result from potential City appropriations in the areas described below:

   a. In the area extending south from the southern boundary of Three Rivers' property (the southern boundary of Township 11 South) for a distance of three miles, the City and Three Rivers agree that the following additional restrictions shall apply:

      i. Within the area extending south of Three Rivers' southern boundary a distance of one and one-half miles, which is depicted as Area A in Figure 1, attached hereto, the City shall be prohibited from acquiring water rights, drilling wells, developing water rights, appropriating water from existing wells, or purchasing or in any way receiving water pumped from wells that are located in Area A, provided, however, that the City may purchase water rights in Area A for the sole purpose of retiring those water rights;

      ii. Within the area extending south of Three Rivers' southern boundary for a distance of one and one-half miles to three miles, which is depicted as Area B in Figure 1:

         1. For the purpose of limiting the City's potential water rights and appropriations in Area B, the maximum amount of water rights and/or water uses at any time in Area B shall be limited to 750 AFY, and this limitation shall be inclusive of all present and future water rights in both Areas A and B;

         2. If the City and Three Rivers agree in writing that there are less than 750 AFY of water rights and water uses in combined Areas A and B, in Area B only, the City may acquire water rights, drill new or supplemental wells, develop water rights, appropriate water from existing wells, or purchase or receive water from wells owned by others, provided, however, that the total amount of these water rights and/or water use/purchase alternatives shall not exceed the difference between the allowable maximum water rights or water use/purchase of 750 AFY and the quantity of all then-existing water rights and water uses in the combined Areas A and B;

3. If the City acquires a water right(s) in Areas A and/or B in accordance with Paragraphs 4.a.i. and 4.a.ii., and the amount of the acquired water right(s) exceeds the allowable maximum amount of 750 AFY in accordance with Paragraph 4.a.ii.:

    a. the City shall be prohibited from selling, leasing, or in any way allowing any person or entity to acquire or use the portion of the acquired water right(s) that are in excess of the allowable maximum amount of 750 AFY; and

    b. the City shall retire the amount of the acquired water rights that is in excess of 750 AFY within ninety (90) days of its water rights acquisition; and

4. If the City obtains water right(s) or purchases bulk water under the limitations set forth in Paragraphs 4.a.i. and 4.a.ii. and another individual or entity files an application for a new appropriation or transfer of water rights into Areas A and/or B, the City and Three Rivers shall both protest the application in an effort to ensure that the maximum diversion limitations established in Paragraphs 4.a.i. and 4.a.ii. will be protected and maintained.

iii. The City shall not protest applications filed with the OSE by Three Rivers seeking a permit to move, replace, or supplement Well Nos. T-442-S-4, T-442-S-15, or T-442-S-16 (Three Rivers' basin-fill wells), provided that Three Rivers' application(s) does not seek to increase the amount of its water rights.

b. In the area of HFR's property and the City's wells associated with OSE File No. T-3825 *et al.*, the following restrictions shall apply: the City shall not locate or develop any well or file for any permit under OSE File No. T-3825 *et al.* or any other filing for a permit with the OSE that would seek to establish a water right or water use in the area south of the now-existing site of Well No. T-3825-S-7 and north of the now-existing site of Well No. T-1797-S-6, which is depicted and identified in Figure 1 as Area D.

5. The following provisions will protect the City's now-existing water rights and wells from injury that could result from potential appropriations:

    a. Three Rivers shall not protest applications filed with the OSE by the City seeking a permit for a transfer of water rights, supplemental well, replacement well, or new appropriation of water rights, provided that the City's application(s) does not seek to increase the amount of its water rights in Area C in Figure 1 and the application complies with the limitations in Paragraphs 4.a.i. and 4.a.ii. for Areas A and B in Figure 1.

    b. Three Rivers shall be prohibited from acquiring water rights, drilling wells, developing water rights, appropriating water from existing wells, or purchasing or in any way receiving water pumped from wells owned by others in the area extending south from the southern boundary of Three Rivers' property (the southern boundary of Township 11 South), provided, however, that Three Rivers may purchase water rights south of its southern boundary for the sole purpose of retiring those water rights.

    c. HFR shall not locate or develop any well or file for any permit under OSE File No. T-1797 *et al.* or any other filing for a permit with the OSE that would seek to establish a water right or water use in the area north of the now-existing site of Well No. T-1797-S-6 and south of the now-existing site of Well No. T-3825-S-7, which is depicted and identified in Figure 1 as Area D, provided, however, that HFR may replace Well No. T-1797-S-7 within 300 feet of its now-existing location.

6. The following provisions describe the dedicated monitoring wells and the City's monitoring activities required for the City's compliance with the standards established in Paragraph 3 of this Settlement Agreement.

    a. Dedicated Monitoring Wells. At least one year before the City commences pumping as described in Paragraph 3.a.i., the City shall drill and equip dedicated monitoring wells M-1, M-2, and M-3, which are listed in Table 2 and shown on Figure 1. The City will acquire land or easements for these dedicated monitoring wells and will bear all costs related to drilling, testing, equipping, operating, maintaining, repairing, and replacing the dedicated monitoring wells. The City will keep the dedicated monitoring wells in good working order. The City will allow HFR and Three Rivers to observe the City's measurement and sampling activities. Upon written request by HFR and/or Three Rivers, the City

will provide reasonable access to the dedicated monitoring wells for inspection, measurement, and sampling by designated representatives of HFR and/or Three Rivers. The City may accompany and observe any inspection, measurement, or sampling activities engaged in by HFR and/or Three Rivers.

b. Monitor Well Design and Development. The dedicated monitoring wells will each be completed to the depths shown in Table 2. Geologic and geophysical logs will be made in each borehole. Screen will be set from the potentiometric surface to total depth, and gravel packed, and the well will be developed for a minimum of six hours. The specific capacity of each dedicated monitoring well will be measured and to be acceptable, a dedicated monitoring well must have a specific capacity of at least 1.0 gallons per minute per foot of drawdown in that well. If a dedicated monitoring well is drilled that does not have a specific capacity of at least 1.0 gallons per minute per foot of drawdown, the City will construct another dedicated monitoring well within 250 feet of the initial dedicated monitoring well and Table 1 and Graphs 1, 2, and 3 will not change. Each well will be equipped with a dedicated sampling pump, a water-level measuring tube, and a locking cap. A permanent identification marker showing the well number will be placed on each wellhead, and a permanent measuring point (generally a point on the top of the casing or measuring tube) will be marked, described and reported, and photographed. This installation data shall be furnished to HFR and Three Rivers.

c. Monitoring Activities. In the next quarter following the City's completion of each dedicated monitoring well, the City will commence monitoring activities in that well. The City will monitor these wells on a quarterly basis for the first two years and on a semi-annual basis thereafter. Quarterly measurements will be taken in the latter half of January, April, July, and October. Semi-annual measurements will be taken in January and July of each year. The City will provide to HFR and Three Rivers the water level and water quality data and laboratory reports resulting from the monitoring activities on or before February 15 and August 15 of each year for semi-annual data collection and on or before February 15, May 15, August 15, and November 15 for quarterly data collection.

i. Groundwater Level Measurements. The City will measure the depth to water (water levels) in each dedicated monitoring well listed in Table 2 with an appropriate measuring device (a weighted steel tape unless circumstances dictate otherwise.)

ii. Water Quality Monitoring Activities. The City will collect a water sample from dedicated monitoring wells M-2 and M-3 after the water-level measurement has been made and water has been discharged from the well for not less than 15 minutes or sufficient time to remove 5 casing-volumes, whichever is longer. Field measurements of specific conductance, pH, and temperature of the water will be made and recorded for those wells. Water samples will be collected in bottles furnished by an accredited analytical laboratory and the bottles will be marked and the samples collected and preserved according to the then-current protocols provided by the laboratory or according to ASTM standards if the laboratory does not provide protocols. The laboratory will analyze the samples for TDS and chloride-ion concentration. The TDS analyses will be done using the residual evaporative technique (EPA Method 160.1 (gravimetric, dried at 180°C) or its equivalent).

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TABLE 2. Dedicated Monitoring Wells

Well Number	Twp., Rge, Section	Model Cell	Purpose	Depth or permitted depth
M-1	12.9.26.122	16,41	Monitoring	Not less than 500 feet, or 300 feet below the water table, whichever is greater
M-2	13.9.12.334	24,40	Monitoring	Not less than 600 feet, or 400 feet below the water table, whichever is greater
M-3	13.9.13.212	25, 41	Monitoring	Not less than 600 feet, or 400 feet below the water table, whichever is greater

7. If the acceptable groundwater level decline or water quality change established in Paragraph 3 is exceeded in a dedicated monitoring well, the City shall take one or more of the following remedial actions:

    a. Water Level Remedies.

        i. For Dedicated Monitoring Well M-1. The City shall take one of the following actions if the acceptable groundwater level in dedicated monitoring well M-1 is exceeded, the choice of which is at the City's sole discretion:

            1. The City shall cease pumping from its wells under OSE File No. T-3825 *et al.* and all other City wells located in Area B in Figure 1, if any.

2. The City shall deliver water in such quantity and at such pressure to Three Rivers that, when that water is combined with the amount of water which can reasonably be pumped by Three Rivers' basin fill irrigation wells, Three Rivers will have 1,200 gallons per minute available at the irrigation system 7 days a week, 24 hours a day, over the period March 1 through October 31. Three Rivers will inform the City regarding the timing for water deliveries and the quantity of the required deliveries. The total combined water quantity delivered by the City and diverted by Three Rivers shall not exceed Three Rivers' water right of 780 AFY from its wells in the basin fill. The City shall deliver this water at a site located east of the railroad tracks, east of Highway 54, and north of County Road BO30, which is depicted as DP-1 on Figure 1. The TDS of the water provided by the City will not exceed the TDS of the water being pumped by Three Rivers from its basin-fill irrigation wells at that time. This is a limited remediation option that may be employed by the City for only one five-consecutive-year period every twenty years. If an excess groundwater level decline as described in Paragraph 3 continues beyond that five-year period, then the City must discontinue this option and resort to another remediation option in this Paragraph 7.a.i.

3. The City may purchase and retire sufficient water rights so that the reduction in area pumping results in water levels measured in dedicated monitoring well M-1 recovering to the acceptable water level specified in Table 1 and Graph 1 within a period not to exceed five years.

ii. For Dedicated Monitoring Wells M-2 and M-3. The City shall take one of the following actions if the acceptable groundwater level in dedicated monitoring well M-2 or M-3 is exceeded, the choice of which is at the City's sole discretion:

1. The City shall reduce pumping from its wells under OSE File No. T-3825 *et al.* by 1,082 AFY for every one foot that measured groundwater level decline at dedicated monitoring well M-2 exceeds the acceptable groundwater level decline

specified in Paragraph 3, Table 1 and Graph 2, or by 954 AFY for every one foot that measured groundwater level decline at dedicated monitoring well M-3 exceeds the acceptable groundwater level decline specified in Paragraph 3, Table 1 and Graph 3, whichever calculated amount leads to the greater reduction in the City's pumping from wells under OSE File No. T-3825 *et al.* These numbers represent unit response functions simulated with the OSE groundwater flow model. For example, if excess groundwater level declines occurred in three consecutive years and the excess groundwater level declines were equal to one foot as measured at dedicated monitoring well M-2 at the end of the third year, the City's diversions in the subsequent year would be reduced by 1,082 acre-feet. If groundwater level declines exceed the acceptable groundwater level decline in a fourth consecutive year, the City's diversions will be decreased again according to the unit response function. The City's diversions will continue to be decreased until groundwater level declines no longer exceed the acceptable groundwater level decline.

2. The City shall deliver water in such quantity and at such pressure to HFR that, when that water is combined with the amount of water which can reasonably be pumped by HFR's irrigation wells, HFR will have 5,000 gallons per minute available at the irrigation system 7 days a week, 24 hours a day, over the period July 1 through September 15; and 5,000 gallons per minute available at the irrigation system 6 days a week, 24 hours a day, over the period March 1 through June 30 and September 16 through October 31. HFR will inform the City regarding the timing for water deliveries and the quantity of the required deliveries. The total combined water quantity delivered by the City and diverted by HFR shall not exceed HFR's water right. The City shall deliver this water at a site located east of the railroad tracks, east of Highway 54, and south of Temporal Creek, which is depicted as DP-2 on Figure 1. The TDS of the water provided by the City will not exceed the TDS of the water being pumped by HFR from its irrigation wells at that time. This is a limited remediation option that may be employed

by the City for only one five-consecutive-year period every twenty years. If an excess groundwater level decline as described in Paragraph 3 continues beyond that five-year period, then the City must discontinue this option and resort to another remediation option in this Paragraph 7.a.ii.

3. The City may purchase and retire sufficient water rights so that the reduction in area pumping results in water levels measured in dedicated monitoring wells M-2 and/or M-3 recovering to acceptable water level(s) specified in Table 1 and Graphs 2 and 3 within a period not to exceed five years.

b. Water Quality Remedies. The City shall take one of the following actions if the allowable water quality change established in Paragraph 3 is exceeded in dedicated monitoring well M-2 or M-3, the choice of which is at the City's sole discretion:

i. The City shall reduce pumping from its wells under OSE File No. T-3825 *et al.* to cause the TDS in the dedicated monitoring well to recover to the allowable TDS as described in Paragraph 3.b. within a period not to exceed three years. If the TDS in a dedicated monitoring well does not recover within three years, the City must cease pumping until the TDS recovers to the allowable level, except the City must continue to provide water under Paragraph 7.b.ii.5. to meet its obligation to HFR.

ii. The City shall deliver to HFR water which meets the following criteria for quantity and quality. The water shall be of sufficient quantity so that when the water supplied by the City is combined with the amount of water which can reasonably be pumped by HFR's irrigation wells, HFR will have 5,000 gallons per minute available at the irrigation system 7 days a week, 24 hours a day, over the period July 1 through September 15, and 5,000 gallons per minute available at the irrigation system 6 days a week, 24 hours a day, over the period March 1 through June 30 and September 16 through October 31. The water supplied by the City shall have a TDS such that when the City's water is combined with HFR's water, the combined water will have a TDS equal to or less than the pumping-rate-weighted average in the HFR well loop as calculated from the TDS measurements taken in HFR wells during

the first two years of the three year period described in Paragraph 3.b. For example, if the pumping-rate-weighted average TDS in the HFR well loop is 2,400 mg/L in the year when the TDS in well M-2 or M-3 first exceeds the standards set forth in Paragraph 3.b. and the pumping-rate-weighted average TDS in the HFR well loop is 2,600 mg/L in the second year when M-2 or M-3 exceeds the standards set forth in Paragraph 3.b., then the quality of the combined water will be 2,500 mg/L.

1. HFR has an irrigation system well loop which irrigates the pecan orchard. For purposes of this provision, TDS and irrigation requirements will be calculated for HFR's irrigation system well loop.

2. The City shall conduct all measurements required to determine the pumping-rate-weighted average TDS in HFR's well loop, and shall pay all associated costs.

3. The pumping-rate weighted average TDS in the well loop will be calculated by multiplying the pumping rate measured at the time of sampling by TDS for each well, summing the product, and dividing by the sum of the pumping rate. For example, if the HFR well loop included 5 wells, and if the pumping rates and TDS levels in the wells were:

Pumping Rate (gpm)	TDS (mg/L)
600	2,400
800	2,200
800	2,600
1,000	2,500
1,200	2,400

Then the pumping-rate weighted average TDS would be calculated as follows:

Pumping-rate weighted average TDS = (600 x 2,400 + 800 x 2,200 + 800 x 2,600 + 1,000 x 2,500 + 1,200 x 2,400) $^{gpm\text{-}mg/L}$/4,400 gpm

Pumping-rate weighted average TDS = 2,423 mg/L

4. The City shall deliver the water at a site located east of the railroad tracks, east of Highway 54, and south of Temporal Creek, which is depicted as DP-2 on Figure 1.

5. If, at the end of three consecutive years of attempting this remediation, the water quality standards described in Paragraph 3.b. are still not being met, then the City must move to another remediation action, as specified in Paragraphs 7.b.i., 7.b.iii., or 7.c., and continue to deliver water to HFR in accordance with Paragraph 7.b.ii. (immediately above) until such time as the water quality standards at dedicated monitoring wells M-2 and M-3 are again being met. During this time period, if remediation option 7.b.i. would require the City to cease all pumping from its wells, it may continue to pump only those amounts of water necessary to meet the City's continuing obligation to HFR under Paragraph 7.b.ii.

iii. The City may purchase and retire sufficient water rights so that the reduction in area pumping results in TDS measured in dedicated monitoring wells M-2 and/or M-3 recovering to the acceptable TDS established in Paragraph 3.b. within a period not to exceed three years.

c. Alternative Remedies. In lieu of the remedial actions described in Paragraphs 7.a. and 7.b., if the acceptable groundwater level decline or water quality change in dedicated monitoring well M-1, M-2, or M-3 exceeds the standards established in Paragraph 3, then HFR or Three Rivers, in its sole discretion, may elect to enter into a written agreement with the City regarding other remedial actions that may be taken by the City that are acceptable to HFR and/or Three Rivers.

d. Costs for Infrastructure and Operations. The City will bear all costs of construction, operation, and maintenance of infrastructure required to

deliver water to Three Rivers and HFR as specified in Paragraph 7.a. and 7.b., including the costs of pumping and treatment if applicable.

8. HFR and Three Rivers will provide reasonable access to all of their existing wells and wells that may be drilled in the future so that the City may measure water levels and/or sample water quality quarterly for two years and twice a year thereafter. The City will be responsible for any damage that it causes to HFR's and/or Three Rivers' wells. The City will bear all costs, including electric demand costs, associated with such activities. The City will provide any information collected to HFR and/or Three Rivers within 30 days after the data are compiled.

9. The City shall not protest applications filed with the OSE by HFR seeking a permit to move, replace, or supplement wells under OSE File No. T-1797 *et al.*, provided that HFR's application(s) does not seek to increase the amount of its water rights, and further provided, that the new well may not be drilled further than 750 feet north of the now-existing location of the well being moved, replaced, or supplemented.

10. HFR shall not protest applications filed with the OSE by the City seeking a permit to move, replace, or supplement wells under OSE File No. T-3825 *et al.*, provided that the City's application(s) does not seek to increase the amount of its water rights, and further provided, that the new well may not be drilled further than 750 feet south of the now-existing location of the well being moved, replaced, or supplemented.

11. This Settlement Agreement is independent of the State Engineer's permit conditions for and administration of any permit issued under OSE File No. T-3825 *et al.* The Parties' rights and obligations related to the City's monitoring and remedial actions that are established in this Settlement Agreement are also independent of the State Engineer's consideration of impairment and requirements regarding monitoring and implementation of remedial action under OSE File No. T-3825 *et al.*

12. In any enforcement action brought by HFR and/or Three Rivers under this Settlement Agreement, the City shall not claim that the State Engineer's actions or inactions with respect to monitoring and remedial requirements under OSE File No. T-3825 *et al.* is inconsistent with the comparable requirements of this Settlement Agreement, and, further, the City shall not claim that the Court should not enforce this Settlement Agreement because of the actions or

inactions of the State Engineer in relation to the State Engineer's administration of OSE File No. T-3825 *et al.*

13. In proceedings other than enforcement proceedings under this Settlement Agreement, HFR and Three Rivers shall not claim in any administrative or judicial context that the acceptable groundwater level declines and water quality changes set forth herein define *per se* impairment under the New Mexico Water Code.

14. In accordance with Paragraph 2.d, the Parties shall jointly move the Court to retain jurisdiction over them and this Settlement Agreement, which will be accomplished by the Court entering a judgment and decree, which provides that:

    a. In the event of a failure by the City to comply with appropriate remedial measures after a triggering event, HFR and/or Three Rivers may file with the Court a motion for an order to show cause why the City should not be found to be in violation of the terms of this Settlement Agreement. An expedited hearing on HFR's and/or Three Rivers' show cause motion will be sought, and if there is a determination that the City is in violation of this Settlement Agreement, the Court shall enter an order requiring that the City immediately cease its violation(s) and implement the appropriate remedial measures established in Paragraph 7 or order the City to comply with the requirements of Paragraph 4.

    b. In the event of a failure by HFR and/or Three Rivers to comply with this Settlement Agreement, the City may file with the Court a motion for an order to show cause why HFR and/or Three Rivers should not be found to be in violation of the terms of this Settlement Agreement. An expedited hearing on the City's show cause motion will be sought, and if there is a determination that HFR and/or Three Rivers is in violation of this Settlement Agreement, the Court shall enter an order requiring that HFR and/or Three Rivers immediately cease its violation(s) and abide by this Settlement Agreement.

    c. The Court also shall have authority to enter an order(s) awarding such additional equitable and monetary relief as is appropriate under the circumstances. The prevailing party or parties in such proceedings shall also be entitled to recover its or their reasonable attorneys' fees and costs.

15. The Court's approval of all terms and conditions of this Settlement Agreement, including, without limitation, its entry of the judgment and decree and its retention of jurisdiction as specified in Paragraphs 2.d. and 14, is a condition precedent to this Settlement Agreement becoming effective and the Parties performance hereunder.

16. If Three Rivers decides to sell its property and/or associated water rights, Three Rivers will advise the City of its intent to sell its land and associated water rights or solely the water rights before it offers the land and associated water rights or solely the water rights to any person or entity.

17. If HFR or Sierra Blanca Pecan Ranch decides to sell its property and/or associated water rights, it will offer its land and associated water rights or solely the water rights to the City before it offers the land and associated water rights or solely the water rights to any person or entity. HFR and Sierra Blanca Pecan Ranch are currently parties to a real estate contract to sell HFR's property and water rights, and this transaction does not constitute a sale of property under this Settlement Agreement.

18. If the City acquires Three Rivers' land and associated water rights or solely its water rights pursuant to Paragraph 16 or if Three Rivers' water rights are permanently transferred from Three Rivers' land, the requirements related to Three Rivers in Paragraphs 3, 4, 6, and 7 shall no longer apply or be valid.

19. If the City acquires HFR's land and associated water rights or solely its water rights pursuant to Paragraph 17 or if HFR's water rights are permanently transferred from HFR's land, the requirements related to HFR in Paragraphs 3, 4, 6, and 7 shall no longer apply or be valid.

20. This Settlement Agreement is not intended to, and expressly does not, give third-party beneficiary status to any person or entity not an express party hereto.

21. Except for the standards, requirements, prohibitions and limitations established in this Settlement Agreement that apply to the Parties' respective present and future water rights and water uses, nothing in this Settlement Agreement shall be construed as establishing any standard for any future applications that the Parties may file with the OSE.

22. All notices, correspondence, documents, or transmittal of records of data required pursuant to this Settlement Agreement shall be sent to the Parties at the

following addresses, unless the other Parties are notified of an address change in writing:

City of Alamogordo:
Pat McCourt, City Manager
1376 E. Ninth Street
Alamogordo, NM 88310
Fax: (575) 329-4396

Counsel to the City of Alamogordo:
James C. Brockmann, Esq.
Stein & Brockmann, P.A.
P.O. Box 5250
Santa Fe, NM 87505
Fax: (505) 986-1028

HFR:
Gordon K. Yahney
P.O. Box 1933
Roswell, NM 88202
Fax: (575) 523-0611

Three Rivers:
Kendall Joyce
118 W. First Street
Roswell, NM 88201
Fax: (575) 623-1801

Counsel to HFR and Three Rivers:
Jeffrey L. Fornaciari, Esq.
Hinkle, Hensley, Shanor & Martin, LLP
P.O. Box 2068
Santa Fe, NM 87504-2068
Fax: (505) 982-8623

23. The Parties have developed this Settlement Agreement through good faith negotiations for the purpose of resolving legal and factual disputes related to pending litigation. No conduct, statements, offers, or compromises made in the course thereof shall be construed as admissions against interest or be used in any legal forum or proceeding.

24. Each party represents that its authorized agent has carefully read and reviewed the terms of this Settlement Agreement and that it, through its authorized agent, understands it.

25. Each party represents and warrants that it is authorized to execute this Settlement Agreement on behalf of the respective Parties hereto and does so freely and voluntarily.

26. Execution of this Settlement Agreement by all institutional entities signifies that all provisions of this Settlement Agreement have been approved by those

entities' respective governing bodies and that those entities bind themselves to the obligations and benefits of this Settlement Agreement.

27. This Settlement Agreement shall be construed in accordance with the laws of the State of New Mexico.

28. This Settlement Agreement shall be binding on and inure to the benefit of the Parties and the respective successors and assigns of their water rights, and shall be binding on all instrumentalities and entities of the City that may participate in the development, use, and treatment of water associated with OSE File No. T-3825 *et al.*, including, without limitation, the Regional Project.

29. This Settlement Agreement may be signed in counterparts by the Parties, and the counterparts executed by each party, when combined, will constitute a complete agreement.

30. This Settlement Agreement constitutes the entire agreement of the Parties with respect to the subject matter hereof. This Settlement Agreement may be amended only by written agreement executed by the affected Parties.

HFR CORPORATION

_____

George Yates

CITY OF ALAMOGORDO

_____

for Donald E. Carroll
Mayor
City of Alamogordo

THREE RIVERS CATTLE LTD., CO.

_____

Kay McMillan

SIERRA BLANCA PECAN RANCH

_____

_____

As the real estate contract purchaser and successor-in-interest to HFR

STATE OF NEW MEXICO)
) ss.
COUNTY OF OTERO)

The foregoing instrument was acknowledged before me this 20th day of November, 2007, by ~~Donald E. Carroll~~, Mayor, on behalf of the City of Alamogordo.
Ron Griggs

Notary Public

My Commission Expires: 7/21/10

STATE OF NEW MEXICO)
) ss.
COUNTY OF _____)

The foregoing instrument was acknowledged before me this _____ day of November, 2007, by Kay McMillan, on behalf of the Three Rivers Cattle Ltd., Co.

Notary Public

My Commission Expires:

STATE OF NEW MEXICO)
) ss.
COUNTY OF _____)

The foregoing instrument was acknowledged before me this _____ day of November, 2007, by George Yates, on behalf of the HFR Corporation.

Notary Public

My Commission Expires:

STATE OF NEW MEXICO)
) ss.
COUNTY OF _____)

The foregoing instrument was acknowledged before me this _____ day of November, 2007, by _____, on behalf of Sierra Blanca Pecan Ranch.

_____
Notary Public

My Commission Expires:

entities' respective governing bodies and that those entities bind themselves to the obligations and benefits of this Settlement Agreement.

27. This Settlement Agreement shall be construed in accordance with the laws of the State of New Mexico.

28. This Settlement Agreement shall be binding on and inure to the benefit of the Parties and the respective successors and assigns of their water rights, and shall be binding on all instrumentalities and entities of the City that may participate in the development, use, and treatment of water associated with OSE File No. T-3825 et al, including, without limitation, the Regional Project.

29. This Settlement Agreement may be signed in counterparts by the Parties, and the counterparts executed by each party, when combined, will constitute a complete agreement.

30. This Settlement Agreement constitutes the entire agreement of the Parties with respect to the subject matter hereof. This Settlement Agreement may be amended only by written agreement executed by the affected Parties.

HFR CORPORATION

Arlene Rowland – Vice President

CITY OF ALAMOGORDO

Donald E. Carroll
Mayor City of
Alamogordo

THREE RIVERS CATTLE LTD., CO.

Kay McMillan

SIERRA BLANCA PECAN RANCH

As the real estate contract purchaser and successor-in-interest to HFR

entities' respective governing bodies and that those entities bind themselves to the obligations and benefits of this Settlement Agreement.

27. This Settlement Agreement shall be construed in accordance with the laws of the State of New Mexico.

28. This Settlement Agreement shall be binding on and inure to the benefit of the Parties and the respective successors and assigns of their water rights, and shall be binding on all instrumentalities and entities of the City that may participate in the development, use, and treatment of water associated with OSE File No. T-3825 *et al.*, including, without limitation, the Regional Project.

29. This Settlement Agreement may be signed in counterparts by the Parties, and the counterparts executed by each party, when combined, will constitute a complete agreement.

30. This Settlement Agreement constitutes the entire agreement of the Parties with respect to the subject matter hereof. This Settlement Agreement may be amended only by written agreement executed by the affected Parties.

HFR CORPORATION

_____

George Yates

CITY OF ALAMOGORDO

_____

Donald E. Carroll
Mayor
City of Alamogordo

THREE RIVERS CATTLE LTD., CO.

_____

Kay McMillan

SIERRA BLANCA PECAN RANCH

_____

_____

As the real estate contract purchaser and successor-in-interest to HFR

entities' respective governing bodies and that those entities bind themselves to the obligations and benefits of this Settlement Agreement.

27. This Settlement Agreement shall be construed in accordance with the laws of the State of New Mexico.

28. This Settlement Agreement shall be binding on and inure to the benefit of the Parties and the respective successors and assigns of their water rights, and shall be binding on all instrumentalities and entities of the City that may participate in the development, use, and treatment of water associated with OSE File No. T-3825 *et al.*, including, without limitation, the Regional Project.

29. This Settlement Agreement may be signed in counterparts by the Parties, and the counterparts executed by each party, when combined, will constitute a complete agreement.

30. This Settlement Agreement constitutes the entire agreement of the Parties with respect to the subject matter hereof. This Settlement Agreement may be amended only by written agreement executed by the affected Parties.

HFR CORPORATION

_____

George Yates

CITY OF ALAMOGORDO

_____

Donald E. Carroll
Mayor
City of Alamogordo

THREE RIVERS CATTLE LTD., CO.

_____

Kay McMillan

SIERRA BLANCA PECAN RANCH

_____

As the real estate contract purchaser and successor-in-interest to HFR

STATE OF NEW MEXICO)
) ss.
COUNTY OF OTERO)

The foregoing instrument was acknowledged before me this_____ day of November, 2007, by Donald E. Carroll, Mayor, on behalf of the City of Alamogordo.

_____
Notary Public

My Commission Expires:_____

STATE OF NEW MEXICO)
) ss.
COUNTY OF _____)

The foregoing instrument was acknowledged before me this_____ day of November, 2007, by Kay McMillan, on behalf of the Three Rivers Cattle Ltd., Co.

_____
Notary Public

My Commission Expires:_____

STATE OF NEW MEXICO)
) ss.
COUNTY OF Chaves)

The foregoing instrument was acknowledged before me this 12 day of December, 2007, by Arlene Rowland, on behalf of the HFR Corporation.

Diana B. Woodard
Notary Public

My Commission Expires: 2/7/08

STATE OF NEW MEXICO)
) ss.
COUNTY OF OTERO)

The foregoing instrument was acknowledged before me this _____ day of November, 2007, by Donald E. Carroll, Mayor, on behalf of the City of Alamogordo.

_____
Notary Public

My Commission Expires:

STATE OF NEW MEXICO)
) ss.
COUNTY OF CHAVES)

The foregoing instrument was acknowledged before me this 26th day of November, 2007, by Kay McMillan, on behalf of the Three Rivers Cattle Ltd., Co.

_____
Notary Public

My Commission Expires: July 31, 2009

STATE OF NEW MEXICO)
) ss.
COUNTY OF _____)

The foregoing instrument was acknowledged before me this _____ day of November, 2007, by George Yates, on behalf of the HFR Corporation.

_____
Notary Public

My Commission Expires:

STATE OF NEW MEXICO)
) ss.
COUNTY OF Otero)

The foregoing instrument was acknowledged before me this 21st day of November, 2007, by Dario Antunez, on behalf of Sierra Blanca Pecan Ranch.

Sharon Burton
Notary Public

My Commission Expires: June 26, 2008

BEFORE THE NEW MEXICO
STATE ENGINEER

IN THE MATTER OF THE APPLICATION BY	)	Hearing No. 02-035
CITY OF ALAMOGORDO FOR PERMIT TO	)	
APPROPRIATE UNDERGROUND WATERS	)	OSE File Nos. T-3825 thru T-3825-S-9
FROM THE SHALLOW AQUIFER LOCATED	)	
IN THE TULAROSA BASIN OF NEW MEXICO	)	

STIPULATION
BETWEEN
THE CITY OF ALAMOGORDO
AND
THE VILLAGE OF TULAROSA

THIS STIPULATION BETWEEN THE CITY OF ALAMOGORDO AND THE VILLAGE OF TULAROSA ("Stipulation") is made this 2d day of ~~June~~ July, 2003, by and between the City of Alamogordo ("City"), whose address is City of Alamogordo, c/o City Manager, 1376 E. Ninth Street, Alamogordo, NM 88310, and the Village of Tularosa ("Village"), whose address is Village of Tularosa, c/o Mayor, 705 St. Francis Drive, Tularosa, NM 88352.

RECITALS:

WHEREAS, Application No. T-3825 thru T-3825-S-9, an application for permit to appropriate groundwater, was filed by the City on September 6, 2000, and amended on January 14, 2002 (the "Application"); AND

WHEREAS, on February 28, 2002, the Village filed its protest with the Office of the State Engineer ("OSE") against the Application; AND

Alamogordo Exhibit 19

WHEREAS, the City and the Village both desire to settle the protest;

NOW, THEREFORE, IT IS MUTUALLY AGREED BETWEEN THE PARTIES HERETO AS FOLLOWS:

AGREEMENT

1. The City agrees to sell bulk water at the cost of production to the Village as a back-up and/or emergency water supply to the extent allowed by Permit No. T-3825 thru T-3825-S-9.

2. If requested by the Village, the City will enter into negotiations with the Village for a long-term contract to provide the Village with a bulk water supply on a continuing basis, in an amount not to exceed the following:

Year	Maximum Diversion[1]
2000-2010	400 AFY
2010-2020	600 AFY
2020-2030	800 AFY
2030-2040	1,200 AFY

These quantities are contingent upon and subject to approval of the Application.

3. By execution of this Stipulation, the Village hereby withdraws its protest to the Application.

4. The Village hereby agrees to support the Application.

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[1] These figures represent the quantities of water diverted from the wells. The quantity of water produced as a result of the desalinization process will be less than the quantity of water diverted. Accordingly, the quantity of water actually produced for the Village will be reduced from the diversion quantities based upon actual efficiency of the desalinization process.

EXECUTED this 2 day of ~~June~~ July, 2003.

CITY OF ALAMOGORDO

By: Donald E. Carroll

Name: Donald E. Carroll

Title: Mayor

Reviewed and approved by counsel:

James C. Brockmann

James C. Brockmann, Esq.
Jay F. Stein, Esq.
Stein & Brockmann, P.A.
P.O. Box 5250
Santa Fe, NM 87502-5250
Phone: (505) 983-3880
Fax: (505) 986-1028

VILLAGE OF TULAROSA

By: Demetrio H. Montoya

Name: Demetrio H. Montoya

Title: Mayor

Reviewed and approved by counsel:

Jeffrey R. Rhodes, Esq.
Burroughs & Rhodes
P.O. Drawer 5008
Alamogordo, NM 88311-5008
Phone: (505) 434-1010
Fax: (505) 434-5805

THE SUPREME COURT OF THE STATE OF NEW MEXICO
January 21, 2010

NO. 32,141

RECEIVED
STEIN & BROCKMANN
JAN 25 2010

TULAROSA COMMUNITY DITCH CORPORATION, DAN C. ABERCROMBIE, ELSIE I. BAILEY, LAYMON HIGHTWOER and ALLEN (BILL) TRAMMELL,

Protestants-Petitioners,

v.

NEW MEXICO STATE ENGINEER, JOHN R. D'ANTONIO, JR.,

Interested Party-Respondent,

and

CITY OF ALAMOGORDO,

Applicant-Respondent.

ORDER

This matter coming on for consideration by the Court upon petition for writ of certiorari, and the Court having considered said petition and responses and being sufficiently advised, Chief Justice Edward L. Chávez, Justice Patricio M. Serna, Justice Petra Jimenez Maes, Justice Richard C. Bosson, and Justice Charles W. Daniels concurring;

NOW, THEREFORE, IT IS ORDERED that the petition for writ of certiorari is denied in Court of Appeals number 28643.

IT IS SO ORDERED.

WITNESS, The Hon. Edward L. Chávez, Chief Justice of the Supreme Court of the State of New Mexico, and the seal of said Court this 21st day of January, 2010.

(SEAL)

Madeline Garcia

Madeline Garcia, Chief Deputy Clerk

ATTEST: A TRUE COPY

Madeline Garcia

Clerk of the Supreme Court
of the State of New Mexico

APPENDIX D

Public Scoping Report

ALAMOGORDO REGIONAL WATER SUPPLY ENVIRONMENTAL IMPACT STATEMENT PUBLIC SCOPING DOCUMENT

Prepared For

U.S. BUREAU OF LAND MANAGEMENT
U.S. BUREAU OF RECLAMATION

Prepared by

SWCA ENVIRONMENTAL CONSULTANTS

April 2005

ALAMOGORDO REGIONAL WATER SUPPLY
EIS PUBLIC SCOPING DOCUMENT

INTRODUCTION

The City of Alamogordo, New Mexico (the City), proposes to develop a sustainable municipal and regional water supply (the Project). As the proponent, the City has compiled information indicating the need for additional water sources for the region as well as for more efficient water conservation. As a result, the City has proposed the development of a sustainable regional water supply. The proposed Project and portions of the supporting infrastructure (pipelines) would be located partly on land and rights-of-way owned and managed by the U.S. Bureau of Land Management (BLM). As a result, the federal action for the BLM is whether to grant the City use of the proposed right-of-way based on the results of the Environmental Impact Statement (EIS). Given that the City seeks federal financial support through Reclamation's Title XVI program, the federal action for Reclamation is whether to partially fund the project based on the results of the EIS. These two actions, individually and collectively, necessitate an analysis under provisions of the National Environmental Policy Act (NEPA).

The Public Scoping process has two parts: providing information to community members about decisions that directly affect them, and soliciting information about the interests and concerns of the community. The purpose of Public Scoping is to identify environmental issues to be considered in the Environmental Impact Statement (EIS) for the Project. For the Alamogordo Project, scoping lasted from August 26 to October 25, 2004.

This *Scoping Report* addresses all aspects of the public scoping process for the Project EIS, including advertising for public meetings, dates and locations of the meetings, and all comments received as a result of these meetings, either at the meetings or through other mechanisms. The public meetings were a vital part of the EIS, which addresses the proposed activities of the Project.

This document summarizes the comments received verbally during the scoping meetings and by both e-mail and regular mail to Project-dedicated addresses during the advertised scoping period. All comments have been given equal consideration regardless of method of transmission.

This report has been prepared pursuant to NEPA, as amended (42 USC 4321 et seq.), and in accordance with the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 CFR Parts 1500–1508).

DESCRIPTION OF PUBLIC SCOPING MEETINGS

Two Public Scoping Meetings (Table 1) were conducted as part of the Project EIS. The purpose of these meetings was to provide information to all interested persons about the proposed project, as well as to provide an opportunity to voice concerns or opinions. At each meeting a series of nine (9) displays explained the NEPA process, the history of the Project, the purpose and need

for the Project, details about the area's hydrology, and potential methods for improving the region's water supply. In addition, attendees were provided a complete information packet reiterating, in greater detail, the information shown on the display boards. SWCA Environmental Consultants (SWCA) presented a PowerPoint presentation, and representatives from the Joint Federal Lead Agencies (JFLA) were available to answer questions and participate in the public discussion.

Table 1. Information on Public Scoping Meetings

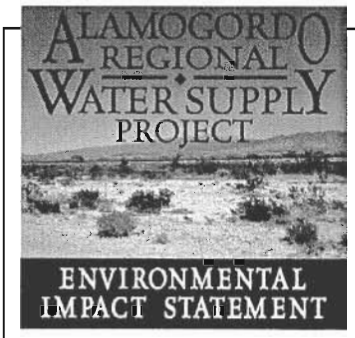
MEETING LOCATION	DETAILS
Alamogordo, New Mexico Willie Estrada Civic Center, 800 East First Street	Tuesday, October 5, 2004 6:00 – 8:00 p.m.
Tularosa, New Mexico Senior Center, 1055 Bookout Road	Wednesday, October 6, 2004 6:00 – 8:00 p.m.

ADVERTISING OF PUBLIC SCOPING MEETINGS

Pursuant to NEPA requirements, each meeting was advertised at least two weeks prior to its scheduled date. A variety of formats and announcement venues were used (Table 2, Figure 1). In each format, the announcements explained the purpose of the public meetings, gave the schedule for the public comment (scoping) period, and provided several methods of obtaining additional information. All display ads in local newspapers were identical in content, although the size and shape of the ads varied according to the requirements of each newspaper.

Table 2. Advertisements for Public Scoping Meetings

ANNOUNCEMENT	VENUE	DATE(s) PLACED
Project Announcement Letter, Brochure, and Comment Card	Mailed to approx. 500 people known to be interested	Mailed First Class on August 23, 2004
Classified Ad "Public Scoping Notice"	*Alamogordo Daily News*	August 26, 2004
Display Ad "Public Scoping Notice" *(both meetings included)*	*Alamogordo Daily News*	August 26, 2004 September 29, 2004
Display Ad "Public Scoping Notice" *(both meetings included)*	*Tularosa Reporter*	September 23, 2004
Display Ad "Public Scoping Notice" *(both meetings included)*	*Ruidoso News*	September 29, 2004
Display Ad "Public Scoping Notice" *(both meetings included)*	*Bucksworth Community News*	September 29, 2004
"Public Scoping Notice" Flyer	Inserted in the Alamogordo monthly municipal water bill	September 2004



PUBLIC SCOPING NOTICE

This is an invitation for you to participate in the identification of issues and alternatives for the Alamogordo Regional Water Supply Project Environmental Impact Statement (EIS) and attend Public Meetings.

What is the Alamogordo Regional Water Supply Project?
The current fresh water supply is not sufficient to meet both current and future water demands for the City of Alamogordo and the surrounding region. As a result, the need for the Project is to secure a sustainable fresh water resource for use by the City and the surrounding region.

The Project is proposed to help serve the water supply needs of the Alamogordo region by continuing to ensure water conservation within the City, and by treating saline water from the Tularosa Basin to meet drinking water standards.

Additional information about the Project is available online at:
http://www.swca.com/arwsp/

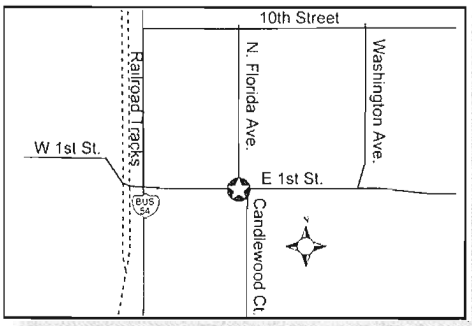
For further information, please contact:
Philip Rhinehart, Bureau of Land Management, (505) 525-4426

When are the meetings?

Public Scoping Meetings will be held at the following times and locations:

Alamogordo

Tuesday, October 5, 2004
6:00-8:00 p.m.
Willie Estrada Civic Center
800 East First Street
Alamogordo, New Mexico, 88310



Tularosa

Wednesday, October 6, 2004
6:00-8:00 p.m.
Senior Center
1055 Bookout Road
Tularosa, New Mexico, 88352

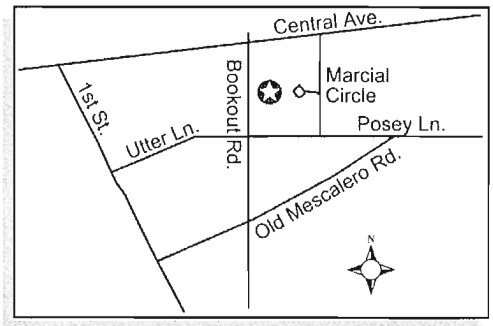


Figure 1. General format for display ads and water-bill insert to announce Public Scoping.

OPPORTUNITIES FOR PUBLIC COMMENTS

SCOPING MEETINGS

After the general presentation, three breakout groups were formed to allow verbal comments. Public concerns were written on flip-charts by SWCA facilitators. In all, 216 comments were collected at the two meetings. As major themes became clear within each group, facilitators created large index cards that were taped to the front wall; 52 priority issues were identified and written on these cards. When the group reconvened for final discussion, participants were asked to place a colored dot on the cards that reflected their three highest priorities. For example, red signified their number one priority (highest), green indicated the second (middle), and yellow was their third choice (lowest) priority. Table 3 shows the 52 concern categories from highest –to lowest priority, based on the ranking provided by attendees. Some cards had no dots, indicating that none of the attendees ranked those issues among their top three priorities. However, all 52 issues were considered to be priorities by the attendees and therefore appear in the table.

ALAMOGORDO MEETING

- 37 people signed in, 25 voted on priority issues via colored dots
- 90 comments were received from three groups during the breakout session
- 22 priorities were placed on index cards

TULAROSA MEETING

- 108 people signed in; 83 voted on priority issues via colored dots
- 136 comments were received from the three groups during the breakout session
- 30 priorities were placed on index cards

Some of the same concerns were shared by both communities. When ALL comments from both communities are combined, the highest priorities undergo a slight change in ranking. The top five priorities in the combined rankings are:

- Drawdown
- Location of wells
- Tularosa area will be destroyed; farming and ranching
- Water provision for 37,000+ people
- Growth; managed (balance growth with use)

Table 3. Top 52 Priorities Identified at Tularosa/Alamogordo Public Scoping Meetings (in descending order of importance as signified by colored dots).

HIGHEST-PRIORITY ISSUES	**MEDIUM-PRIORITY ISSUES**
Location of wells	Science – use all available
Tularosa area destroyed; farming and ranching	Takings
Water provision for 37,000+ people	NOT a "regional" plan
Drawdown in wells	Manage growth in Alamogordo (should)
Drawdown	Acequias – effect on
Growth; managed (balance growth with use)	Tularosa historic/cultural (protection)
Accountability for well impacts	OSE participation
Don't drain the mountain!	Economic impact (negative)
Water rights; existing	Monitoring measures
Tularosa; survival as a community	Location of wells
Mechanism to stop project (wanted)	Surface water; effect on Tularosa's
Tularosa Creek	Objective science (desired)
Watershed management	Water management
Location of plant	Wildlife (influence on)
40-year planning period (too short)	Ground water mining
Interconnection with mountain rivers/aquifer	Socioeconomics
	Water; no one community should own/control it
LOWER-PRIORITY ISSUES	(commenter) Supports the project
Water quality	Project monies (should be) spent locally
Forest Service / flood management	Water bills (increases)
Clean water; control over	Water prices
OSE decision's influence on project?	Administration of constructed project
Process – and how it affects water use	Pollution concerns
Water distribution in/out of region	Waste (disposal of)
White Sands Monument protection	Water capture
Biased science	Length of timeline (40-year analysis too short)
Land decisions	
Want a strong protective agreement between cities	
Biased presentation (SWCA is biased)	

COMMENT CARDS, LETTERS, AND E-MAILS:

Comment Cards were distributed during the initial mailing and were also provided at the Scoping Meetings, both in the Information Packets provided and on tables next to each display board. Postal and e-mail addresses were provided for the receipt of comments:

SWCA Environmental Consultants
Attention: Alamogordo Regional Water Supply Project
7001 Prospect Place NE, Suite 100
Albuquerque, NM 87110

almwater@swca.com

Information about the Project, the Public Scoping Meetings, and Opportunities to Comment were published on the BLM website. A separate website was dedicated to Project information: www.swca.com/arwsp/ Four of the comment cards provided in the information packets were completed and turned in during the Alamogordo meeting, and six were turned in during the Tularosa meeting. Three typed comment letters were also deposited in the comment box at Scoping Meetings.

Comment cards, letters, and e-mails were received through October 25, 2004, the end of the scoping period. The final result was 33 comment cards, 21 letters, and seven emails. Twelve comments were entered at the Project website. Collectively, the different methods yielded 546 separate comments.

OVERVIEW OF COMMUNITY CONCERNS

Key issues and concerns expressed during public and agency scoping will affect impact analysis and alternatives development. Issues of primary concern to the public at the Alamogordo Public Scoping meeting were water provision for projected growth in the Alamogordo region, ground-water draw down, balanced growth with water use, and the City's accountability for any impacts to non-City ground water wells. Additional key issues were watershed management, the location of the proposed facilities, growth management, and economic impacts.

At the Tularosa Public Scoping meeting, issues of primary concern to the public were the proximity of the proposed wells to the Village of Tularosa and other residential wells outside the village, the potential effects of the proposed Project on ranching and agriculture in the region, the potential for ground-water drawdown in residential wells, brackish water intrusion, and managing growth in the region. Additional key issues were the potential effects on acequias and surface water, the economic impact, and monitoring measures.

DESCRIPTION OF SCOPING COMMENT ANALYSIS

In the words of the Supreme Court, the purpose of the NEPA process is to "place upon an agency the obligation to consider every significant aspect of the environmental impact of a proposed action." All findings are reported in the Final Environmental Impact Statement to "ensure that the agency will inform the public that it has considered environmental consequences in its decision-making process."

Hand-in-hand with informing the public is the need to solicit information about the interests and concerns of the communities that would be affected by a proposed project. Comments received during Public Scoping assist in the identification of environmental issues that may require consideration in the Environmental Impact Statement. Pursuant to the NEPA process, comments are sorted into general categories that match specific sections in the proposed project's EIS so that each pertinent comment can be addressed.

PURPOSE AND NEED (CHAPTER 1)

The Purpose and Need statement provides the justification for a proposed action. The "Purpose" describes what the action is intended to accomplish, while the "Need" explains what problem needs to be solved. The Purpose and Need statement leads to selection of the method perceived to best address the issue. The chosen method is the "Proposed Action."

ALTERNATIVES (CHAPTER 2)

The Proposed Action describes the lead agency's plan to address the issues described in the Purpose and Need statement. An "Alternative" is a substitute for the Proposed Action that may still accomplish the needed action, but in a different manner. A reasonable Alternative should meet the needs of the proposed project while minimizing or completely avoiding significant impacts to area resources.

AFFECTED ENVIRONMENT (CHAPTER 3)

The Affected Environment section describes the current human environment, natural and human-made, including both physical conditions and quality-of-life issues. The latter includes social and economic, health and safety, recreation, and visual and aesthetic components. The physical environment comprises cultural, historic, and tribal resources, and the water, geology, wildlife, plants, and other elements that make up the ecosystem. This section of an EIS must provide adequate detail to assess the severity of any potential impacts of the project described in the Proposed Action.

ENVIRONMENTAL CONSEQUENCES (CHAPTER 4)

Sometimes referred to as the "Impacts Assessment," this section analyzes the impacts of the Proposed Action and of any Alternative(s) described in Chapter 2 to the resources described in the Affected Environment (Chapter 3). The analysis provides the foundation for the decision-

maker's decision by describing the environmental impacts (good or bad) of each Alternative, and proposes mitigation measures to eliminate or minimize adverse effects.

CONSULTATION AND COORDINATION (CHAPTER 5)

All aspects of the NEPA process, including scoping meetings, comments received, and distribution of the EIS, are reported in this section. It also describes coordination with agencies such as the U.S. Fish and Wildlife Service concerning wildlife species within the project area.

LIST OF PREPARERS (CHAPTER 6)

This section describes the title, education, professional experience, and contribution to the EIS process of all contributing personnel, including agency representatives, contractors, sub-consultants, and project proponents.

ANALYSIS OF COMMENTS

The majority of letters received from area residents during the Project Scoping Process indicated that much thought and consideration went into their comments. Every comment letter received was entered into a database and assigned an identification number based on its sequential entry. Since most letters addressed a variety of concerns, the contents were divided into separate statements, each of which received an additional number signifying a consecutive comment. For example, a comment ID# of "104-418" means the entire letter was the 104th entry into the database while the comment itself was the 418th individual comment received. Each statement was then reviewed and categorized by issue class, such as agriculture, water rights, or location of the proposed project (Table 4).

Table 4. Comment Category.

Comment Category	Comment Category
Agriculture	Surface Water
Alternative	Water Management
Cultural/Historic	Water Quality
Economic	Water Rights
EIS/NEPA Process	Health/Safety
Environmental	Purpose and Need
Growth	Visual/Aesthetic
Location	Miscellaneous
General Opinion	Tribal
Science Used	T & E Species
Ground Water	

The issues raised in each comment were also classified according to their final disposition. The "Comment Disposition" column (Table 5) describes which of the six EIS chapters that best considers issues raised by the public.

Table 5. Comment Disposition within the EIS.

Chapter in EIS	Comment Disposition	CODE
Chapter 1	Purpose and Need	PN
Chapter 2	Alternatives	ALT
Chapter 3	Affected Environment	AE
Chapter 4	Environmental Consequences	ENC
Chapter 5	Consultation & Coordination	CC
Chapter 6	List of Preparers	PRP
	Out of Scope	OOS

In every scoping process, regardless of the proposed project under review, some comments are, by nature, "out of scope" for the project, that is, are not directly related to the project and are therefore beyond the concerns that can be addressed in the EIS. These comments may, for example, concern government or private agencies that are not involved in the proposed project, decisions that are not in the power of project proponents, or recommended activities that are not within the authority of the proponent(s). However, we appreciate every comment received and understand that all comments are important to the sender. Therefore, all written comments are included in Table 6, though some are identified as "Out of Scope." The Comment Disposition column directs the reader to the EIS Chapter pertaining to each comment.

Each comment with the associated comment category, identification number, and disposition is in tabular format for organization and cross-referencing purposes (Table 6).

Table 6. Comment Analysis.

Comment Category	Comment	Comment ID	Comment Disposition
Agriculture	Taking water north of Tularosa to quench the needs of Alamogordo may lower the water table so much that it would create a tremendous negative impact on the irrigation needs of Tularosa farmers.	105-92	ENC
Agriculture	[Concerning] current agricultural wells: how will the decline in the water table affect current usage?	106-103	ENC
Agriculture	I don't want to see all my pecan and fruit trees die.	117-412	ENC
Agriculture	HFR and Three Rivers note the falsity of the City's claim that its proposed water appropriation will not reduce agricultural water uses in the Tularosa Basin because its proposed project will appropriate only "unusable" water. The truth is that the water the City claims to be "unusable" is currently being used by HFR, Three Rivers, and several other agricultural, commercial, and domestic users in the Tularosa Basin.	138-469	ENC
Agriculture	The City's proposed project will cause most of HFR's wells to experience substantial drawdowns and eventually lose their ability to pump during the irrigation season.	138-480	ENC
Alternative	Mr. Kerry Miyoshi has developed a truly comprehensive model of recharge through watershed restoration and a number of desalination stations around Alamogordo itself rather than north of our endangered agricultural district around Tularosa. Miyoshi's plan restores the health of the foothills, creates a natural sustainable recharge system for municiple drinking water.	74-55	ALT

Comment Category	Comment	Comment ID	Comment Disposition
Alternative	You could integrate your public stewardship with [Mr. Kerry] Miyoshi's model and create an environmental map that could result in a tourist economy and agricultural economy that could sustain a significant population here in spite of the ups and downs of the military bases.	74-57	ENC
Alternative	The proposed wells are to be 1000 feet in depth. South of Alamogordo, the water table is less than 200 feet in many places and there is about 100 in elevation to overcome. The energy savings would be significant over a long term if they were forced to develop the well field elsewhere.	100-69	ALT
Alternative	The economic consequences of going south of Alamogordo instead of north of Tularosa for water would be that it would save money by reducing pumping costs and eliminate reverse osmosis costs.	100-71	ALT
Alternative	The proposed well field location is in conflict with the Tularosa Basin 40 Year Water Plan which recommends that Alamogordo put a desal plant near Alamogordo.	100-72	ALT
Alternative	The Tularosa Basin 40 Year Plan also recommends that Alamogordo begins negotiating with the DOD to drill wells south of Alamogordo or develop saline water resource near Alamogordo.	100-73	ALT
Alternative	John Shoemaker's water study incorporated into the 40 Year Plan shows that there is a 200 year FRESH WATER supply located south of Alamogordo, available to the City with DOD permission. It could not be in the best interest of the DOD to let Alamogordo dry up.	100-74	ALT

Comment Category	Comment	Comment ID	Comment Disposition
Alternative	One option that was not discussed during the scoping process, that has been advertised by the City, is that with two additional stages, the City can purify their effluent water and return it to their potable water circuit. The City has projected this option but has not pursued it. With proper safeguards built in, this could be a viable option.	110-195	ALT
Alternative	Why aren't you taking water out of the basin west of Alamogordo rather than the current location, which has the potential of severely impacting many communities and private property owners?	79-245	ALT
Alternative	[What about] capturing fresh water up in the mountains before it runs into the basin and soaks into the salty basin water; this will improve the watershed.	79-247	ALT
Alternative	Alamogordo should consider taking water from south of Alamogordo or west of Alamogordo.	79-248	ALT
Alternative	Moving the desal plant west and south may cost more, but the cheapest way may not be the BEST way.	79-250	ALT
Alternative	If data from these monitors [around the desal well field] indicate reductions in quality or quantity beyond projected hydrological modeling, the diversion from the field could be reduced to maintain the desired levels.	81-258	ENC
Alternative	Alamogordo has an adequate supply of water south of the City's dog canyon [that] has not been tapped yet.	82-261	ALT

Comment Category	Comment	Comment ID	Comment Disposition
Alternative	An important fact that you [should] consider in this Impact Statement: If Alamogordo cared about not ruining the lives of her neighbors, the well(s) could be drilled in the parking lot of their village hall. Every drop of fresh water that runs under Tularosa could be captured by drilling their obscene wells in their own back yard, not in ours.	83-264	ALT
Alternative	Alamogordo has other alternate locations they can exploit.	84-275	ALT
Alternative	If Tularosa has a little extra water, sell it to Alamogordo with established cut-off parameters.	84-276	ALT
Alternative	There is plenty of water south and southwest of Alamogordo which they could use that would NOT effect 1600 wells.	85-281	ALT
Alternative	There is plenty of water south and southwest of Alamogordo which they could use that would NOT effect Tularosa.	85-282	ALT
Alternative	There is plenty of water south and southwest of Alamogordo which they could use that would NOT effect springs for wildlife and even the White Sands pupfish.	85-283	ALT
Alternative	I am opposed to Alamogordo drilling water wells north of Tularosa as I believe drilling wells [there] will have ADVERSE EFFECTS on the farmers, ranchers, and all residents living in this area, including myself and my family. Why doesn't Alamogordo drill wells south or east of Alamogordo?	93-327	ALT

Disposition Key:

AE: Affected Environment
ENC: Environmental Consequences
PRO: Process
ALT: Alternatives
OOS: Out of Scope
PRP: List of Preparers
CC: Consultation and Coordination
PN: Purpose and Need

Comment Category	Comment	Comment ID	Comment Disposition
Alternative	There is adequate water south of Alamogordo with gas on it. The State could use the gas and the water. Alamogordo could have adequate water with no more treatment. [This would be better?] than the plan to [take] our water. There is also lots of water in White Sands.	94-331	ALT
Alternative	All of this development [Mission Hills, Sedona Ridge, Cottonwoods Heights, North Park] is east of White Sands Blvd. and south of Alamogordo. Why can't they drill their wells in that end of town?	96-340	ALT
Alternative	With the revenues of all the people that buy these [new development] homes, the City of Alamogordo could afford the cost of pumping water up-hill instead of draining our livelihood and our property values.	96-341	ALT
Alternative	I think Alamogordo should get their water from the west or the south, where there is more water available.	98-352	ALT
Alternative	The Sacramento Mountains Watershed Restoration Corporation proposes the relocation of the wells to an area further west into the Tularosa Basin and the spreading out of the well field so that no well cone of depression will interfere with another, or more importantly interfere with the mountain water tables.	113-364	ALT
Alternative	Wells should also be spaced further apart north and south in the basin to ensure that water extracted does not exceed the recharge to that area. Once recharge is exceeded and sustainability is lost, then environmental impacts spread outward from the depleted recharge area.	113-366	ENC

Comment Category	Comment	Comment ID	Comment Disposition
Alternative	The current project is described as "treating saline water" from the basin. The designated area of the current project does not contain "saline water." The water within this area [Tularosa Basin] can be extracted, then mixed with fresher water to meet potable standards without the need for RO or desalination treatments. The benefits of RO or desalination treatments will be most effective if the project is located further west into higher saline water that requires such treatment.	113-367	AE
Alternative	[The following fact needs to be a part of the Environmental Impact Statement]: The private sector can easily supply the water needs of this area WITHOUT increasing the current drawdown of our water table.	115-398	ENC
Alternative	[The following fact needs to be a part of the Environmental Impact Statement]: Alamogordo can buy water like other cities in New Mexico.	115-401	ALT
Alternative	Why not buy water from the current owners? SUPPORT OUR ECONOMY – DO NO NOT DESTROY IT.	116-407	ALT
Alternative	Make sure that your report states that the PRIVATE SECTOR CAN SUPPLY the area water needs. This viable alternative (solution) is available to Alamogordo and Ruidoso. They have been offered the water, yet they ignore the solution in hopes of hoodwinking the Government.	116-408	ALT
Alternative	I think Alamogordo should drill their wells south of Alamogordo.	117-415	ALT
Alternative	Alamogordo needs to put their well field out at HAFB where there is a lot of brackish water.	118-430	ALT

Comment Category	Comment	Comment ID	Comment Disposition
Alternative	There are farms and ranches willing to sell or lease you water, instead of stealing it!	118-433	ALT
Alternative	[The following fact must be part of the EIS]: The private sector can easily supply the water needs for this area WITHOUT increasing the current drawdown of our water table.	119-442	ALT
Alternative	[The following fact must be part of the EIS]: Alamogordo should buy water like other cities in New Mexico.	119-445	ALT
Alternative	There is water south of Alamogordo. This is an alternative place to drill. This was also brought out at the OSE hearing in Oct. 2003.	120-451	ALT
Alternative	During the State Engineer Hearing, HFR and Three Rivers presented evidence demonstrating that if the City engaged in responsible water resource management efforts such as continued conservation, development of projects such as the Aquifer Storage and Recovery program, and watershed management, the City may need at most 1,299 AFY in additional water rights to meet its reasonable future water demands [not the 10,000 AFY requested by the project].	138-489	PN
Alternative	In October 1997, the City issued its Aquifer Storage Recovery Study (ASR) which... concluded that an ASR project could provide the City with an additional 2,000 AFY of water. The City now inexplicably ignores the significant amounts of additional groundwater that would be available through the development of an ASR project.	138-491	ALT

Comment Category	Comment	Comment ID	Comment Disposition
Alternative	The ASR project is capable of supplying the City with a significant portion of its peak water demands through immediate use at the time of diversion, and through underground storage for future use. Because the City's own study estimated that an ASR project could provide the City with approximately 2,000 AFY and the City's maximum reasonable need for additional water is 1,299 AFY, the EIS should consider the fact that the City could meet its demand for additional water through development of an ASR project which would not impair existing water rights or create significant risks of harm to local water users, cultural and historical sites, the environment, or native plants and animals.	138-492	ALT
Alternative	HFR and Three Rivers reiterate that the City does not need additional water rights because the City will be able to meet all of its reasonable future water demands by pursuing responsible water resource management initiatives such as continued conservation, watershed restoration, and the Aquifer Storage and Recovery project.	138-514	PN
Alternative		1-551	PN
Cultural/Historic	The custom and culture, the way of life of a community [Tularosa] is at stake.	100-61	ENC
Cultural/Historic	The State lands where the Tecalote Ruins are located is being proposed as the location of the desal plant. I believe the bare area adjacent to US 54 is an old farm used by this ancient community when Rinconada Creek ran down to their homes. Making a hazardous dump adjacent to the largest prehistoric ruins in Otero County and building a plant on top of their ancient farm would be wrong.	100-81	ENC
Cultural/Historic	Innumerable [cultural/historic] sites would probably be disturbed by the service roads to the wells.	100-82	ENC

Comment Category	Comment	Comment ID	Comment Disposition
Cultural/Historic	The foundation of local cultural roots, as it relates to the life-giving quaint acequias of Tularosa, will be destroyed.	105-96	ENC
Cultural/Historic	The location of the well field/desalinization plant threatens to destroy the largest Native American Archeological site in the Tularosa Basin. The area is also part of a Civil War Calvary area where soldiers grew feed for their horses. Many of the soldiers returned to the area to settle after the civil war. Their family descendants are still in the village.	111-209	ENC
Cultural/Historic	The potential permanent destruction of our historic acequia system, which was instrumental in the settlement of the "solares" which still exist today, and the "horteliza" which is still farmed today [is a concern].	111-212	ENC
Cultural/Historic	ALAMOGORDO MUST BE STOPPED UNTIL SUFFICIENT DATA CAN BE GATHERED THAT WOULD GUARANTEE THE PROTECTION OF OUR HISTORIC WATER SYSTEM. THE POTENTIAL FOR OUR "NON-EXISTANCE" IN A FEW YEARS IS VERY REAL.	111-213	ENC
Cultural/Historic	[Another concern is] the destruction of a historic agricultural community and area as well as the custom and culture that it supports.	111-217	ENC
Cultural/Historic	The destruction of the pre-historic rock site at 3-Rivers Petroglyph Site and the habitat in the area is of great concern.	111-224	ENC
Cultural/Historic	I am worried that our grandchildren and their grandchildren will no longer have the opportunity to grow up on a farm and experience a positive work ethic, as our children have.	98-346	ENC

Comment Category	Comment	Comment ID	Comment Disposition
Cultural/Historic	Tularosa is known for its roses and once had rushes growing naturally along the river. The custom and culture of the village will be negatively impacted if the roses and other vegetation die[s].	98-347	ENC
Cultural/Historic	Tularosa's acequia system makes Tularosa unique; it has been a part of the village's heritage since 1909. The ditch supplies water for the village vegetation, as well as [for] the farmer's crops. "Tularosa" will no longer be an appropriate name for a village which dries up and becomes a desert.	98-348	ENC
Cultural/Historic	There are some Indian ruins in the area where the proposed wells may be drilled. This concerns me because a cultural resource could be destroyed.	98-349	ENC
Cultural/Historic	I believe that Alamogordo should look for water elsewhere in an area where community and a culture will not be destroyed.	98-350	ENC
Cultural/Historic	This [project] will also have an affect on the Rinconada area of the Mescalero Apache Indian reservation. Plus the Tecolote Ruins are located very near the proposed area of the wells and desalination plant, if not in the very area.	120-424	ENC
Cultural/Historic	HFR and Three Rivers have not seen any cultural resource or historic site surveys or evaluations regarding the archaeological and historic sites that may be affected by the proposed water treatment facilities, pipelines, holding ponds, well field, and all other associated components of the City's proposed project. Before being allowed to move forward with its desalination project, the City should provide the BLM and the BOR with a list of each archaeological or historical site that may be affected by its proposed project and describe the ways in which the City's proposed project may adversely impact those sites.	138-485	ENC

Comment Category	Comment	Comment ID	Comment Disposition
Cultural/Historic	The State lands where the Tecalote Ruins are located is being proposed as the location of the desal plant. I believe the bare area adjacent to US 54 is an old farm used by this ancient community when Rinconada Creek ran down to their homes. Making a hazardous dump adjacent to the largest prehistoric ruins in Othero County and building a plant on top of their ancient farm would be wrong. Innumerable sites would probably be disturbed by the service roads to the wells also.	99-532	ENC
Cultural/Historic	This [Tularosa] acequia has been in constant use since 1865 and should not be damaged by this proposed project, The custom and culture, the way of life of a community is at stake.	99-537	ENC
Economic	There is rumor that it will be cheaper to recap this water from the mountains [and who cares what becomes of the area between the north wells and Alamogordo]. Cheaper for who, the people of Alamogordo or all the people who will end up moving out because they have no water.	139-15	ALT
Economic	A value must be placed on the underground water. This will require in-depth studies of the long term ecological impacts of water removal (impact on above-ground springs, possible subsidence of land surface, etc., estimate quantity of water available).	56-32	AE
Economic	This project should pay for itself in a reasonable period of time to include the value of water removed as determined in ["A value must be placed on the underground water"].	56-33	AE
Economic	[Tularosa] real estate prices will dramatically fall.	105-94	ENC
Economic	How will the current [agricultural well] users be protected?	106-104	ENC

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Economic	How will the current users be supplemented, or compensated?	106-107	ENC
Economic	Currently the farmers and ranchers are providing long term dollars and multipliers to the economy. There is a potential that the excess use of their water will affect the strength of our local economy.	106-109	ENC
Economic	It seems that you will be changing a more-stable economy in favor of a more liquid economic structure (housing and growth).	106-110	ENC
Economic	Drought will come again -- long term residents (farmers and ranchers) are more apt to wait-out the rough years than to get up and move. Economically, the long-term residents provide more inputs ($$) to the economy and stabilize it.	106-111	ENC
Economic	I am very concerned about losing our irrigation in the 49 blocks. What is land worth without water?	107-115	ENC
Economic	We have people in the area [Tularosa] whose livelihood depend[s] on the crops they raise. I would really appreciate your considering our situation and hope there is something you can do about this.	107-119	ENC
Economic	A new high capacity Alamogordo City well field in the Tularosa part of the aquifer will negatively impact the existing agricultural wells and the domestic wells. Consider the expense and hardship that will be created causing individuals to redrill their wells and still not being able to economically reestablish their water supply, knowing that many of the existing wells are shallow, marginal producers of water [with] inadequate quantity and quality.	110-193	ENC

Comment Category	Comment	Comment ID	Comment Disposition
Economic	The water Alamogordo is proposing to permanently remove is used by domestic and farming. It is water people use daily for household and farming use. Removing this huge amount will destroy and devastate hundreds of families, affect their income, destroy their investments.	111-199	ENC
Economic	All economic growth in the Tularosa Basin could potentially stop, excluding Alamogordo. The economic impact is already being felt in our area simply because of the threat of the removal of the water as proposed by Alamogordo.	111-218	ENC
Economic	I want to be compensated for the loss of my property, and investments. REQUIRE ALAMOGORDO TO POST A BOND. IF THEY ARE SO CONFIDENT THEY WILL NOT DO HARM, THEN THEY SHOULD BE REQUIRED TO DO SO.	111-219	ENC
Economic	If these wells are permitted, Alamogordo should be required to make regular contributions to a fund that will be set aside for the use of the region's farmers and ranchers and other rural residents to hire attorneys to litigate when the wells draw down and livelihoods and homes are lost.	77-234	ENC
Economic	Who will pay for the destruction of my property rights?	79-242	ENC
Economic	BOR is partially funding this project? How much does "partially" mean?	79-243	ENC
Economic	My big concern is [that] there is going to [be] a shortage of my well's water, which hurts the property value in Tularosa and nearby areas if the well is drilled as proposed, and we will be a worthless spot in the desert.	82-260	ENC

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Economic	Who will compensate me when my well goes dry?	84-272	ENC
Economic	Who will compensate me for my investment when [even] the rumor is established about the water supply being depleted?	84-273	ENC
Economic	I know, our water would flow to them [Alamogordo] via gravity, so therefore it would cost them less because they'd have to pay to pump it back up north if they went south for the water. Maybe, just maybe, it would dawn on them how truly valuable water is!!! Concern and compassion for other people seems to be missing, so if it hits their pocketbooks, maybe they'll understand.	85-284	ENC
Economic	The cost and impacts of an additional water supply for Alamogordo should be borne by Alamogordo and not by people in the area around Tularosa.	87-295	ENC
Economic	[If a well site is placed on the missile range or air force base or some other location south and west of Alamogordo] this water will likely be more brackish, but the cost of desalinizing this water can be borne by Alamogordo and the Federal government.	87-297	ALT
Economic	A depleted aquifer on which an entire region is dependent will have massive socio-economic impacts with the passing of time.	87-299	ENC
Economic	The Tularosa area is a low-income area. The socio-economic impacts will be a clear case of environmental injustice.	87-300	ENC

Comment Category	Comment	Comment ID	Comment Disposition
Economic	If the State Engineer approves the permit to drill the wells, then the City [of Alamogordo] should not be afraid to - and be required by the State Engineer's approval - to post a damage/depletion bond in the amount of the value of all of the properties that have wells that could be affected by their action. This value can be found at the Otero County Court House in the County Assessor's Office.	88-305	ENC
Economic	This [damage/depletion bond that should be posted by the Alamogordo] should also have automatic triggers in it, i.e. if a well goes dry, the bond should pay to drill the well deeper - and if no water can be found, the bond should be required to purchase the property at fair market value as if it still had water.	88-306	ENC
Economic	If my well pumps dry, will Alamogordo pay to have my well drilled deeper so I can get water?	93-326	ENC
Economic	We feel there should be some fund set up to compensate all who have wells and are affected by the proposed process.	95-334	ENC
Economic	A good portion of the economy in Otero County could and will be severely affected by depletions of the fresh water, and or, contamination.	114-382	ENC
Economic	The tax base on agriculture would be eliminated or severely reduced.	114-383	ENC
Economic	[Project could result in] the loss of income on 1,000+ acres of pecans, several 100 acres of pistachio, grape vineyards, wine production and other agricultural products.	114-384	ENC

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Economic	[Project could result in] the devaluation of residence properties, acreages, in the outlying areas would be in the 10's of millions, because without potable water at an affordable cost, the property is worthless.	114-385	ENC
Economic	The default on mortgages held on these properties would be enormous and chance of recovery is minimal.	114-386	ENC
Economic	Any diminishment of water for either [Tulie Creek or Tularosa wells] would have to be protected and a guarantee effected.	114-388	ENC
Economic	A private utility or semi-public utility can be in business in short order - Alamogordo's attempt to loot the Tularosa area of their water will takes YEARS - millions will be squandered in court before Alamogordo gets their way.	116-406	ALT
Economic	I feel that the State should make Alamogordo put up a bond with an automatic trigger. That way if my well, or any of the other 1,060 wells in the Tularosa area, goes dry, we can automatically draw on the insurance.	117-410	ENC
Economic	I don't want to see the value of my place completely destroyed because my well goes dry.	117-411	ENC
Economic	Please look at the testimony given [at the OSE meeting] by the hydrologists who were representing the protestants. The drought has already caused some people to have to lower their pumps in their wells and even a small reduction in water level could cause tremendous economic, social and cultural damage to this area that is living on the edge of the poverty level.	120-419	AE

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Economic	Alamogordo should have to put up a $250 million bond and compensate owners who have an adverse impact on their wells and property values.	118-435	ENC
Economic	[The following fact must be part of the EIS]: Alamogordo's attempt to take water from our area threatens our future and our local economy. It has a NEGATIVE impact upon our real property values.	119-446	ENC
Economic	HFR and Three Rivers have evidence that the City's proposed project will cause both HFR's and Three Rivers' wells to become unusable, their water rights to become more difficult if not impossible to exercise, and their agricultural activities to become cost prohibitive.	138-472	ENC
Economic	The City has not offered to compensate HFR, Three Rivers, High Nogal, or other water users for the expected adverse impacts on their wells, water rights, and farming and ranching operations, or for the City's indirect taking of their property rights.	138-473	ENC
Economic	As a result [of expected substantial drawdowns], HFR will not have sufficient well pumping capability to irrigate its pecan orchards and its farming operation will become cost prohibitive.	138-481	ENC
Economic	Although it will take longer for the City's proposed project to have a similar [drawdown] impact on Three Rivers' farming operations, Three Rivers will eventually experience the same type of loss in the productive capacities of its wells and thus, lose its ability to remain economically viable.	138-482	ENC
Economic	Instead [of offering compensation], the City has disingenuously claimed that its proposed project will not adversely impact existing water rights and that the project will not directly reduce agricultural uses in the area of the project.	138-483	ENC

Comment Category	Comment	Comment ID	Comment Disposition
Economic	[The list of essential data from the NM Assessment Program Workshop includes]: basic cost-benefit analysis (identify demand, end users, potential alternatives).	138-504	ENC
Economic	The proposed wells are to be 1000 feet in depth. South of Alamogordo, the water table is less than 200 feet in many places and there is about 100 [feet] in elevation to overcome. The energy savings would be significant over a long term if they were forced to develop the well field elsewhere.	99-523	ALT
Economic	The economic consequences of going south of Alamogordo instead of north of Tularosa for water would be that it would save money by reducing pumping costs and eliminate reverse osmosis costs.	99-525	ALT
Economic	The ranch on which the well field would be located would be decimated. The constant interference with the livestock operation and hunting enterprise would be costly. As the water table falls, the economic viability of the enterprise, as well as the value of the ranch, would fall. The employment opportunites for local people would be reduced.	99-533	ENC
Economic	Tularosa is a low-income area. Farms around Tularosa will also be adversely affected. The farmers at Tularosa did not have enough money for an adequate study of the effects to their water table.	99-535	ENC
Economic	I have many concerns. We live in the county outside of Tularosa, as we have for the last 21 years. We retired from the military in 1992 and decided to stay. It is a very unusual area with many habitats found only here. We would like to live out the rest of our lives here. Now for the big concern-- water. Without water, my retirement homestead would be totally usuless. As I go further into fixed income WHO will pay to redrill our water well. We would have to sell-- leaving behind many beloved memories, and take next to nothing for our land. This concerns my wife and I very deeply. I would hope you would consider other options.	210-554	ENC

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Economic	2. Who will pay to deepen my well if the drawdown is larger than your computer models suggest?	211-558	ENC
EIS Process	The [Mescalero Apache] Tribe requests that it be provided, care of this address, a copy of the draft EIS. John D. Wheeler Attorney-at-Law P.O. Box 1810 Alamogordo, NM 88310 (505) 437-5750	101-5	PRO
EIS Process	Can you please provide the complete details of the project on your website so that those of us who could not attend the meeting can understand the specifics?	135-8	PRO
EIS Process	When are comments from public scoping meetings to be made available on the web site?	136-9	PRO
EIS Process	Please include meeting slides on the web site	136-10	PRO
EIS Process	From the common person's view, there has not been enough explanation for the need to take water from the mountains, which could affect farms, towns,and water levels of area residents.	139-12	PRO
EIS Process	I consider the initial information you sent us totally inadequate for a very serious response.	56-28	PRO

Comment Category	Comment	Comment ID	Comment Disposition
EIS Process	[Commenter] would like to be included in future workshops.	62-37	PRO
EIS Process	I am hereby requesting that you include our letters, our concerns, and this information [about potential degradation and destruction of White Sands National Monument] in your Environmental Assessment and that full consideration and evaluation of this subject be noted and included in the Environmental Impact Statement.	66-50	PRO
EIS Process	The EIS needs to evaluate much more than the impact of a few roads. The future way of life in a whole community and its neighbors will be affected by this proposed project.	100-65	ENC
EIS Process	The Tularosa Community Ditch wants to participate as a co-developer of the EIS because it is a unit of New Mexico State Government.	100-84	The BLM and Reclamation will continue to involve the Tularosa Community Ditch Corporation throughout the EIS development process.
EIS Process	The officials involved in these secret meetings should disavow themselves and be replaced by non-biased officials. This includes officials by biased political entities and municipalities. This also includes the people officiating the very NEPA process it is supposed to be policing.	109-133	PRO
EIS Process	[Code of Ethics that should be followed by project officials, continued] Issue public statements only in an objective and truthful manner	109-136	PRO
EIS Process	[Commenter's opinion that the planned Project has ignored the following fact]: Public input and involvement utilized.	109-161	PRO

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EIS Process	[Commenter's opinion that the planned Project has ignored the following fact]: Description of the environment needs to be performed -- records of conditions prior to the implementation of the proposed project which acts as a benchmark against which to measure environmental changes and assess impacts.	109-170	PRO
EIS Process	[Commenter's opinion that the planned Project has ignored the following fact]: Significant Environmental Impacts -- A listing of all impacts from which the significant impacts are selected for further study based on magnitude significance extent and special sensitivity, including minor, short-term, moderate, direct and indirect.	109-171	ENC
EIS Process	[Commenter's opinion that the planned Project has ignored the following fact]: Socio-Economic Analysis of Proposed Projects -- The socio-economic conditions should be identified as well as the positive and negative impacts of the proposed project on the socio-economic environment. The socio-economic analysis should include information on land-use, the main economic activities, potential damanges to people in other cities, the mountains, and adjoining basins.	109-172	ENC
EIS Process	[Commenter's opinion that the planned Project has ignored the following fact]: A True Analysis of Alternatives -- documentation of all alternatives including the "no action" altemative in developing the project, with each alternative evaluated in respect of its potential environmental impact and capital and operating costs.	109-173	PRO
EIS Process	[Commenter's opinion that the planned Project has ignored the following fact]: Mitigation Action / Mitigation Management Plan -- Documentation and cost assessment for all potential adverse impacts and its mitigation at each stage of the project. The full documentation and assessment of mitigation is important in the selection of the preferred alternative which would form the basis on which the remainder of the study is conducted.	109-174	PRO

Comment Category	Comment	Comment ID	Comment Disposition
EIS Process	[Commenter's opinion that the planned Project has ignored the following fact]: Environmental Management and Training -- how the environment will be managed during both the construction and operational phases of the project. This should include an outline of any training program for employees of the facility and identify any institutional needs for implementing the recommendations.	109-175	AE
EIS Process	[Commenter's opinion that the planned Project has ignored the following fact]: Environmental Monitoring Program -- there should be a monitoring program or plan detailing the reasons for and the costs associated with the monitoring activities.	109-176	ENC
EIS Process	[Commenter's opinion that the planned Project has ignored the following fact]: True Public / Community Involvement -- The study should involve non-governmental organizations and citizens in the community in which the proposed project will be implemented. This may take the form of either direct involvement of the affected citizens or inclusion [of] local knowledge or expertise in the environment. This should not be dominated by partisan government interests or nongovernmental business interests.	109-177	PRO
EIS Process	[Commenter's opinion that the planned Project has ignored the following fact]: If this project is approved against the wishes of the general public, the proposed plan must call for continuing surveys and operation by an independent authority.	109-178	ENC
EIS Process	A lot more data gathering, evaluation and considerations need to be done before this project can be fully and properly evaluated.	110-197	AE
EIS Process	WE HAVE NOT BEEN PROPERLY INFORMED AS REQUIRED BY LAW OF THE CITY OF ALAMOGORDO'S PLAN, YET THEY ARE BEING ALLOWED TO CONTINUE ON WITHOUT QUESTION, AND WE ARE BEING ASKED TO COMMENT ON THINGS WE HAVE NOT BEEN GIVEN INFORMATION ON.	111-206	PRO

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EIS Process	Alamogordo Mayor Don Carroll once said the needs of the many outweigh the needs of the few. Phil Rhinehart told me personally that Alamogordo would not be allowed to proceed on the project until after the NEPA study. That, I assume, is at least 18 months. We will see if this statement turns true.	111-228	PRO
EIS Process	Please mail all the group's (3) work sheets to me when you are finished with your report [flip-charts created by breakout groups at scoping meetings].	76-231	PRO
EIS Process	Record the Concerns and Issues [voiced by attendees of the scoping meetings?] and summarize [them].	78-236	PRO
EIS Process	I don't understand the purpose of these [public scoping] meetings, [occurring] before the State Engineer's ruling?	80-252	PRO
EIS Process	Who are the owners of SWCA?	80-255	PRO
EIS Process	The Alamogordo Daily News reported that "the City of Alamogordo" hired SWCA. Is that true?	80-256	PRO
EIS Process	Put it [the Project] to a vote by the People (and screen the voters) in Tularosa.	84-277	PRO
EIS Process	There were many battles fought in the past over water. I'd hate to see that happen again. Hopefully, this process will prevent that.	85-287	PRO

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EIS Process	The EIS should be looking at the Project's footprint on the ground impacts, and [the EIS] should not be allowed to be used as a way to substitute for, or override the decisions of, the New Mexico State Engineer on the City of Alamogordo's water application.	86-291	PRO
EIS Process	The EIS should be based on facts and not on emotional and often mistaken or misleading statements made by the attendees [at the Alamogordo public scoping meeting].	86-293	PRO
EIS Process	Individuals conducting the [Alamogordo] scoping meeting indicated that they were changing the process that is usually followed in conducting an EIS. I am concerned that if this EIS varies from the process that has been accepted by Government Agencies and the Courts in the past, that they may be opening the BLM, the BOR, and the City [of Alamogordo] up to an endless round of court challenges by those who may not agree with the findings of the EIS.	86-294	PRO
EIS Process	My personal impression of this [Alamogordo public scoping] meeting was negative. The City manager, engineer, mayor, and water plant manager, were all allowed to vote on the most important projects. [This is] "biased"! Managed growth? Limited population? False figures. More water rights than water. Too many representatives from the City [of Alamogordo] to make scoping factual and accurate.	90-313	PRO
EIS Process	No answers [were provided at public scoping meetings?] for knowledge of final ownership, destination, or purpose of these water resources.	90-315	PRO
EIS Process	The Sacramento Mountains Watershed Restoration Corporation is also disappointed that a local input meeting was not held in Ruidoso where major impacts are likely to occur.	113-372	PRO

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EIS Process	The handling of the two local meetings to date has given the appearance that they were nothing more than public relations events designed to sell the project and that the NEPA process is being handled with a bias towards Alamogordo's wishes.	113-373	PRO
EIS Process	It is obvious that the Environmental Impact Statement is being funded and prepared simply to justify the attempted taking of water by the City of Alamogordo.	115-394	PRO
EIS Process	These facts {all the ones beginning with [The following fact needs to be a part of the Environmental Impact Statement]: } are not what Alamogordo wants to see in your report, however, you will be held accountable for the contents of your OFFICIAL statement.	115-403	PRO
EIS Process	It is obvious that the EIS is being funded and prepared to justify the attempted taking of water by the City of Alamogordo. Water for their city should be their responsibility and NOT a regional problem.	119-439	PRO
EIS Process	These facts {all the ones beginning with [The following fact must be part of the EIS]: } are NOT what Alamogordo wants to see in your report, however, you will be held accountable for the content of your OFFICIAL statement.	119-447	PRO
EIS Process	After the City's submission of this deep aquifer data and monitoring plan, HDR, Three Rivers, and other local water rights owners should be allowed to submit comments on the City's submissions and participate in the development of a meaningful remedial scheme that would require the City to discontinue its proposed pumping upon demonstration of water rights impairment, and that would define the appropriate means of compensating the owners of impaired water rights.	138-496	PRO

Comment Category	Comment	Comment ID	Comment Disposition
EIS Process	HFR and Three Rivers believe that the BLM and the BOR should defer the EIS until the City completes its requested additional test wells and obtains the critical deep aquifer data, and until all interested parties have had an opportunity to comment on the City's test well results and conclusion.	138-513	PRO
EIS Process	At the Scoping meeting, Tracylee said that the EIS would evaluate the effects of the building of a right-of-way to the proposed wells. The EIS needs to evaluate much more than the impact of a few roads. The future way of life in a whole community and its neighbors will all be affected by this proposed project.	99-518	ENC
Environmental	Prevent wind and water erosion of bare ground during ground-disturbing activities by implementing preventive measures such as temporary seeding, hydromulching, or use of erosion control mats.	53-18	ENC
Environmental	Restore habitats on disturbed sites using appropriate native vegetation following project activities.	53-19	ENC
Environmental	Analyze the potential effects of desalination concentrate disposal on natural resources, in addition to techniques used, and present the information in the EIS.	53-23	ENC
Environmental	The wildlife populations and their habitat would be irreversibly altered.	100-77	ENC
Environmental	Nearly all animals and insects need some water to sustain themselves. Dyring up of even a few water sources leads to increased predation around water holes.	100-78	ENC

Comment Category	Comment	Comment ID	Comment Disposition
Environmental	Reducing surface water sources would affect insect populations, bird populations, and right on up the food chain. Wildlife populations will be negatively impacted.	100-80	ENC
Environmental	The water may sink into the ground prior to reaching Tularosa in order to replenish the low water table created by Alamogordo's water needs. The Tularosa creek would then become a dry, lifeless rocky creek bed.	105-99	ENC
Environmental	[Prior water projects in Tularosa caused] the beautiful trees [to] die. Tularosa is like an oasis in the desert -- we would like to keep it that way.	107-116	ENC
Environmental	Damage from this project will extend throughout the Sacramento Mountains and to the adjoining Tularosa and Pecos Basins. This means damage to the White Mountain Nature Preserve, the sovereign nation of the Mescalero Apache Reservation, the Tularosa River, and communities such as Ruidoso, Tularosa, and Cloudcroft.	109-123	ENC
Environmental	The overall lowering effect of ground water levels will result in the further disappearance of springs, rivers, streams, and potentially destroy thousands of acres of forested watersheds.	109-124	ENC
Environmental	The ripple effect [of lowering ground water levels] would extend to flora and fauna.	109-125	ENC
Environmental	[Commenter's opinion that the planned Project has ignored the following fact]: Environmental concerns met.	109-160	ENC

Comment Category	Comment	Comment ID	Comment Disposition
Environmental	[Commenter's opinion that the planned Project has ignored the following fact]: Taking large amount of water from basin aquifers damages the mountains.	109-165	ENC
Environmental	[Another concern is] the destruction of a complete riparian area that survives because of the Rio Tularosa. This includes the Mescalero Apache Reservation, the community of Bent, NM, as well as many residents along the creek way. Not to be omitted are the large variety of species of migrating birds, plants, and wildlife, as well as historic fruit trees that have been in the area since the early 1800's.	111-215	ENC
Environmental	[Another concern is] the destruction of springs in the surrounding area, many of which are located on the Mescalero Apache Reservation; specifically those located at the Shanta homestead and the Rinconada.	111-225	ENC
Environmental	Careful plans (accurate) need to be made re: the waste/sludge of this project when the plant is started using water south of Alamo. It [the sludge?] must have some value? But NOT just piled up to allow the wind to disperse it all over.	85-288	ENC
Environmental	[The] Environmental Impact Statement must include what (>5,000 mg/TDS) will be done with 10,000 acre feet per year [which] will be around 186.3 tons of sludge per day. What will Alamogordo do with this sludge?	91-317	ENC
Environmental	The ripple effect [from lowering ground water levels] would extend to flora, fauna, and human development within the mountains.	113-362	ENC

Comment Category	Comment	Comment ID	Comment Disposition
Environmental	Disposal of the brine waste concentrate that would be produced during the City's proposed reverse osmosis process presents a number of environmental problems. The brine waste contains concentrated levels of naturally occurring salts and minerals as well as chemicals such as sulphuric acid, dispersants, coagulants, biocides, and sodium bisulfite which are added during the pretreatment process to remove contaminants such as carbonate, chlorine, and microorganisms which can cause harm to the system or the osmosis membrane. Consequently, the brine concentrate is classified as an "industrial waste" by the United States Environmental Protection Agency, and disposal of any effluent in surface water requires a National Pollutant Discharge Elimination System (NPDES) permit.	138-474	ENC
Environmental	The City has not identified its chosen brine disposal system, nor has it produced adequate information to assess the environmental impacts that will be caused by disposing of the significant quantities of brine that will be generated by its proposed project. Although the City could propose brine disposal options which include surface water discharge, deep well injection, land application, evaporation ponds/salt processing, and brine concentration, each of these heretofore unevaluated disposal options presents its own unique environmental risks.	138-475	ENC
Environmental	[re: Environmental risks from the City's as-yet not chosen brine disposal options]: Surface water discharge and land application [options] can increase the salt load in the receiving waters and soils which will result in contaminated water resources and reduced soil fertility.	138-476	ENC
Environmental	[re: Environmental risks from the City's as-yet not chosen brine disposal options]:Evaporation ponds present environmental problems because they often require large land areas and they typically require impervious disposal areas to prevent contamination of fresh water supplies and soils.	138-477	ENC
Environmental	[re: Environmental risks from the City's as-yet not chosen brine disposal options]: Deep well injection requires permits, monitoring wells, and access to deep, contained aquifers to ensure that fresh water supplies are not contaminated.	138-478	ALT

Comment Category	Comment	Comment ID	Comment Disposition
Environmental	There is substantial reason to be concerned that brine disposal from the City's proposed project will degrade the quality of water and soil in the Tularosa Basin and this must be addressed during the EIS process.	138-479	ENC
Environmental	HFR and Three Rivers have not seen any surveys or evaluations relating to the impacts that native species of plants and wildlife may suffer as a result of the well field, pipeline, water treatment facilities, holding ponds, and all other associated components of the City's proposed project.	138-486	ENC
Environmental	The wildlife populations and their habitat would be irreversibly altered. Nearly all animals and insects need some water to sustain themselves. The common animals such as coyote, rabbits, and deer need water. Drying up even a few water sources leads to increased predation around water holes. Reducing surface water sources would [therefore] affect insect populations, bird populations, and right on up the food chain. Wildlife populations will be negatively impacted.	99-530	ENC
Environmental	4. What is going to happen with the waste generated by the desalinization plant?	211-560	ENC
Growth	[there should be] monitoring on construction/growth	63-39	ENC
Growth	Please consider a moratorium on new construction, both industrial and residential.	65-44	OOS
Growth	I think that the growth rate of our community [Tularosa] must be looked at realistically -- too many people and not enough water will not help any of us.	108-118	ENC

Comment Category	Comment	Comment ID	Comment Disposition
Growth	Growth and expansion accelerates the demand for water. No one wants to consider limiting growth by removing part of the military activities and personnel at HAFB, and relocating them out of this area is a viable solution in the bigger picture.	110-182	OOS
Growth	Our Federal government has closed bases before; limiting growth and economy by this manner will not be as much of a disaster as the depletion of the aquifer will be.	110-183	OOS
Growth	Look at controlling the problem at the root of the problem, adjust demand and control growth.	110-185	ENC
Growth	A MORATORIUM ON NEW BUILDING AND SWIMMING POOLS SHOULD BE PLACED ON THE CITY OF ALAMOGORDO NOW! You can't get a glass of water at an Alamogordo restaurant, but you can pool hop through town and never dry out.	111-221	ENC
Growth	An important fact that you [should] consider in this Impact Statement: This only positively affects a handful of Alamogordo developers and real estate brokers who see this as the ultimate opportunity to lure retched Californians who are sick of the megalopolis mess they have created in their own backyard, and are seeking a new pristine site to dump their problems into. What will ten thousand transplants bring to Otero County other than their crime and other social issues? How will 10,000 transplanted California residents improve New Mexicans' way of life? Is a "city" of 37,000 in Alamogordo better for any single citizen "better" than an Alamogordo of 25,000? If you think so, tell me in what way would that be better.	83-268	AE
Growth	I'm retired, we have invested our life savings in this place, and now someone in a little town wants to take the Tularosa water so they can grow bigger with NO thought of what happens to this nice little town.	84-270	ENC

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Growth	We have lived here 25 years; therefore, we are very concerned re: losing our well water so that Alamogordo can have more car washes, golf courses, sprinklers spraying into the streets, water wasting toilets, swimming pools, etc. etc., ad infinitum!!	85-280	ENC
Growth	This barren land will not support a large city.	94-330	ENC
Growth	It seems Alamogordo has no concern for the little towns around it. They just keep on developing. We received in the mail a booklet advertising the locations of new developments: Mission Hills, Sedona Ridge, Cottonwoods Heights, North Park, and even advertising swimming pools.	96-339	ENC
Growth	A desert environment can't support a large population without damage. The City of Alamogordo should limit growth, conserve water and live within the existing water supply.	97-344	ENC
Growth	It is imperative that Alamogordo assumes responsibility for its own growth rather than siphoning off the lifeblood of another community.	98-354	ENC
Growth	They [Alamogordo] have not implemented a moratorium on new building, swimming pools, etc.	114-392	ENC
Growth	I don't want to see all the agriculture around Tularosa die because Alamogordo is obsessed with GROWTH and the almighty dollar.	117-414	ENC

Comment Category	Comment	Comment ID	Comment Disposition
Growth	We [Tularosa] should not be forced to die so they [Alamogordo] can grow.	117-416	ENC
Growth	I think Alamogordo should stop issuing building permits and be happy with their size.	117-417	ENC
Growth	Alamogordo needs to live within their resources instead of stealing Tularosa water.	118-436	ENC
Growth	The consequences of not developing the project at this location are minimal: Alamogordo would not be able to control the growth rate in the upper portion of the Basin around Tularosa.	99-521	ENC
Growth	Why should any intelligent citizen think that desalinization is an answer, when we are proving that a) our needs are increasing exponentially, as we) continue to allow for increased need, while faced with c) dwindling supplies of (any) usable water. What we are doing is continuing to deplete at a faster rate than we are replenishing. How smart is that?	209-557	ENC
Location	We live north of Alamogordo/west of hwy 54/south of Tularosa. How will this project affect the level of our well water supply?	134-7	AE
Location	Go elsewhere for your water, like Texas, where you don't have to desalinate water!	75-58	ALT

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Location	The consequences of NOT developing the the project at this location are minimal: Alamogordo would not be able to control the growth rate in the upper portion of the Basin around Tularosa.	100-67	PN
Location	According to the Tularosa Basin 40 Year Water Plan, about 19% of the untapped fresh and brackish water is north of Tularosa and over 40% is south of Alamogordo. It is baffling as to why the City [of Alamogordo] would go after the smaller quantity of brackish water rather than the larger quantity of fresh water.	100-68	ALT
Location	The reverse osmosis plant should develop the saline water resource west of Alamogordo: the brackish water component in our Basin [Tularosa] is already developed.	100-70	ALT
Location	The location of the plant seems to counteract the determined goal "to use brackish water, and change/clean [it] to a more suitable water." The current planned location will tap some of the bain's best water. If the system is designed as planned, it should take inadequate water and transform IT to potable.	106-112	ENC
Location	The location is not the most economically efficient for the intended good. It seriously needs to be revisited.	106-113	ALT
Location	We are extremely concerned about the Alamogordo Well Field. I don't know why that name is used when the location is north of my land in Tularosa.	95-332	AE
Location	We are adamantly opposed to the location of the Alamogordo well field. Alamogordo claims they want to pump brackish water, yet they go straight to the source of our fresh water.	118-429	ALT

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Location	The reverse osmosis plant should develop the saline water resource west of Alamogordo, the brackish water component in our Basin is already developed.	99-524	ALT
Location	The proposed well field location is in conflict with the Tularosa Basin 40 Year Water Plan, which recommends that Alamogordo put a desal plant near Alamogordo. The Tularosa Basin 40 Year Plan also recommends that Alamogordo begins negotiating with the DOD to drill wells south of Alamogordo or develop the saline water resource near Alamogordo. John Shoemaker's water study incorporated into the 40 year Plan shows that there is a 200 year FRESH WATER supply located south of Alamogordo, available to the City with DOD permission. It could not be in the best interest of the DOD to let Alamogordo dry up.	99-526	ALT
Location	The water table at Tularosa is already falling. This huge appropriation near the upper end of the Basin will create a huge cone of depression that will eventually affect the entire eastern side of the Basin.	99-528	ENC
Location	I would like to submit the following comments on issues that must be addressed.□ 1. The area described in the Federal Register as that which would be potentially affected should include the mountain communities of Mescalero, Ruidoso and others in the Northern Sacramento Mountains.	212-556	AE
Location	3. Why doesn't Alamogordo drill wells in the Bonito, an Timberon areas and tie them into their existing pipeline?	211-559	ALT
Location	5. There is more water South of Alamogordo than to the North. Why is this plant being built North of Tularosa instead of South of Alamogordo on land they already own?	211-561	ALT

Comment Category	Comment	Comment ID	Comment Disposition
Location	The Alamogordo Regional Water Supply Project completely depends on water from the Sacramento Mountains for it's success. This must be made clear!	212-563	ALT
General Opinion	We are putting in place a plant in Alamogordo to research brackish saline water-- we have all the brackish saline water needed [under the basin] to supply hugh amounts of water for many years to come.	139-14	ALT
General Opinion	Since 88% of the lands in Otero County are under the National Environmental Protection mandates and laws, by virtue of being federally managed lands, you all must abide with the Environmental Protection Agency mandates.	74-56	PRO
General Opinion	How do we stop this before it gets started!	75-59	PRO
General Opinion	Taking water north of Tularosa and circumventing the village of Tularosa appears to be highly imporper, immoral; bordering on being illegal. The entire issue speaks to the possibility of irregularity in dealings between elected officials from Alamogordo and Tularosa.	105-101	ENC
General Opinion	This water issue does not seem to reflect adequate input from the stakeholders in Tularosa. Community discussion has been minimal via the [Tularosa] Mayor's office. There does not seem to be any benefit or improvement for the quality of life of Tularosa residents.	105-102	PRO
General Opinion	[The Project] is biased both in scope and by the very processes and officials which are supposed to protect and defend the public.	109-121	CC

Comment Category	Comment	Comment ID	Comment Disposition
General Opinion	City officials for Alamogordo should be looking towards the future, but their past and current actions suggest that they do not have any understanding of the natural environment. They should drop the search for "wet" water (water they can touch or remove). The City shows a continual search further and further away from their borders for new water, destroying watersheds and groundwater in their wake.	109-126	ALT
General Opinion	There is constant one-sided local media coverage of the Alamogordo project and a high amount of mis-information given by city officials and their contractors.	109-131	PRO
General Opinion	It is troubling to discover that decisions are being made outside of the public eye by politicians, agencies, contractors, and developers. The results of these secret meeting[s] should be made available to the public and [the secret meetings] should no longer take place.	109-132	PRO
General Opinion	[Code of Ethics that should be followed by project officials, continued] Avoid deceptive acts	109-137	PRO
General Opinion	[Code of Ethics that should be followed by project officials, continued] Conduct themselves honorably, responsibly, ethically, and lawfully so as to enhance the honor, reputation, and usefulness of the profession.	109-138	PRO
General Opinion	[Commenter's opinion that the planned Project has ignored the following fact]: Office of the State Engineer (OSE) current[ly] has over-appropriated of water resources.	109-145	OOS

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General Opinion	[Commenter's opinion that the planned Project has ignored the following fact]: OSE is unable to limit future appropriations, is under-manned and under-funded, and has not properly defined "Public welfare."	109-146	OOS
General Opinion	[Commenter's opinion that the planned Project has ignored the following fact]: Forest restoration is necessary, but should be done only for increased fire danger from dry conditions, not merely for water or wood.	109-152	OOS
General Opinion	[Commenter's opinion that the planned Project has ignored the following fact]: Drought is not the cause of our problems today.	109-166	AE
General Opinion	At this point we are trying to justify supporting the Alamogordo City problem by trying to provide a solution for a shorter time frame. Mining water out from under the County's regions outside the City of Alamogordo stands to cause a negative impact to the quality of life and property values for a lot of established families out in the rest of the County and should not be condoned.	110-180	ENC
General Opinion	Reducing the activities at HAFB is an option that can reduce the burden on our limited resources and needs to be considered.	110-184	OOS
General Opinion	Taking the water others are beneficially using to redirect it to the City's need, without regard for the long-range impact it will have to customs, culture and quality of life that the Tularosa neighbors have established and enjoy, should not be the answer.	110-188	ENC

Comment Category	Comment	Comment ID	Comment Disposition
General Opinion	Just robbing Peter to pay Paul should not be condoned.	110-190	ENC
General Opinion	Is the intention of your Scoping Presentation to project that the City is using saline water unfit for any other use? Using brackish water or borderline water that is already being used and is being cleaned up with available household filters, reverse osmosis units, water softeners or conditioners, is a different situation than the City mining and using saline water that no one is using or capable of using?	110-194	AE
General Opinion	It became clear that this is not a regional project when data presented by SWCA did not include any other area in the "region." Only the City of Alamogordo was represented. Therefore it is not a "regional" plan but an Alamogordo plan.	111-198	PRO
General Opinion	BLM, BOR, and NEPA LACK SUFFICIENT PROTECTIVE MEASURES TO PROTECT THE PEOPLE WHO STAND TO BE THE MOST HARMED. ITS ALL ABOUT $$$$.	111-200	PRO
General Opinion	People HAVE NOT BEEN, NOR ARE THEY NOW properly informed regarding the project. WE DO NOT KNOW WHERE the proposed plant is to be located north of Tularosa.	111-201	PRO
General Opinion	WE HAVE NOT BEEN GIVEN PLANS OR PROPOSALS ABOUT THE PROJECT. HOW CAN WE MAKE COMMENTS AND HAVE CONCERNS WHEN WE ARE NOT ADEQUATELY INFORMED IN ALL ASPECTS OF THE PROJECT BY THE CITY OF ALAMOGORDO?	111-202	PRO

Comment Category	Comment	Comment ID	Comment Disposition
General Opinion	Not all of us want to have swimming pools. There is a quality of life issue regarding the difference in how we [Tularosa] choose to live and how they [Alamogordo] choose to live. ALAMOGORDO IS CATERING TO A TRANSIENT POPULATION [the military] AT EVERYONE ELSES EXPENSE!	111-220	ENC
General Opinion	The statewide drought seemingly has singled out Alamogordo as the only ones effected. We are all struggling with the drought but have chosen responsibility over the almighty dollar.	111-227	ENC
General Opinion	It is my opinion that the area Alamogordo chose to place their well field is the tip of the ice burg and they will eventually move further north into the Carrizozo area to "take" more water that they do not need. It is water that they are creating a need for. It is water that is already being used.	111-229	ENC
General Opinion	Keep Alamogordo out of their neighbor's back yard. I find no objection in the desalinization facility or their well project as long as it is in Alamogordo and away from all of us.	111-230	ALT
General Opinion	Today, Oct. 6, 2004, I was informed by land appraisers working for the City of Alamogordo, that Alamogordo is in the process of attempting to trade city-owned land in Timberon for state-owned land six miles north of Tularosa, with the explicit intent to drill wells there. This indicates, among other things, that Alamogordo has farther-reaching plans for this area's water than they have made public. Once they begin encroaching, they have no intention of stopping.	77-232	PRO
General Opinion	Alamogordo's water problems could have been, should have been, and probably WERE foreseen many years ago. Their incompetence, carelessness and greed should not become the burden of the small, mostly minority-populated communities which have the misfortune to exist within the City's sphere of intended influence. These communities and MOST of their families pre-date Alamogordo in this region.	77-233	PN

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General Opinion	Regarding "management" of resources: the forest must be managed to IMPROVE the watershed.	79-246	OOS
General Opinion	I believe that we, the people of Tularosa, are being forced to give up our water to Alamogordo because the funding was pre-arranged by Sen. Domenici and the governor of the state.	82-259	PN
General Opinion	An important fact that you [should] consider in this Impact Statement: This is not a de-salination project or issue. The Tularosa water sought by the City of Alamogordo is pure fresh water. De-salination is a red herring used to confuse those who do not understand what is going on, including U.S. Senator Pete Domenici.	83-263	AE
General Opinion	Taking, stealing the water, and ruining the farm land, from families whose ancestors settled this area 150 years ago, in order to line the bankrolls of good for nothing carpet-bagging developers and real estate brokers is an abysmally vicious grievous mortal sin condemned by God Almighty.	83-265	ENC
General Opinion	An important fact that you [should] consider in this Impact Statement: There is plenty of water now for Alamogordo residents, who are only angry about the pricing of their water, and arbitrary pricing confuses the truth about water supplies. There may not be enough water for 10,000 more Alamogordo swimming pools filled with pure fresh drinking water.	83-267	ENC
General Opinion	If New Mexico's Governor Richardson, of the national political party that says it's for the "little guy" is really for his constituency, why is he an active participant in the pillage and rape of Tularosans?	83-269	OOS
General Opinion	What kind of person would enter into an agreement with someone that cheats, steals, and lies to those they are supposed to be representing? Responsible individuals should render their resignation or face RECALL.	84-271	OOS

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General Opinion	This project on public lands will be challenged by the self-elected elite (Liberals) which has cost the Americans and U.S. Government (we are one and the same) over 24 billion dollars.	84-274	PRO
General Opinion	Water is like oxygen, A LIFE requirement, and too precious to waste (on Alamogordo).	84-278	OOS
General Opinion	Did money change hands between the Alamogordo leadership and the Tularosa leadership?	84-279	CC
General Opinion	Tulie did NOT agree to this plan with Alamo. A grand total of 3 people (politicians) in Tulie made that pact. NONE of the farmers, ranchers, general population of Tulie were consulted. We had NO INPUT. That is NOT right.	85-285	PRO
General Opinion	It is TOTALLY wrong for Alamo to control our water and therefore our very lives. That is NOT democracy. We will NOT allow this to happen without a battle! Hopefully words and reasoning will be effective.	85-289	ENC
General Opinion	We should not lose sight of the fact that the purpose of this project is to help provide a reliable and sustainable source of water for the 36,000+ residents of Alamogordo.	86-290	PN
General Opinion	Many of the concerns stated [at the Alamogordo public scoping meeting] by those in attendance (many of whom were from Tularosa) were merely a rehash of the issues raised at the public hearing before the State Engineer, which was apart of the City's water application.	86-292	PRO

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General Opinion	Much of the demand for water in Alamogordo is the result of the Federal Government's action in placing a large air force base in the area. If the closure of air force bases causes further expansion of Holloman Air Force Base, the demand for water in Alamogordo will increase. The Federal government should be approached on their responsibility for helping create the demand for water and should be asked to contribute land for a well site on the missile range or air force base or some other location south and west of Alamogordo.	87-296	OOS
General Opinion	Now that these systems [La Luz and Labacita Canyon] no longer provide enough water to meet their [Alamogordo] ever-growing demand, they plan to invade another neighbor. This is also wrong. They City claims the science says the new wells won't affect the wells around Tularosa.	88-304	ENC
General Opinion	This concept [of posting a damage/depletion bond] is no different than required by the State for businesses that financially can affect other people (construction contractors, financial institutions, insurance companies). This would be a small price to pay to obtain a large source of water to sustain the City of Alamogordo's greedy, short-sighted growth rate.	88-307	ENC
General Opinion	I live in Alamogordo: as we are searching for and developing an adequate water supply for our community, I believe we must keep in mind the needs of the smaller communities and also the individuals with their own wells.	89-308	ENC
General Opinion	I believe that the individual well owners and the smaller communities could be, and should be, treated in such a way as to [not] be unfairly used. I don't know how that can be done, but I believe that with all of the expertise available to you, it can be done!	89-312	ENC
General Opinion	My personal impression of this [Alamogordo public scoping] meeting was negative. The City [of Alamogordo] officials steal assets from citizens and pioneers, ruining property values and business opportunities, to sell water to residents for lawns and to foreign government armies and their employees and families.	90-314	PRO

Comment Category	Comment	Comment ID	Comment Disposition
General Opinion	Which government will eventually control this endeavor? Local? State? Federal?	90-316	CC
General Opinion	One look at the barren land around here will show definitely that Alamogordo taking water [from] north of us means death to all of us [in the] north. If we die, Alamogordo will die also.	94-328	ENC
General Opinion	We are almost certain that Tularosa farmers were not included when this "Alamogordo Well Water Field" plan was initiated. Why should Alamogordo build a plant using water from our part of the basin?	95-335	AE
General Opinion	After many years and Alamogordo's incompetency to plan for the future, [this] does not give them the right to steal water from our part of the basin.	95-337	ENC
General Opinion	If Alamogordo is allowed to drill the wells north of Tularosa, it will affect our way of life and our ability to farm. Both the ditch water (supplied by Tularosa Creek) and the wells will be affected.	98-345	ENC
General Opinion	It is not ethical for Alamogordo to control the destiny of Tularosa or any other community. It is not right for one community to be greedy enough to destroy another.	98-353	OOS
General Opinion	As a land owner, I feel like our future depends on your decision.	112-357	ENC

Comment Category	Comment	Comment ID	Comment Disposition
General Opinion	Further damage to already stressed mountain watersheds will affect communities in both the Tularosa Basin and the Pecos Valley.	113-363	ENC
General Opinion	Due to the greater porosity and higher hydrostatic pressure of the mountains, a cone of depression that reaches into the mountain range will more rapidly deplete mountain water than basin water. Cones of depression must be kept away from the mountain escarpment.	113-365	ENC
General Opinion	To effectively create a regional water management program, this project needs to be removed from the control of the City of Alamogordo. Their selfish concerns blind them to the needs of other communities and water users within the area.	113-369	OOS
General Opinion	The program was designed and proposed without the input of the surrounding landowners and other interested parties.	113-370	PRO
General Opinion	Alamogordo city management has consistently subverted any attempts at modification of the project to exclude any impairment of environment or socioeconomic impacts to the region.	113-371	OOS
General Opinion	The Sacramento Mountains Watershed Restoration Corporation is not adverse to a regional desalination project to extract saline waters from the Tularosa Basin. It does, however, strongly object to a project that is designed to mine waters for short-term benefits of a particular community and that will impact the environmental and socioeconomic health of neighboring communities.	113-374	ENC

Comment Category	Comment	Comment ID	Comment Disposition
General Opinion	[The current project] inherently predicts water table draw drowns that will deplete a valuable resource of future generations and that will have major environmental and socioeconomic impacts that will radiate outwards from the project site.	113-376	ENC
General Opinion	We will have taken a fresh water pool that keeps the saline water push[ed] west, plus serves 6 - 8,000+ people, related businesses, agriculture, and contaminate[d] it.	114-380	ENC
General Opinion	Alamogordo has made little or no attempt to help itself other than to grab someone else's water.	114-390	PN
General Opinion	Alamogordo has continued on as if nothing is wrong and it is business as usual, expecting to use other's water supply to make up their shortage - if it is a shortage.	114-393	PN
General Opinion	Water for the City of Alamogordo should be a city problem and not a problem for the region.	115-395	PN
General Opinion	[The following fact needs to be a part of the Environmental Impact Statement]: The well field is on land belonging to ALL AMERICANS, not a select few.	115-397	AE
General Opinion	[The following fact needs to be a part of the Environmental Impact Statement]: Alamogordo wants the Federal Government to solve and fund their City water needs.	115-399	PN

Comment Category	Comment	Comment ID	Comment Disposition
General Opinion	[The following fact needs to be a part of the Environmental Impact Statement]: We voters object to the Government agency's participation in Alamogordo's attempt to swindle the American taxpayer.	115-400	PN
General Opinion	[The following fact needs to be a part of the Environmental Impact Statement]: Alamogordo's attempt to take water from our area threatens our future and our economy. It has a NEGATIVE impact upon our entire underground and stream water systems and the future of our Community.	115-402	ENC
General Opinion	Alamogordo's water policy has hurt their adjacent neighborhoods, like La Luz; they will not be permitted to damage Tularosa so easily.	115-404	ENC
General Opinion	Local water rights holders can supply the area water need. However, this would cost the users money. Alamogordo's plan is to have the State and Federal Governments pay for their water.	116-405	ALT
General Opinion	I sincerely believe, if Alamogordo is allowed to drill these wells north of Tularosa, that our wells and the Tularosa Creek will eventually go dry.	117-409	ENC
General Opinion	I want to be able to water my cattle and other animals.	117-413	ENC
General Opinion	Alamogordo has already dried up the Sacramento Mountains. Please don't let them dry up Tularosa also.	117-418	ENC

Comment Category	Comment	Comment ID	Comment Disposition
General Opinion	There is no way to put a dollar figure on the loss that would occur (Historically, Culturally, Socially, Environmentally, and Economically) if this project is allowed to proceed.	120-423	ENC
General Opinion	THIS IS NOT A REGIONAL WATER PLAN. They have not worked with any other governmental agency in this area to formulate this project.	120-427	PN
General Opinion	Your pumping would be detrimental to our wells!	118-432	ENC
General Opinion	This is not a regional water plan. This is the "Alamogordo Water Plan." There is no contract between Alamogordo or anybody else. They [Alamogordo] said they "could" sell water "if they had some left over."	118-434	PN
General Opinion	If this is a "regional plan" using Tularosa water, then Tularosa should build a plant and sell water to Alamogordo.	118-437	ALT
General Opinion	[The following fact must be part of the EIS]: The well field is on land belonging to ALL AMERICANS, not Alamo's water users.	119-441	PN
General Opinion	[The following fact must be part of the EIS]: Alamogordo wants the Federal Government to solve their water problems and for the American taxpayers to foot the bill.	119-443	PN

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General Opinion	[The following fact must be part of the EIS]: The voters object [to] the Government agency's participation in Alamogordo's attempt to swindle the American taxpayer.	119-444	PN
General Opinion	Alamogordo's water policy has hurt its neighborhoods such as La Luz; we do not want our government officials to help them hurt us.	119-448	PN
General Opinion	Take away from the poor because they can not afford the lawyers of the rich. Tularosa verses Alamogordo.	139-515	ENC
General Opinion	At the Water Hearing in Alamogordo concerning this proposed new allocation by Alamogordo, there was much discussion about whether one entity could "hoard water" for future use or be a water broker with other entities. Verbal discussions with OSE personnel at the Hearing suggest that developing the water as such is contrary to present New Mexico water law. Alamogordo City Planners should not be allowed to determine who will get water and how much, outside of their municipality, especially by wanting jto drill wells over 22 miles away. Is having a Regional Water Plan, ran by Alamogordo, legal, as they are proposing it?	99-519	CC
General Opinion	Otero County is in the process of revising its County Comprehensive Plan. The new planning period will be 60 years rather than the current 40. All EIS planning should assume a pumping schedule of 60 years to complement local planning efforts. If $28,000,000+ is invested in an RO system, then we should assume that they will continue pumping after the 40 years, if there is enough water left to justify continuing to pump.	99-527	ENC
Science Used	A 60 or 100 year pumping schedule would reveal much more severe environmental consequences to the [Tularosa] Creek and its users and should be evaluated. The effects on creek flow should be evaluated for at least 100 years, not a graduated quantity for 40 years.	100-63	ENC

Comment Category	Comment	Comment ID	Comment Disposition
Science Used	The aquifer beneath Tularosa is not called the Hueco-Bolsom aquifer as referred to in the Federal Register Notice. The aquifer the notice refers to is located south of Orogrande. The legal notice is wrong. The "Tularosa Basin aquifer" or "Tularosa aquifer" is the terminology used by local planners for describing waters found under or near Tularosa. The Notice is deceptive and leads you to believe that the affected area is located south of Orogrande.	100-64	AE
Science Used	We are especially concerned that the project will be pushed through before the study of the Impact on Flow of Tularosa Creek is completed.	100-83	ENC
Science Used	The use of gravity as the only delivery method utilized should be properly researched. Many other major communities have utilized pumping methods very inexpensively for their customers and [other methods] should not be discounted on bias alone.	109-128	ALT
Science Used	Major studies should be done with sound scientific methods (no agenda or bias), and should not be directed by municipalities. This work should be performed by independent scientists (with no agenda or bias), and this work should be reviewed and approved by all parties. It is suggested that Federal government agencies be involved and additional work performed by universities.	109-129	AE
Science Used	[Code of Ethics that should be followed by project officials, continued] Perform services only in their area of competence	109-135	PRO
Science Used	[Commenter's opinion that the planned Project has ignored the following fact]: Monitoring to protect watersheds and aquifers must be continually performed	109-141	ENC

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Science Used	[Commenter's opinion that the planned Project has ignored the following fact]: Sustainable levels must be known, not modeled, and followed.	109-142	AE
Science Used	[Commenter's opinion that the planned Project has ignored the following fact]: Current usage of flawed models, with many parameters assumed or incorrectly applied, many made to satisfy end conditions, and with no alternative calculations.	109-149	AE
Science Used	[Commenter's opinion that the planned Project has ignored the following fact]: Hydrological, geological, geophysical, geochemical, isotopic testing can yield assumed parameters.	109-150	AE
Science Used	[Commenter's opinion that the planned Project has ignored the following fact]: Subsidence monitoring needed.	109-154	ENC
Science Used	[Commenter's opinion that the planned Project has ignored the following fact]: Constant independent monitoring of water production.	109-155	ENC
Science Used	[Commenter's opinion that the planned Project has ignored the following fact]: Well production testing at levels to be utilized.	109-156	ENC
Science Used	[Commenter's opinion that the planned Project has ignored the following fact]: Fault testing to characterize transmission and movement of groundwater in the mountain block environments.	109-157	ENC

Comment Category	Comment	Comment ID	Comment Disposition
Science Used	[Commenter's opinion that the planned Project has ignored the following fact]: Current and future demands accurately represented.	109-163	PN
Science Used	Scientific data collection, support, planning, funding and implementing are needed to maximize our water production for the present and future. Good science and common sense is needed.	110-181	AE
Science Used	Changing the flows in the water shed can result in undesirable and irreversible consequences. Good science is needed.	110-189	AE
Science Used	I do not believe that the depiction and inference that the Tularosa Basin and Hueco Aquifer are involved, as you presented in the scoping meeting, is accurate. This point needs to be evaluated based on more accurate scientific data before any assumption or judgments should be made.	110-196	AE
Science Used	Alamogordo has insufficient data to prove that there will not be harm to any and all in the area of their proposed project.	111-203	AE
Science Used	There is a threat to the Rio Tularosa. Alamogordo has not presented significant data to prove that the water shed from the Rio Tularosa will not be adversely affected.	111-210	ENC
Science Used	The proposed desalinization facility could be dated technology based on the findings of the planned Sandia Research Facility at Alamogordo. Why is Alamogordo building a desalinization plant when research regarding the desalinization process is ongoing?	111-223	AE

Comment Category	Comment	Comment ID	Comment Disposition
Science Used	The map [displayed at scoping meetings] has a lot of errors that need to be fixed and [make it] more accurate.	78-235	AE
Science Used	I hope your report is better than your fancy multi-color maps - which shows Hiway 82 from Tularosa to Alamogordo?	80-254	PRO
Science Used	The Board of County Commissioners recognizes the potential benefits of desalinization projects to supply water to citizens. Conflicting hydrological analysis have raised concerns from adjacent property owners who utilize the aquifer for domestic and agricultural water needs. In an effort to diffuse potential conflicts, we would recommend monitoring wells [be] located around the desal well field.	81-257	ENC
Science Used	Draw-downs are based on a 40 year model/water study. What do we want New Mexico to look at 50 to 100 years from now? Does this mean we should have [a] 100 year water plan, not [a] 40 year one?	91-318	ENC
Science Used	Watershed protection was a high public concern in the book, "Taking Charge of our Water Destiny." Page 43 says "Before proceeding with attempts to increase water yields from watersheds, conduct a detailed study of potential water gains (including their timing and durations) and costs, and develop a long term watershed management plan that ensures compliance with all applicable federal and state laws. Manage watersheds to protect water supplies from catastrophic high-intensity fires and maintain a healthy watershed."	91-319	ENC
Science Used	You have a study showing our water supply will not be affected; however, other data shows it definitely will make an impact.	95-336	ENC

Comment Category	Comment	Comment ID	Comment Disposition
Science Used	The water in the wells north of Tularosa is not "saline" as the legal notice states. The water is actually "brackish" and very suitable for farming without any modifications or desalination.	98-351	AE
Science Used	They [Alamogordo] have apparently decided not to wait for the results of testing from the experimental desalination plant to clean up a brackish water supply in their own immediate area.	114-391	AE
Science Used	The rumor is that [the Walker well south of Alamogordo] is already pumping sand and can not be used for its projected amount of water. WHY??? Is this bad science??	120-426	AE
Science Used	They [City of Alamogordo] have not followed the guidelines set out in the district 40 year plan that they helped to write, but really exclude everyone's opinion but their own.	120-428	AE
Science Used	The data presented is bias[ed]! The opposing parties data, which is quite different, is not presented.	118-438	AE
Science Used	The desalination plant mentioned in the [40 year] plan WAS to be south of Alamogordo, not north of Tularosa.	120-449	ALT
Science Used	Alamogordo is always changing their plans. First they wanted to drill 19 wells and applied for them with the OSE. Then it was lowered to 10 wells. Now they want to drill more test wells to actual[ly] see if there really is that much water in the area of the proposed well field. These new test wells have been applied for with the OSE. When their engineers were questioned at the OSE meeting in Oct. about the amount of water that was there, they began a gradual retreat on the accuracy of their science.	120-452	PN

Comment Category	Comment	Comment ID	Comment Disposition
Science Used	During the State Engineer hearings on the City's water rights application held in October 2003, HFR and Three Rivers demonstrated that the City does not have any data or information about the deep aquifer system associated with its proposed well field, and therefore, that the City has no support for its evaluation of the impacts that its proposed appropriation and use of 10,000 AFY of water will have on existing water rights.	138-454	ENC
Science Used	[During the OSE hearings, HFR and Three Rivers] presented evidence that the City does not need an additional 10,000 AFY of water rights to meet its present and future water needs.	138-455	PN
Science Used	The BLM and the BOR must consider the adverse impacts that the City's proposed project will have on water quantity and quality in the aquifer(s) beneath the Tularosa Underground Water Basin ("Tularosa Basin"). Despite the existence of evidence demonstrating that the City's proposed project is likely to adversely impact existing water rights and resources in the surrounding area, this critical threshold issue has not been properly evaluated by the City's hydrologist, John Shomaker & Associates, Inc.	138-457	ENC
Science Used	John Shomaker & Associates, Inc. analysis is not reliable because JSAI has virtually no data regarding the productive capacity or hydrological characteristics of the deep aquifer beneath the City's proposed well field. And, in a transparent effort to deny the absence of this critical data, JSAI makes a series of unsupportable, unverifiable, and overly optimistic assumptions regarding the deep aquifer's ability to provide a sustainable, high yield source of water for the City's proposed project.	138-458	ENC
Science Used	Instead of conducting appropriate studies in the deep aquifer [i.e. approximately 700 to 3,000 feet below land surface] in a manner that could realistically simulate the City's plan to pump ten individual 1,000 feet wells at the rate of 1,000 gallons per minute, the City drilled just one test well to a depth of approximately 700 feet and then pumped that well at a rate of only 50 gallons per minute. Because the test well did not stress the aquifer under conditions similar to those required by the City's project, the test well did not generate the data that are necessary to evaluate the impacts the City's proposed project will have upon the aquifer and existing water rights. Consequently, the City's well test does not provide support for the City's hydrological analysis of the impacts of its proposed appropriation of 10,000 acre feet per year.	138-459	ENC

Comment Category	Comment	Comment ID	Comment Disposition
Science Used	The City has conceded the inadequacy of its well test by submitting its December 15, 2003 application to the BLM for an amended permit to drill wells on BLM land; and the City has stated: "The additional test wells are needed to provide critical engineering data as to the quality and quantity of water in the Snake Tank area. "The City of Alamogordo is requesting to amend right-of-way NM 104116 in order to allow additional testing of the Snake Tank water well field. Following the State Engineers Office hearings in November, the City feels it needs to have additional information regarding depth and quality of water in the field. This information can be provided to the State Engineers Office for consideration of the City's requested water right and will also provide critical engineering data to the City as it develops plans for eventual development of the well field."	138-460	ENC
Science Used	In this regard [request for additional test wells], the City has requested State Engineer approval to drill three (3) exploratory wells on BLM land to depths of approximately 1,000 feet below land surface to evaluate the productive hydrologic capability of the deep aquifer by pumping the test wells at a rate of 1,000 gallons per minute. The City's request... constitutes a belated but necessary attempt by the City to obtain critical data regarding the productive capability of the deep aquifer. The BLM and the BOR should be mindful of the glaring absence of this critical data and postpone the EIS evaluation of the impacts of the City's proposed project on existing water rights and resources until after the City has drilled appropriate test wells, developed sufficient field data, and provided other interested parties an opportunity to evaluate and comment on those findings.	138-461	ENC
Science Used	The City's hydrological model is unreliable because it rests upon a series of unsupportable and unverifiable assumptions regarding the deep aquifer's [hydrologic characteristics and] productive capacity.	138-462	ENC
Science Used	Despite the fact that the State Engineer's hydrology model is the time-tested and established tool for evaluating the impacts of new water rights within the Tularosa Basin, the City's hydrology consultant created an entirely new model that has never been used by the State Engineer or any other agency to evaluate the potential impacts of a water rights application.	138-463	ENC

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Science Used	The City's hydrology model... with virtually no supporting data: assumes significantly higher values for the amount of annual recharge to the groundwater system than the State Engineer's model (The City's model assumes groundwater recharge that is more than three (3) times the amount used in the State Engineer's model. Therefore, the City's model assumes more water in the aquifer system, which causes the model to underestimate drawdowns of existing wells from the City's proposed project.)	138-464	ENC
Science Used	The City's hydrology model... with virtually no supporting data: assumes significantly higher [The City's hydrology model... with virtually no supporting data]: assumes much higher values for hydrologic conductivity and transmissivity than the State Engineer's model (By overestimating these values, the City's model underestimates the drawdowns resulting from the City's proposed project and overestimates the productivity of the wells in the Basin.)	138-465	ENC
Science Used	[The City's hydrology model... with virtually no supporting data]: assumes too great an aquifer thickness, which causes drawdowns at existing production wells to be underestimated (The City's model assumes, without ANY evidence, that there is a productive aquifer from 700 to 3,000 feet below ground surface.)	138-466	ENC
Science Used	[The City's hydrology model... with virtually no supporting data]: greatly overestimates the percentage of pumping that will be derived from evapotranspiration salvage and consequently, underestimates the City's withdrawals from groundwater storage and the resulting water level declines in existing wells.	138-467	ENC
Science Used	By relying on these [The City's hydrology model] unsupported and unverifiable assumptions, JSAI's hydrology assessment greatly overestimates available water supplies and underestimates the drawdown impacts on existing water rights that will be caused by the City's proposed project.	138-468	ENC

Comment Category	Comment	Comment ID	Comment Disposition
Science Used	Because the City has provided no data regarding the productive properties and capacity of the deep aquifer below its proposed well field, there is no evidence that deepening, monitoring wells, or a plan of replacement would mitigate or prevent the City's proposed pumping from impairing existing water rights. The City has no evidence that deepening wells will allow owners of dewatered irrigation wells, such as HFR and Three Rivers, to recover their lost water production capacities to the degree and in a manner sufficient to meet their seasonal irrigation demands.	138-493	ENC
Science Used	There is no data to support a meaningful monitoring plan because the City has produced no evidence regarding how many and what types of wells would be required, what the wells would monitor for, what findings would require the City to cease pumping, and what compensatory or remedial measures would be required of the City when the monitoring wells demonstrate that existing water rights are being impaired.	138-494	ENC
Science Used	Before the EIS process is allowed to go forward, the City should be required to... submit a detailed plan for monitoring the impacts that its proposed pumping will have on the water table and the ability of existing water rights owners to continue using their water rights.	138-495	ENC
Science Used	HFR's and Three Rivers' EIS comments are supported by the New Mexico Brackish Groundwater Assessment Program (NM Assessment Program) Workshop's January 15, 2004 "Report of Findings and Recommendations." After the workshop, the NM Assessment Program issued a Report identifying the essential data required PRIOR to development of a plan to develop a brackish aquifer. Mirroring HFR's and Three Rivers' comments,... the list of essential data includes: hydrologic properties (specific yield, storativity, hydraulic conductivity, transmissivity) of the saline aquifer;	138-497	ENC
Science Used	[The list of essential data from the NM Assessment Program Workshop includes]: volumetric assessment (areal extent, thickness, and recoverable storage) of saline water supplies;	138-498	ENC

Comment Category	Comment	Comment ID	Comment Disposition
Science Used	[The list of essential data from the NM Assessment Program Workshop includes]:defined geologic framework (general structural and stratigraphic framework of basin) at an appropriate scale and level of detail for stage of development;	138-499	ENC
Science Used	[The list of essential data from the NM Assessment Program Workshop includes]: basic groundwater conditions and water availability (water table map, general flow conditions, areas of recharge and discharge, productivity);	138-500	ENC
Science Used	[The list of essential data from the NM Assessment Program Workshop includes]: chemical suitability of saline water for desalination technologies (TDS, conductivity, pH, temperature, major cations/anions, iron, manganese, aluminum, and silica);	138-501	ENC
Science Used	[The list of essential data from the NM Assessment Program Workshop includes]: suitable geologic formations for injection of concentrate or other suitable concentrate disposal options;	138-502	ENC
Science Used	[The list of essential data from the NM Assessment Program Workshop includes]: accurate 3-dimensional representation of the salinity and chemical composition of groundwater;	138-503	ENC
Science Used	The NM Assessment Program further concluded that, prior to implementation of a plan for developing a brackish aquifer, officials should obtain data regarding: simulation of the effects of withdrawal of saline water (transient changes in hydraulic head, chemical composition in three dimensions {x, y, z} and movement of the freshwater-saline water interface) with variable density groundwater flow model;	138-505	ENC

Comment Category	Comment	Comment ID	Comment Disposition
Science Used	[Prior to implementation of a plan for developing a brackish aquifer, officials should obtain data regarding]: large scale water budgets (recharge, discharge, and flow characterization) for basins of interest, including groundwater modeling and geochemical modeling;	138-506	ENC
Science Used	[Prior to implementation of a plan for developing a brackish aquifer, officials should obtain data regarding]: understanding of the thermal regime, particularly for basins in or adjacent to the Rio Grande Rift;	138-507	ENC
Science Used	[Prior to implementation of a plan for developing a brackish aquifer, officials should obtain data regarding]: information regarding necessary supporting infrastructure (energy resources for plant, pipelines, pump stations, etc.);	138-508	ENC
Science Used	[Prior to implementation of a plan for developing a brackish aquifer, officials should obtain data regarding]: evaluation and ranking of potential environmental risks associated with saline water development (subsidence, potable water degradation, drying of playas, and ecosystem impact).	138-509	ENC
Science Used	HFR and Three Rivers reiterate that this [NM Assessment Program recommendations] is precisely the type of information that they and other protestants have identified as critical to, and yet still missing from, the City's proposed project.	138-510	ENC
Science Used	In its discussion of the viability of developing brackish water from the Eastern Tularosa Basin, the [NM Assessment Program Workshop] Report notes that researchers have only a "moderate level of knowledge of {its} geology" and that the "central part of the basin is largely uncharacterized because it is associated with military land and the saline water is likely in low yield aquifers."	138-511	AE

Comment Category	Comment	Comment ID	Comment Disposition
Science Used	Despite the fact that the [NM Assessment Program Workshop] Report identifies the Eastern Tularosa Basin as the highest priority for development of brackish water resources, the Report notes that prior to development of the Basin, officials should obtain "a better assessment of impacts to freshwater resources and sustainability or lifespan of the project."	138-512	ENC
Science Used	The aquifer beneath Tularosa is not called the Hueco-Bolsom aquifer as referred to in the Federal Register Notice. The aquifer the notice refers tois located south of Orogrande. The legal notice is wrong. "The Tularosa Basin aquifer" or "Tularosa aquifer" is the terminology used by local planners for describing the waters found under or near Tularosa. The Notice is deceptive and leads you to believe that the affected area is located south of Orogrande.	99-516	AE
Science Used	The Notice [of Intent to prepare an EIS] repeatedly refers to the water as saline. The Public Scoping Notice flyer mailed to me, and the Federal Register notice both say that saline water will be treated for use by Alamogordo. Are they planning to deplete our brackish water resource at Tularosa or will the project really be using saline water as commonly defined in New Mexico?	99-517	AE
Science Used	A 60-year pumping schedule would reveal much more severe environmental consequences to the [Tularosa] Creek and its users. We don't want our Creek [or] our acequia to last 40 years, we want it to last for many, many future generations. Therefore, the effects on creek flow should be evaluated for at least 100 years, not a graduated quantity for 40 years.	99-539	ENC
Science Used	The history starts in 1983; I think that there was bond issue in Alamogordo for the building or study of feasiblility of building a desalination facility. If this is true, should not the results of this effort be introduced into this proposal?	206-552	ALT

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Science Used	I find this appalling. The City of Alamogordo consistently uses short sighted methods to determine long term fixes. Nowhere in the 1995-2000 time frame do I see evidence of slowing construction in the area to thwart increasing water needs, exacerbated by drought. I see lining the reservoirs, and Bonito Lake Pipeline projects. Clearly, both are small measures to take. Especially when construction booms in the area.	209-553	ALT
Science Used	2. The sole source of water for this project has been mis-represented as being part of a vast supply of salt water that can be used to meet the needs for water for thousands of years. The salt water in the basin is too salty to recover as drinking water. It's not economically feasible. The technology does not exist that would justify the claims of a limitless supply of water through desalination. The fact is, the water being de-salinated is only marginally brackish and is MIXED with the processed water before being sold as drinking water.	212-562	ALT
Ground Water	Analyze the potential indirect and cumulative effects of the project on water tables.	53-20	ENC
Ground Water	Please consider subsidence in your analysis. What happens when you remove water from beneath the surface... how much water is [lost in wells?]	63-38	ENC
Ground Water	Please consider subsistence [subsidence] in your analysis. How much water is beneath the surface in the basin? Total? What happens when some, and how long before ALL, is removed?	65-43	ENC
Ground Water	[re: subsidence] Does the surface collapse? How quickly? 10 yrs? 20? 40?	65-47	ENC
Ground Water	My understanding is that the water is trapped between clay layers, throughout the basin. It's a finite resource. What date, in your analysis, will we dry up using this process?	65-48	ENC

Comment Category	Comment	Comment ID	Comment Disposition
Ground Water	As for the deep well pumping project, look at land subsidence on the north central mesas of Arizona where your agency, the Department of Interior, allowed 40 years of large scale pumping on Hopi and Navajo reservation lands. Those communities are now devastated, springs and rivers have dried up, earth cracks and subsidence is occurring.	74-51	ENC
Ground Water	The water table at Tularosa is already falling. This huge appropriation near the upper end of the Basin will create a huge cone of depression that will eventually affect the entire eastern side of the Basin.	100-75	ENC
Ground Water	This appropriation would drain the area north of Tularosa causing irreversible impacts according to the hydrologist's reports presented at the Water Rights Hearing in October of 2003.	100-76	ENC
Ground Water	[The] location, being north of Tularosa, is certainly going to affect all users and their water level.	106-105	ENC
Ground Water	I am not convinced that, with as much technology as we have available to use, that there is not a better method of ensuring that everyone has enough water without affecting the water tables.	108-117	ENC
Ground Water	[Commenter's opinion that the planned Project has ignored the following fact]: Groundwater and surface water are interconnected – you cannot effect one without effecting the other.	109-139	ENC
Ground Water	[Commenter's opinion that the planned Project has ignored the following fact]: Groundwater is a very finite resource, current overuse is a lien on future generations.	109-143	ENC

Comment Category	Comment	Comment ID	Comment Disposition
Ground Water	[Commenter's opinion that the planned Project has ignored the following fact]: Overproduction will permanently damage aquifers and cause subsidence.	109-144	ENC
Ground Water	[Commenter's opinion that the planned Project has ignored the following fact]: Faults are not a boundary to flow, especially in highly tectonically altered areas such as the Sacramento Mountains and surrounding basins.	109-148	ENC
Ground Water	[Commenter's opinion that the planned Project has ignored the following fact]: Tularosa Basin does NOT have an unlimited supply of water.	109-164	ENC
Ground Water	[Commenter's opinion that the planned Project has ignored the following fact]: Salt water intrusion is a very real danger.	109-167	ENC
Ground Water	[Commenter's opinion that the planned Project has ignored the following fact]: Recharge at higher elevations sustains the watershed, increases hydrostatic pressure, and provides water for all.	109-169	ENC
Ground Water	We have been told there is an unlimited source of water in the basin - why do you say the water is limited? The water is limited in the mountains, creeks, and wells [not in the basin].	79-244	ENC
Ground Water	The safe yield of the aquifer in the region of the proposed well field has been historically exceeded because it is a mined aquifer. The proposed well field amplifies the rate of depletion.	87-298	ENC

Comment Category	Comment	Comment ID	Comment Disposition
Ground Water	Not only should the proposed project be eliminated, but studies should be conducted to determine how to keep ground water pumping within the safe yield of the aquifer.	87-301	ALT
Ground Water	From what I have heard, there is a basin of brackish water underneath us [Alamogordo] that could supply us with plenty of water for many years. By a process of reverse osmosis, this water can be made useable for all of us. This sounds great! I am all for it!	89-309	ALT
Ground Water	As this water is pumped, thus lowering the water table, won't that also cause the upper levels of water [to] drop, thus leaving these individual wells dry?	89-310	ENC
Ground Water	[In the book, "Taking Charge of our Water Destiny" page 58 discusses groundwater]: "With a few exceptions, groundwater is a non-renewable resource. As we use up our groundwater supplies, they become unavailable for drought years or to help us meet our water needs in the future. We cannot afford to completely squander this essential resource before searching for better ways to manage it. Of course, we are using groundwater up much faster in some areas of the state than in others, and of course it is those areas that demand is accelerating. These are the areas where steps need to be taken to protect the resource. One step is increased measuring, metering, and reporting of diversions in order to understand the magnitude of depletions. A tiered groundwater management system with appropriate safeguards to protect areas where groundwater supplies are threatened is another [step?]."	91-320	AE
Ground Water	When I moved here [Tularosa] 26 years ago, I had two neighbors east of me. In the past approx. 15 years, many people have moved into this area. All these residents have private wells too. Since all of these people have moved here and new wells have been dug, I have noticed a considerable amount of increased minerals in the water. I do not believe there is nearly as much underground water in the Tularosa Basin in this area as [the] experts predict.	93-323	ENC

Comment Category	Comment	Comment ID	Comment Disposition
Ground Water	The Bureau of Land Management should not grant Alamogordo use of the proposed right-of-way for project infrastructure and the Bureau of Reclamation should not partially fund the Alamogordo Regional Water Supply Project. The proposed Snake Tank well field could lower the water table in the surrounding area and result in existing domestic and irrigation wells running dry.	97-342	ENC
Ground Water	The Tularosa Basin has experienced several years of drought. Runoff from the mountains is insufficient to replace groundwater being withdrawn. "Groundwater in the basin is primarily recharged by ephemeral streams draining the surrounding mountains and discharging either across the permeable alluvial fans at the mouths of the steep canyons or by underflow in these canyons, which enter the alluvial fan directly (BLM 1984)."	97-343	ENC
Ground Water	Our families have been involved in raising livestock in Otero County since before N. Mexico was a state. As a result, we have a first-hand knowledge [of] how important your water supply is. We also know that without this important commodity, your place is worth virtually nothing. When you drill this many wells into the ground, you can't avoid draining the underground water supply that furnishes the whole Tularosa Basin with irrigation and house-use water.	112-355	ENC
Ground Water	I can't imagine how anyone can think that, when you pump from a pool, what is over it on another level will go down in[to] the vacuum left. We may be wrong in our thinking, but won't we be in a mess if we are right.	112-356	ENC
Ground Water	The SMWRC [Sacramento Mountains Watershed Restoration Corporation] is concerned that the Alamogordo Regional Water Supply Project will impact the environment by the lowering [of] water tables within the Sacramento Mountains extending as far as 30 miles or more into the mountains from the proposed site of the water extraction.	113-358	ENC
Ground Water	Extracting an additional 10,000 acre feet of water [per year] from an area already stretched to its sustainable levels will cause a more rapid depletion of water from the mountains.	113-359	ENC

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Ground Water	[A report by] Kerry Miyoshi indicates that the substructure of the mountains is conducive to rapid underground water flows towards the area being depleted. This could entail the removal of ground waters from such areas as the White Mountain Nature Preserve, the Mescalero Apache Reservation, the Tularosa River, and the communities as far inland as Ruidoso.	113-360	ENC
Ground Water	Pumping north of Tularosa will reduce the water available to the Tularosa area. Tularosa and surrounding area wells (irrigation and domestic), numbering 1100 - 1600 are presently experiencing a lowering of the water of 20 - 100+ feet. This is due totally to the extended drought of the last 8-10 years. No one has shown what an additional 13,000+ acre-feet would do to an already declining water table or the economic devastation to the local area.	114-377	ENC
Ground Water	We do not know how much damage will occur to our water supply. But as precious as water is, even a little damage could be devastating to our Village and the surrounding area.	120-422	ENC
Ground Water	Water still runs downhill whether it is on the surface or underground. We are downhill from these proposed wells, and so the water they would be taking would be water that replenishes our water table. Everything boils down to the fact that water taken from a source uphill from you will affect your water source.	120-453	ENC
Ground Water	According to the Tularosa Basin 40 Year Water Plan, about 19% of the untapped fresh and brackish water is north of Tularosa and over 40% is south of Alamogordo. It is baffling as to why the City would go after the smaller quantity of brackish water rather than the larger quantityof fresh water.	99-522	ALT
Ground Water	Groundwater is presently recycled several times from the upper end of the Basin to the lower end. This appropriation would drain the area north of Tularosa, causing irreversible impacts according to hydrologist's reports presented at the Water Rights Hearing in October of 2003.	99-529	ENC

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Ground Water	The farm immediately below or south of the well field would be the first farm put out of business. At the Water Rights Hearing in October of 2003, all hydrologists agreed that this farm would be within a cone of depression. The amount of depletion and the potential for salt water intrusion was debated. Both are going to happen, according to hydrologists giving testimony for Heyco, High Nogal Ranch, and Three Rivers Ranch.	99-534	ENC
Surface Water	Analyze the potential indirect and cumulative effcts of the project on surface flows in Sacramento Mountains streams.	53-21	ENC
Surface Water	As demand for water increased in the Tularosa Basin, and more water sources are developed, including more wells, regional water users may increase the use of surface water. Analyze how the project could indirectly or cumulatively affect surface flows and associated riparian habitats as a result of increased use of surface water.	53-22	ENC
Surface Water	Deep well pumping will lower the surface water table and further dry out soil moisture, further weakening artesian pressure in the foothills of the mountains here.	74-52	ENC
Surface Water	Dr. Mioshi, at the Water Rights Hearing in October 2003, testified that the flow of all surface water, including the springs that feed Tularosa creek, would be affected.	100-62	ENC
Surface Water	Water that now flows from the mountains down the Tularosa Creek may be diminished or dry up, thus negatively affect[ing] all wildlife and fauna along the pathway of the creek.	105-98	ENC

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Surface Water	[Commenter's opinion that the planned Project has ignored the following fact]: Mountains and basins [are] interconnected: Mountains = fractured rock, highly permeable, quick water flow through system, high hydrostatic pressure / Basin = slow water flow, variable permeability, low hydrostatic pressure	109-140	ENC
Surface Water	[Commenter's opinion that the planned Project has ignored the following fact]: Restoration of alluvial stream beds needed.	109-153	OOS
Surface Water	If Tularosa Creek is [the] only water source for [the] Village of Tularosa, if this dries up [there] will be no fresh water source and also Tularosa Ditch Corporation and acequias will dry up.	91-322	ENC
Surface Water	The lowering of ground water levels will result in the further disappearance of springs, rivers, streams, and potentially destroy thousands of acres of forested watersheds.	113-361	ENC
Surface Water	Tulie Creek will also be affected by the lowering water table and could be dried up, depending on the underground flow to the basin.	114-381	ENC
Surface Water	The transmissivity of the water in the aquifer was highly debated at the [October, 2003 Water Rights] Hearing. Dr. Keri Mioshi, ENMU geology professor, testified... that the cone of depression would affect springs and streams above the well field, even onto the Mescalero Apache Tribal Lands.	99-536	ENC

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Surface Water	Dr. Mioshi, at the Water Rights Hearing in October 2003, testified that the flow of all surface water, including the springs that feed Tularosa Creek, would be affected. These springs are within or near the forty year cone of depression.	99-538	ENC
Water Mgmt.	Alamogordo should initiate strict limits on groups or agencies advocating additional population or water uses.	56-29	ALT
Water Mgmt.	Current water rates should be steeply progressive (the more used, the higher the price).	56-30	ALT
Water Mgmt.	Landscaping must encourage use of resource efficient plants and systems.	56-31	ALT
Water Mgmt.	Consideration should be given to removing any exotic plants or animals that are depleting the currently available water (wild horses, oryx).	56-35	AE
Water Mgmt.	We wouldn't need this project, or at least not so soon, if we captured a small fraction of the rainfall that falls on the city and flows through the streets and then out into the desert to disappear.	64-40	ALT
Water Mgmt.	The Army Corps of Engineers flood control project here should have included impounding this water [captured rainfall] for city use. Maybe the project could still be used for this.	64-41	OOS

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Water Mgmt.	Conservation of water has much more potential - more graywater residential use - use of cisterns - micro impoundments of rainfall for graywater use.	64-42	ENC
Water Mgmt.	If we stopped building today, how long before we run out of water using desal?	65-45	ENC
Water Mgmt.	Please consider how long Alamogordo should exist. A 50 year plan is insufficient, we should be looking 100 years down the Road.	65-46	ENC
Water Mgmt.	Is there a "real" water crisis? It sure sounds like Alamogordo plans to start selling water as soon as they begin pumping ours [Tularosa's].	100-66	PN
Water Mgmt.	The government's goal should be to restore and protect our watersheds and help provide sustainable water supplies to both mountain and basin communities. It should not arbitrarily choose support for one over the other, or to knowingly damage one to the benefit of the other.	109-122	PN
Water Mgmt.	No water production should be beyond sustainability for it results in damage to the environment. The City has identified this loss but does not conclude that they have caused their own water loss. Instead, they believe it needs this project and new water source.	109-127	ENC

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Water Mgmt.	Alamogordo already has too many high production wells in a small area, the La Luz wellfield. This lack of comprehension [of the natural environment] has led to a large amount of interference between these wells. The City's lack of understanding has led [them] to improperly blame watershed residents, the drought, or the overgrowth of trees as the cause for the lack of water. [The fact is] the major cause of their lack of water is overproduction (beyond sustainable levels) for years, their impoundment of recharge areas (high-elevation springs), and lack of support for watershed restoration.	109-130	ENC
Water Mgmt.	[Commenter's opinion that the planned Project has ignored the following fact]: Water budgeting and water banking must be done. Independent studies should characterize watershed and recharge.	109-151	ENC
Water Mgmt.	[Commenter's opinion that the planned Project has ignored the following fact]: Independent governing body over water resources -- Regional Authority.	109-159	ENC
Water Mgmt.	[Commenter's opinion that the planned Project has ignored the following fact]: Water conservation measures taken.	109-162	ENC
Water Mgmt.	I do not oppose the wise and sustainable use of resources, but I believe that management and the studies necessary to properly direct management decisions on these issues are best left in the hands of the independent government agencies such as the U.S. Forest Service and the U.S. Geological Survey under the mandates of existing laws which seeks balance between multiple users and provide for public input.	109-179	OOS
Water Mgmt.	Will this project provide water for Tularosa?	79-237	PN

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Water Mgmt.	Who will dictate how much water Tularosa gets?	79-238	ENC
Water Mgmt.	Who will determine the price of the water?	79-239	ENC
Water Mgmt.	Salt cedars have spread to us unwanted. Most people are clueless how much water they use. Salt cedars should be removed. We've gotten rid of them on our land (about 16 acres).	85-286	ALT
Water Mgmt.	Everybody in Tularosa Basin - except Alamogordo - is very careful about how we use our water. They are wasteful with their water supply and we are careful. That is why we have a viable water supply now.	94-329	PN
Water Mgmt.	It is imperative that any water production project be designed for SUSTAINABILITY. The current project does not address sustainability.	113-375	ENC
Water Quality	Tularosa water quality will go down if the rate of pumping goes up.	106-106	ENC
Water Quality	[Commenter's opinion that the planned Project has ignored the following fact]: Water quality must be maintained for all users.	109-158	ENC

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Water Quality	Is the water brackish or saline? The City of Alamogordo's well application to the OSE state[s] that they will remove "brackish" [water] but the federal publication only states that the water within the basin is saline and it is defined as water that has a total dissolved solids that is above drinking water standards.	111-207	AE
Water Quality	THERE IS NOTHING TO GUARANTEE THAT THE WATER BEING USED BY DOMESTIC AND FARMING WILL NOT BE PERMANENTLY REMOVED, AND ALLOW FOR INTRUSION OF THE SALINE WATER.	111-208	ENC
Water Quality	If these wells are drilled, there will be salt water incursion of saline water into the well cone draw-down, pumped void, from west of Tularosa, and Tularosa will become a dead wasteland in our lifetime.	83-266	ENC
Water Quality	We have lived here in Tularosa for over 10 years and we depend on our alfalfa for a living. When we started, the water was very good, but in the last couple of years the quality has changed and the level has dropped 2 feet, from what I've been told.	96-338	ENC
Water Quality	[The project is described as "treating saline water" from the basin]: The current residents, farmers, and ranchers within the affected area utilize these waters currently without treatment.	113-368	AE
Water Quality	The withdrawal of this large amount of fresh water will further lower the fresh water level and allow the brackish or saline water to the west to intrude into the fresh water pool. Some wells are experiencing this intrusion at this time and earlier.	114-378	ENC
Water Quality	The result of the lowering water table and subsequent intrusion of saline water will contaminate the fresh water pool in the surrounding area, then there will be no fresh water for this whole area.	114-379	ENC

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Water Rights	This acequia [in Tularosa] has been in constant use since 1865 and should not be [allowed to be] damaged by this proposed project.	100-60	ENC
Water Rights	[Taking water north of Tularosa] may also "steal" and dry up the centuries old water rights of those living within the original "49 blocks."	105-93	ENC
Water Rights	Groups of [Tularosa] home owners may form to pursue litigation over the loss of "water rights."	105-95	ENC
Water Rights	Why haven't we visited the leasing options prior to this initiative? Most farmers would be open to leasing excess water rights.	106-108	ALT
Water Rights	[Commenter's opinion that the planned Project has ignored the following fact]: Winter's doctrine dealing with the sovereignty of the Mescalero-Apache nation and it's right to water resources.	109-147	PRO
Water Rights	[Commenter's opinion that the planned Project has ignored the following fact]: The People of NM own the water, not municipalities or the OSE. OSE is a trustee of the resources.	109-168	OOS
Water Rights	If the City's wells and springs are no longer producing water at the registered level of their water rights, how come the water rights have not been adjusted down? I have been given to understand that the production capacity of the water right source, plus beneficial use, are what justifies a claim for registered water rights, so, following the letter and intent of the law, their registered water rights should have been adjusted to the amount of producible water put to beneficial use.	110-186	PN

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Water Rights	I do not feel the lack of water from their sources should entitle them to take the regional neighbor's water without fair compensation and I wondered if that was what you were trying to imply was justified [by the water rights graph displayed at scoping meetings].	110-187	PN
Water Rights	Purchasing existing, verifiable and active agricultural water rights at market value will have less negative impact in the larger picture than the proposed mining of water at an accelerated rate by allowing new competition with all of the other existing water users in the proposed new City well field in the aquifer north of Tularosa.	110-191	ALT
Water Rights	If you are implying that the City [of Alamogordo] has water rights in one or more aquifers that are legal and transferable, when they are not proven in the legal and proper sense in this new location, following the letter and intent of the law as I understand it, I need verification that you are right before I can feel comfortable accepting it.	110-192	AE
Water Rights	Tularosa and the residents have senior water rights dating back to the early 1800's.	111-211	AE
Water Rights	WE HAVE SENIOR PRIORITY OVER ALAMOGORDO!	111-214	AE
Water Rights	Mayor Montoya has given away our water rights; what recourse do we have?	79-240	PRO
Water Rights	What safeguards are in place for the private property owner and his adjudicated water rights?	79-241	ENC

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Water Rights	When the average citizen does not use their water rights, they lose their water rights. Why, if Alamogordo is not using its water rights, why aren't they losing THEIR water rights?	79-249	OOS
Water Rights	They [Alamogordo] have not used the water rights adequately yet, but there is talk of allowing Ruidoso to take over the water rights from the Bonita Lake water supply that Alamogordo has now. There is something going on that is not right and it does not have Tularosa's best interest in it.	82-262	ALT
Water Rights	Why did the brief power-point presentation at the Tularosa public meeting include a graph of Alamogordo's water rights and total produced water, but did not include graphs of predicted pumping effects? The data of predicted pumping effects was most relevant to the audience.	87-302	ENC
Water Rights	The City of Alamogordo has been allowed, by owning water rights, to invade its neighbors in La Luz and Labacita Canyons to install collection systems that are drying up the area and causing the area's residents' wells to go dry. This is ethically and morally wrong.	88-303	AE
Water Rights	Of course, [if the project occurs] Alamogordo would have plenty of water for everyone. But it seems that, in this case, the individual well owners would be giving their water to Alamogordo, and Alamogordo would be selling their own water back to them. Something seems wrong with that picture.	89-311	OOS
Water Rights	[The EIS] also needs to look at Federal reserved water rights such as national forests, parks, and Bureau of Land Management grazing lands, [all] by inference granted sufficient water to those lands for them to fulfill their purpose[s].	91-321	OOS

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Water Rights	At the [Tularosa public scoping meeting Oct. 6, 2004] they showed a chart/graph of Alamogordo water rights from 1982 to 2002, a 20 year period. However, they did not show an water rights for Tularosa, La Luz, Boles Acres, Holloman AFB, AlamoRosa or any other areas affected in the county. I feel like this was biased, discriminatory, and down right UNFAIR!	93-324	AE
Water Rights	I thought it was supposed to be a REGIONAL Water Meeting [in Tularosa, Oct. 6, 2004]. I sure failed to see anything regional about it! It seemed to me [that] nobody else in the County had any water rights except Alamogordo.	93-325	OOS
Water Rights	We have irrigation wells with water rights and are afraid this [Project] will affect our water table.	95-333	ENC
Water Rights	Water rights in the Tularosa area require precedence over Alamogordo's claim. The rights in this area are all senior to their claim, beginning before 1865 up to this moment. This includes all wells and the Tulie Creek.	114-387	OOS
Water Rights	Tulie Creek water, both surface and subsurface, has been in use for many years prior to the establishment of Alamogordo; prior to 1865 for both domestic and agriculture use.	114-389	ENC
Water Rights	The following fact needs to be a part of the [Environmental Impact] statement: Alamogordo wants to take water that does not belong to them.	115-396	OOS
Water Rights	The Village of Tularosa was originally settled in 1860-65 and they established water rights long before Alamogordo was ever on the drawing board.	120-420	ENC

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Water Rights	Please look at Alamogordo's track record. Everywhere they have acquired water rights, they have dried up the source of water or the area that was previously watered by this source. Examples [are] Timberon area, Sacramento Lake area, La Luz Canyon area, La Luz well field, the F[r]esnal Canyon area (they have filed a lawsuit costing tens of thousands of dollars against Alamogordo over the water), the most recent the Walker well south of Alamogordo. We in the Tularosa area cannot afford to be another statistic of failed water sources for Alamogordo.	120-425	ENC
Water Rights	Tularosa is a farming community. We have had water rights here dating back to before New Mexico was a state. You are totally disregarding our water rights.	118-431	AE
Water Rights	The following fact must be part of the EIS: Alamogordo wants to take water that does not belong to them.	119-440	PN
Water Rights	Because of the proximity of HFR's wells to the City's proposed well field, HFR's wells and water rights/uses will be immediately and substantially impacted by the City's proposed project. For example, the regridded State Engineer Model predicts that the City's proposed project will cause HFR's wells to suffer drawdowns between 29 - 81 feet. This will cause five of HFR's nine wells to go dry, two wells to be severely impacted, and two wells to be adversely impacted within 40 years.	138-470	ENC
Water Rights	The City's proposed project will cause Three Rivers' water rights/uses to suffer similar adverse effects [similar to those effects on HFR wells] over a more extended time frame.	138-471	ENC
Water Rights	The City's proposed project... constitute[s] an indirect, uncompensated taking of their [HFR and Three Rivers] water rights and the resulting loss of their agricultural businesses. Consequently, there is no merit to the City's claim that it has chosen not to acquire agricultural water rights. The reality is that the City has chosen to pursue its proposed project by means which will allow the City to take existing agricultural water rights without having to pay for them.	138-484	PN

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Water Rights	Is there a "real" water crisis? It sure sounds like Alamogordo plans to start selling water as soon as they begin pumping ours. If Bonita Lake is to become surplus, then the Tularosa community should get this body of water in return for the water Alamogordo plans to pump out from under us.	99-520	PN
Water Rights	As a landowner and lifelong resident of Tularosa I am concerned about the proposed drilling, and desalinization plant and the effect it will have on the future of my home and water supply. I currently use acequia water rights to irrigate 27 mature pecan trees as well as numerous fruit and shade trees on my property. I have a well to supplement it the acequia water. My concerns are:□ 1. Substantial drawdown of the aquifer by drilling and pumping the at the top end of the aquifer.	211-555	ENC
Health/Safety	[If Tularosa Creek dries out] the beautiful cottonwood trees, wildlife and plants will wither away and add more dust to the air, possibly creating health problems for those with breathing problems and allergy disease.	105-100	ENC
Health/Safety	These [biased, secret-meeting] officials and contractors should hold, at a minimum, the following Code of Ethics: hold paramount the health, safety, and welfare of the public.	109-134	PRO
Health/Safety	Waste from the proposed desalinization plant could be as much as 186.3 tons a day. WHAT IS THE RESIDUE MADE UP OF, HOW MUCH OF IT IS TOXIC, DOES IT CONTAIN ARSENIC OR ANY OTHER HAZARDOUS MATERIALS?	111-204	ENC
Health/Safety	Residue from the desalinization facility will produce a huge environmental hazard near our homes, which has the potential to make us ill and kill us. WHAT WILL BECOME OF THE RESIDUE? ARE THERE PLANS TO REINJECT IT, CARRY IT OFF AND DISPOSE OF IT? WHERE, HOW, WHEN?	111-205	ENC

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Health/Safety	The location of the wells, desalinization facility should be placed in Alamogordo's back yard, not ours! Our health, safety, and survival should count for something too.	111-222	ALT
Purpose and Neec	If the object is to desalinate brackish saline water for future use, why are we wanting to use good water which will affect the lives of many people.	139-13	PN
Purpose and Neec	[The Project] is dangerous, deceptive, and disastrous and is not currently feasible as planned.	109-120	OOS
Purpose and Neec	This project is not scheduled to begin pumping the full amount of water for 30 years; if Alamogordo had started this project 50 years ago, we would not be here today.	120-421	PN
Purpose and Neec	It is a power play to control the valley and destroy all other ways of life outside the Alamogordo City Limits. Alamogordo is planning to double their population in the next 40 years. That would be 70,000 people (See their 40 year plan). This project is not about a need for water now, but 40 years from now.	120-450	PN
Purpose and Neec	[During the OSE hearings, HFR and Three Rivers] demonstrated that if the City engaged in responsible water resource management efforts such as continued conservation and the development of alternative water supply sources such as aquifer storage and recovery, the City may need, at most, an additional 1,299 AFY of water rights over the next forty years.	138-456	PN

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Purpose and Need	HFR and Three Rivers agree with the City's statement... that the development and testing of the three (3) wells will provide critical data for evaluating the productive capability of the aquifer in the proposed well field area. HFR and Three Rivers believe that it is premature for the BLM to consider granting rights-of-way and other associated permits until after the City has completed its well development and testing and until the City, HFR, Three Rivers, and other interested parties have had an opportunity to evaluate and comment on the deep aquifer data and information that are collected by the City.	138-487	AE
Purpose and Need	Despite the fact that the City is now characterizing its reverse osmosis project as a "regional" water supply plan, the fact is that the City failed to meet its statutory burden for receiving approval for a regional water supply plan because it did not present the State Engineer with any evidence of the proposed regional water users' current water supplies, projected demands, or 40-year water plans. Therefore, the City's reverse osmosis project should be evaluated only with respect to the City's current water supplies and reasonable future needs.	138-488	PN
Purpose and Need	The City has understated its current, reliable supply of water by failing to consider the high quality water available from Bonito Lake. It is unreasonable for the City to completely discount its Bonito Lake water supply and to ignore the fact that Bonito Lake has provided the City with an average of 712 AFY of high quality drinking water over the past 35 years.	138-490	PN
Visual/Aesthetics	We are against any project that destroys and degrades the existing balance of water storage and recharge that brings the unique artesian flow to the surface where it has created and maintains the white sand dunes in place in the White Sands National Monument Park. We do not want this one of a kind special wonder of nature to be degraded and destroyed because of a lack of knowledge of how and why these dunes exist.	66-49	ENC
Visual/Aesthetics	How soon will one of the most beautiful and unique natural wonders, the White Sands dune formations, stay in place?	74-53	ENC

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Visual/Aesthetics	Soil moisture provides the pedestal for those ever reforming shifting white dunes [White Sands Monument]. If that pedestal dries out, the dunes will cover all of us in a fine white veil within the life time of the children here.	74-54	ENC
Visual/Aesthetics	One of the most appealing, nerve-soothing aspects of hearing water traverse throughout the village [of Tularosa] will be forever gone.	105-97	ENC
Misc	Just wanted to go on record as being 100% opposed to the idea.	137-11	OOS
Misc	I think the following should be banned in this area: Hunting, trapping, new roads, grazing, logging, mining or drilling, all two-stroke engines of any kind, burning which pollutes air and kills with heart attacks and causes asthma.	55-27	OOS
Misc	Seek alternative locations for the Air Force units.	56-36	ALT
Misc	Did BLM have input at the State Engineer Hearings?	80-253	OOS
Tribal	Participation of the Mescalero Apache Tribe was not sought in any meaningful way in the scoping process. As you are aware, an affected tribe's participation must be sought unless there is a limited exception under 40 C.F.R. 1507.3(c), which there is not.	101-3	PRO

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Tribal	The [Mescalero Apache] Tribe requests that all of the expected or potential impacts that the proposed action may have on the Tribe be thoroughly studied.	101-4	PRO
Tribal	The Hopi Cultural Preservation Office supports the identification and avoidance of prehistoric archaeological sites and Traditional Cultural Properties.	54-24	AE
Tribal	[The Hopi Cultural Preservation Office] opposes BLM Instruction Memoranda 98-131-2, which prohibit reburial of Native American human remains excavated from BLM land and subject to the Native American Graves Protection and Repatriation Act on BLM Land. Therefore, we oppose all ground disturbing activities on BLM land with the potential to distureb the remains of our ancestors.	54-25	AE
Tribal	[The Hopi Cultural Preservation Office] requests consultation on this proposal. To assist us in determining if this project may impact cultural resources significant to the Hopi Tribe, please provide us with a copuy of the cultural resources survey of the area of potential efffect for review and comment.	54-26	PRO
Tribal	As the proposed government action is planned for several miles from the Mescalero Apache Reservation, the Mescalero Apache Tribe will necessarily be affected. Government-to-government consultation has not occurred. The Tribe has not been adequately informed regarding the nature of the proposed government action.	101-85	PRO
Tribal	The [Mescalero Apache] Tribe would request that the comment period be reopened to address any scoping issues that the Tribe may have after it has been fully briefed regarding the proposed action.	101-86	PRO

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Comment Category	Comment	Comment ID	Comment Disposition
Tribal	What effect will the diversion of water have on the trust water resources of the Mescalero Apache Reservation? This question must be answered squarely, both with respect to anticipated negative impacts on water quality and water quantity on the Mescalero Apache Reservation.	101-87	ENC
Tribal	How will this proposed action interfere with the federal government's trust responsibilities towards the Mescalero Apache Tribe's other natural resources? Will any negative impact on the quality or quantity of water on the Mescalero Apache Reservation have a corresponding impact on the plants and wildlife -- including endangered species -- on the Reservation?	101-88	ENC
Tribal	Has, or will, either the Bureau of Reclamation or the Bureau of Land Management consult[ed] with the Fish and Wildlife Service regarding potential impacts in this area?	101-89	ENC
Tribal	Another aspect that needs to be considered in the scoping process is what economic impact this action will have on the Tribe. Will by products of the desalination project have a negative impact on the land values of nearby tribal property?	101-90	ENC
Tribal	Will the byproducts create pollution problems for the [Mescalero Apache] Tribe?	101-91	ENC
Tribal	[Another concern is] the destruction of the water shed from the Sacramento Mountains which is part of the sacred White Mountain, which is home of the sacred Apache Mountain Spirits.	111-226	ENC
T & E Species	Analyze the potential effects of the project on federal and state-listed species, such as the Common ground-dove	53-17	AE

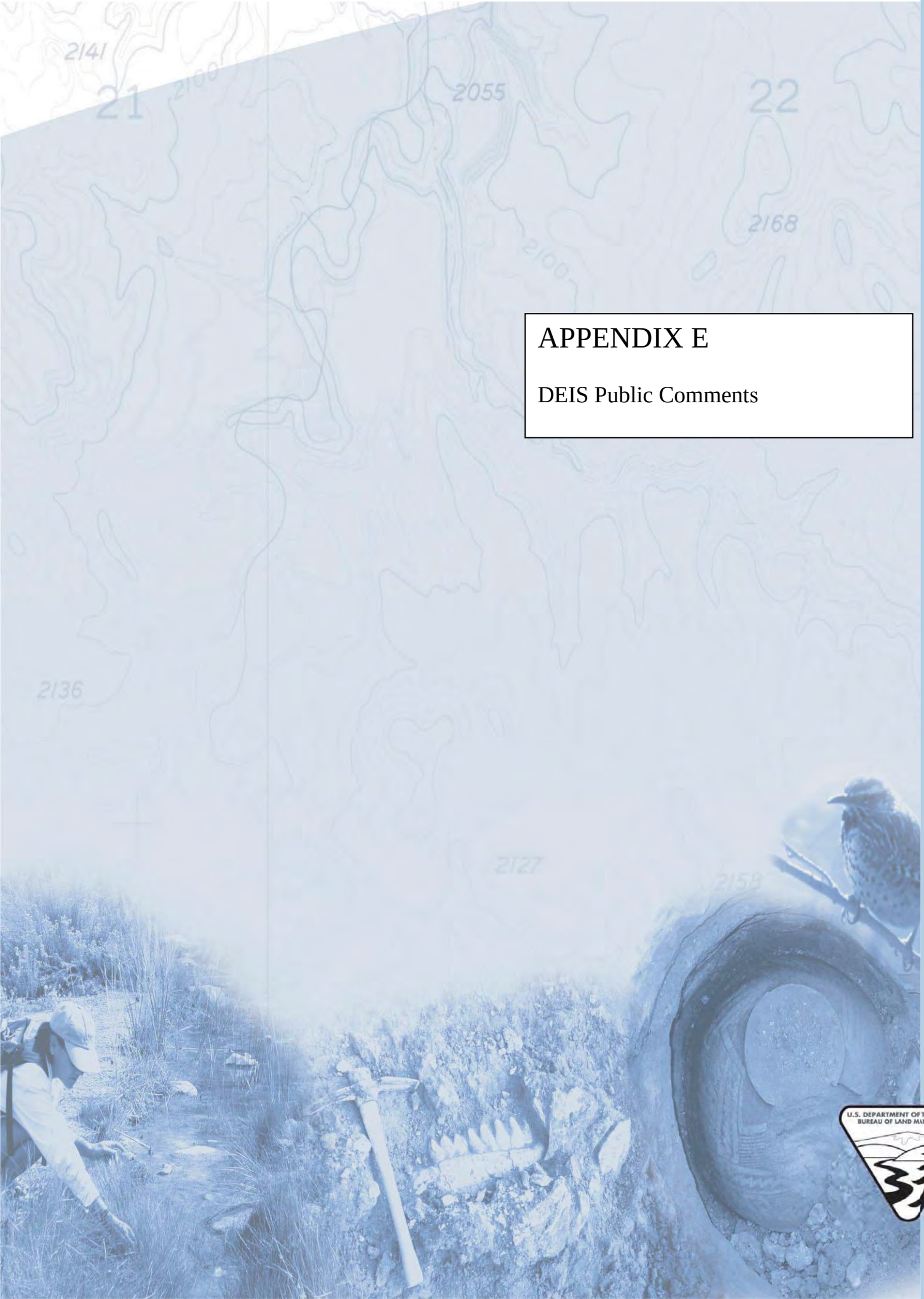
Disposition Key:

AE: Affected Environment
ENC: Environmental Consequences
PRO: Process
ALT: Alternatives
OOS: Out of Scope
PRP: List of Preparers
CC: Consultation and Coordination
PN: Purpose and Need

Comment Category	Comment	Comment ID	Comment Disposition
T & E Species	Alamogordo is at the foot of the Sacramento Mountains which support a very large array of endangered plants and animals. The city [of Alamogordo] already takes huge amounts of water from the mountains, both directly and from underground sources. No more should be taken.	56-34	ENC
T & E Species	The White Sands Pupfish has a very limited area of habitat; it could lose some of its habitat and population. An intense study is needed to ascertain if this species, as well as more common ones, would be affected.	100-79	ENC
T & E Species	[Another concern is] the destruction of two threatened/endangered species in the Tularosa Basin; the White Sands Pup Fish and the Sacremento Mountains Checkerspot Butterfly, both of who rely on the water supply in the mountains and valleys for their survival.	111-216	ENC
T & E Species	The White Sands Pupfish has a very limited area of habitat; it could lose some of its habitat and population. An intense study is needed to ascertain if this species, as well as more common ones, would be affected.	99-531	ENC

APPENDIX E

DEIS Public Comments



Comment Document Number	Comment Number	Commenter	Comment Category	Comment	Response
1	**1A.1**	Abercrombie, Dan	Time Period	Analysis should evaluate a period longer than 40 years	The right-of-way permit would be granted for a specific term if approved. Monitoring, as referenced in settlement agreement and court hearings, will determine if additional analysis is needed during the right-of-way term. The hydrologic model was for a 40-year term based on the project use and approved by the NMOSE and court hearings.
1	**1A.2**	Abercrombie, Dan	Court Proceedings / Agreements	Document should mention the original court proceedings that show over 1,000 wells and their impact	The Draft EIS addresses the court proceedings and includes them as references in Appendix C. The list of approximately 1,000 wells includes almost all of the wells in the eastern Tularosa Basin that were included in the hydrologic analysis performed by the expert witnesses in the administrative hearing and the District Court trial (JSAI 2006; NMOSE WRD Exhibits 1 and 1A). Hydrologists conducted modeling runs and those analyses provided model-predicted drawdown estimates on wells if the City's application was granted. These analyses showed no impact of the vast majority of the wells, very minor impacts on several wells, and slightly larger impacts on a few wells in the immediate vicinity of the City's proposed well field (NMOSE WRD Exhibit 1A). With respect to the nearby wells with the greatest model-predicted drawdown estimates, the City and all of the affected parties reached settlement agreements allowing the City's water rights application to be granted by the NMOSE and the courts (Draft EIS Appendix C; Stipulation between the City of Alamogordo and Christophers and Settlement Agreement between and among the City of Alamogordo and HFR and Three Rivers). The State Engineer, the Twelfth Judicial District Court, and the New Mexico Court of Appeals all found that all other impacts were insignificant and did not constitute impairment to existing water rights under New Mexico law, thereby allowing the City to obtain its water rights permit (DEIS Appendix E – Minute Order of the Twelfth Judicial District Court; Appendix C – Memorandum Opinion by the New Mexico Court of Appeals). The New Mexico Supreme Court denied a writ of certiorari seeking its review of the New Mexico Court of Appeals' decision. The model-predicted drawdown estimates of hydrologic effects on other surface and groundwater sources from the State Engineer administrative hearing and from the District Court trial over-predict what the actual hydrologic effects will be. For purposes of the modeling runs, the hydrologists assumed the desalination project would be operated at full capacity (4,000 afy) for the next 40 years. This represents a worst case scenario that will not actually happen. More accurately, the City intends to operate the desalination facility as its third water source. The City will always first rely on its surface water rights from La Luz, Fresnal, and Alamo canyons. This is the City's best quality water and it is the least expensive water to supply for municipal purposes. Second, the City will use its existing groundwater sources. Because of poor water quality, this groundwater must be blended with better quality surface water. The third source that the City will use will be the Snake Tank well field. This is the most expensive potable water for the City to produce and it will be used to supplement the first two sources and only as a base supply as the City's population grows over time (Livingston and Shomaker 2006).

Comment Document Number	Comment Number	Commenter	Comment Category	Comment	Response
1	**1A.3**	Abercrombie, Dan	Water Resources	The document did not mention the impact to the little springs along the edge of the basin.	Analysis of the potential impact to springs can be found on pages ES-5, 2-39, 4-3, 4-15, 4-17, 4-18, and 4-39. As part of the administrative hearing and then the District Court trial, hydrologic impacts to springs from the proposed well field were evaluated (JSAI 2006; NMOSE WRD Exhibit 1). The New Mexico State Engineer and then the District Court determined the springs in the mountains were not hydraulically connected to the regional aquifer in the basin, and no impacts were identified. Many of the springs were identified as part of a perched groundwater system and not connected to the regional aquifer, again, meaning no hydrologic effects to the springs as a result of pumping from the Snake Tank well field. Springs in the middle of the Tularosa Basin are not calculated to be affected because potential drawdown is offset by salvaged evapotranspiration (pumping causes a reduction in shallow groundwater evaporation instead of drawdown) (JSAI 2006).
1	**1A.4**	Abercrombie, Dan	Desal Plant	I thought that when they drill the wells under the desal plant that they only had brackish water, not a saline aquifer where they could inject their concentrate into	A description of the deep-well injection is available on pages 2-18, 4-5, and 4-27. The proposed well field is located north of the Village of Tularosa off Snake Tank Road. The production wells will be drilled into a basin-fill aquifer with brackish groundwater with an estimated total dissolved solids of 2,500 ppm. The proposed desalination plant will be located just west of Alamogordo, where proposed injection wells would inject residual concentrate into a different aquifer where saline groundwater resides in limestone underlying the basin-fill aquifer (JSAI 2009).
1	**1A.5**	Abercrombie, Dan	Desal Plant	There wouldn't be much room for the desal plant if the evap ponds are going to take up 80 acres.	The City of Alamogordo will have a much smaller evaporation pond at the La Velle Road site. As the City ramps up production, the evaporation ponds will become smaller. Injection will be the primary method. There will not be 80 acres of evaporation ponds at the desalination facility to be located west of Alamogordo. The primary method of concentrate disposal will be deep well injection. The City may consider small evaporation ponds, less than 10 acres, as an initial method of concentrate disposal in the early stages of plant operation because this would be a more efficient means of disposal until the plant produces at a higher output and more concentrate is produced to justify deep well injection .
1	**1A.6**	Abercrombie, Dan	Time Period	The impact should be studied for 100 years	The right-of-way permit would be granted for a specific term if approved. Monitoring, as referenced in settlement agreement and court hearings, will determine if additional analysis is needed during the right-of-way term. The hydrologic model was for a 40-year term based on the project use and approved by New Mexico Office of State Engineer and court hearings.
1	**1A.7**	Abercrombie, Dan	Water Resources	The BLM did not consider long-term impacts to Tularosa Creek	Impacts to Tularosa Creek are discussed on pages 4-2 and 4-5.
1	**1A.8**	Abercrombie, Dan	Water Resources	There is no pump in the world that will pump water when water is 10 feet below it	Non-substantive.
1	**1B.1**	Bookout, Orvall	Time Period	I don't think the 40-year plan is right. I think it should be 100-years.	The right-of-way permit would be granted for a specific term if approved. Monitoring, as referenced in settlement agreement and court hearings, will determine if additional analysis is needed during the right-of-way term. The hydrologic model was for a 40-year term based on the project use and approved by New Mexico Office of State Engineer and court hearings.
1	**1C.1**	Trammell, Evelyn	Water Resources	There should be some kind of date as to just how soon the production wells should be drilled, so they can start monitoring when they start using the wells.	The date is contingent upon the City of Alamogordo receiving appropriate approvals, permits, and funding. No exact date can be provided in the EIS.

Comment Document Number	Comment Number	Commenter	Comment Category	Comment	Response
1	**1C.2**	Trammell, Evelyn	Water Resources	The document leaves the impression that not all the wells are located on the 20 acres and they're not.	All wells identified for production are within the project footprint. A map of the well field footprint is on page 2-6.
1	**1D.1**	Abercrombie, Brenda	Time Period	I'm still concerned that the EIS did not consider a longer period than 40 years out.	The right-of-way permit would be granted for a specific term if approved. Monitoring, as referenced in settlement agreement and court hearings, will determine if additional analysis is needed during the right-of-way term. The hydrologic model was for a 40-year term based on the project use and approved by New Mexico Office of State Engineer and court hearings.
1	**1D.2**	Abercrombie, Brenda	Water Resources	It seems like there is going to be more damage to the wells and to Tularosa Creek.	Impacts to Tularosa Creek are discussed on pages 4-2 and 4-5.
3	**3.1**	Rhodes, Jeffrey, Tularosa Village Attorney	Court Proceedings / Agreements	The specific concern is based on section 2.2.2 Alternative B-Proposed Action which states that the desal facility is to be constructed in Alamogordo and how that will impact the commitment of the City to fulfill its obligations under the Agreement in 2003 to sell water to the Village of Tularosa.	The 2003 agreement is not analyzed in the EIS. It is outside the jurisdiction of the BLM.
4	**4.1**	Joe Jr, Tony, Navajo Nation	Cultural Resources	HPD-TCP has concluded the proposed undertaking/project area will not impact Navajo TCPs.	Non-substantive.
5	**5.1**	Kuwanwisiwma, Leigh, Hopi	Cultural Resources	If this (LA 150031) prehistoric site cannot be avoided and will be adversely affected by project activities, we request continuing consultation on this proposal including to be provided with a copy of any proposed treatment plans for review and comment.	Non-substantive.
6	**6.1**	Marquardt, John	General	This water project is vital to Alamogordo	Non-substantive.
7	**7.1**	Armstrong, Fred, White Sands National Monument	Water Resources	The high water table holds the dunes together, preventing them from rapidly eroding. If the water table were to decline, the dunes would likely dry up and blow away resulting in the loss of many unique endemic plants and animals that have adapted to this unique environment.	The potential impacts to groundwater at White Sands National Monument (WSNM) is included on pages 4-5, 4-9, and 4-10. Additional water resources information can be found in Appendices H and I. The uplifted bedrock along the Jarilla Fault (north to south through HAFB) prevents the propagation of drawdown westward toward the dunes. Groundwater flowing over the Jarilla Fault either evaporates or becomes groundwater flow to WSNM (JSAI 2006). The effects of pumping would first reduce the rate of evaporation and then cause drawdown. The groundwater flow model simulation of the proposed Snake Tank well field and regional pumping has demonstrated that most all of the pumping reduces the rate of evaporation of groundwater flowing over the uplifted bedrock along the Jarilla Fault with little to no drawdown effects (JSAI 2006). Furthermore, Alternative A (No Action) would result in greater drawdown on the groundwater system supplying WSNM than Alternative B (Snake Tank well field) because the pumping to meet future municipal demands in Alternative B is moved north out of the groundwater system supplying WSNM thereby lessening impacts.

Comment Document Number	Comment Number	Commenter	Comment Category	Comment	Response
7	**7.2**	Armstrong, Fred, White Sands National Monument	Water Resources	We do not understand the mechanics of the underground hydrology and whether or not the high water table underlying the dunes is related to the deeper aquifers of the Tularosa Basin. We do not sufficiently understand how precisely water is transported to Lake Lucero and Alkali Flat, which ultimately results in the formation of new gypsum for the dunes. Both of these processes are fundamental to maintaining the geologic integrity of the White Sands dune field. Thus, we are concerned about the potential for the groundwater system to be disrupted through the drawdown of groundwater resources outside the monument.	The potential impacts to groundwater at White Sands National Monument (WSNM) is included on pages 4-5, 4-9, and 4-10. Additional water resources information can be found in Appendices H and I. The uplifted bedrock along the Jarilla Fault (north to south through HAFB) prevents the propagation of drawdown westward toward the dunes. Groundwater flowing over the Jarilla Fault either evaporates or becomes groundwater flow to WSNM (JSAI 2006). The effects of pumping would first reduce the rate of evaporation and then cause drawdown. The groundwater flow model simulation of the proposed Snake Tank well field and regional pumping has demonstrated that most all of the pumping reduces the rate of evaporation of groundwater flowing over the uplifted bedrock along the Jarilla Fault with little to no drawdown effects (JSAI 2006). Furthermore, Alternative A (No Action) would result in greater drawdown on the groundwater system supplying WSNM than Alternative B (Snake Tank well field) because the pumping to meet future municipal demands in Alternative B is moved north out of the groundwater system supplying WSNM thereby lessening impacts.
7	**7.3**	Armstrong, Fred, White Sands National Monument	Water Resources	The EIS groundwater models indicate that the precise location of the Jarilla Fault is unknown. In addition, the models assume that the Jarilla Fault is a barrier to groundwater movement from the eastern half of the basin to the lower elevations in the western half of the basin. However, there is no scientific evidence to support these assumptions.	There is extensive evidence related to the Jarilla Fault and the associated uplifted bedrock that divides the Tularosa Basin. JSAI (2006) describes the Jarilla Fault and how the groundwater flow model treats the Jarilla Fault and associated geologic structures. A geophysical survey of the Jarilla Fault can be referenced from Healey, D. L., Wahl, R. R., and Currey, F. E., 1978, Gravity Survey of the Tularosa Valley and Adjacent Areas, New Mexico: U. S. Geological Survey Open-File Report 78-309. The Jarilla Fault is mapped by Seager, W. R. Hawley, J. W., Kottlowski, F. E., and Kelley, S. A., 1987, Geology of east half of Las Cruces and northeast of El Paso 1° X 2° sheets, New Mexico: New Mexico Bureau of Mines and Mineral Resources Geologic Map 57. Physical features representing the uplifted bedrock east of the Jarilla Fault include Tularosa Peak, Jarilla Mountains, and the geologic log from the Garton well. The analysis relies on the best available information. Monitoring will continue throughout the project.
7	**7.4**	Armstrong, Fred, White Sands National Monument	Water Resources	The EIS ignores any potential water table lowering or reduction of groundwater across the fault (Jarilla). Lowering the water table in this area could permanently eliminate these small surface water features and the wildlife dependent upon them.	Model-simulated 40-year drawdown contours resulting from projected future pumping from existing rights and from the proposed Snake Tank well field (Alternative B) are concentrated along the eastern side of the Tularosa Basin (JSAI 2006; NMOSE WRD Exhibit 1). Near the Jarilla Fault and on top of the uplifted bedrock, model-simulated 40-year drawdown is less than 1 foot when considering future pumping due to existing water rights and the Snake Tank well field (Alternative B), combined. Model-simulated drawdown contour maps are provided in JSAI (2006). See also Response to Comment No. 7.1, above. The analysis relies on the best available information. Monitoring will continue throughout the project.
7	**7.5**	Armstrong, Fred, White Sands National Monument	Cumulative Impacts	We don not believe the Snake Tank Well Field project will significantly affect the hydrology of White Sands National Monument by itself. However, the potential cumulative impacts on the dunes of White Sands National Monument resulting from groundwater pumping in the eastern sub-basin by this and other development is unknown.	The City's groundwater permit approved by the New Mexico State Engineer and the Twelfth Judicial District Court, as confirmed by the New Mexico Court of Appeals, will actually benefit WSNM. Once the Snake Tank well field is operational, it will move groundwater pumping north and away from the primary flow system to White Sands. Under the No Action Alternative (Alternative A), the City would be increasing groundwater pumping in the vicinity of WSNM, thereby increasing impacts. The effects of past, present, and future groundwater pumping are presented in JSAI (2006). The NMOSE Tularosa Basin Guidelines (Appendix N) also play a role in limiting groundwater pumping in the more immediate area. We are currently not aware of any other groundwater development projects within the eastern sub-basin. Cumulative impacts can be found on pages 4-38 to 4-49.

Comment Document Number	Comment Number	Commenter	Comment Category	Comment	Response
7	**7.6**	Armstrong, Fred, White Sands National Monument	Cumulative Impacts	Table 4-8, cumulative impacts on water resources, does not currently include the potential cumulative impacts associated with the Solar Energy Zone (SEZ) Programmatic EIS currently proposed by the BLM. Project is also referred to as Red Sands SEZ.	Renewable energy solar projects vary greatly in their required water use, depending on size and type of technology chosen for the facility. Photovoltaic technology requires relatively little water use and concentrated solar thermal requires much more water to operate. Any solar project sited within the Solar Energy Zone will require a water rights permit from the NMOSE specifying the point of diversion, purpose of use, place of use, and quantity of water sought to be appropriated. There is no way to estimate water requirements for a theoretical solar project or related impacts to other water resources. No analysis can be made until an application is filed with the NMOSE. Until then, any such analysis is speculative.
8	**8.1**	Weeks, Craig, EPA	General	EPA has classified your DEIS and proposed action as LO, i.e. EPA has a Lack of Objections.	Non-substantive.
9	**9.1**	Tyler, Fred	Court Proceedings / Agreements	The DEIS is for a "Regional" project which was to include the sale of bulk treated water to the Village of Tularosa on an emergency ir (or) permanent basis should the need arise.	Non-substantive.
9	**9.2**	Tyler, Fred	Court Proceedings / Agreements	The Abstract states the desalination facility is now to be constructed in Alamogordo thus negative the 2003 Agreement between the Village and the City unless the City is planning to pump treated water back to the village or unless the City expects citizens of the Village to use trucked-in water in an emergency or permanent basis.	The 2003 agreement is not analyzed in the EIS. It is outside the jurisdiction of the BLM.
9	**9.3**	Tyler, Fred	Alternatives	I did not find Dry Canyon listed as an alternative site to be considered for a well field. Dry Canyon is BLM and State land to the South of US 82 and northeast of Alamogordo and would be closer and less expensive to build infrastructure.	Dry Canyon is part of the Sacramento Mountain block in close proximity to La Luz and Fresnal Creeks. The area was evaluated as an alternative site by the City of Alamogordo, but the area is limited by physical availability of groundwater and by the potential effects of development on mountain streams and the related surface water rights. JSAI (2006) and USGS (Waltemeyer 2001) have calculated the watershed yield of Dry Canyon to be less than 1,276 afy with limited groundwater storage. JSAI (2008) evaluated the potential for drilling deep water supply wells in the Dry Canyon area and concluded a 3,500 foot test well would be required to determine if there was potential for developing groundwater. In sum, a well field in the Dry Canyon area is not feasible due to lack of water availability and a much greater impact on existing water rights.
9	**9.4**	Tyler, Fred	Alternatives	Dry Canyon would meet required criteria but was not considered most likely because the effects that drilling and pumping in that area would have on certain citizens of Alamogordo many of which are substantial well and land owners and the possible adverse effects to the wells of Alamogordo residents vs. Tularosa residents.	Dry Canyon would not meet the criteria established by the City of Alamogordo because a well field in that area would not yield sufficient groundwater for a long-term municipal water supply. In addition, there would be many existing surface water and groundwater users who could be hydrologically affected by a new well field in the Dry Canyon area, making it likely that the State Engineer would not grant an application to appropriate groundwater in that area. The aquifer beneath the Snake Tank well field contained a vast supply of uniform quality groundwater with relatively few existing water rights in the area, making it the most idea site for a large-scale municipal water supply project.

Comment Document Number	Comment Number	Commenter	Comment Category	Comment	Response
9	**9.5**	Tyler, Fred	Court Proceedings / Agreements	The 2003 Agreement with the State Engineer and the Village of Tularosa and the City of Alamogordo has been unilaterally cancelled by the City of Alamogordo by their decision to place the desalination facility in Alamogordo instead of at the well field as originally planned.	Non-substantive.
9	**9.6**	Tyler, Fred	Water Resources	Paragraph 1 states that brackish water intrusion or increase in presence of salts in fresh water could also increase with pumping. Pumping mildly brackish water could draw more saline water into the area.	While the Draft EIS states that salt water encroachment into freshwater sources "could" happen, none of the experts in the State Engineer administrative hearing or the District Court trial considered this likely. See findings by JSAI (2006), USGS (Huff 2005), and NMOSE (2006). The consensus of expert hydrologists was that the water table will not be lowered enough to reverse the direction of groundwater flow from the saline groundwater to the brackish or fresh groundwater. The District Court even adopted the experts' conclusion in this regard in its Minute Order (Appendix E, FOF ¶ 88). Not even the project opponents challenged this expert opinion at the administrative hearing, at the District Court trial, or on appeal. Information regarding this comment can be found on pages 2-36 and 2-37. The City of Alamogordo will need to continue groundwater monitoring throughout the project.
9	**9.7**	Tyler, Fred	Water Resources	Chapter 4 states that groundwater quality is not expected to be adversely affected. It continues… saline groundwater is not expected to migrate into freshwater groundwater sources based on the extent of draw-down predicted over the next 40 years. These two sections are conflicting as well as misleading.	The two sections had conflicting information and have been updated for consistency. While the Draft EIS states that salt water encroachment into freshwater sources "could" happen, none of the experts in the State Engineer administrative hearing or the District Court trial considered this likely. See findings by JSAI (2006), USGS (Huff 2005), and NMOSE (2006). The consensus of expert hydrologists was that the water table will not be lowered enough to reverse the direction of groundwater flow from the saline groundwater to the brackish or fresh groundwater. The District Court even adopted the experts' conclusion in this regard in its Minute Order (Appendix E, FOF ¶ 88). Not even the project opponents challenged this expert opinion at the administrative hearing, at the District Court trial, or on appeal.
9	**9.8**	Tyler, Fred	Time Period	This DEIS has been tailored to the specifications of the City of Alamogordo in that it has been prepared for the same period as the City's water plan-40 years. An EIS is normally prepared for the possible total duration of the project requiring it. If Alamogordo plans to quit pumping from the Snake Tank well field in 2045 then the DEIS is OK. If Alamogordo will be pumping water after 2045 then the DEIS is defective and needs to be re-done for the total possible time frame the project would be active. Period!	The right-of-way permit would be granted for a specific term if approved. Monitoring, as referenced in settlement agreement and court hearings, will determine if additional analysis is needed during the right-of-way term. The hydrologic model was for a 40-year term based on the project use and approved by the NMOSE and court hearings.

Comment Document Number	Comment Number	Commenter	Comment Category	Comment	Response
9	**9.9**	Tyler, Fred	Court Proceedings / Agreements	The review of Alamogordo's applicable for permit to appropriate groundwater in the Tularosa Basin done by Andrea Mendoza, Water Resource Specialist Supervisor, dated 02/01/07 is based on the fact that at the date of Application to Appropriate Groundwater, 09/06/00., the plan was that "this treated water will be transported via pipeline for beneficial use by all water systems, industrial or commercial operations in Otero County that wish to participate in the project and purchase bulk water."	Non-substantive.
9	**9.10**	Tyler, Fred	General	I suspect that the determining factor in getting the application approved was that more than the City of Alamogordo would benefit from this "Regional" project	Non-substantive.
10	**10.1**	Alterson, Arthur	General	I think this DEIS makes the fullest necessary statement of merits, limitations, adverse impacts, and reasonable offsetting measures for all these adverse impacts.	Non-substantive.
10	**10.2**	Alterson, Arthur	General	Concerning the process, I must express a strong criticism of the length of time administrative agencies appeared to take in making decisions and moving the process along. The lapse of time from step to step, often awaiting some staffer's action or to satisfy an extraordinary concern appeared excessive to my relatively naive understanding of the NEPA process. Individual staffers at times seemed to hold a virtual veto owing to a lack of limits on how long a decision may take.	Non-substantive.
10	**10.3**	Alterson, Arthur	General	I like to think the delays the ARWSP endured was exceptional, for whatever reason. Unfortunately, the ARWSP case leads many to condemn NEPA. Actually, I feel the process generally serves many societal goods.	Non-substantive.

Comment Document Number	Comment Number	Commenter	Comment Category	Comment	Response
10	**10.4**	Alterson, Arthur	General	I believe the process has produced a better project by doing what NEPA I think is supposed to do: force the responsible actors to think out the project in detail, consider reasonable alternatives, float proposals in the public forum, consider the multi-faceted public response, benefit from the new point of views, ameliorate cancers, and hopefully reduce the adverse effects of what in the absence of NEPA may be unconsidered and unprepared for consequences.	Non-substantive.
10	**10.5**	Alterson, Arthur	General	I urge the BLM to adopt this DEIS with little change as the EIS for the federal action. I also think that the EIS makes the case for no impact for other actions by Federal agencies regarding possible funding for this worthwhile project.	Non-substantive.
11	**11.1**	Garcia, Hector, Bureau of Reclamation	General	This comment is for information purposes only if the City decides to obtain federal funding through Reclamation's Title XVI process. Reclamation reminds the City hat if Title XVI funds are requested, Table 2-5 will need to be updated utilizing up to date cost estimates.	Table 2-5 has been updated to reflect the most recent cost estimates.
11	**11.2**	Garcia, Hector, Bureau of Reclamation	General	This sentence indicates that one of the issues of primary concern during the Alamogordo public scoping meeting was for a "water provision for projected growth in the region." This statement of the issue is not clear, is that there should be a "reliable source(s) of water for the expected growth in the City and Otero County?"	The sentence has been restructured to clarify the information.
11	**11.3**	Garcia, Hector, Bureau of Reclamation	General	Please change to read: "The City would be responsible for the construction, operation, maintenance, and replacement of the project. A Federal cost-share from Reclamation's Title XVI funding may be available, and is limited by law to not more than 25 percent of the total cost of planning, design, and construction not to exceed $20 million. However, reclamation takes no position on whether such a project should receive funding under the Title XVI Program, or be authorized for construction by the Congress."	Text was updated per the comment.
11	**11.4**	Garcia, Hector, Bureau of Reclamation	General	add "the" before City, to read: During these meetings, the primary public comment concerning alternatives was a recommendation that "the" City identify…"	Text was updated per the comment.

Comment Document Number	Comment Number	Commenter	Comment Category	Comment	Response
11	**11.5**	Garcia, Hector, Bureau of Reclamation	General	add table number to read: …and power costs, have been estimated and are shown in Table "2-5" as annual payments…	Text was updated per the comment.
11	**11.6**	Garcia, Hector, Bureau of Reclamation	General	The table cost estimates for raw water and finished water pipeline calculate to 24 miles of pipe. However, on page 2-4, under Groundwater Wells, it is indicated that the well field is 26 miles north of Alamogordo, and page 2-12, under Desalination Facility it is indicated that water produced from the wells would be delivered through approximately 29 miles of pipe; and on page 2-16, under Pipelines, it is indicated that the pipeline system would convery water about 34 miles to the desalination facility located in Alamogordo. Once the distance is decised then the costs can be determined correctly on the table.	Text was updated per the comment.
11	**11.7**	Garcia, Hector, Bureau of Reclamation	General	Please change to read: " Federal funding may be available for planning, design, and construction of the facility through Reclamation's Title XVI program. Operation, maintenance, and rehabilitation will be the responsibility of the Project sponsor."	Text was updated per the comment.
12	**12.1**	Hanuschak, Dulcinea	Court Proceedings / Agreements	Inadequate discussion and analysis of the settlement agreement the City executed on November 20, 2007.	The City of Alamogordo agreements are discussed on pages ES-3, 1-3,1-8, 1-9, 2-7, 2-8, and 2-9. In addition, Appendix C includes all court rulings and agreements.
12	**12.2**	Hanuschak, Dulcinea	Court Proceedings / Agreements	The DEIS does not include mitigation measures which correspond to monitoring requirements mandated by the settlement agreement.	The stipulation between the City of Alamogordo and Christopher and the settlement agreement between and among the City of Alamogordo and HFR and Three Rivers are private contractual agreements that are only enforceable by parties to those agreements. Because they are contractual matters between private parties, they are beyond the jurisdiction of the BLM and were not the subject of the Draft EIS. The BLM has no jurisdiction or authority to require mitigation measures that correspond to monitoring requirements in a private two-party contract. Pursuant to the administrative groundwater permitting process authorized under New Mexico law, the NMOSE has adopted a monitoring well program that was proposed by the City of Alamogordo and the State Engineer has the authority to require compliance with all elements of that monitoring program. Mitigation measures for this project are included in Section 4.3 on page 4-49. Additional mitigation measures will likely be added when the City of Alamogordo receives individual permits for specific aspects of the project.

Comment Document Number	Comment Number	Commenter	Comment Category	Comment	Response
12	**12.3**	Hanuschak, Dulcinea	Court Proceedings / Agreements	The DEIS fails to include mitigation measures which correspond to remediation requirements in the settlement agreement.	Mitigation measures for this project are included in Section 4.3 on page 4-49. Additional mitigation measures will likely be added when the City of Alamogordo receives individual permits for specific aspects of the project.
12	**12.4**	Hanuschak, Dulcinea	Court Proceedings / Agreements	The DEIS does not include mitigation measures which correspond to setback requirements set forth in the settlement agreement	The stipulation between the City of Alamogordo and Christopher and the settlement agreement between and among the City of Alamogordo and HFR and Three Rivers are private contractual agreements that are only enforceable by parties to those agreements. Because they are contractual matters between private parties, they are beyond the jurisdiction of the BLM and were not the subject of the Draft EIS. The BLM has no jurisdiction or authority to require mitigation measures which correspond to monitoring requirements in a private two-party contract. Pursuant to the administrative groundwater permitting process authorized under New Mexico law, the NMOSE has adopted a monitoring well program that was proposed by the City of Alamogordo and the State Engineer has the authority to require compliance with all elements of that monitoring program. The setback requirement is discussed on page 2-9. Other mitigation measures are included in Section 4.3 on page 4-49.
12	**12.5**	Hanuschak, Dulcinea	Impact Analysis	Incomplete analysis of land subsidence issues.	Land subsidence discussion and analysis is included in the document on pages 2-37, 2-39, 4-9, 4-10, 4-40, and 4-41. Additional information can be found in Appendices H and I.
12	**12.6**	Hanuschak, Dulcinea	Impact Analysis	Incomplete analysis of socioeconomic impacts.	Socioeconomic impacts are analyzed on pages 4-20, 4-41, 4-45, 4-46, and 4-52.
12	**12.7**	Hanuschak, Dulcinea	Impact Analysis	Incomplete analysis of impacts on soils (airborne soils, erosion, loss of topsoil).	Impact to soils is considered minimal. The City of Alamogordo will commit to fugitive dust permits, construction permits, and SWPPPs to minimize these impacts from construction activities. Additional information can be found on pages 4-10, 4-11, and 4-50.
12	**12.8**	Hanuschak, Dulcinea	Impact Analysis	Inconsistent analysis of agricultural impacts - prime farmland.	Impacts to agricultural impacts and prime farmland are discussed and analyzed on pages 3-39 and 4-21.
12	**12.9**	Hanuschak, Dulcinea	General	Inadequate analysis of FLPMA Compliance. The DEIS acknowledges that FLPMA requires the project to correspond with White Sands Resources Management Plan. However, the Management Plan provides that ROWs are issued to protect natural…resources associated with public land and adjacent lands and are to be coordinated with the needs of adjacent landowners.	Right-of-way permits are allowable in this area. The WSRMP requires multiple use mandate. Coordination with adjacent landowners is conducted as much as possible.
12	**12.10**	Hanuschak, Dulcinea	Impact Analysis	The Project may adversely impact grazing allotments but does not analyze the feasibility of providing grazing permittees with alternative base water sources for their livestock.	Analysis of impacts to grazing permittees is on page 4-16. Potential drawdown of the water table from the extraction wells in the Snake Tank well field could reduce water availability for base waters. If base waters become unusable by livestock, the permittee would be given the opportunity to provide and apply for an alternative base water source.

Comment Document Number	Comment Number	Commenter	Comment Category	Comment	Response
12	**12.11**	Hanuschak, Dulcinea	Impact Analysis	Incomplete analysis of potential impacts on wildlife. The DEIS does not identify how frequently SWCA had the opportunity to observe the species identified as potentially occurring in the project area, or the circumstances of any such observation.	Details of the survey methods and results were prepared for the USFWS in the Biological Assessment. The survey met the requirements of the USFWS. Information regarding the survey is located on pages 3-20, 3-22, 3-23, and 3-25 to 3-30.
12	**12.12**	Hanuschak, Dulcinea	Impact Analysis	Incomplete analysis of energy requirements. The information the Project uses is based on outdated PNM and El Paso Electric analyses from 2006 and 2002. In addition, the DEIS states that PNM plans to upgrade service availability in the Tularosa Basin to support a projected increase in demand but does not state whether this upgrade will significantly increase the costs of the Project.	PNM is currently installing the transmission line to ensure more reliable service. The City of Alamogordo did not request the upgrade nor are they paying for a portion of the upgrade.
12	**12.13**	Hanuschak, Dulcinea	Cumulative Impacts	Incomplete analysis of cumulative impacts. The DEIS does not identify the wastewater treatment plant as a project which, when combined with ARWSP may result in cumulative environmental impacts.	The wastewater treatment plant is located is 1.5 to 2 miles south of the desalination location. Upgrades to one portion of the treatment plant is planned and is in the design phase. Information regarding the wastewater treatment plant has been included in the cumulative impacts section of the document.
12	**12.14**	Hanuschak, Dulcinea	Alternatives	Incomplete analysis of the alternatives. The No Action alternative acknowledges that the City's need could be significantly limited with the implementation of additional conservation measures which would result in a consumption rate of 136.51 gpcpd. Despite the fact that a 136.51 gpcpd consumption rate would significantly decrease the City's need for additional water supplies, the DEIS dismisses the No Action alternative as inadequate to meet the City's projected growth. The DEIS fails to present any alternative based on the reduced consumption rate.	Please refer to page 2-2 which details the No Action Alternative
12	**12.15**	Hanuschak, Dulcinea	Court Proceedings / Agreements	The FEIS should analyze whether the purpose and need for additional City water supplies that will be satisfied in the event that the remediation procedures included in the Settlement Agreement are implemented.	Please refer to pages 1-1 to 1-3, which describe the project's purpose and need.

Comment Document Number	Comment Number	Commenter	Comment Category	Comment	Response
12	**12.16**	Hanuschak, Dulcinea	Alternatives	The DEIS dismisses the alternative of purchasing or leasing agricultural water rights as "speculative" without presenting any analysis of why it is not feasible to determine the availability of sufficient water rights. However, the Settlement Agreement indicates that the City has identified Sierra Blanca's agricultural water rights as a valuable potential purchase. That is the Settlement Agreement provides the City with a right of first refusal in the event that Sierra Blanca decides to sell its water rights.	The City did an extensive analysis regarding the option of purchasing agricultural water rights and transferring them into the City's municipal water supply system and determined that a municipal desalination facility better suited its criteria for a long-range, large-scale independent municipal water supply project. According to NMOSE estimates, there are approximately 90,000 irrigated acres claimed in the Tularosa Basin. The NMOSE estimates that approximately 17,000 acres are actually irrigated, meaning that more than 80% of the claimed "paper water rights" in the basin may not be valid. The State Engineer closely scrutinizes whether land has been actually irrigated and whether there is a valid water right before allowing a transfer. It is not uncommon for the State Engineer to deny an application to transfer water rights in whole or in part if there is not a solid history of irrigation on the "move from" land. To keep the hydrologic system whole, the State Engineer only allows a transfer of the consumptive use portion of the water right. For example, if a farmer irrigates alfalfa and diverts 3 afy, the State Engineer has a long-standing assumption that 50% of the water applied is consumed by the crop and the other 50% returns to the groundwater system. Accordingly, the State Engineer would only allow 1.5 afy to be transferred from the move-from site. 2,700 acres would need to be fallowed in the immediate vicinity to produce the same amount of water that would be produced by the Snake Tank well field. Because most farms are relatively small in size, it would require dozens and dozens of applications to transfer these water rights. Each application would be advertised and subject to protest. The City estimated that it would cost millions of dollars in administrative expenses on attorneys and experts to accomplish these transfers, not including the price to purchase the water rights. Because over 80% of the paper water rights are not used or valid, it becomes a highly speculative and very expensive venture. The City was also concerned about negative impacts on the agricultural economy by taking such a large portion of the actually irrigated acres out of production. Because of the NMOSE's Tularosa Basin Administrative Guidelines (Appendix N), the City cannot increase diversions from any of its existing wells. Accordingly, the City could not transfers valid existing water rights into its existing wells. Instead, it would be required to keep the move-from points of diversion (wells) from existing agricultural water rights that it might purchase and construct pipelines to transport the water into the City's potable water supply system. This would require hundreds of miles of pipelines from different farms, easements, new construction, and operation, maintenance, and repair costs on an unwieldy infrastructure system. All criteria considered, converting agricultural rights into municipal rights is highly speculative because so many of the claimed paper water rights will not be valid and the uncertainty of the administrative process. It would also be more much more expensive and time consuming than other alternatives. With respect to the City's settlement agreement with HFR, the settlement agreement is a private contractual agreement that is only enforceable by parties to that agreement. Because it is a contractual matter between private parties, it is beyond the jurisdiction of BLM and was not the subject of the DEIS. Next, the comment incorrectly states that the City has a right of first refusal on Sierra Blanca water rights (Appendix C – settlement agreement between and among the City of Alamogordo and HFR Three Rivers at ¶ 17). This possibility remains too speculative upon which to rely when the City is in immediate need of an additional water supply.

Comment Document Number	Comment Number	Commenter	Comment Category	Comment	Response
12	**12.17**	Hanuschak, Dulcinea	Court Proceedings / Agreements	The DEIS does not mention other alternative agricultural sources of water offered to the City. For instance, in 2009, Mesa Verde Ranch, offered to donate water to the City for a five-year period, after which Mesa Verde was willing to sell its water rights or bulk water to the City.	With respect to Mesa Verde Ranch, the City carefully evaluated this option and it was not feasible for a number of reasons. First, Mesa Verde did not have an established water right that had been put to beneficial use. Instead, it had a permit that allowed it to use a certain amount of groundwater subject to conditions of approval that had not yet been met. Next, a technical analysis prepared by the City revealed issues with well yield, water quality, and cost for infrastructure. See JSAI 2009 Report titled Evaluation of Mesa Verde Ranch LLC Water Supply Offer (a copy of which will be provided by the City of Alamogordo). The City determined that it was not in its interest to perfect another party's water right at a multi-million dollar cost to the City and have nothing to show for it but the uncertainty of a bulk water lease. Common policy among all New Mexico municipalities it to own their water rights as opposed to the uncertainty of leases.
12	**12.18**	Hanuschak, Dulcinea	Cumulative Impacts	The DEIS does not mention the City's wastewater treatment plant expansion and upgrade in evaluating the need for the project and fails to analyze the impact of the expansion on the City's projected water needs.	The wastewater treatment plant is located is 1.5 to 2 miles south of the desalination location. Upgrades to one portion of the treatment plant is planned and is in the design phase. Information regarding the wastewater treatment plant has been included in the cumulative impacts section of the document.
12	**12.19**	Hanuschak, Dulcinea	General	The DEIS incorrectly states that reclaimed wastewater would not help the City meet its projected needs for potable water, but does analyze why use of reclaimed water would not provide a meaningful reduction in the City's need for water development from the Snake Tank wells.	The City of Alamogordo is now using reclaimed water reducing their overall potable water needs. This information is Included in 40-year water plan report. The reclaimed wastewater is being used for agricultural purposes, watering golf courses, etc. The demand as identified in this DEIS does not include this quantity being applied to agriculture and golf courses. Reclaimed wastewater does not directly contribute to the City's potable water supply system, but use of reclaimed water for purposes that would otherwise have required potable water does offset some portion of the City's overall potable water demand. Like conservation, use of reclaimed wastewater can assist the City in meeting its overall potable water demands, but does not provide a large-scale, independent water supply as the Snake Tank well field would. Tertiary treatment is also very expensive as is evident by the lack of other municipalities in New Mexico that utilize this process.
13	**13.1**	Sharp, Julie, NPS Denver	General	The National Park Service has reviewed this project, and determined that no parks will be affected; therefore, we have no comments	Non-substantive.
14	**14.1**	Schweers, Marianne	General	I support this project. Alamogordo is already behind the power curve in procuring enough water to meet the needs of its citizens. Personally, I see this as just one of the measures that needs to be taken. I would like to see the basin communities working with WSMR to utilize the water resources that currently lie on WSMR. The Army could take everything they need and there would still be ample acre feet for the communities useage.	Non-substantive.
15	**15.1**	Schweers, George	General	Please consider this a yes vote to move forward on all four component parts	Non-substantive.
16	**16.1**	Jaszai, Stephen	General	I support! Rarely are communities able to act proactively. This will resolve tremendous amount of time, effort, and money in the future.	Non-substantive.

Comment Document Number	Comment Number	Commenter	Comment Category	Comment	Response
17	**17.1**	Price, Joan	Water Resources	The BLM DEIS is inadequate in addressing current knowledge of fresh water sources for ARWSP.	Current information regarding known freshwater sources is found in Chapter 3 of the DEIS as well as Appendices H and I.
17	**17.2**	Price, Joan	Impact Analysis	The DEIS is also inadequate in analysis of impacts on Village of Tularosa and surrounding agricultural district.	Analysis of impacts is found in Chapter 4 of the DEIS.
17	**17.3**	Price, Joan	Water Resources	The environmental parameters regarding fresh water sources have become far more apparent during the development of the ARWSP. Very important and relevant data, findings and analysis has emerged since the AWSP was first being organized. Significant fresh water sources do exist for Alamogordo without the desalination project.	The best available information and data were used during the analysis.
17	**17.4**	Price, Joan	Environmental Justice	The many changes in the design of the AWSP have greatly increased costs to taxpayers on the local, state, and federal level and to the regional rate payers; the greater burden of costs is falling on the shoulders and pocketbooks of the Village of Tularosa and rural private well owners whose population is poorer, less populated and less educated as a whole than residents in the rest of the region. They are far different than Alamogordo with its dependency and economic ties to the military reservation needs and resulting often shifting growth projections. This violates requirements for environmental justice.	All costs associated with the Snake Tank well field and desalination facility have been paid by the City of Alamogordo, with some state and federal assistance. No residents of the Village of Tularosa, or those in the vicinity of the Village of Tularosa, have been asked or required to pay any costs associated with the project. See also Response to Comment No. 17.10, below. Most of the project will be funded by state and federal grants.
17	**17.5**	Price, Joan	Water Resources	regarding fresh water sources, the CEQ for the NEPA process requires that the DEIS and FEIS include the best available data. The first major comprehensive study of the Sacramento Mountain precipitation and recharge of groundwater has been completed by the NM School of Mines and several associated scientific institutions. The draft report is available on-line and is under peer review for release within a few months. This major work needs to be included in evaluation of Alamogordo's stated need for sources of water.	The report entitled *Sacramento Mountains Hydrology Study* is being prepared by the New Mexico Bureau of Geology and Mineral Resources. It is a draft report is not final. A DEIS cannot rely on a draft report and the DEIS on the ARWSP was prepared using the best available science.

Comment Document Number	Comment Number	Commenter	Comment Category	Comment	Response
17	**17.6**	Price, Joan	Alternatives	Theoretical research exists now to demonstrate that restoration the wetlands in the several watersheds serving Alamogordo (now capped off at the spring heads) would store an equivalent amount of water as is needed for drinking purposes in Alamogordo	The EIS cannot reply on theoretical research and it is not clear what theoretical research is the subject of this comment. The City of Alamogordo contracted Steven T. Finch with John Shomaker & Associates and Dan Stephens with Daniel B. Stephens & Associates to review the theories presented by Mr. November. The theories were found to be flawed and lacking representation of fundamental hydrologic concepts and facts. See letter report prepared by Dan Stephens to City of Alamogordo dated September 7, 2007 .
17	**17.7**	Price, Joan	Water Resources	The comprehensive research, findings and analysis of Dr. Kay Havenor of Roswell of existing private wells and fresh water recharge groundwater patterns in agricultural district west and south of the Snake Tanks wells site has never been incorporated in the study of impacts in the court disputes or your DEIS. The CEQ requires these current studies and findings to the included in the DEIS.	The CEQ requires the use of the best available data, and technical work performed by Dr. Havenor did not qualify using this criterion. Dr. Havenor presented no testimony to the State Engineer in the administrative hearing. He first testified on behalf of project opponents on a narrow hydrologic area during the trial in the Twelfth Judicial District Court. His opinions were contradicted by many expert witnesses, including Dr. John Shomaker, Mr. Steve Finch, Mr. Eric Keyes, Mr. Neil Blandford, Mr. Doug Rappuhn, and Mr. Jim Sizemore. In reaching its decision, the District Court relied on the more credible expert testimony of Dr. John Shomaker, Mr. Steve Finch, Mr. Eric Keyes, Mr. Neil Blandford, Mr. Doug Rappuhn, and Mr. Jim Sizemore, and it did not rely on any of Dr. Havenor's analyses or testimony because it found the other hydrologists' analyses and conclusions to be more credible (Appendix E – Minute Order). The District Court's decision was upheld on appeal (Appendix C – Memorandum Opinion). In sum, the best available data on the hydrology of the Tularosa Basin is found in sources other than Dr. Havenor's report.
17	**17.8**	Price, Joan	Court Proceedings / Agreements	The original stipulation with Tularosa Mayor Demetrio Montoya was completely simplistic without any careful legal obligations between the two. The revised stipulation was very complex, reworded for legal consideration, used in court proceeding considering the AWSP application for surface acre-feet from the well site AND NEVER SIGNED INTO LAW yet everything proceeded. This requires a new court case.	The City of Alamogordo's Settlement Agreement with the Village of Tularosa is a contractual matter that is beyond the jurisdiction of the BLM and was not the subject of the DEIS.
17	**17.9**	Price, Joan	Court Proceedings / Agreements	The relocation of the desalination plant from the Snake Tank site requires new and potentially expensive costs to supply emergency drinking water to Tularosa. The delivery method is not defined and there are no guarantees to the Village. This is a clear violation of environmental justice requirements.	The City of Alamogordo's Settlement Agreement with the Village of Tularosa is a contractual matter that is beyond the jurisdiction of the BLM and was not the subject of the DEIS.

Comment Document Number	Comment Number	Commenter	Comment Category	Comment	Response
17	**17.10**	Price, Joan	Court Proceedings / Agreements	The court costs to settle protests and the cost of construction, maintenance and distribution, electrical sources significantly for taxpayers and rate payers. A $26 million loan grant from the NM Finance Authority with a five year spending requirement has had to be extended and costs are now $33; a grant for a three year spending requirement to build the pipeline - $4.5 million and a loan for $1.13 million. Please find enclosed news paper articles. When will increases end and who will pay?	Most of the project will be funded by state and federal grants. The City has proceeded prudently and diligently with respect to all elements of the Snake Tank well field and related desalination facility. Initially, the City believed it should not proceed beyond initial engineering design until it had secured a water rights permit. It took several years to complete the administrative process and to obtain a permit from the State Engineer (Appendix A). The State Engineer's decision was appealed to District Court. After a trial de novo, the District Court entered a Minute Order approving a permit for the City (Appendix E). Project opponents appealed the District Court's decision, which was confirmed by the New Mexico Court of Appeals (Appendix C). After the New Mexico Supreme Court refused to consider the matter on appeal at the project opponents' urging, the City's permit for a new appropriation of groundwater became final. Concurrently with the water rights permitting process, the City was proceeding with the NEPA process. The City filed applications for rights-of-way across BLM lands years ago to construct wells for the Snake Tank well field and for pipelines to transport the groundwater. This DEIS is part of that process.
17	**17.11**	Price, Joan	Court Proceedings / Agreements	The entire history of legal court wording, technical consideration and the DEIS itself cater to a well educated readership, probably requiring at least 2 years of college level education. This, in a state that, while having high testing standards, still ranks very low in literacy at the high school level and only 25% even go onto college, even less complete two years. These documents are not written for the lay person as managed under Clinton-Gore administration.	The authors of the document go to great lengths to tailor the document to the layperson and will take this into consideration for the final EIS. Technical reports are referenced in the document as appendixes.
17	**17.12**	Price, Joan	General	This work is not available for an informed decision-making process but for a paid elite in an industry who do not look at alternatives for fresh water or the vital importance of a successful agricultural economy.	Non-Substantive
18	**18.1**	Brockmann, James	General	The DEIS mentions once, but does not emphasize, that Alamogordo also has a present need for the ARWSP.	Please refer to pages 1-1 to 1-3, which describe the project's purpose and need.
18	**18.2**	Brockmann, James	General	The ARWSP fills the City's requirement for present, as well as future, needs and the DEIS should recognize this.	Please refer to pages 1-1 to 1-3, which describe the project's purpose and need.

Comment Document Number	Comment Number	Commenter	Comment Category	Comment	Response
18	**18.3**	Brockmann, James	Alternatives	Contrary to the statement on page 2-32 of the DEIS, transfer of water rights into existing City wells is not an option. The City had "excess" water rights in the La Luz and Prather wells and voluntarily reduced these "paper water rights" in its settlement with the State Engineer because these wells could not physically produce this amount of water. It would make no sense for the City to now transfer water rights to these wells since they cannot produce more water than what the City presently has rights to.	A description of the difference between actual and paper water rights as been added to the document.
18	**18.4**	Brockmann, James	Alternatives	In the discussion about the possibility of transferring irrigation water rights, it should be noted that another major consideration involves the validity of such rights. The State Engineer estimates that there are approximately 100,00 afy of claimed "paper" water rights in this area of the Tularosa Basin, yet only 15,000-20,000 afy are valid water rights with a history of beneficial use. Accordingly, the State Engineer will closely scrutinize any transfer of agricultural water rights with a high potential for denial of the transfer based upon a non-valid right.	A description of the difference between actual and paper water rights as been added to the document.
18	**18.5**	Brockmann, James	Court Proceedings / Agreements	The DEIS only mentions the decision of the State Engineer and the Twelfth Judicial Court, without mention of the affirmation by the New Mexico Court of Appeals and the New Mexico Supreme Court refusing to grant a Writ of Certiorari. In other parts of the DEIS, the appellate process is properly described, so as a whole, the DEIS is complete in that respect.	The affirmation by the New Mexico Court of Appeals and the New Mexico Supreme Court refusing to grant a Writ of Certiorari has been added to the document.
18	**18.6**	Brockmann, James	Water Resources	The DEIS tends to overstate impacts on groundwater and surface water because of its choice of adjective. The empirical facts speak for themselves.	Non-substantive.
18	**18.7**	Brockmann, James	Water Resources	The evidence presented before the State Engineer in the administrative hearing and at trial de novo in the Twelfth Judicial Court, as upheld on appeal, showed no identifiable impacts on surface water rights as a result of ARWSP.	We have conducted analysis as required by law but have considered the analysis done by the parties involved in the lawsuit as well.

Comment Document Number	Comment Number	Commenter	Comment Category	Comment	Response
18	**18.8**	Brockmann, James	Water Resources	With respect to ARWSP impacts on groundwater, the City believes the use of the word "substantial" overstates any impacts. The State Engineer and the New Mexico courts found that this impact (groundwater) did not rise to the level of impairment and the DEIS should not characterize such drawdowns as "substantial." The City suggests reporting the empirical results or changing the adjective.	A discussion between impairment and impacts has been added to the document.
18	**18.9**	Brockmann, James	Water Resources	Neither the State Engineer nor the courts found the impairment to existing water rights, and neither found a "substantial" impact. This was a rigorous process in which project opponents had the opportunity to bring forth evidence that supported their claims, but none was presented.	A discussion between impairment and impacts has been added to the document.
18	**18.10**	Brockmann, James	General	The City believes that the DEIS does a good job of describing the ARWSP and the City's proposed purpose and need for an additional independent water supply.	Non-substantive.

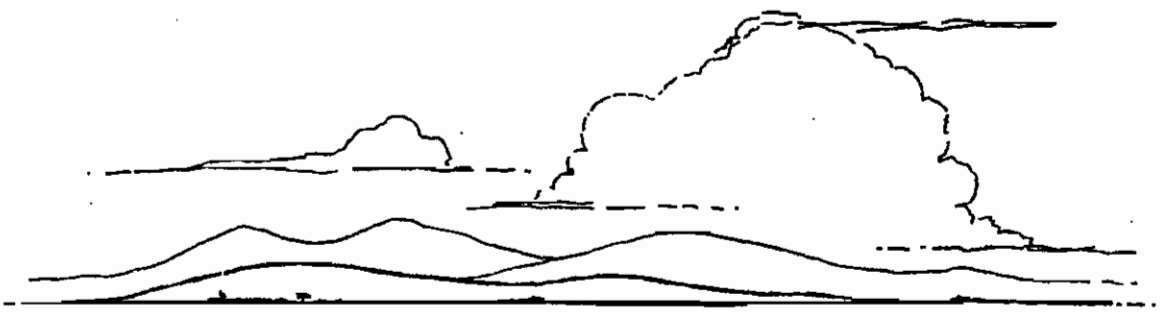
APPENDIX F

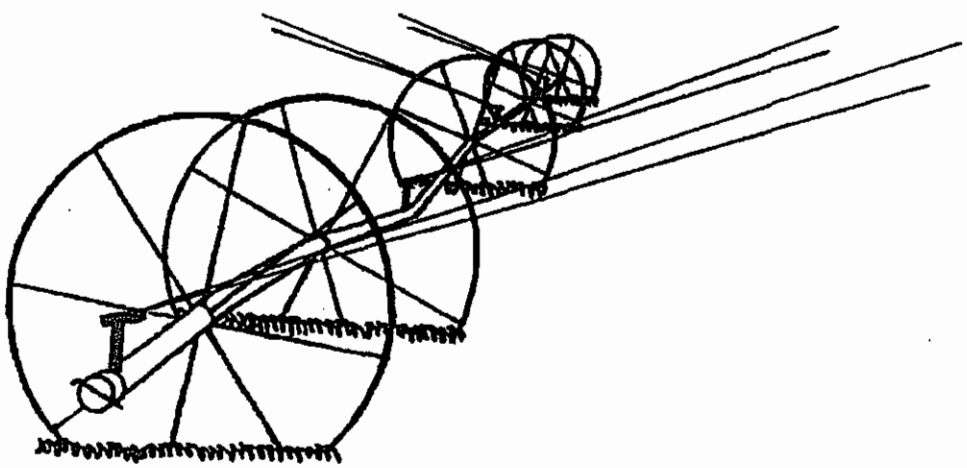
Technical Reports 51 and 48

Water Use by Categories in New Mexico Counties and River Basins, and Irrigated Acreage in 2000

Prepared by

Brian C. Wilson, P.E.
Anthony A. Lucero
John T. Romero, P.E.
Patrick J. Romero





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Technical Report 51
February 2003

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Water Use by Categories in New Mexico Counties and River Basins, and Irrigated Acreage in 2000

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Chapter 1

Introduction

1.1. PURPOSE

Limited in quantity, and in some areas by its quality, water is a primary factor in determining the future growth of New Mexico. The purpose of this report is to provide decision makers with the most comprehensive, current, and useful water use data available so that informed decisions can be made to insure the conservation and wise use of the state's water resources.

1.2. PREVIOUS WATER USE INVENTORIES

The U.S. Bureau of Reclamation (1950) published water withdrawals and depletions in drainage basins and for the state for 1945-49. Reynolds (1959) reported similar data for 1955 to the U.S. Senate Select Committee on National Water Resources. Withdrawals and depletions in 1965 were compiled by the New Mexico State Engineer Office and published by the New Mexico State Planning Office (1967). Data for 1970 were compiled by the New Mexico State Engineer Office and published by the U.S. Bureau of Reclamation and the New Mexico Interstate Stream Commission (1976). Data for 1975, 1980, 1985, 1990, and 1995 were compiled and published by the New Mexico State Engineer Office (Sorensen, 1977 and 1982; Wilson, 1986, 1992, 1997).

1.3. THE 2000 WATER USE INVENTORY

The results of New Mexico's 2000 water use inventory are presented in this report. Categories inventoried include: Public Water Supply; Self-Supplied Domestic; Irrigated Agriculture; Livestock; Self-Supplied Commercial, Industrial, Mining, and Power; and Reservoir Evaporation. The composition of each water use category is defined to facilitate the assimilation of data into the U.S. Geological Survey National Water Use Information System which was established by a directive from the U.S. Congress in 1977 to provide current, uniform, and reliable water use data.

Chapter 2 is an executive summary of water use in the state and each river basin. In Chapter 3, factors which affect water use in communities and results of six benchmark studies on residential water use are reviewed. In Chapter 4, application of the Blaney-Criddle method for determining consumptive irrigation requirements is explained, a computational aid which lists the equations used to compute irrigation withdrawals and depletions is provided, and causes of poor irrigation efficiency and measures which can be taken to improve farm water management are summarized.

In Chapter 5, the results of a study on water requirements for beef cattle are reviewed, and suggested guidelines for estimating water requirements for dairies are presented. Chapter 6 includes guidelines for estimating water requirements for recreational facilities, notes on the impact of the species of turfgrass on irrigation water requirements for golf courses and measures which can be taken to conserve water, and characteristics of water use in the industrial sector. In Chapter 7, the importance of quantifying reservoir evaporation is recognized and an overview of methodologies which can be used to estimate evaporation is presented.

In the series of tables presented in the latter part of this report, water withdrawals and depletions in New Mexico counties and river basins in 2000 are tabulated for each of the nine water use categories. A table dedicated to Public Water Supply and Self-Supplied Domestic lists individual water systems by county, population, per capita water use, withdrawals, depletion factors, and depletions. Tables for Irrigated Agriculture (1999) are provided which show the consumptive irrigation requirements, incidental depletion factors, acreage irrigated by type of irrigation system and source of water, on-farm irrigation efficiency, off-farm conveyance efficiency, withdrawals, conveyance losses, and depletions for projects and locales in each county.

A glossary of terms and maps showing the state's counties, river basins, declared groundwater basins and location of irrigated cropland are also included.

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Chapter 2

Executive Summary

2.1. THE STATE

Water withdrawals and depletions in New Mexico counties and river basins in 2000 are tabulated for nine water use categories: Public Water Supply; Self-Supplied Domestic; Irrigated Agriculture; Livestock; Self-Supplied Commercial, Industrial, Mining, and Power; and Reservoir Evaporation. The composition of each of these categories is defined in the text and detailed descriptions of the procedures used to quantify withdrawals and depletions are presented in a step-by-step format.

In 2000, withdrawals for all categories totaled 4,233,890.66 acre-feet. Surface water accounted for 2,358,990.18 acre-feet or 55.72% of the total withdrawal, and ground water for 1,856,224.48 acre-feet or 43.84%. Depletions totaled 2,596,574.84 acre-feet or 62% of the withdrawals. Surface water accounted for 1,254,403.40 acre-feet or 48.31% of the total depletion, and ground water for 1,342,171.44 acre-feet or 51.69%.

Irrigated Agriculture accounted for 3,223,954 acre-feet or 76.15% of the total withdrawals. Surface water accounted for 1,847,357 acre-feet or 57.30% of the irrigation withdrawals, and ground water for 1,376,597 acre-feet or 42.70%. In some areas of the state surface water supplies were not sufficient to meet the irrigation demand. Off-farm conveyance losses in canals and laterals amounted to 734,050 acre-feet or 39.74% of the surface water diverted for irrigation. Irrigation accounted for 1,772,951 acre-feet or 68.28% of the total depletions. Surface water accounted for 751,475 acre-feet or 42.39% of the irrigation depletions, and ground water for 1,021,476 acre-feet or 57.61%.

The total acreage irrigated on farms in 2000 was 998,793 acres. Approximately 388,157 acres or 38.86% was irrigated with surface water, and 610,636 acres or 61.14% was irrigated with ground water. Drip irrigation accounted for 7,436 acres or 0.74%, flood for 530,754 acres or 53.14%, and sprinkler for 460,603 acres or 46.12%.

Public Water Supply and Self-Supplied Domestic accounted for 366,942.68 acre-feet or 8.67% of the total withdrawals. Surface water accounted for 37,875.85 acre-feet or 10.32% of the withdrawals, and ground water for 329,066.83 acre-feet or 89.68%. These two categories accounted for 215,908.68 acre-feet or 8.32% of the total depletions. Surface water accounted for 19,237.78 acre-feet or 8.91% of the total depletions, and ground water for 196,670.90 acre-feet or 91.09%.

The population of New Mexico increased from 1,686,477 in 1995 to 1,819,046 in 2000, an increase of 132,569 or 7.29%. Approximately 1,292,072 or 71.03% of the state's population live in urban communities.

Together, Public Water Supply, Self-Supplied Domestic, and Irrigated Agriculture accounted for 84.81% of the total withdrawals and 76.60% of the total depletions.

Mining and Power accounted for 131,026.55 acre-feet or 3.09% of the total withdrawals. Surface water accounted for 53,465.37 acre-feet or 40.81% of the withdrawals, and ground water for 77,561.18 acre-feet or 59.20%. These two categories accounted for 104,234.80 acre-feet or 4.01% of the total depletions. Surface water accounted for 45,185.13 acre-feet or 43.35% of the depletions, and ground water for 59,049.67 acre-feet or 56.65%.

Livestock, Commercial, and Industrial accounted for 80,530.03 acre-feet or 1.90% of the total withdrawals. Surface water accounted for 7,530.56 acre-feet or 9.35% of the withdrawals, and ground water for 72,999.47 acre-feet or 90.65%. These two categories accounted for 72,042.96 acre-feet or 2.77% of the total depletions. Surface water accounted for 7,068.09 acre-feet or 9.81% of the depletions, and ground water for 64,976.87 acre-feet or 90.19%.

Evaporation from reservoirs with a storage capacity of 5,000 acre-feet or more amounted to 431,437.40 acre-feet or 10.19% of the total withdrawals, and 16.62% of the total depletions.

2.2. ARKANSAS-WHITE-RED RIVER BASIN

Withdrawals in the basin totaled 394,829.83 acre-feet or 9.33% of the state total. Surface water accounted for 291,444.72 acre-feet or 73.82% of the basin withdrawals, and ground water for 103,385.11 acre-feet or 26.18%. Depletions in the basin totaled 247,315.92 acre-feet or 9.52% of depletions in the state. Surface water accounted for 160,982.92 acre-feet or 65.10% of the basin depletions, and ground water for 86,333 acre-feet or 34.91%.

Irrigated Agriculture accounted for 301,360 acre-feet or 76.33% of the basin withdrawals. Surface water accounted for 206,589 acre-feet or 68.55% of the irrigated withdrawals in the basin, and ground water for 94,771 acre-feet or 31.45%. Off-farm conveyance losses in canals and laterals amounted to 95,105 acre-feet or 46.04% of the surface water diverted for irrigation in the basin. Irrigation accounted for 156,973 acre-feet or 63.47% of the basin depletions. Surface water accounted for 77,435 acre-feet or 49.33% of the irrigation depletions, and ground water for 79,538 acre-feet or 50.67%.

Acreage irrigated in the basin totaled 140,575 acres or 14.07% of the state total. Drip irrigation accounted for 82 acres or 0.06%, flood for 71,591 acres or 5.09%, and sprinkler for 68,902 acres or 49.01%. Approximately 73,480 acres or 52.27% were irrigated with surface water, and 67,095 acres or 47.73% were irrigated with ground water.

Public Water Supply and Self-Supplied Domestic accounted for 7,398.55 acre-feet or 1.87% of the basin withdrawals. Surface water accounted for 2,664.48 acre-feet or 36.01% of the withdrawals, and ground water for 4,734.07 acre-feet or 63.99%. These two categories accounted for 4,601.40 acre-feet or 1.86% of the basin depletions. Surface water accounted for 1,659.98 acre-feet or 36.08% of the total depletions, and ground water for 2,941.42 acre-feet or 63.92%.

The population in the basin was 36,357 or 2.0% of the state total. Approximately 14,137 or 38.88% of the basin population live in urban communities. The largest city in the basin is Raton (7,282).

Mining accounted for 570.36 acre-feet or 0.14% of the basin withdrawals, and 308.19 acre-feet or 0.12% of the basin depletions. Surface water accounted for 307.77 acre-feet or 99.86% of the depletions.

There are no self-supplied power generating stations in the basin.

Livestock and Commercial accounted for 5,110.92 acre-feet or 1.29% of the basin withdrawals. No industrial water uses were reported. Surface water accounted for 1,231.30 acre-feet or 24.09% of these withdrawals, and ground water for 3,879.62 acre-feet or 75.91%. These categories accounted for 5,042.93 acre-feet or 2.04% of the basin depletions. Surface water accounted for 1,189.77 acre-feet or 23.59% of the depletions, and ground water for 3,853.16 acre-feet or 76.41%.

Evaporation from reservoirs with a storage capacity of 5,000 acre-feet or more amounted to 80,390 acre-feet or 20.36% of the basin withdrawals, and 32.51% of the basin depletions.

2.3. TEXAS GULF RIVER BASIN

Withdrawals in the basin totaled 523,180.91 acre-feet or 12.36% of the state total. Surface water accounted for 196.99 acre-feet or 0.04% of the basin withdrawals, and ground water for 522,983.92 acre-feet or 99.96%. Depletions in the basin totaled 427,541.84 acre-feet or 16.47% of depletions in the state. Surface water accounted for 196.99 acre-feet or 0.05% of the basin depletions, and ground water for 427,344.85 acre-feet or 99.95%.

Irrigated Agriculture accounted for 460,554 acre-feet or 88.03% of the basin withdrawals and 380,907 acre-feet or 89.09% of the basin depletions. All of the withdrawals came from ground water. Acreage irrigated in the basin totaled 280,840 acres or 28.12% of the state total. Drip irrigation accounted for 918 acres or 0.33%, flood for 27,141 acres or 9.66%, and sprinkler for 252,781 acres or 90.01%. All of the acreage was irrigated with ground water.

Public Water Supply and Self-Supplied Domestic accounted for 29,920.05 acre-feet or 5.15% of the basin withdrawals, and 15,191.05 acre-feet or 3.55% of the basin depletions. All of the withdrawals came from ground water.

The population in the basin was 111,606 or 6.14% of the state total. Approximately 93,459 or 83.74% of the basin population live in urban communities. The largest cities in the basin are Clovis (32,667), Hobbs (28,657), Portales (11,131) and Lovington (9,471).

Mining and Power accounted for 21,709.62 acre-feet or 4.15% of the basin withdrawals, and 17,684.15 acre-feet or 4.14% of the basin depletions. All of the withdrawals for these two categories came from ground water.

Livestock, Commercial, and Industrial accounted for 13,997.24 acre-feet or 2.68% of the basin withdrawals. Surface water accounted for 196.99 acre-feet or 1.41% of these withdrawals, and ground water for 13,800.25 acre-feet or 98.59%. These categories accounted for 13,759.64 acre-

feet or 3.22% of the basin depletions. Surface water accounted for 196.99 acre-feet or 1.43% of the depletions, and ground water for 13,562.65 acre-feet or 98.57%.

There are no reservoirs in the basin with a capacity of 5,000 acre-feet or more.

2.4. PECOS RIVER BASIN

Withdrawals in the basin totaled 837,165.09 acre-feet or 19.77% of the state total. Surface water accounted for 296,741.09 acre-feet or 35.45% of the basin withdrawals, and ground water for 540,424 acre-feet or 64.55%. Depletions in the basin totaled 535,602.12 acre-feet or 20.63% of depletions in the state. Surface water accounted for 154,303.08 acre-feet or 28.81% of the basin depletions, and ground water for 381,299.04 acre-feet or 71.19%.

Irrigated Agriculture accounted for 696,900 acre-feet or 83.25% of the basin withdrawals. Surface water accounted for 236,807 acre-feet or 33.98% of the irrigation withdrawals in the basin, and ground water for 460,093 acre-feet or 66.02%. Off-farm conveyance losses in canals and laterals amounted to 71,919 acre-feet or 30.37% of the surface water diverted for irrigation in the basin. Irrigation accounted for 419,792 acre-feet or 78.38% of the basin depletions. Surface water accounted for 98,639 acre-feet or 23.50% of the irrigation depletions, and ground water for 321,153 acre-feet or 76.50%.

Acreage irrigated in the basin totaled 190,061 acres or 19.03% of the state total. Drip irrigation accounted for 265 acres or 0.14%, flood for 139,880 acres or 73.60%, and sprinkler for 49,916 acres or 26.26%. Approximately 41,963 acres or 22.08% were irrigated with surface water, and 148,098 acres or 77.92% were irrigated with ground water.

Public Water Supply and Self-Supplied Domestic accounted for 48,639.41 acre-feet or 5.81% of the basin withdrawals. Surface water accounted for 4,424.56 acre-feet or 9.10% of the withdrawals, and ground water for 44,214.85 acre-feet or 90.90%. These two categories accounted for 33,233.53 acre-feet or 6.20% of the basin depletions. Surface water accounted for 1,506 acre-feet or 4.53%, and ground water for 31,727.53 acre-feet or 95.47%.

The population in the basin was 177,173 or 9.74% of the state total. Approximately 116,966 or 66.02% of the basin population live in urban communities. The largest cities in the basin are Roswell (45,293), Carlsbad (25,625), Las Vegas (14,565) and Artesia (10,692).

Mining accounted for 18,091.91 acre-feet or 2.16% of the basin withdrawals, and 10,802.54 acre-feet or 2.02% of the basin depletions. Over 94% of the withdrawals for mining came from ground water.

There are no self-supplied power generating stations in the basin.

Livestock, Commercial, and Industrial accounted for 21,353.77 acre-feet or 2.55% of the basin withdrawals. Surface water accounted for 1,477.88 acre-feet or 6.92% of these withdrawals, and ground water for 19,875.89 acre-feet or 93.08%. These categories accounted for 19,594.05 acre-feet or 3.66% of the basin depletions. Surface water accounted for 1,422.48 acre-feet or 7.26% of the depletions, and ground water for 18,171.57 acre-feet or 92.74%.

Evaporation from reservoirs with a storage capacity of 5,000 acre-feet or more amounted to 52,180 acre-feet or 6.23% of the basin withdrawals, and 9.74% of the basin depletions.

2.5. RIO GRANDE BASIN

Withdrawals in the basin totaled 2,042,176.66 acre-feet or 48.23% of the state total. Surface water accounted for 1,405,188.94 acre-feet or 68.81% of the basin withdrawals, and ground water for 636,987.72 acre-feet or 31.19%. Depletions in the basin totaled 1,074,599.14 acre-feet or 41.39% of depletions in the state. Surface water accounted for 665,006.95 acre-feet or 61.88% of the basin depletions, and ground water for 409,592.19 acre-feet or 38.12%.

Irrigated Agriculture accounted for 1,453,891 acre-feet or 71.19% of the basin withdrawals. Surface water accounted for 1,126,975 acre-feet or 77.51% of the irrigation withdrawals in the basin, and ground water for 326,916 acre-feet or 22.49%. Off-farm conveyance losses in canals and laterals amounted to 494,812 acre-feet or 43.91% of the surface water diverted for irrigation in the basin. Irrigation accounted for 611,410 acre-feet or 56.90% of the basin depletions. Surface water accounted for 392,878 acre-feet or 64.26% of the irrigation depletions, and ground water for 218,532 acre-feet or 35.74%.

Acreage irrigated in the basin totaled 293,768 acres or 29.41% of the state total. Drip irrigation accounted for 6,121 acres or 2.08%, flood for 257,078 acres or 87.51%, and sprinkler for 30,569 acres or 10.41%. Approximately 189,469 acres or 64.50% were irrigated with surface water, and 104,299 acres or 35.50% were irrigated with ground water.

Public Water Supply and Self-Supplied Domestic accounted for 252,337.11 acre-feet or 12.36% of the basin withdrawals. Surface water accounted for 11,998.08 acre-feet or 4.75% of the withdrawals, and ground water for 241,206.03 acre-feet or 95.59%. These two categories accounted for 141,908.84 acre-feet or 13.21% of the basin depletions. Surface water accounted for 5,829.41 acre-feet or 4.11%, and ground water for 136,079.43 acre-feet or 95.89%.

The population in the basin was 1,290,353 or 70.94% of the state total. Approximately 947,910 or 73.46% of the basin population live in urban communities. The largest cities in the basin are Albuquerque (448,607), Las Cruces (74,267), and Santa Fe (62,203).

Mining and Power accounted for 37,248.77 acre-feet or 1.82% of the basin withdrawals. Surface water accounted for 515 acre-feet or 1.38% of the withdrawals, and ground water for 36,733.77 acre-feet or 98.62%. These two categories accounted for 28,848.35 acre-feet or 2.68% of the depletions, and ground water for 28,760.80 acre-feet or 99.70%.

Livestock, Commercial and Industrial accounted for 34,214.72 acre-feet or 1.68% of the basin withdrawals. Surface water accounted for 2,028.86 acre-feet or 6.09% of these withdrawals, and ground water for 32,131.91 acre-feet or 93.91%. These categories accounted for 27,946.95 acre-feet or 2.60% of the basin depletions. Surface water accounted for 1,726.99 acre-feet or 6.18% of the depletions, and ground water for 26,219.96 acre-feet or 93.82%.

Evaporation from reservoirs with a storage capacity of 5,000 acre-feet or more amounted to 264,485 acre-feet or 12.95% of the basin withdrawals, and 24.61% of the basin depletions.

2.6. UPPER COLORADO RIVER BASIN

Withdrawals in the basin totaled 333,026.05 acre-feet or 7.87% of the state total. Surface water accounted for 329,344.24 acre-feet or 98.89% of the basin withdrawals, and ground water for 3,681.81 acre-feet or 1.11%. Depletions in the basin totaled 266,200 acre-feet or 10.25% of depletions in the state. Surface water accounted for 262,721.05 acre-feet or 98.69% of the basin depletions, and ground water for 3,479.06 acre-feet or 1.31%.

Irrigated Agriculture accounted for 222,694 acre-feet or 66.87% of the basin withdrawals, and 171,722 acre-feet or 64.51% of the basin depletions. All of the withdrawals came from surface water. Off-farm conveyance losses in canals and laterals amounted to 37,641 acre-feet or 16.90% of the surface water diverted for irrigation in the basin.

Acreage irrigated in the basin totaled 74,771 acres or 7.49% of the state total. Flood irrigation accounted for 18,821 acres or 25.17%, and sprinkler for 55,950 acres or 74.83%.

Public Water Supply and Self-Supplied Domestic accounted for 22,484.03 acre-feet or 6.75% of the basin withdrawals. Surface water accounted for 19,523.13 acre-feet or 86.83% of the withdrawals, and ground water for 2,960.90 acre-feet or 13.17%. These two categories accounted for 12,956.41 acre-feet or 4.87% of the basin depletions. Surface water accounted for 10,176.09 acre-feet or 78.54% of the depletions, and ground water for 2,780.32 acre-feet or 21.46%.

The population in the basin was 133,287 or 7.33% of the state total. Approximately 87,680 or 65.78% of the basin population live in urban communities. The largest cities in the basin are Farmington (37,844), Shiprock (8,156), Bloomfield (6,417) and Aztec (6,378).

Mining and Power accounted for 50,528.78 acre-feet or 15.17% of the basin withdrawals. Surface water accounted for 100% of these withdrawals. These two categories accounted for 44,234.31 acre-feet or 16.62% of the basin depletions. Surface water accounted for 100% of the depletions.

Livestock, Commercial, and Industrial accounted for 2,937.24 acre-feet or 0.88% of the basin withdrawals. Surface water accounted for 2,216.33 acre-feet or 75.46% of these withdrawals, and ground water for 720.91 acre-feet or 24.54%. These categories accounted for 2,905.39 acre-feet or 1.09% of the basin depletions. Surface water accounted for 2,206.65 acre-feet or 75.95% of the depletions, and ground water for 698.74 acre-feet or 24.05%.

Evaporation from reservoirs with a storage capacity of 5,000 acre-feet or more amounted to 34,382 acre-feet or 10.32% of the basin withdrawals, and 12.92% of the basin depletions.

2.7. LOWER COLORADO RIVER BASIN

Withdrawals in the basin totaled 103,511.73 acre-feet or 2.44% of the state total. Surface water accounted for 54,749.79 acre-feet or 52.89% of the basin withdrawals, and ground water for 48,761.94 acre-feet or 47.11%. Depletions in the basin totaled 45,315.75 acre-feet or 1.75% of depletions in the state. Surface water accounted for 11,192.49 acre-feet or 24.70% of the basin depletions, and ground water for 34,123.26 acre-feet or 75.30%.

Irrigated Agriculture accounted for 88,555 acre-feet or 85.55% of the basin withdrawals. Surface water accounted for 54,292 acre-feet or 61.31% of the irrigation withdrawals in the basin, and

ground water for 34,263 acre-feet or 38.69%. Off-farm conveyance losses in canals and laterals amounted to 34,573 acre-feet or 63.68% of the surface water diverted for irrigation in the basin. Irrigation accounted for 32,147 acre-feet or 70.94% of the depletions in the basin. Surface water accounted for 10,801 acre-feet or 33.60% of the irrigation depletions, and ground water for 21,346 acre-feet or 66.39%.

Acreage irrigated in the basin totaled 18,778 acres or 1.88% of the state total. Flood irrigation accounted for 16,243 acres or 86.50%, and sprinkler for 2,485 acres or 13.23%. Approximately 8,474 acres or 45.13% were irrigated with surface water, and 10,304 acres or 54.87% were irrigated with ground water.

Public Water Supply and Self-Supplied Domestic accounted for 9,163.54 acre-feet or 8.85% of the basin withdrawals. Surface water accounted for 132.60 acre-feet or 1.45%, and ground water accounted for 9,030.94 acre-feet or 98.55%. These two categories accounted for 8,017.44 acre-feet or 17.69% of the basin depletions. Surface water accounted for 66.30 acre-feet or 0.83% of the depletions, and ground water accounted for 7,951.14 acre-feet or 99.17%.

The population in the basin was 70,270 or 3.86% of the state total. Approximately 31,920 or 45.42% of the basin population live in urban communities. The largest cities in the basin are Silver City (10,545), and Lordsburg (3,379).

Mining accounted for 2,877.10 acre-feet or 2.78% of the basin withdrawals, and 2,357.36 acre-feet or 5.20% of the basin depletions. All of the withdrawals came from ground water.

There are no self-supplied power generating stations in the basin.

Livestock, Commercial, and Industrial accounted for 2,916.09 acre-feet or 2.82% of the basin withdrawals. Surface water accounted for 325.19 acre-feet or 11.15% of these withdrawals, and ground water for 2,590.90 acre-feet or 88.85%. These categories accounted for 2,793.95 acre-feet or 6.17% of the basin depletions. Surface water accounted for 325.19 acre-feet or 11.64% of the depletions, and ground water for 2,468.76 acre-feet or 88.36%.

There are no reservoirs in the basin with a capacity of 5,000 acre-feet or more.

Chapter 3

Public Water Supply and Self-Supplied Domestic

3.1. INTRODUCTION

The procedures presented in this report for the quantification of withdrawals and depletions for Public Water Supply and Self-Supplied Domestic reflect many refinements that were born out of lessons learned from inventories conducted in the 1970s and 1980s. These procedures emphasize the need to capture information about individual water systems which will provide a more accurate picture of the sources of water—particularly transfers of water between utilities, population served, self-supplied municipal facilities that must be accounted for, and depletion rates. Population estimates for 2000 are discussed, and overview of factors that affect water use in communities is presented, and the results of six benchmark studies of residential water use are summarized. Notes on individual water systems in New Mexico are also provided.

3.2. COMPOSITION OF CATEGORIES

3.2.1. Public Water Supply (PS). Includes community water systems which rely upon surface and/or groundwater diversions other than wells permitted by the Office of the State Engineer under Section 72-12-1 NMSA 1978, and which consist of common collection, treatment, storage, and distribution facilities operated for the delivery of water to multiple service connections. Examples of such systems include municipalities that serve residential, commercial, and industrial water users; prisons; residential and mixed use subdivisions; and mobile home parks. Water used for the irrigation of self-supplied golf courses, athletic fields, and parks or to maintain the water level in ponds and lakes owned and operated by municipality or water utility is also included in this category. The purpose of this criteria is to capture all water uses which are debited against the water rights of public water suppliers where such rights have been defined. This category is identified as **Major Group 49, Industry Group 494**, and **Industry 4941** in the Standard Industrial Classification Manual (1987).

3.2.2. Domestic (DO). Includes self-supplied residences which may be single family dwellings or multi-family dwellings with wells permitted by the Office of the State Engineer under Section 72-12-1 NMSA, where water is used for normal household purposes such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets, evaporative cooling, water softener regeneration, and watering lawns and gardens; and livestock watering provided that this

is not the sole purpose of use. This category is identified as **Major Group 88, Industry Group 881**, and **Industry 8811** in the Standard Industrial Classification Manual (1987).

3.3. PROCEDURE FOR QUANTIFYING PUBLIC WATER SUPPLY WITHDRAWALS AND DEPLETIONS

Step 1: Preparation for this category begins with the identification of all the public water suppliers in the state. Regulatory agencies responsible for monitoring the quality of drinking water generally maintain a directory of community water supply systems. Municipal leagues or associations may also publish a directory of municipal offices that list the name and phone number of the city manager, clerk, and water and sewer superintendent.

Step 2: While many water suppliers are required to report their annual withdrawals to State Engineer District Offices, there are many which are under no obligation to do so either because they are not within a declared groundwater basin or because they have prebasin rights. Furthermore, withdrawals are not the only data required for the purpose of the water use inventory. We also need to know: Is the community water system located within the established boundaries of a larger municipality? How many people are served by the water system? How many connections are there? Is the water system metered? If the system is metered do the records reflect water sold or withdrawals measured at the ultimate source of supply? Were there any system malfunctions such as meter breakdowns that would affect the total measured deliveries or withdrawals during the calendar year? Is all or part of the water distributed imported from another municipality? If water is imported, how much and from whom? Is water exported to other communities? If water is exported, how much and to whom? Has the community implemented any water conservation measures?

After compiling a name and address listing of all public water suppliers, a questionnaire is mailed to each one. This is generally the cheapest way to collect data. Questionnaires must be carefully designed to avoid misinterpretation by the recipient.

Water purveyors that don't respond to questionnaires may have to be contacted by phone. Telephone surveys are more expensive, however, response time is typically one to five days, and they often yield additional information that is very helpful. One of the disadvantages of telephone surveys is that they often turn into a game of tag and there are some people who won't return a call or are reluctant to leave messages.

Step 3: Some water suppliers may report the quantity of water sold rather than the total withdrawal from the source. The difference between a water utility's production and its water sales to consumers is referred to as unaccounted-for water. Unaccounted-for water includes measuring errors caused by inaccurate meters or incorrect meter reading, transmission losses in the distribution system, water used for fire fighting, system flushing, sewer cleaning, construction, and other miscellaneous uses that are not metered. Unaccounted-for water is generally 10% to 20% of the total entering the distribution system in metered systems and is typically 30% in unmetered systems (Tchobanoglous, 1979; Moyer, 1985). A water system is generally considered to be performing well if unaccounted-for water is only 10% of the total withdrawals.

For the purpose of this inventory, if the withdrawals reported by a water purveyor are for water sold, they are divided by 0.90 to arrive at an estimate of the total withdrawal.

Step 4: In census years, population figures for many of the communities served by water utilities may be extracted from statistics published by the U.S. Bureau of the Census. It is important that these figures be compared with the data reported by water suppliers. If a water supplier reports a population served which is greater than the census population, this may indicate that the water supplier exports water to other communities or it may suggest an error in the census data. If the population reported by a water supplier is less than the census figure, this may indicate that there are other small community water systems located within the defined boundaries of the municipality. It is important that the number of inhabitants in self-supplied residences and subdivisions that are located within a community served by a public water supplier be subtracted from the population of the larger community of which they are a part.

Populations of communities not identified in the census must be obtained from the water system manager, the city clerk, or a regulatory agency, or they may be estimated by some other means. Many water utilities estimate the population they serve with reasonable accuracy on the basis of the total number of connections and the average number of residents served per connection. The number of residents served per connection typically range from 2.5 to 3.5. Nationally, U.S. Census Bureau data indicate that the average occupancy rate is 2.7 capita per dwelling unit.

In non-census years the population must be estimated. Methodologies may range from a simple linear interpolation to complex correlations based on the demographic characteristics of individual communities.

Step 5: Per capita water use in gallons per day (gpcd) is computed using the following equation:

$$GPCD = (W)(892.74)/POP$$

where W is the sum of the annual surface water and groundwater withdrawals in acre-feet and POP is the population. The gpcd may be used to check the water use figures reported by the water supplier. If the gpcd appears to be unusually high or low, this indicates a possible error in either the population data or the water use. When data appears to be erroneous, the water supplier is generally contacted by phone to discuss any discrepancies or suspect data.

Nestled in some of the states most popular resort areas are a number of communities which have a very small permanent residential population. In the summertime these communities experience a large influx of vacationers who come to enjoy New Mexico's rarefied air and enchanting landscapes for three or four months while the weather is favorable to leisurely outdoor living. There are also some communities that experience the mirror image of this phenomenon, i.e., there is a large influx of seasonal visitors in the winter months. These are the snowbirds who come to New Mexico to escape harsh winters that are typical of other parts of the nation.

A similar phenomenon occurs on military installations but on a daily basis. While the population of enlisted personnel and their families may be relatively small, each day there is a large influx of civilians who work on the base during the day. In addition, many military installations also have a golf course that increases water requirements.

The withdrawals reported in this inventory for communities that experience a seasonal influx of temporary residents, and military installations that experience a daily influx of civilian workers, reflect the total water use. However, because the population and per capita water requirements reported are based on the number of New Mexico residents who live in the community year-round, these communities will generally exhibit a high rate of per capita water use. Such communities have been flagged in Table 6, which is included in the latter part of this report.

Step 6: Where data is available, depletions for public water supply are estimated by taking the difference between total withdrawals and the effluent discharged from the sewage treatment plant. This approximation assumes that there is no seepage (including deep percolation from landscape irrigation) or storm-water runoff entering the sewer system; there is no seepage (leakage) out of the sewer system; there are no self-supplied water users discharging water into the sewer system; and water users supplied by public water utilities do not discharge household effluent into septic tanks.

If wastewater is discharged directly into a water body without treatment, or the annual inflow into a wastewater treatment plant is unknown, or the difference between measured diversions from the source of water and inflow into the wastewater treatment plant is an unreliable indicator of depletions due to infiltration, exfiltration, etc., depletions may be estimated by multiplying withdrawals by a depletion factor of 0.50. In communities where treated sewage effluent is used to irrigate golf courses, parks, athletic fields, and forage crops; or for industrial purposes such as cooling tower makeup water, the depletion rate may be 70% to 100%. The irrigation of forage crops with treated sewage effluent is a common method of wastewater disposal in communities where there are no watercourses or discharges to existing watercourses are prohibited.

3.4. PROCEDURE FOR QUANTIFYING SELF-SUPPLIED DOMESTIC WITHDRAWALS AND DEPLETIONS

Step 1: The self-supplied domestic population in each county is obtained by subtracting the population served by public water suppliers from the total population in a county. When a county is divided into two or more river basins the total county population must be separated into its basin components. The population served by public water suppliers in each basin is then subtracted from the total population of the respective basins to yield the residual population.

Step 2: The total withdrawal in acre-feet is computed using the following equation:

$$W = (POP)(GPCD)/892.74$$

Where W is the annual withdrawal in acre-feet; POP is the population; and GPCD is gallons per capita per day.

Step 3: Depletions are estimated by multiplying withdrawals by a depletion factor, which is assumed to be 1.00 for the purpose of this inventory. In previous inventories a depletion factor of 0.45 has been used, however, because there is increasing evidence that septic tank discharges rarely reach the aquifers that are the source of supply, a more conservative approach has been adopted for this inventory.

3.5. STATE POPULATION

3.5.1. Source of Data

The U.S. Census Bureau reported that the population of the state in 2000 was 1,819,046. This represents an increase of 20% over the 1990 population of 1,515,069, or an annual increase of approximately 1.8%. The distribution of the population in each county by river basin is based upon ratios derived from 1990 census block and tract data that was overlaid with hydrologic

cataloging units (U.S. Geological Survey, 1991). 2000 census block data was not used because assistance to overlay this data with hydrologic units was unavailable.

3.5.2. Counties with Highest Rate of Growth

Ranked from high to low, the fastest growing counties in New Mexico from 1990 to 2000 are Torrance (64.4%), Valencia (46.2%), Sandoval (41.9%), Santa Fe (30.7%), and Dona Ana (28.9%).

3.5.3. Impact of Growth

As a result of this growth, communities are struggling to keep up with the demand for affordable housing, education facilities, water and sewer services, solid waste disposal, transportation services, and police and fire protection; air pollution and traffic congestion is getting worse, groundwater pollution from septic systems is increasing, water tables are declining and there are signs of land subsidence in some metropolitan areas such as Albuquerque, and new subdivisions are being built on prime farmland. The impact of growth on community water supplies has become critical. While some municipalities have adopted end-use water conservation measures to reduce the demand for water, without a growth management plan, the number of connections and population served may continue to rise, increasing the aggregate demand on the water supply and the rate at which nonrenewable sources are depleted.

3.6. FACTORS WHICH AFFECT WATER USE IN COMMUNITIES

Water use in communities is affected by many factors which include demographic and economic characteristics; climate; availability of electric, water, and sewer services; condition of the water system and operating characteristics; and conservation measures. Water conservation is defined as any action or technology that reduces the amount of water withdrawn from water supply sources, reduces consumptive use, reduces the loss or waste of water, improves the efficiency of water use, increases recycling and reuse of water, or prevents the pollution of water. Conservation measures may contribute towards a reduction in average daily water use in a community. In addition, reducing the demand may add years to the life of aquifers that are being mined, reduce the cost of wastewater treatment, save energy, postpone or eliminate the expansion of water treatment and distribution systems, and decrease the volume of wastewater discharged into rivers and streams.

3.6.1. Rural Electrification. While not so much a factor today, historically, rural electrification has had a significant impact on water use. Up until the development of rural electrification, most rural homes lacked not only electrical appliances, but also modern plumbing due to the absence of pressurized water supply. Thus, the rural electrification program initiated the development of modern rural plumbing and greatly increased the demand for water as well as the need for septic tank waste disposal systems.

3.6.2. Type of Community. Residential communities will use less water per person than highly commercialized or industrialized communities. The type of housing that is most common will also affect use. Low density residential areas, i.e., those with few housing units per acre, with large gardens and lawns will have a higher water use per person than higher density areas with multiple family dwellings such as townhouses, condominiums, and apartment complexes.

3.6.3. Personal Income. The economic level of householder and the market value of homes influences water use because the individual in a higher-valued area is likely to have more water using appliances, ornamental shrubbery and larger lawn areas that are irrigated.

3.6.4. Climate and Season. Water use is normally highest during the warm summer months. More water is used for lawn and garden irrigation, car washing, filling swimming pools; bathing is more frequent; and evaporative coolers (swamp coolers) are more widely used. The amount of rainfall that normally falls in a specific area will affect the amount of water required for lawn and garden irrigation. During winter months in cold climates, water use may be surprisingly high. In some areas residents run water faucets continuously to prevent water from freezing and bursting the pipes. Some water systems follow the same practice to protect water mains above the frost line.

3.6.5. Sewers. Linaweaver (1967) observed that population density is not an important factor in areas with public sewers because of the dominant influence on domestic use of the economic level as reflected by the average market value of the homes. However, in septic tank areas, i.e., in areas where there are no sewers, economic level has effect on domestic use. Householders apparently use smaller amounts of water for domestic purposes because of concern that their septic tank will require more frequent cleaning, or, if they have their own well, that the pump for their well will break down and require expensive repair service.

3.6.6. Public Education. Education programs designed to increase the public's awareness about the status of a community's water supply resources and system, and measures that can be taken to conserve water may be effective in improving water use efficiency and reducing demand.

3.6.7. Metering and Rate Structuring (Water Pricing). Whether householders are billed according to metered water use or on an unmetered flat-rate basis appears to have little influence on indoor domestic use, but it has considerable influence on landscape irrigation and other outdoor water uses. When a householder can use all the water he wants and does not have to pay any more than other water users, the duration of time on, frequency on, frequency of use, and rate of use when on all tend to increase. Converting a flat-rate, non-metered system to a metered system has been shown to reduce water use by as much as 25% (AWWA, 1986). In Denver, Colorado, Galveston, Texas, the replacement or repair of residential and commercial meters that had been reading low by 11% and 39% respectively, reduced the water demand by more than 10% after customers began paying for the actual amount of water used (Anonymous, 1980). Increasing block-rate structures tend to make consumers more water conscious and discourage wasteful water use practices.

3.6.8. Recordkeeping and Water Audits. It is imperative that a recordkeeping system be established to monitor operation and maintenance costs, revenues, and the use of water. A water audit is a detailed examination of where and how much water enters the system, and where and how much leaves it. Water system audits facilitate the assessment of current water uses and provide data needed to reduce water and revenue losses, and forecast future demand. With this information, the water utility is better equipped to target conservation efforts and system improvements where they are most needed. Estimating and reducing unaccounted-for water is a major objective of a water system audit. Unaccounted-for water includes distribution-system losses through leaks, unmetered water delivered through fire hydrants, water taken illegally from the distribution system, inoperative system controls (for example, blowoff valves and altitude-control valves), water used in flushing water mains or sewers, and meters out of calibration (Center for the Study of Law and Politics, 1990, p. 35). Unauthorized use of hydrants includes

theft by chemical lawn service companies, building contractors, and water haulers who have the tools needed to open hydrants without permission.

3.6.9. Leak Detection and Repair. New water mains are generally water tight when they are first installed; however, as the system ages, settling of pipe may partially open joints causing leakage. Leakage will also increase due to pipe corrosion and deterioration of joint compounds. Systematic leak detection can greatly reduce distribution costs and wastewater treatment expenses. A leakage reduction program begins with a water audit, proceeds to a leak-detection and repair program, and, finally, includes improved system maintenance and rehabilitation.

3.6.10. Pressure Reduction. High water pressure at the outlets will generally result in higher water use because the flow rate is higher than under low pressure conditions. Pressure will have an effect on leakage because the rate of flow from a leak is proportional to the square root of the pressure. By increasing a 25 psig service pressure to 45 psig, water use can be expected to increase as much as 30% (AWWA, 1986). In new housing developments where water pressure is maintained at 50 psi instead of 80 psi, a 3% to 6% savings in water use may be expected (Bailey, 1984).

3.6.11. Indoor Plumbing Fixture and Appliance Ordinances, Audits, and Retrofits. The installation of water-saving plumbing fixtures (toilets, showerheads, and faucets) and appliances (dishwashers, washing machines, evaporative coolers, and water softeners) in new construction or as replacements can be very effective in reducing water use. **The National Energy Policy Act of 1992 now requires that toilets manufactured after January 1, 1994 for dwelling units, use not more than 1.6 gallons per flush (gpf); the maximum flow rate of showerheads shall not exceed 2.5 gallons per minute (gpm); and the maximum flow rate of kitchen and bathroom faucets shall not exceed 2.5 gpm.** Manufacturers have also made significant improvements in the efficiency of appliances. At the time of this writing, new dishwashers use 6 to 8 gallons per load; top-loading washing machines 39 to 43 gallons per load; and front-loading washing machines 20 to 30 gallons per load. (Consumer Reports, July, 1996; January, 1997; July, 1997). Improvements have also been made in evaporative coolers and water softeners that reduce water use. Indoor water use in a home with water conserving plumbing fixtures and appliances is shown in Table 3.2 which appears later in this chapter.

3.6.12. Landscape Ordinances, Audits, and Retrofits. A landscape design ordinance enacted by a local government or water utility can be a very effective water conservation measure. Homeowners, and commercial and industrial enterprises that adopt low-water use landscaping, efficiently irrigated, can reduce outdoor water use significantly. Landscaping ordinances can be incorporated into the building permit approval process. Landscape design requirements are most effective when accompanied by a design review service offered through the city or county planning office, or local water utility. Such services can help subdividers, homeowners, and businesses develop landscaping plans that are consistent with community water conservation goals. Some communities designate review boards, usually consisting of landscape architects or planners, to evaluate and approve landscape designs for certain types of new development. For example a city or county may use a review board to ensure that new landscaping and irrigation systems comply with its xeriscape requirements. After the landscape project has been completed, the site is visited and a certificate of compliance is issued if all landscape design requirements are met. To provide an incentive for low water use landscaping, a credit or rebate may be offered toward the connection fee if homeowners comply with landscaping guidelines. Such incentives may also be offered to encourage homeowners or businesses to convert high-water using landscapes and inefficient irrigation systems to low water use landscapes and efficient irrigation systems.

3.6.13. Water Waste Ordinances. Water waste is usually defined in local government ordinances as water that flows or is discharged from a residence or place of business onto an adjacent property or public right-of-way. Such discharges occur most often from landscape irrigation or leaking water pipes. Water waste ordinances may curtail waste.

3.6.14. Irrigation with Reclaimed Wastewater. The reuse of treated sewage effluent for the irrigation of golf courses, parks, athletic fields, and greenbelts; or for industrial purposes, can reduce the demand for freshwater.

3.7. RESIDENTIAL WATER USE

3.7.1. Benchmark Studies of Indoor Water Use. Residential water use is comprised of two components: (1) indoor, i.e., uses inside of the house, and (2) outdoor, i.e., uses outside of the house. The results of several benchmark studies that have been conducted to quantify domestic water use in American homes are summarized in the text that follows.

3.7.1.1. Bennett (1975). To define the parameters that affect the design of home wastewater systems, six middle class families in Boulder, Colorado were monitored for 15 consecutive days during the month of January when there was no outdoor water use. All of these homes had been constructed since 1950, were equipped with modern appliances, and were connected to the municipal water and sewage system. At each of these residences the male head of household was away at work during the day, the older children were in school, and several of the wives were engaged in part-time employment or community work. Indoor water use for this study group ranged from 32 to 82 gpcd and averaged 45 gpcd. After comparing water use in two different households which were nearly identical in terms of number of family members, age of children, and size of home, it was concluded that water use depended more upon life style than family size or age, as evidenced by the fact that, in the household which had the lower water use, the housewife and her youngest child were away from home in the afternoons. In general, data indicated that small families had a higher per capita water use than larger families. While participants in this study typically used 30 gallons per shower, it was also observed that a teenager may use up to 50 gallons per shower, this amount apparently being limited by the size of the hot water heater.

3.7.1.2. Brown and Caldwell (1984). In 1980 the U.S. Department of Housing and Urban Development initiated a three-year residential water conservation demonstration program. Homes of upper income families with and without water-saving fixtures were selected nationwide. To compare the effects of different types of water conserving devices on indoor water use, water fixture use data was compiled into three separate groups. Estimated per capita water use resulting from this study was as follows. Group I, homes with no water-conserving devices—78 gpcd. Group II, homes with conventional nonconserving toilets retrofitted with dams, bags, or bottles; showers with moderate flow restrictors; and dishwashers and washing machines with moderate water requirements—68 gpcd. Group III, homes with high efficiency low-flush toilets, low-flow showers, dishwashers and washing machines—60 gpcd. An important discovery in this study was that leakage from conventional as well as low-flush toilets was typically 4 gpcd and as high as 24 gallons per day per toilet.

3.7.1.3. Cohen (1974). General Dynamics, under the sponsorship of the U.S. Environmental Protection Agency, monitored water use in eight single-family homes with three or more occupants in two New England states and California for a period of one year. Indoor water use for

these households without any water saving devices installed ranged from 43 to 94 gpcd and averaged 56 gpcd. The average water use for sewered homes was 67 gpcd as compared with 44 gpcd for those with septic tanks. While the type of waste disposal system showed a definite affect upon per capita use, variations in per capita use between households with the same type of waste disposal system were attributed to differences in family habits and life styles.

3.7.1.4. Cotter (1974). During the period 1971-73, researchers at New Mexico State University conducted a study of domestic water use at selected subdivisions in Albuquerque and Las Cruces, New Mexico. The residents monitored in this study were predominantly middle income family homes served by municipal water and sewage systems. Indoor water use for all of the homes included in the study averaged 79 gpcd.

3.7.1.5. Linaweaver (1967). From 1961 to 1966 the John Hopkins University, under the sponsorship of the Federal Housing Administration and in cooperation with 16 water utilities, conducted a study of 41 subdivisions representing the climatic diversity of regions throughout the United States to determine the water use patterns and demand rates imposed on water systems in residential areas. Indoor water use for all 41 study areas, including single-family homes and apartments, averaged 59 gpcd. Indoor per capita use for individual areas ranged from 39 gpcd in a lowered-valued area to 127 gpcd in a high-valued area. Indoor water use for specific categories was as follows: for homes with septic tanks—47 gpcd; for metered areas in the eastern United States with municipal water and sewers—51gpcd; for apartments—62 gpcd; for flat-rate areas—66 gpcd; and for metered areas in the western United States with municipal water and sewers—67 gpcd. With the exception of the septic tank areas, variations in per capita use were primarily attributed to differences in the market values of homes and population density.

3.7.1.6. Siegrist (1976). Indoor water use in 11 rural Wisconsin homes occupied by families of various sizes and economic backgrounds was monitored continuously for 434 days yielding a range of wastewater flow from 25 to 57 gpcd and an average of 43 gpcd. Comparison of winter and summer water use showed no significant seasonal differences. Siegrist observed that water use within the home has changed over the years due to the increasing number of modern appliances, e.g., automatic dishwashers, garbage disposals, and clothes washers which use more water for permanent press fabrics. Changes in the habits of householders have also affected the volume of water and how it is used. On a lighter note, Siegrist also observed that use of in-sink garbage disposals is generally less frequent in homes with big dogs because the dog is given the majority of meal scraps.

3.7.2. Outdoor Water Use

Outdoor water use varies widely depending upon the climate and irrigation requirements of lawns, gardens, trees and ornamental shrubbery; the quantity of water used for washing vehicles, driveways, sidewalks, and the exterior of homes; and filling and maintaining swimming pools, landscape ponds etc. Where outdoor water uses are a factor, they generally account for 50% to 70% of the total residential water use (indoor plus outdoor). In a study of 20 residents in Las Cruces, New Mexico (Cotter, 1974), annual water use for landscape irrigation ranged from 108,000 gallons to irrigate 3,328 square feet, to 204,000 gallons to irrigate 5,219 square feet. Where desert landscaping has been adopted, outdoor water use may account for only 3% or less of the total residential water use.

Table 3.1. Indoor water use in single and multi-family dwelling units without water conserving plumbing fixtures and appliances, in gallons per capita per day (gpcd). (Source: Brown and Caldwell, 1984).	
Items and Assumptions	GPCD
Toilets (5.5 gal/flush x 4 flush/capita day)	22.0
Toilet leakage (0.17 x 24 capita/gal day)	4.1
Showers (3.4 gpm x 4.8 minute)	16.3
Baths (50 gal/bath x .14 bath/capita day)	7.0
Faucets (Estimated)	9.0
Dishwasher (14 gal/load x .17 load/capita day)	2.4
Washing machine (55 gal/load x .30 load/capita day)	16.5
Total	77.3
Note that evaporative cooling and water softener regeneration may increase the water requirements by up to 25 gpcd.	

Table 3.2. Indoor water use in single and multi-family dwelling units with water conserving plumbing fixtures and appliances, in gallons per capita per day (gpcd). The prototype for this table is based on Brown and Caldwell's report (1984) prepared for the U.S. Department of Housing and Urban Development, Washington, DC.	
Item and Assumptions	GPCD
Toilets (1.6 gal/flush x 6 flush capita day)	9.6
Toilet leakage (0.17 x 24 gal/capita day)	4.1
Showers (2.5 gpm x 4.8 minute)	12.0
Baths (50 gal/bath x .14 bath/capita day)	7.0
Faucets (Estimated)	9.0
Dishwasher (7 gal/load x .17 load/capita day0	1.2
Washing machine (43 gal/load x .30 load/capita day)	12.9
Total	55.8
Note that evaporative cooling and water softener regeneration may increase the water requirement by up to 25 gpcd.	

3.8. PER CAPITA WATER USE FOR SELF-SUPPLIED DOMESTIC

The preceding discussion illustrates that there is a wide range of values for residential water use. For the purpose of estimating withdrawals for the self-supplied domestic population, in most counties an areawide average of 80 gpcd is used. In counties where water requirements for landscape irrigation and evaporative cooling are more prevalent, an areawide average of 100 gpcd is used; and in Catron, Cibola, McKinley, and San Juan counties where a segment of the population does not have indoor running water, an areawide average of 70 gpcd is used.

3.9. NOTES ON INDIVIDUAL WATER SYSTEMS

Site-specific data reported in many of the water use categories inventoried is often annotated with a water transfer code (WTC) which is used to flag (1) water imports and exports across a state or

county line, or river basin boundary; (2) the transfer of water from one public water supplier to another; (3) the transfer of water from a public water supplier to a facility which is also self-supplied; and (4) to note other facets of a water system which may be of interest. These water transfer codes, many of which appear in Table 6 in the latter part of this report, are defined as follows.

0—No water transfers occurred.

1—Water is imported across a state or county line, or river basin boundary.

2—Water is exported across a state or county line, or river basin boundary.

3—Water delivered to customers (e.g., a water utility, commercial and industrial enterprises or individual residences) outside of the city or village in which the water supplier is based is not included in the withdrawal shown.

4—Water delivered to customers outside of the city or village in which the water supplier is based is included in the withdrawal shown, and the population reported also reflects the additional population served.

5—Water delivered to customers outside of the city or village in which the water supplier is based is included in the withdrawal shown, but a reasonable estimate of the additional population served is unavailable or customers served are commercial and industrial enterprises for which population figures are not relevant.

6—All of the water distributed in this community is received from another water utility.

7—Part of the water distributed in this community is received from another water utility and is included in the withdrawal shown.

8—Part of the water used at this self-supplied facility is received from a water utility or another organization. The water transferred to this facility is not included in the withdrawal shown.

9—Water is provided to seasonal visitors in addition to the established residential population. The withdrawal shown reflects the total water use, however, the population and per capita use reported are based on the number of residents who live in the community year-round.

10—This military installation experiences a daily influx of civilian workers. The withdrawal shown reflects the total water use, however, the population and per capita use reported are based on the number of military personnel and their families who live on the installation year-round.

Notes on individual water systems are listed by county in the text that follows. Except where noted otherwise, water transferred from one water utility to another is added to the withdrawal of the receiving organization and is subtracted from the withdrawal of the utility from which the water was purchased. The withdrawals reported in Table 6 of this report reflect these adjustments.

Bernalillo County (01): (a) The Albuquerque water system serves a population of about 448,607 inside the city limits, and 11,393 outside, for a total of 460,000. This total does not include the residential population at Kirtland Air Force Base which has its own water system. 2000 withdrawals for Ladera and Los Altos golf courses, which are self-supplied municipal facilities, are included in the total withdrawal reported for the Albuquerque water system. **(b)** The

Entranosa Water Co-Op delivers water to a population of about 4,355 in Bernalillo County, and 2,345 in Santa Fe County. **(c)** Irrigation withdrawals for the Double Eagle Golf Course, which is a self-supplied municipal facility, are included in the withdrawal reported for Paradise Hills.

Chaves County (05): (a) In addition to producing municipal drinking water, Dexter also pumps ground water to maintain the water level in Lake Van, which is outside the village limits, and to irrigate park areas around the lake. **(b)** Roswell's treated sewage effluent is reused for irrigated crop production by farmers who contract with the city.

Cibola County (06): (a) In 1983 the Acoma tribe filed suit against the city of Grants to curtail the discharge of sewage effluent into the Rio San Jose which is the source of the tribe's irrigation water. As a result of a court order issued in 1990, Grants implemented a "zero discharge plan" which reuses treated sewage effluent to irrigate the Coyote del Malpais Golf Course. **(b)** The population served by the Milan water system includes about 208 residents in a subdivision outside the city limits.

Colfax County (07): (a) Angel Fire Services Corporation supplies all of the water for the condominiums, private homes, hotels, restaurants, shops, golf courses, and snow making at the ski resort. **(b)** The population served by the Raton water system includes residents outside the city limits. **(c)** The population served by the Springer water system includes residents in subdivisions outside the city limits and the Boys School.

Curry County (09): 2000 irrigation withdrawals for Clovis Golf Course, which is a self-supplied municipal facility, are included in the withdrawals reported for Clovis.

De Baca County (11): Fort Sumner supplies all of the water distributed by the Valley WUA.

Dona Ana County (13): (a) The population served by the Hatch water system includes residents in Placitas and Rodey which are outside the city limits. **(b)** The population served by the Las Cruces water system does not include residents served by private water systems within the city. **(c)** Picacho Hills owns and operates one self-supplied golf course and delivers water to various satellite subdivisions, and the additional population are included in the data reported for Picacho Hills. **(d)** Rincon delivers water to the U.S. Border Patrol and this water is included in the withdrawal reported for Rincon. **(e)** Santa Teresa owns and operates two self-supplied golf courses. 2000 irrigation withdrawals for the golf courses are included in the withdrawal reported for Santa Teresa.

Eddy County (15): (a) Artesia supplies all of the water distributed by the Morningside Water Co-Op. **(b)** Artesia's treated sewage effluent is reused to irrigate city parks. **(c)** The population served by the Carlsbad water system includes residents in La Huerta, which is outside the city limits. 2000 irrigation withdrawals for the Lake Carlsbad Golf Course, which is a self-supplied municipal facility, are included in the withdrawal reported for Carlsbad. **(d)** Carlsbad delivered 78.35 acre-feet to Otis and is reflected in the withdrawal reported for Otis. **(e)** In addition to the water purchased from Carlsbad, Otis produced 1219.82 acre-feet from its own wells. **(f)** Loving supplies all of the water distributed in Malaga.

Grant County (17): (a) Silver City delivers water to Arenas Valley, Pinos Altos, Tyrone, and Rosedale. **(b)** Silver City's treated sewage effluent is reused to irrigate the Silver City Golf Course. **(c)** Chino Mines supplies all of the water distributed by the Hurley water system.

Guadalupe County (19): **(a)** Santa Rosa supplies all of the water distributed in Rio Pecos Villa. **(b)** Vaughn exports water to Duran and Encino in Torrance County and delivers water to various ranchers. The water exported and the water delivered to the ranchers is not included in the withdrawal report for Vaughn.

Lea County (25): **(a)** Eunice provides part of the water used at Warren Petroleum's gas processing plant which is located outside of the city limits. This withdrawal is included in the withdrawal for Eunice. **(b)** Jal's treated sewage effluent is reused to irrigate the Jal Country Club Golf Course.

Lincoln County (27): **(a)** Nogal imported 3.90 acre-feet of surface water from the Bonita pipeline. **(b)** Irrigation withdrawals for the Links Golf Course, which is a self-supplied municipal facility, is included in the withdrawal reported for Ruidoso.

Los Alamos County (28): **(a)** The withdrawal reported for Los Alamos includes water delivered to Los Alamos National Laboratories and White Rock. **(b)** Los Alamos and White Rock's treated sewage effluent is reused to irrigate Los Alamos golf course, numerous athletic fields, and for cooling tower makeup at power generating stations.

McKinley County (31): Gallup delivers water to Fort Wingate and Gemerco, and various commercial enterprises outside the city limits.

Otero County (35): **(a)** The reported population and withdrawal for Alamogordo does not include the residential population of, or water deliveries to, Holloman Air Force Base which is outside the city limits; and exports to Capitan, Carrizozo, Ft. Stanton, and Nogel which are in Lincoln County. **(b)** Alamogordo's treated sewage effluent is reused to irrigate the Desert Lakes Golf Course. **(c)** Orogrande delivers water to the Bureau of Land Management, the U.S. Forest Service, and two ranches. The withdrawal reported for Orogrande reflects these deliveries.

Quay County (37): The population served by the Tucumcari water system includes residents in Liberty (population 194), RAD and Tuc-Cam (combined population of 672) which are outside the city limits. 2000 irrigation withdrawals for Tucumcari Golf Course, which is a self-supplied municipal facility, are included in the withdrawals reported for Tucumcari.

Rio Arriba County (39): The population of Espanola is split between Rio Arriba County (population 8,070) and Santa Fe County (population 1,616).

Roosevelt County (41): Portales supplies all of the water distributed by the Roosevelt County Water Co-Op.

Sandoval County (43): **(a)** Corrales does not have a municipal water system. Residents are self-supplied. The population of Corrales is split between Bernalillo County (population 676) and Sandoval County (population 6,658). **(b)** Rio Rancho's treated sewage effluent is reused to irrigate the Rio Rancho Country Club Golf Course.

San Juan County (45): **(a)** Aztec supplies water to the Flora Vista WUA and the Southside WUA. **(b)** Flora Vista also purchased 77.81 acre-feet of surface water from Farmington, and produced 308.0 acre-feet of ground water from its own wells. **(c)** Bloomfield supplies water to East and West Hammond MDWCA, and the Lee Acres WUA. **(d)** Farmington supplies water to the Cedar Ridge WUA, the Flora Vista WUA, the Lower Valley WUA (Kirtland), NTUA Shiprock, and the Upper La Plata WUA. 2000 irrigation withdrawals for the Pinon Hills Golf

Course, which is self-supplied municipal facility, are included in the withdrawals reported for Farmington. (e) In addition to 3.85 acre-feet of surface water purchased from Farmington, the Lower Valley WUA also diverted 1083.97 acre-feet of surface water from its own diversion works.

Santa Fe County (49): (a) The Sangre de Cristo Water Company serves a population of about 61,003 inside the city limits and 9,997 outside, for a total of 71,000. Las Campanas, which is reported as a separate entity in the tables, accounts for approximately 750 of the 9,997 living outside the city limits. **(b)** Santa Fe's treated sewage effluent is reused to irrigate the Santa Fe Country Club Golf Course.

Sierra County (51): The population served by the Truth or Consequences water system includes residents in Williamsburg (527), which is outside the city limits. 2000 irrigation withdrawals for the Oasis Golf Course, which is a self-supplied municipal facility, are included in the withdrawal reported for T or C.

Taos County (55): (a) Taos treated sewage effluent is reused to irrigate the Taos Country Club Golf Course. **(b)** The Twining Water and Sanitation District supplies all of the potable water for the condominiums, hotels, restaurants, and shops in Taos Ski Valley. Water used for snow making is permitted under water rights owned by the Taos Ski Valley, a separate corporation, and this water use is tabulated in Commercial rather than Public Water Supply.

Torrance County (57): Duran and Encino both import water from Vaughn in Guadalupe County. See Guadalupe County.

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Chapter 4

Irrigated Agriculture

4.1. INTRODUCTION

The procedure presented in this report for quantifying irrigation withdrawals and depletions addresses many facets of irrigation that are often overlooked. It recognizes the need for the separation of irrigation water requirements by type of irrigation system and source of water. Application of the original Blaney-Criddle method for determining the consumptive irrigation requirement of a cropping pattern is described in detail and includes discussion of methods which are used to adjust estimated crop water requirements to account for water supply shortages and other factors. A computational aid that lists the equations used to compute irrigation withdrawals and depletions is provided. Causes of poor irrigation efficiency are identified, and an overview of what can be done to improve irrigation water management is presented. For definitions of terms used in this section, see the glossary included in this report.

4.2. COMPOSITION OF CATEGORY

Irrigated Agriculture (IR). Includes all diversions of water for the irrigation of crops grown on farms, ranches, and wildlife refuges. This category is identified as **Major Group 01** and **Industry Group 011-017** in the Standard Industrial Classification Manual (1987).

4.3. PROCEDURE FOR QUANTIFYING IRRIGATION WITHDRAWALS AND DEPLETIONS

Step 1: Identify irrigated cropping areas and tabulate the gross irrigated acreage for each individual crop in the cropping pattern by type of irrigation system. The gross acreage is the irrigated acreage as defined in the glossary, plus the multiple-cropped acreage.

Sources of irrigated cropland data include the U.S. Bureau of Indian Affairs; the U.S. Bureau of Reclamation; the U.S. Department of Agriculture, Agriculture Stabilization and Conservation Service, Natural Resources Conservation Service, and National Agricultural Statistics Service; irrigation districts; and county extension agents. Hydrographic surveys, adjudications and court decrees, licenses and permits for water rights, and recent aerial photography may also be helpful in determining the acreage irrigated.

It is important that the irrigated acreage be broken out by type of irrigation system because the incidental depletion factors which are used in the determination of total depletions, and the irrigation efficiencies that are used in the determination of total withdrawals, vary with the type of irrigation system. The methods which farmers use to apply water to irrigated cropland can be separated into four categories: (1) drip irrigation, (2) flood irrigation, (3) sprinkler irrigation, and (4) subsurface irrigation. Each of these categories encompasses a variety of water application methods.

Drip or trickle irrigation can be defined as the precise application of water on, above, or beneath the soil by surface drip, subsurface drip, bubbler, spray, mechanical move, and pulse systems. Water is applied as discrete or continuous drops, tiny streams, or miniature spray through emitters or applicators placed along a water delivery line near the plant.

Flood irrigation includes furrow, border-strip, level-basin, and wild flooding. It is often referred to as "surface irrigation," because the water applied flows over the surface of the irrigated field, or "gravity irrigation;" because free water runs downhill.

Sprinkler irrigation systems can be divided into periodic move systems, which are sprinklers that remain at a fixed position while irrigating, and continuous move systems, which are sprinklers that move in either a circular or straight path while irrigating. The periodic move systems include sprinkler lateral, overlapped hose-fed sprinkler grid, perforated pipe, orchard sprinklers, and gun sprinklers. The dominant continuous move systems are center pivot and side-roll sprinklers.

Subsurface irrigation requires the creation of an artificial water table over a natural barrier that prevents deep percolation. The water table is kept at a fixed depth, usually 12 to 30 inches, below the surface. Moisture is supplied to the plant roots through upward capillary movement. Water may be introduced into the soil profile through open ditches, mole drains, or tile drains. However, in most areas where subsurface irrigation is practiced, water is distributed to the fields by canals, laterals, and field ditches. Subsurface irrigation was used on an experimental basis in New Mexico in the early 1900s, but it is no longer practiced today as described above. However, there are a few farmers in the state who are experimenting with the use of subsurface drip systems to irrigate crops such as alfalfa.

Step 2: The irrigated acreage tabulated for each type of irrigation system is further broken down according to the sources of water. Sources of water include surface water, ground, and combined water. When a field is irrigated with both ground and surface water, the source is designated combined. In this case the primary source is usually surface water that is supplemented by water pumped from a well.

Cropland irrigated by combined water is initially tabulated separately because it is impossible to determine from visual inspection of irrigated cropland in the field or from aerial photography how much of the cropland is irrigated by ground water and how much by surface water. To be meaningful however, the acreage irrigated by combined water must eventually be separated into its ground and surface water components. If records of measured withdrawals are available, the components are computed in Step 12 after the theoretical withdrawal has been computed. When measured withdrawals are not available, the components must be estimated. In this case, a rough approximation of the components may be gleaned by (1) an examination of water rights documentation, if such records exist; (2) comparing recorded streamflows with the estimated demand; or (3) by contacting personnel in the Cooperative Extension Service and the Natural Resources Conservation Service, or individual farmers who know the area well.

Step 3: The average temperature and total recorded rainfall for each month is obtained from the weather station that is most representative for a specific cropping area. When an irrigated cropping area is located between two or more weather stations, the influence of each station should be weighted according to its distance from the centroid of the cropping area. The sum of the weighted values from each station yields the composite data to be used in subsequent calculations.

Step 4: The growing or irrigation season for each crop is defined by the earliest and latest moisture use dates. For annual crops such as corn and spring small grains, the earliest moisture use date is normally assumed to be the planting date, and the latest moisture use date as the day before harvest begins. For some annual crops such as corn, spring small grain, and cotton, farmers may apply a preplant irrigation. So, for example, if a 15-day preplant irrigation is applied, seed is planted on April 1 and the crop reaches maturity in 140 days, the beginning of the growing season would be taken as March 17, and consumptive use would be computed for a 155-day growing season.

For perennial crops such as alfalfa and permanent pasture grasses, the earliest moisture use date correlates with the mean daily air temperature that activates the transpiration process, and the latest moisture use date correlates with the mean daily air temperature that signals the cessation of transpiration on the next day. The earliest and latest moisture use dates may also be established by simply observing when growth begins and ends.

Step 5: The theoretical consumptive use (U) or evapotranspiration (ET) of water by individual crops in the cropping pattern tabulated for each type of irrigation system is calculated using the original Blaney-Criddle method (1950, 1962) and seasonal consumptive use coefficients (K). If, for example, part of the overall cropping pattern is flood irrigated and the remaining portion is sprinkler irrigated, two separate CIRs would be computed.

Step 6: Effective rainfall is computed using the procedure presented in Table 3, page 13 of Technical Bulletin No. 1275 (Blaney, 1962) or Table 5, page 21 of Technical Report 32 (Blaney, 1965).

Step 7: The consumptive irrigation requirement (CIR) for each crop in the cropping pattern is computed by subtracting the effective rainfall (R_e) from the consumptive use (U), i.e., the $CIR=U-R_e$, or $CIR=ET-R_e$

Step 8: The crop distribution ratio (CDR) is computed by dividing the acreage planted in a specific crop by the total acreage for all crops included in the cropping pattern.

Step 9: Multiplying the CIR by the crop distribution ratio yields the weighted CIR for a crop. The sum of all the weighted CIRs is the CIR for the cropping pattern. If the cropping pattern includes multiple-cropped acreage, i.e., acreage on which two or more crops are produced in the same year, the CIR for the cropping pattern is multiplied by the ratio of the gross irrigated acreage to the net irrigated acreage to yield the CIR for the cropping pattern. The net irrigated acreage is the difference between the gross irrigated acreage and the multiple-cropped acreage. The adjusted CIR would be computed as follows:

$$CIR_a=CIR[A_g/(A_g-A_m)]$$

Where A_g is the gross irrigated acreage and A_m is the multiple-cropped acreage.

For New Mexico's 2000 water use inventory, CIRs were computed for 184 different cropping patterns using 1999 weather data, 1999 irrigated acreages compiled by OSE staff with the assistance of the U.S. Department of Agriculture Farm Service Agency and New Mexico State University Agricultural Extension Agents and computer software developed by the author (Wilson, 1990). Note that 1999 crop acreages and weather data were used rather than 2000 data because drought conditions prevailed throughout the better part of the state for the first six months of 2000. Because the water use data published in this report is often used for long-term planning, the drought year data would not represent normal conditions appropriate for planning.

Step 10: The farm delivery requirement (FDR) is computed by dividing the CIR expressed as a depth or volume by the on-farm irrigation efficiency (E_f). For example, if the CIR is 2.0 acre-feet per acre and E_f=60%, FDR=CIR/E_f=2.0/0.60=3.33 acre-feet per acre.

The on-farm irrigation efficiency is affected by farm and field conditions, i.e., type of soil, slope, length and width of field, land surface preparation (leveling and tillage), root depth of crop at the time of each irrigation event (the root depth of annual crops changes throughout the growing season), antecedent soil moisture conditions, quality of irrigation water, type of irrigation system, available head at the farm headgate, frequency and amount of water applications, and farm water management practices. An efficient irrigation system may result in higher plant transpiration rates that an inefficient system because there will be fewer dry spots on the field (better distribution uniformity); and the crop yield per unit of water transpired will be higher under good management than under poor management (Burt, 1995).

Step 11: The project diversion requirement (PDR) or off-farm diversion requirement is computed by dividing the farm delivery requirement by the off-farm conveyance efficiency (E_c). For example, if the FDR =3.33 acre-feet per acre and E_c =70%, PDR=FDR/E_c=3.33/0.70=4.76 acre-feet per acre.

Step 12: If records of measured withdrawals are available, the ground and surface water components for combined water can be determined by comparing the total theoretical withdrawal with the measured withdrawal. If a shortage occurs, i.e., the measured surface water withdrawal is less than the theoretical withdrawal, it is assumed that the difference is made up with ground water. The acreage irrigated by surface water is then the product of the surface water withdrawal and irrigation efficiency divided by the CIR; and the acreage irrigated by ground water is the difference between the total acreage irrigated and the estimated acreage irrigated by surface water.

It is important that when separating combined water into its ground and surface water components, that the appropriate irrigation efficiencies are used when the source of the surface water is located off-farm while the source of the ground water originates on-farm.

Step 13: Any event or condition imposed by man or nature that affects the health of irrigated crops during the growing season will generally reduce the amount of water consumptively used by plants to a level which is below that predicted by the Blaney-Criddle method for a well-watered crop which is free of disease. Thus, it may be necessary to adjust the theoretical CIR and estimated diversion requirements to reflect these conditions. The conditions that should be taken into consideration when estimating crop water requirements can be separated into five categories.

Weather Conditions. Excessive rain and flooding that inundates crops and damages diversion structures or ditch conveyance capacity; hail, high winds, and drought.

Soil Conditions. Salinity, sodicity, pH excesses or deficiencies, nutritional imbalances, i.e., excesses or deficiencies in nitrogen (N), phosphorous (P), and potassium (K); and waterlogging.

Biological Conditions. Crop damage caused by wild animals, birds, and insect infestations; plant diseases; and weeds.

Farm Operations. Application of physical, chemical or organic amendments; application of pesticides and herbicides; equipment failure such as the breakdown of groundwater pumping plant; shortages of farm laborers.

Economic Conditions. Cost of water and changes in the market price of crops may affect the farmer's decision to irrigate. If crop prices fall during the irrigation season, a farmer may apply fewer irrigations and actually stress the crop at the expense of lower yield rather than supply the full crop water requirement.

If measured withdrawals are available, they are compared with computed withdrawals and the CIRs are adjusted downward where measured withdrawals are less than the computed withdrawals. Records of measured withdrawals are often available for irrigation projects administered by some of the organizations mentioned in Step 1. When measured withdrawals are not available, water shortages and necessary adjustments to CIRs may be estimated on the basis of field observations made during the irrigation season and comparison of recorded streamflows with the irrigation demand.

Step 14: Coefficients for incidental depletions, referred to as incidental depletion factors from hereon, are assigned to each area according to the type of irrigation system and source of water. Incidental depletions may be expressed as a function of irrigation diversions or the CIR. When expressed as a function of irrigation diversions the total incidental depletion is computed as follows:

$$ID=PDR(F_1)+FDR(F_2+F_3)$$

Where PDR is the project diversion requirement; FDR is the farm delivery requirement; and F_1, F_2, and F_3 are the incidental depletion factors above-farm (canals and laterals), on-farm, and below-farm. See glossary for definitions of these terms.

Expressed as a function of the CIR, the total incidental depletion is computed as follows:

$$ID=CIR(G_1+G_2+G_3)$$

where G_1, G_2, and G_3 are the incidental depletion factors above-farm, on-farm, and below-farm.

It is important to remember that G_1, G_2, and G_3 will not have the same value as F_1, F_2, and F_3 because they are based on two different functions. Multiplying G_2 and G_3 by the on-farm irrigation efficiency (E_f) will yield the value of F_2 and F_3, i.e., $F_2=G_2E_f$ and $F_3=G_3E_f$. Multiplying the CIR by G_1 and dividing the product by the project diversion requirement (PDR) will yield the value of F_1, i.e., $F_1=G_1CIR/PDR$.

Incidental depletions associated with canals and laterals are generally estimated by determining (1) the total length of canals and laterals, (2) the top width of the water surface, (3) the fringe width on each side of the canal where phreatophytes consumptively use seepage water, (4) the percent of time during the irrigation season when water is flowing, and (5) the net evaporation

rate during the irrigation season. Taking the product of all these elements and dividing by the normal CIR (total acre-feet) for the area under study yields the incidental depletion factor for canals and laterals expressed as a function of the CIR.

Note that because the dimensions, phreatophyte population, and percent of time laterals are flowing will be different from canals, incidental depletions for canals and laterals are generally estimated separately and then aggregated.

In New Mexico, for flood irrigation systems (furrow or basin-border) operating at 55% efficiency, incidental depletions on-farm are generally estimated as 2.75% of the diversions at the farm headgate or well, or 5% (2.75/0.55) of the CIR. For sprinkler irrigation systems operating at 65% efficiency, incidental depletions on-farm are generally estimated as 17% of the farm withdrawals, or 26.2% (17/0.65) of the CIR. In some areas of the state, such as the Roswell Artesian Basin in Chaves and Eddy counties, where sprinklers operate at about 70% efficiency, incidental depletions are estimated as 24.3% (17/0.70) of the CIR. Sternberg (1967) found that sprinkler losses were much greater during the daytime (20% of farm withdrawals) due to higher temperatures and wind movement, than during the nighttime (14% of farm withdrawals). The incidental depletion factors used in this inventory for sprinkler irrigation reflect the average of sprinklers operating day and night. Incidental depletions for high-pressure sprinkler irrigation in areas where high winds prevail, such as the Northern High Plains of New Mexico, which includes Curry, Harding, Quay, and Union counties, are estimated as 22% of the farm withdrawals, or 33.8% (22/0.65) of the CIR.

Incidental depletions associated with drains below-farm may be estimated using the same technique applied to canals and laterals. Evapotranspiration losses from areas below-farm where runoff and seepage accumulate can be estimated on the basis of the wetted area, percent of time the area is wet, and net evaporation rate or CIR for native vegetation.

In water resources management, it is often assumed that the difference between the total diversion and crop consumptive use in return flow to the stream system or groundwater aquifer. If incidental depletions are ignored, estimates of return flow will be too high. It is important therefore, that incidental depletions be properly accounted for.

Figure 4.1 illustrates how incidental depletions fit into the total water demand on an irrigation project that diverts surface water from a stream or reservoir, and transports it via canals and laterals to farms. In this example, the consumptive irrigation requirement (CIR) is 2.0 acre-feet per acre; the on-farm efficiency (E_f) is 60%; the farm delivery requirement (FDR) is 3.33 acre-feet per acre; the off-farm conveyance efficiency (E_c) is 70%; and the project diversion requirement (PDR) is 4.76 acre-feet per acre. Incidental depletion factors expressed as a percent of the consumptive irrigation requirement, are 4%, 5%, and 5%, above-farm (canals and laterals), on-farm, and below-farm, respectively.

Step 15: The total quantity of water depleted (D) on a farm or irrigation project is the sum of the CIR and the incidental depletions (ID), i.e., D=CIR+ID. For example, if the CIR=2.0 acre-feet per acre and the total incidental depletion expressed as a function of the CIR is 14% ($G=G_1+G_2+G_3=0.14$) then:

Since ID=CIR(G),

$$D=CIR(1+G)=2.0(1+0.14)=2.28 \text{ acre-feet per acre}$$

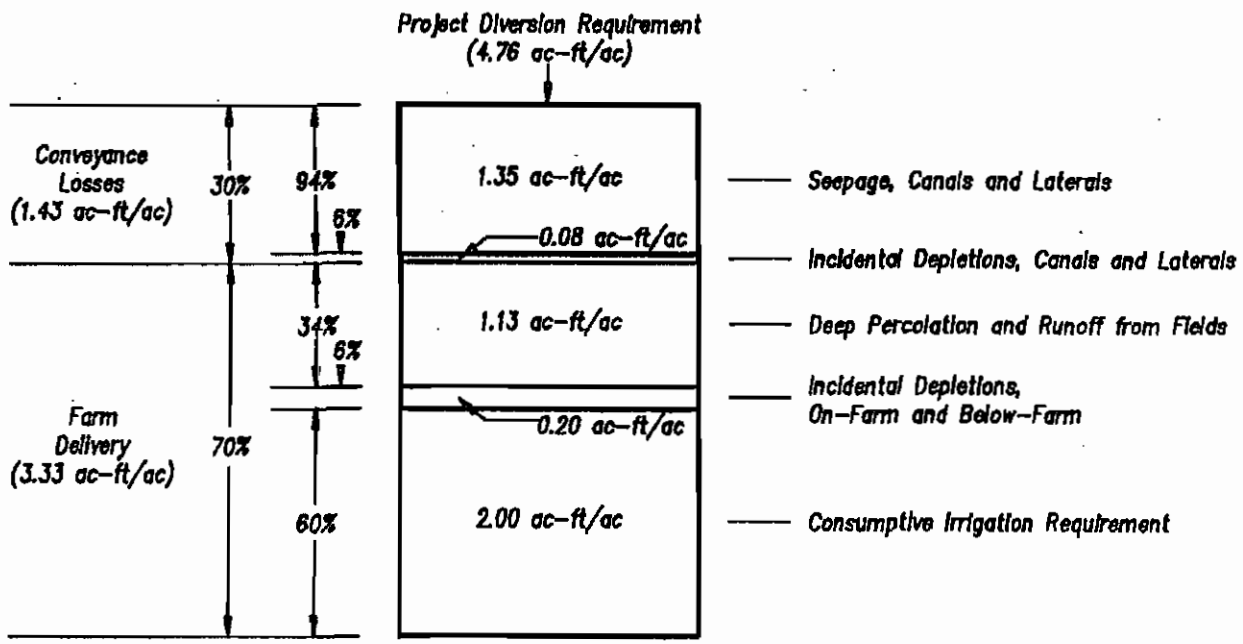

Figure 4.1 Components of the Water Demand on an Irrigation Project

THE ORINGINAL BLANEY-CRIDDLE METHOD

4.4.1. Consumptive Use (U)

The original Blaney-Criddle method (1950, 1962) was born out of studies conducted in New Mexico during 1939 and 1940 in the Pecos River Joint Investigation initiated by the National Resources Planning Board. It uses mean monthly air temperatures (T) expressed in degrees Fahrenheit, monthly percentage of annual daylight hours (P) based on latitude of the area under study, seasonal consumptive use coefficients (K), and length of growing season to estimate the total consumptive use (U) or evapotranspiration (ET) of water during the growing season for a crop that is well watered and free of disease. The consumptive use in inches for each month is expressed as:

$$U=ET=[(T)(P)/100](K)$$

Adding the consumptive use computed for each month yields the total consumptive use for a specific crop during the growing season. Note that the monthly values computed using the above expression are not the actual consumptive use that occurs in any one month since the seasonal crop coefficient is used. The monthly values are computed for convenience in determining the seasonal value.

The distinctive feature of the original Blaney-Criddle method is that the consumptive use coefficient (K) remains constant throughout the frost-free period. If the growing season of a crop begins before the last spring frost of 32 degrees Fahrenheit occurs or extends beyond the occurrence of the first fall frost of 32 degrees Fahrenheit, for this part of the growing season that is outside the frost-free period, another consumptive use coefficient is generally applied that is lower than the value used during the frost-free period. For crops which have a growing season that begins before or extends beyond a frost date, in a month in which a frost occurs, the days inside and outside the frost-free period must be separated into two different components so that the appropriate consumptive use coefficients can be applied. In a month in which the growing season begins or ends, the consumptive use coefficient is multiplied by the ratio of the number of days in the month the crop is "growing" to the total number of days in that month.

4.4.2. USBR Effective Rainfall (Re)

The amount of rainfall that becomes available to crops is influenced by the following factors: (1) duration and intensity of rainfall; (2) antecedent moisture condition of soil; (3) infiltration capacity of the soil; (4) presence of surface seals and crusts; (5) slope of fields; (6) root development of the crop; and (7) interception by the plant canopy.

As it was published in 1950, the original Blaney-Criddle method did not include a procedure for estimating effective rainfall. Blaney (1962) later adopted a method that was developed by the U.S. Bureau of Reclamation (USBR). The USBR method expresses effective rainfall as a percentage of the total monthly rainfall and for each one inch increment in rainfall there is a corresponding decrease in the percentage of effective rainfall. The USBR method was originally published as a table of values. However, since the table is often misinterpreted, the effective rainfall is better expressed as a set of equations. Note that the effective rainfall (R_e) cannot exceed the consumptive use (U). Adding the effective rainfall computed for each month yields the total effective rainfall for a specific crop during the growing season.

Table 4.1. USBR effective rainfall.	
Monthly Rainfall (R) (Inches)	Effective Rainfall (R_e) (Inches)
$1 \leq R$	Re=0.95R
$1 < R \leq 2$	R_e=0.95+0.90(R-1)
$2 < R \leq 3$	R_e=1.85+0.82(R-2)
$3 < R \leq 4$	R_e=2.67+0.65(R-3)
$4 < R \leq 5$	R_e=3.32+0.45(R-4)
$5 < R \leq 6$	R_e=3.77+0.25(R-5)
$R > 6$	R_e=4.02+0.05(R-6)
Key to symbols: < means less than; ≤ means less than or equal to; and > means greater than.	

4.5. CALIBRATION OF CONSUMPTIVE USE FOR ALFALFA AND PECANS

4.5.1. Alfalfa

In the late 1970s, researchers at New Mexico State University developed a crop production function for alfalfa which correlates annual evapotranspiration (consumptive use) with annual crop yield (Sammis, 1979, 1982). This crop production function is a linear relationship that may be expressed as follows:

$$Y=0.1572ET_{in}-0.5904$$

where Y is the annual yield in tons per acre at 15% moisture content, which is the normal field-dried condition; and ET_{in} is the annual evapotranspiration in inches. Rearranging this equation to solve for ET_{in}, results in the following expression:

$$ET_{in}=(Y+0.5904)/0.1572$$

By substituting the annual yield reported for a specific calendar year into the equation, the annual consumptive use can be computed, and the weighted consumptive irrigation requirement for the cropping pattern, adjusted accordingly.

For the purpose of this water use inventory, alfalfa yields reported by the New Mexico Agricultural Statistics Service for 1999 were used in Sammis's crop production function to calibrate ET for alfalfa in several counties. If the ET predicted by Sammis's crop production function was higher than the value computed using the original Blaney-Criddle method and a consumptive use coefficient (K) of 0.85 inside the frost-free period and 0.50 outside the frost-free period, the ET produced by the crop production function was used in determining the consumptive irrigation requirement for alfalfa, provided that the reported yields were accurate and sufficient water was available to satisfy the irrigation demand. Counties in which this adjustment was made include: Bernalillo, Curry, De Baca, Dona Ana, Grant, Harding, Hidalgo, Lea, Luna, Roosevelt, Sandoval, San Juan, San Miguel, Santa Fe, Sierra, Socorro, Torrance, Union, and Valencia.

4.5.2. Pecan Orchards

It is generally accepted amongst both producers as well as agricultural researchers that the water requirements for pecan orchards are much higher than for other deciduous orchards. Studies conducted in the Rio Grande Valley near Las Cruces, New Mexico and El Paso, Texas by the Bureau of Reclamation in 1972-73 and by Miyamoto in 1981 (Miyamoto, 1983) indicate that the annual consumptive use of mature pecan trees typically ranges from 39.36 to 51.24 acre-inches per acre and depends on the tree size and planting density.

Historically, the New Mexico State Engineer Office has estimated the water requirement for pecan orchards using the original Blaney-Criddle method and seasonal consumptive use coefficient of 0.65. The research conducted by the Bureau of Reclamation and Miyamoto indicates that the seasonal coefficient of 0.65 is much to low and needs to be revised. There is also evidence that the threshold temperatures which are normally used to define the growing season for deciduous orchards are inappropriate for pecan orchards. Transpiration of pecan orchards generally begins when the mean daily air temperature reaches 60 degrees Fahrenheit in the spring, and it ends the day after the first fall frost of 28 degrees Fahrenheit or below occurs in the fall (Miyamoto, 1983).

Using this criteria to define the growing season, and assuming the annual consumptive use of water in a pecan orchard is at least 39.36 inches, and that the value of the consumptive use coefficient outside the frost-free period is 0.40, the author has calibrated the seasonal consumptive use coefficient for the frost-free period. This calibration results in a seasonal consumptive use coefficient (K) of 0.90 inside the frost-free period, and was used to quantify the consumptive irrigation requirements of pecan orchards included in 1999 cropping patterns.

4.6. COMPUTATIONAL AID FOR IRRIGATION TABLES

The equations which follow are used to compute the irrigation withdrawals and depletions shown in Tables 8 and 9 in the latter part of this report. They may also be used for other irrigation studies.

4.6.1. Computing Withdrawals (Table 8)

(1) $TFWSW=CIRSW(ASWO+ASWC)/E_f$
(2) $TFWGW=CIRGW(AGWO+AGWC)/E_f$
(3) $TPWSW=TFWSW/Ec$ where $Ec > 0$
(4) TPWGW=TFWGW (assuming the source of water is on-farm)
(5) CLSW=TPWSW-TFWSW

4.6.2. Computing Depletions (Table 9)

(1) TFDSW=CIRSW(1+IDFOF)(ASWO+ASWC)
(2) TFDGW=CIRGW(1+IDFOF)(AGWO+AGWC)
(3) TPDSW=CIRSW(1+IDFSW)(ASWO+ASWC)
(4) TPDGW=CIRGW(1+IDFGWO)(AGWO)+CIRGW(1+IDFGWC)(AGWC)

4.6.3. Key to Acronyms Used in Equations

(a) AGWC = ground water component of acreage irrigated with both surface and ground water (combined water).
(b) AGWO = acreage irrigated with ground water only.
(c) ASWC = surface water component of acreage irrigated with both surface and ground water (combined water).
(d) ASWO = acreage irrigated with surface water only.
(e) CIRGW = consumptive irrigation requirement for acreage irrigated with ground water.
(f) CIRSW = consumptive irrigation requirement for acreage irrigated with surface water.
(g) CLSW = surface water conveyance losses in canals and laterals from stream or reservoir to farm headgate.
(h) E_f = on-farm irrigation efficiency.
(i) E_c = off-farm conveyance efficiency.
(j) IDFBF = incidental depletion factor, below-farm.
(k) IDFCL = incidental depletion factor, canals and laterals, from stream or reservoir to farm headgate.
(l) IDFGWO = sum of incidental depletion factors that apply to withdrawals of ground water only. Note that if the source of water is on-farm (spring or wells), IDFGWO=IDFOF. However, if the source of water is off-farm, IDFGWO=IDFCL+IDFOF.
(m) IDFGWC = sum of incidental depletion factors that apply to the groundwater component of withdrawals where both surface and ground water (combined water) are applied, i.e., IDFGWC=IDFOF+IDFBF when the groundwater source is on-farm.
(n) IDFOF = incidental depletion factor on-farm.
(o) IDFSW = sum of incidental depletion factors that apply to surface water withdrawals, i.e., IDFSW=IDFCL+IDFOF+IDFBF
(p) TFDGW = total farm depletions, ground water.
(q) TFDSW = total farm depletions, surface water.
(r) TFWGW = total farm withdrawal, ground water.
(s) TFWSW = total farm withdrawal, surface water.
(t) TPDGW = total project depletion, ground water.
(u) TPDSW = total project depletion, surface water.
(v) TPWGW = total project withdrawal, ground water.
(w) TPWSW = total project withdrawal, surface water.

4.7. ACREAGE IRRIGATED

For the purpose of this inventory, irrigated crop acreages and weather data for the 1999 calendar year was used in most areas to reflect normal conditions rather than a drought year condition. In Sierra, Dona Ana, and San Juan County, irrigated crop acreages used in this report are based on inventories conducted in calendar year 2000 using Geographic Information Systems (GIS) technology.

The total acreage irrigated on farms in 1999 was 998,793 acres. Approximately 388,157 acres or 38.86% were irrigated with surface water, and 610,636 acres or 61.14% were irrigated with ground water. Irrigated acreage and sources of irrigation water in New Mexico counties in 1999 are presented in Table 11 in the series of tables included in the latter portion of this report.

Drip irrigation accounted for 7,436 acres or 0.74%, flood for 530,754 acres or 53.14%, and sprinkler for 460,603 acres or 46.12%. Acreage irrigated by drip, flood, and sprinkler application

methods and sources of water in New Mexico counties in 1999 are presented in Table 12 in the series of tables included in the latter portion of this report.

Table 4.2. Acreage irrigated in New Mexico, 1980-1999.

Year	Acres
1980	1,087,120
1985	941,245
1990	984,285
1995	963,050
1999	998,793

4.8. SURFACE WATER SHORTAGES

In Cibola County irrigators were short 75%; in McKinley County irrigators were short 90%; and in San Juan County irrigators along the La Plata River were short 14% and the Hammond Irrigation District was short 26%.

In Colfax County shortages were about 39% on the Cimarron River and the Vermejo Conservancy District was short 46%; in Mora County irrigators along the Mora River were short 18%; in San Miguel County irrigators along the Gallinas River were short 65%; and in Quay County the Arch Hurley Conservancy District was short 56%.

In Taos County, irrigators dependent upon surface water from the Rio Costilla were short 40%; in Santa Fe County the Santa Cruz Irrigation District (part in Rio Arriba County) was short 66% and the Pojoaque Valley Irrigation District was short 28%.

Surface water shortages also occurred in Eddy County in the Carlsbad Irrigation District and in Dona Ana County in the Elephant Butte Irrigation District (primarily in the winter months when there are no surface water deliveries); however, these shortages were offset by pumpage from supplemental wells.

4.9. CAUSES OF POOR IRRIGATION EFFICIENCY

The main body of the text that follows was adopted from a U.S. Government interagency task force report entitled "Irrigation Water Use and Management" (U.S. Department of Agriculture, 1979). The original text has been edited and updated for inclusion in this report.

In 1999, off-farm conveyance losses in canals and laterals in New Mexico were estimated at 734,050 acre-feet or about 40% of the total surface water withdrawals for irrigation. Off-farm conveyance losses can be attributed to permeable canals, obsolete, inadequate, or improperly maintained facilities, and excessive vegetative growth. Seepage through unlined canals is the main contributor to conveyance losses. Seepage rates are proportionately greater for canals with intermittent flows than for those under continuous operation. Obsolete, inadequate, or improperly maintained facilities result in poor control and management of water throughout the off-farm conveyance system which affects the on-farm management of water, causes seepage and transpiration losses, causes sediment to accumulate and contributes to structural failure and poor operation of the canals.

Physical conditions that contribute to inefficient water use on-farm include unlined farm ditches, lack of measurement structures, poor farm layout, and improper maintenance; and variabilities within fields of soil intake rates, water holding capacities, and erosion resistance. The method of water application, i.e., the type of irrigation system, affects irrigation efficiency, particularly if the method is not suited to soil or topographic conditions. On flood irrigated farms, the relationship between field slope, field length, soil characteristics, and water flow must be balanced to achieve uniform application with minimum deep percolation and surface runoff. For example, the slope and water flow rate may be acceptable, but the length of the field may be too long for the soil conditions. Flood irrigation of steep or nonuniform slopes may result in poor application uniformity, soil erosion, excess surface runoff, and deep percolation. Sprinkler irrigation on fine-textured soils produces surface runoff if the intake rate of the soil is exceeded by the application rate of the sprinkler.

Management factors that contribute to inefficient water use on-farm include lack of soil moisture data and improper timing of irrigation, lack of adequate flow measurements, incorrect application amounts, and lack of adequate facilities to control water. The timing of irrigations and the application amounts may vary because of water availability, other farm activities, or an off-farm job that requires the irrigator's attention, resulting in lower irrigation efficiencies. Farm labor hired for irrigating crops may not have the necessary experience to understand the soil, water, crop, and field relationships needed to achieve good efficiencies.

Institutional and social factors that affect on-farm irrigation efficiency include existing laws and court decrees, water and energy prices, and social attitudes related to land use. Under the doctrine of prior appropriation, an irrigator may use the total amount of water decreed, even if inefficiently, rather than lose the right to divert the water. The rate schedules to assess or charge irrigators in irrigation districts for the cost of water delivered in many cases are constant and do not discourage excessive use of irrigation water.

4.10. IMPROVING OFF-FARM CONVEYANCE EFFICIENCY

The off-farm conveyance efficiency can be improved by lining canals and laterals; installing closed pipe systems; consolidation and/or realigning the distribution system; replacing or installing flow-regulating structures; scheduling regular maintenance inspections and performing necessary work; and controlling aquatic and/or ditchbank weeds.

4.10.1. Canal Linings. Materials used for linings include compacted clays, hard-surface materials such as concrete or soil cement, or membranes such as asphalt and flexible plastic. Selection of a lining material is generally based on its availability, cost, and geographic location or climate where it is intended to be used. A compacted earth lining of silty clay has a seepage rate of about 2.394 gallons per square foot of wetted perimeter per day, while concrete lining has a seepage rate of about 0.598 gallons per square foot per day.

There are other benefits to lining systems in addition to reducing seepage. They include (1) the control of ditchbank weeds and aquatic growth which consume water and require use of herbicides, (2) a reduction of soil erosion, (3) an improvement in water quality, (4) a possible reduction in operation and maintenance costs, (5) reduced drainage requirements, and (6) reclamation of agricultural lands lost to seepage.

Pipe conveyance systems provide a means of completely enclosing a system to avoid many of the water losses that occur in an open system. In the past, pipelines to carry irrigation water were

used mainly where physical barriers such as steep escarpments and canyons made open systems impractical. In mountain valley situations, consideration should be given to installing pipelines for gravity sprinkler systems.

Relatively few piped systems have been installed to date. Where piped systems have been installed, conveyance efficiencies greater than 95% have been attained. Additional benefits include better utilization of lands along system rights-of-way, elimination of safety hazards common to open systems, reduction of evaporation losses, and better control of water delivered to the farm, thus providing more options for the farmer.

Many conveyance systems were constructed along contours of the land to minimize excavation and fill construction activities that in the past were performed by crude and inefficient machinery. This resulted in the existence of many long and winding systems that have very high losses. Piping of such systems increases the off-farm conveyance efficiency, reduces seepage, and may reduce operation and maintenance costs.

4.10.2. Consolidation and/or Realignment. Consolidation and/or realignment is possible today because of modern construction methods. Better irrigation system features such as improved water control structures and lining and piping materials also make consolidation and/or realignment practical as effective water conservation measures. Benefits include: (1) reduced operation and maintenance activities for water users, (2) improved farm unit layout, (3) elimination of weeds along deleted waterways, (4) improved service to water users, (5) improved economic use of the land, and (6) reduction of diversion requirement.

4.10.3. Water Measurement. Water measurement accuracy is important in the operation of any water conveyance system. Measuring devices are essential if an accurate accounting of what happens to the water is to be made. Proper evaluation of losses is necessary to establish the economic advisability of providing canal linings.

4.10.4. Inline Structures. Inline structures include water measurement and regulating structures. Regulating devices are checks, check-drops, turnouts, diversion structures, check inlets, and regulating reservoirs. These structures are used to regulate the flow passing through the conveyance system and/or control the elevation of the upstream water surface. The equitable delivery of water to irrigators is dependent upon the size of the discharge openings, referred to as farm turnouts, and the water level behind the openings. If the structures of the system cannot maintain a constant or uniform water level, proper deliveries cannot be made to the irrigator. This may cause irrigators to use the water supply inefficiently. The use of proper check structures in a system also regulates the water level along the system, thus reducing operational wastes and losses.

4.10.5. Automation of Regulating Structures. The automation of regulating structures is designed to increase the overall efficiency of the system and reduce operational waste. While storage reservoirs and the outlet works of dams, diversion dams and canal headworks are often self-contained and isolated, they can be the focal point for demands of the conveyance system. The proper operation of these facilities through automation can help meet downstream diversion demands in the river (water rights and/or fish and wildlife commitments), and also lessen hydraulic fluctuations to provide smooth operation of the entire system. Automatic controls of check structures can sense deviations of water surfaces on the canal and operate adjacent checks upstream and downstream to provide a nearly constant water level. Automation of turnouts provides uniform deliveries from the distribution system to the farm. Wasteways are the traditional safety valves of the canal operation. They remove excess water and prevent

overtopping of the canal. Operational wastes can be eliminated or greatly reduced when a high degree of automation is utilized on other structures within the system. Benefits that would accrue as a result of automation of facilities would be both tangible and intangible. The tangible benefits could be reduced operation and maintenance costs of the conveyance and distribution system, and more reliable water supply. Intangible benefits might include safety, and aesthetic values.

4.10.6. Maintenanee of Facilities. Proper maintenance of facilities that control and regulate the flow of water is fundamental to good water management practices of the project and the water users. The accuracy of measuring devices, most important for efficient operations, can be assured through inspection and routine maintenance. Facilities designed to maintain water levels in the system need to be under a regular maintenance program to provide optimum service. The regular removal of debris from the system throughout the season and removal of sediment during the off-season will eliminate many operating problems.

4.10.7. Weed and Phreatophyte Control. A weed and phreatophyte control program can effectively minimize excessive vegetation in and along ditchbanks and can be accomplished by mechanical, chemical or biological means. Any method of control will have economic and environmental impacts. Chemical control is generally the most effective and economical but may not be environmentally acceptable. Mechanical control may be less effective and more costly in manpower and equipment. Benefits of a routine weed and phreatophyte control program include increased water delivery capacity, a possible reduction in operation and maintenance costs, and reduced water consumption by ditchbank vegetation.

4.10.8. Conveyance Design. The application of any measure that may improve on-farm efficiency is often limited by the design and management of the conveyance and distribution system. Existing systems have been designed to deliver water by a continuous flow, rotation, or demand method. The continuous flow and rotation methods may discourage efficient on-farm and system water use. The rotation delivery system is designed with a capacity to deliver water for short periods of time at scheduled regular intervals. The demand system of delivery method is designed with a capacity to deliver on short notice the flow ordered by an irrigator. The demand method is best suited to promote the efficient use of water. Any improvement measures, either on-farm or in the system, should be interrelated with the delivery capacities of the system. This will provide the type of irrigation delivery system that will allow the irrigator flexibility in choosing on-farm methods to conserve water. However, to change from one method to a more efficient method may require installation of costly structural measures.

4.10.9. Scheduling Water Deliveries. Scheduling water deliveries is an important water management measure. Scheduling deliveries provides for the allocation of water in accordance with actual and projected crop use, rainfall, cultural practices, delivery system carrying capacity, and field irrigation characteristics. Deliveries can be scheduled to make the most effective and efficient use of the total water supply. Use of scheduling might eliminate the need for enlargement of the conveyance system to deliver more efficient flows. Scheduling deliveries on most distribution systems can be accomplished without additional operating personnel.

4.11. IMPROVING ON-FARM IRRIGATION EFFICIENCY

The on-farm measures are those that affect the problems causing efficiency on the farm. These measures deal with the on-farm delivery system, field application system, and water management problems.

4.11.1. Ditch Lining or Piping. An effective method of reducing seepage is to line ditches or replace them with pipelines. These measures are similar to lining or piping off-farm systems. Ditch lining may be less costly to install but is not suitable to all topography and farm layouts. Piping is more effective than ditch lining in managing water because it eliminates evaporation, and when buried, can be farmed over and automated easily. Both lining and piping may reduce labor and maintenance costs of the irrigator.

4.11.2 Land Leveling. Land leveling is reshaping the surface of a field to planned irrigation grades or slopes and is most important in flood irrigation systems. Proper land grades for the field application system being used allow better control and more uniform application of water, which may result in increased efficiency. Where basin-border irrigation is practiced, fields which have not been leveled will require a greater depth of water to cover the high and low spots, and in the low spots, more water will be lost to deep percolation. Thus, the depth or volume of water required to irrigate a laser leveled field will be less than what is needed for a field that has not been leveled because the highs and lows have been removed.

4.11.3 Minimum Tillage. Crop residue left by minimum or no-tillage increases soil tilth, allows more water to penetrate the soil and prevents puddling and runoff. Deep tillage with a chisel plow also increases penetration and breaks up hardpan that can restrict root development. (Anonymous, 1980).

4.11.4. Water Control Structures. Water control structures are those on-farm facilities that control and regulate the flow of water from the farm delivery point to the field. These facilities are similar to the off-farm inline structures, but are designed for smaller flows. Examples of water control and regulating structures are checks, drops, divider boxes, and reservoirs. The control and regulation of water flow on the farm is required to distribute water throughout the on-farm delivery system. Using divider boxes and checks, water can be diverted from one location to another. Checks are used to maintain the constant water level required to achieve efficient application of water on the fields. Drop structures allow the transportation of water along steep slopes, while maintaining a nonerosive slope in each reach of the conveyance system. Where adequate hydraulic head is available at the farm headgate, high-flow turnouts can reduce the irrigation time, the amount of water applied, and labor requirements; improve distribution uniformity of the surface application; and increase the efficiency of water-borne nutrient applications. On-farm reservoirs can accumulate low flow rates from wells or canals until sufficient volume is available for efficient application. Water control structures are most effective in the mountain meadow and intermediate valley irrigation zones where the on-farm delivery systems are relatively old and usually lacking in measuring devices and structures.

4.11.5. Flow Measurement Devices. For the irrigator to apply the specified amount of water at each irrigation, he must have some method of water measurement. Flow measurement devices can be installed in open ditches and in pipelines. Some examples are Parshall flumes, cutthroat flumes, weirs, orifice plates, and flow meters. In addition to telling farmers how much water has been pumped, meters are also useful in determining the efficiency of a pumping plant and detecting potential well and pump problems before they become a serious problem. Installation of flow measuring devices will not in itself conserve water. These devices must be maintained and used by the irrigator to control the amount of water applied. They will be most effective when used in conjunction with an irrigation scheduling program.

4.11.6. Tailwater Recovery Systems. Tailwater recovery systems are used to catch runoff resulting from irrigation and return the water into the original delivery system or onto another irrigated field. The system usually consists of a sump, pit, or collection reservoir located below

the irrigated area, a pump, and a pipeline to deliver water back to the delivery system or to the irrigated field. Tailwater pits may lose a third of the inflow because of deep percolation and evaporation (Blair, 1981). They may also become a potential breeding ground for mosquitoes. A better alternative may be to adopt management practices that reduce runoff and eliminate the need for tailwater recovery.

4.11.7. Selection of Application Method. Three methods of irrigation water application—flood, sprinkler, and drip—were described earlier in this section. Switching from one of these methods to another constitutes a change in method of irrigation application. This is a valid alternative for improving water use and management where the existing irrigation system is poorly suited to the site conditions and the desired degree of efficiency cannot be obtained by improving the system design.

No one irrigation method is consistently more efficient than other methods, and conversion from one method to another should be based on such a premise. The potential change in method should be based on evaluation of land slope, crops to be irrigated, water supply, water intake and water-holding capacity of the soil, labor, and other factors, including economic and environmental impacts. The method selected should conserve soil as well as water. To do this, it may be necessary or desirable to use more than one method of irrigation on any given farm. For example, crops which are drip irrigated may have to be flood or sprinkler irrigated occasionally to apply a sufficient head of water to leach salts out of the root zone.

A change from flood to sprinkler irrigation may be warranted when soils have high intake rates that cause excessive deep percolation with flood methods; fields are steep or have complex slopes; or light frequent water applications are required due to crop requirements or soil water-holding characteristics. Efficient flood irrigation is possible, except on steep slopes and coarse-textured soils, when flow rates, time of set, and length of run are properly chosen. Flood systems may be preferred when large water applications are needed for leaching to maintain salt balance; when sprinkling with low quality water would cause damage to crop foliage; when effective use of rainfall and erosion control is feasible by land leveling; or when sprinkler evaporation losses are excessive due to wind and other climatic conditions. Drip irrigation should be considered when (1) the water supply is limited, (2) there is need for a high degree of automation (reduced labor), (3) slopes are excessive, or (4) the cost of water is high.

4.11.8 Improved Application Method. The improved design of an existing application method can be effective in managing irrigation water by facilitating better control of the available water supply. Other purposes may include more effective use of rainfall and labor, reduction of energy requirements, reduction in operation and maintenance costs, and provision for safety features. Reorganization of irrigation systems should be based on analyses of the particular site conditions by personnel who have expertise in irrigation design and water management.

Examples of design changes for sprinkler systems include reorificing sprinkler heads, and changing sprinkler spacings and operating pressures to improve distribution patterns and application rates. Center pivot sprinklers may be fitted with drop down tubes which bring the spray nozzles to within a few inches of the ground. These systems which are referred to as low energy precision application systems (LEPA), can achieve application efficiencies of up to 95%. Because water is applied at low pressure directly above the furrow, wind drift and evaporation losses are virtually eliminated. To maximize uniform water activity with LEPA systems, farmers may use furrow dikes to hold the water in place until it has had time to soak in. Irrigators who have converted their irrigation systems from conventional furrow to LEPA report reduced labor costs of up to 75%, decrease of 35% to 50% in energy costs, water savings of at least 25%, and

increases in yields of 25% or more because water previously lost to evaporation is available to the crops. (Anonymous, 1989).

Flood system design may often be improved by adjusting run lengths and furrow streams to prevent excessive deep percolation and runoff; changing dimensions of border strips to obtain proper advance and recession of the irrigation streams; reducing irrigation grades by land leveling; adjusting spacing of field ditches; and adding tailwater recovery facilities, automation, and measuring equipment. A time-controlled surge irrigation valve management correctly in conjunction with a furrow irrigation system can eliminate irrigation tailwater losses minimize deep percolation losses and reduce the length of time that water in the furrow is exposed to evaporation. Water savings of 10% to 40% have been measured after the addition of surge valves to conventional irrigation systems (Anonymous, 1989).

4.11.9. On-Farm Irrigation Water Management. On-farm irrigation water management is the determination and control of the rate, amount, and timing of irrigation water application to soils to supply water needs in a planned and efficient manner. Improvements in water management can reduce mining of groundwater supplies, reduce diversion rates from natural streams or reservoirs, reduce tailwater runoff, reduce deep percolation losses, reduce nutrient losses, improve water quality, and improve crop yields. Management improvements can be made by irrigation scheduling and applying water in desired rates and amounts. Many irrigators apply water on a set schedule without regard to crop needs or moisture-holding capabilities of the soil because of habit or other constraints. Inadequate or ill-timed applications can result in lowered crop yields. Irrigation scheduling involves use of data on soil moisture availability, crop water requirements, and rainfall to achieve a soil moisture balance for the irrigator's fields. The objective is to enable the farmer to determine when he needs to irrigate and how much water to apply. Additional labor can often allow the irrigator to better manage his water.

Scheduling is most effective when irrigation water supplies are adequate, but can be useful in managing a limited supply. If a complete scheduling program is not used, soil moisture determination by itself can improve water management. Whether the determination is made by a shovel, probe, moisture block, or tensiometer, the level of soil moisture is estimated, and irrigation water is applied if moisture is below a specified level. This specified level will vary, depending on the soil, climate, crop, and stage of crop development. Excess water application may cause surface runoff or deep percolation. Inadequate application will not maintain an optimum moisture level and will require more frequent irrigations. The timing and measurement of water are essential to determine how much is being applied.

The potential benefits of irrigation scheduling are illustrated by the following examples.

In 1976, farmers in central Nebraska who were cooperators in an irrigation scheduling program piloted by the University of Nebraska applied an average of 15 inches of water to about 5,000 acres of cropland; farmers who were not in the program applied an average of 24 inches of water. (Ruen, 1977). As a result, farmers in the scheduling program reduced both the amount of ground water pumped and the cost of pumping by about 38%.

The University of Nebraska irrigation scheduling technique used a computerized scheduling program on Nebraska's AGNET computer system. Soil moisture data for the AGNET program was collected from electrical resistance blocks placed in the soil at depths of 0.5, 1.5, 2.5, and 3.5 feet. Irrigations were scheduled when the moisture in the root zone was more than 50% depleted. The irrigation water applied was less than that necessary to fill the soil profile completely, so the soil could absorb rainfall if it should occur.

Since 1984, at the cost of a few dollars per acre, farmers in 16 counties in California have reduced the amount of water they apply to their fields by 15% to 50% using gypsum blocks to signal when its time to irrigate. In Colorado, farmers who have installed gypsum blocks at one or two sites within each circle under center pivot irrigation have reduced their annual diversions by 30% to 40% and their pumping costs by $2,000 or more per field (Richardson, 1992).

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Chapter 5

Self-Supplied Livestock

5.1. INTRODUCTION

The procedure presented in this report for quantifying livestock withdrawals and depletions relies primarily upon the number of livestock reported by various state and federal agencies and per capita water requirements for each species of animal determined from agricultural research. A brief overview of factors that affect livestock water use is presented. The results of a recent study of drinking water requirements for beef cattle are reviewed. The migration of West Coast dairies to New Mexico and the exponential increase in the number of dairy cattle in Chaves County are noted. Water requirements for modern dairies are discussed in detail, and suggested guidelines for quantifying withdrawals and depletions in dairies are not included.

5.2. COMPOSITION OF CATEGORY

Livestock (LS). Includes water used to raise livestock, maintain self-supplied livestock facilities, and provide for on-farm processing of poultry and dairy products. This category is identified as **Major Group 02** in the Standard Industrial Classification Manual (1987) and there are also several subgroups.

5.3. PROCEDURE FOR QUANTIFYING LIVESTOCK WITHDRAWALS AND DEPLETIONS

Step 1: Numbers of beef cattle, chickens, hogs, milk cows, and sheep are enumerated by the U.S. Department of Agriculture, National Agricultural Statistics Service, and reported by county and species. Data used in this report was extracted from the New Mexico Agricultural Statistics Service's 2000 edition of "New Mexico Agricultural Statistics." The number of horses and mules in each county is obtained from data reported in property tax valuations filed with county assessors. When a county is divided into two or more river basins, the number of livestock in each basin is estimated based on local knowledge of grazing lands, location of feedlots, etc.

Step 2: Livestock water requirements for consumption (drinking) and other uses (e.g. dairy sanitation) exclusive of stockpond evaporation are estimated on the basis of a per capita use where metered withdrawals are unavailable. (Metered withdrawals are available for all dairies in Chaves County.) Withdrawals are computed using the following equation:

$$W=(GPCD)(POP)/892.74$$

where W is the annual withdrawal in acre-feet; POP is the population; and GPCD is gallons per capita per day. Water requirements for chickens, hogs, horses, mules, and milk cows are assumed to come from ground water sources only. However, drinking water requirements for beef cattle and sheep are generally assumed to come from both surface and groundwater supplies, with the emphasis on groundwater sources where surface water supplies do not provide a reliable source of water year around or where the quality of surface water supplies is unsatisfactory for livestock drinking water.

Step 3: Depletions for beef cattle, chickens, hogs, horses and mules, and sheep are assumed to equal withdrawals. The depletion rate for dairies will vary depending upon the nature of the operation. (See the discussion of dairies later in this section, and in particular, Tables 5.3 and 5.4.)

5.4. FACTORS WHICH AFFECT LIVESTOCK WATER USE

Livestock and poultry obtain water from three sources: water that is (1) consumed as free water, (2) contained in the feed, and (3) made available through metabolic processes. Many factors influence the intake of water by livestock and poultry. They include, species, size, age, sex, and production of the animal; amount and content of the feed; accessibility to water; and air temperature.

There are nearly as many different waste disposal systems as there are livestock enterprises. Manure generated by livestock on pasture and range is deposited directly on the land. Manure in lot areas is often dry and easily scraped and handled with loaders and spreaders. Holding ponds are often used to retain feedlot runoff until the waste can be spread. Manure in closely confined areas with slab or slotted floors is often wet, near a fluid state. It may be collected by flushing gutters, hosing or by falling through the slats into a holding tank, lagoon or oxidation ditch. It is applied to the land with slurry or tank spreaders or irrigation equipment, or is recycled. Many waste disposal systems require no additional water. However, over the years, and increasing number of hog and beef-cattle feeders and dairy herdsmen have adopted a partial or total liquid disposal system. Liquid systems may need to have water added to hose floors, flush gutters, start batch oxidation and/or dilute solid concentrations for biotic action or ease of handling.

Freshwater may also be required for animal washes and dips, quarter washdown and disinfectant sprays, cleaning and sanitizing equipment, washing eggs, and dust control. In addition to water consumed by animals, there are watering losses that include tank and trough evaporation, tank overflows, trough spills, and continuous ripple flow discharge (to prevent freezing). Overflows of watering devices are losses incurred with drinking water; however, these losses are not intake and are in addition to drinking water requirements. Watering losses are generally estimated as 10% of animal drinking water requirements (SCS, 1975).

5.5. LIVESTOCK NUMBERS

As of December 31, 2000, the number of beef cattle (exclusive of heifers) in New Mexico was estimated as 564,000. The number of milk cows in New Mexico in 2000 was estimated as 236,000; sheep and lambs as 290,000 (New Mexico Agricultural Statistics Service, 2000). The Agricultural Statistics Service no longer reports the number of hogs, pigs, and chickens. The

number of these animals used in this report are based on 1995 data. Hogs and pigs were estimated at 5,000 and chickens at 1,400,000. The number of horses was estimated as 24,870.

5.6. WATER REQUIREMENTS FOR BEEF CATTLE

Sweeten (1990a) studied drinking water requirements of 28,000 beef cattle on a feedlot in Texas over a period of 11 months during 1984 and 1985. Meter records from the municipality that provided water to the feedlot indicated an average consumption of 7 gallons per head per day (gpcd) and a range from 4.2 gpcd in the winter to 10.3 gpcd in the summer. Analysis of the data showed that drinking water requirements can be estimated at 0.48 gallons of water per pound of dry feed consumed. On the basis of this criteria, the data shown in Table 5.1 was developed. Given an 80% dry matter ration, an 800-pound animal will consume 9.6 gallons of water per day. A 10,000 head feedlot would require a continuous pumping rate of 67 gallons per minute (gpm) to meet the average demand and approximately 134 gpm to meet the peak demand. The pumping rate required for an 8-hour day utilizing a storage reservoir would be at least 200 gpm for a 10,000 head feedlot, and 400 gpm to meet the peak demand.

The average weight of a steer in New Mexico is about 764 pounds (New Mexico Agricultural Statistics Service, 1991). Using the guidelines developed by Sweeten, the average water requirement per head of beef cattle on an 80% dry matter ration would be 9.2 gallons per day. Allowing for trough water losses would increase the water requirement slightly. For the purpose of this water use inventory, withdrawals for beef cattle are computed on the basis of 10 gpcd and depletions are assumed to equal withdrawals.

Table 5.1. Drinking water requirements for beef cattle in gallons per capita per day (gpcd). (Source: Sweeten, 1990a).

Liveweight (lbs/hd)	Dry Feed Consumption (lbs/hd/day)	Water Required (gpcd) Dry Matter in Ration (%)		
		70	80	90
600	12	8.2	7.2	6.4
800	16	11.0	9.6	8.5
1000	20	13.7	12.0	10.7
1200	24	16.5	14.4	12.8

Note: To get gpcd, divide dry feed consumption by the percent of dry matter in ration expressed as a decimal and multiply the result by 0.48.

5.7. WATER REQUIREMENTS FOR MODERN DAIRY BARNS

In California, where strict air and water quality standards have been enacted, and prolonged drought has dried up the supply of cheap subsidized water farmers count on for the irrigation of pastures, dairymen have fixed their gaze on the land of enchantment in search of greener pastures. Eager to attract new business to give new life to a sagging economy, New Mexico bankers have made an extensive effort to seize this opportunity by enticing dairymen from California and Arizona to relocate in New Mexico. Dairymen have been attracted to New Mexico by inexpensive land, the availability of water, the low price of feed such as alfalfa, and a hospitable

climate (McCutcheon, 1991). In Chaves County alone, the number of dairy cattle has more than tripled from 1990 to 2000. In the last two decades Dona Ana and Roosevelt counties have also experienced a dramatic increase in the number of dairy cattle. Table 5.2 illustrates the historical increase in the number of milk cows in Chaves, Dona Ana, and Roosevelt counties.

Table 5.2. Number of milk cows in Chaves, Dona Ana, and Roosevelt counties as of January 1, 1976-2000. (Source: New Mexico Agricultural Statistics Service).

Year	Chaves	Dona Ana	Roosevelt
1976	2700	5500	5000
1977	3000	6500	5000
1978	3500	7000	4800
1979	4000	8500	5000
1980	4000	9200	5100
1981	5000	13100	6700
1982	7200	16000	6800
1983	9700	19300	6800
1984	10800	21000	7500
1985	12000	23800	7600
1986	13200	26000	7500
1987	10500	24400	6800
1988	10500	23400	6700
1989	12000	24000	7200
1990	19000	24000	9000
1991	34000	24500	9000
1992	39500	24500	11000
1993	49000	26000	16000
1994	56400	31000	18000
1995	70000	31000	20400
1996	69000	35000	25000
1997	70000	39000	27000
1998	67000	38000	32000
1999	76000	35000	33000
2000	80000	36000	35000

New diaries today typically operate with 1,000 or more head and maintain high animal concentrations in confined lots or corrals on small acreages relative to the number of cows. Typical animal spacings in open lots are 600 square feet per cow. Large amounts of water are used for manure removal and milk sanitation (Sweeten, 1990b).

Frank Wiersma (1988), Professor of Agricultural Engineering and Cooperative Agricultural Extension Service Dairy Specialist at the University of Arizona, developed the following guidelines for estimating water requirements of dairies.

Total daily water consumption by lactating cows is influenced by ambient climatic conditions and by milk production level. There is a compensating interaction between these two parameters in

that high temperatures reduce milk production level. Based on current studies, daily water consumption per lactating cow is given by the following equation:

$$GPCD=26+0.3(MP-40)$$

where GPCD is water consumed in gallons per capita per day and MP is fluid milk production in pounds per day. Since this equation is based on the premise that milk production is not less than 40 pounds per day, at which level the gpcd is 26, water requirements for lactating cows should be 26 gallons per day or the value produced by the above equation, whichever is greater. For a dairy operation to be profitable, cows must generally produce 65 to 75 pounds of milk per day. Substituting 75 pounds per day into the equation yields an average drinking water requirement of 36.5 gpcd.

In addition to lactating cows, dairies also have dry cows, bulls, springer heifers, young calves, and replacement heifers on the premises. One-quarter to a third of the dairy herd is generally retired each year and replaced with younger stock. Most of the water used exclusively by non-lactating animals on the dairy is for drinking. However, water is also used for hospital treatment, foot baths, water trough cleaning, and equipment washing. Total water requirements for non-lactating animals are about 20 gallons per animal per day or the equivalent of 6.6 gallons per lactating cow per day assuming there is one non-lactating animal for every three lactating cows (i.e., 6.6 gpcd=20gpcd/3).

Many of the milking eenter operations requiring water use are dictated by sanitary codes. All milk lines and associated equipment must be washed, rinsed and sanitized after each milking operation. Both hot and cold water are used. Parlor and holding area grates, floors, and walls must also be hosed down to remove manure after each milking. Hoses with spray nozzles must be available at all milking stalls for teat and udder cleansing prior to attachment of milking equipment.

A small number of dairies in New Mexico prewash the udders of lactating cows prior to entry into the parlor with a grid of jet sprayers at floor level in the holding area. Most dairies in New Mexico however, wash the udders with hand-held hoses before milking. Hoses with spray nozzles must be available at all milking stalls for teat and udder cleansing prior to attachment of milking equipment.

A small number of dairies in New Mexico prewash the udders of lactating cows prior to entry into the parlor with a grid of jet sprayers at floor level in the holding area. Most dairies in New Mexico however, wash the udders with hand-held hoses before milking. This practice requires much less water than an automated sprinkler wash. For dairies with sprinkler udder washing systems, the total water requirement for the milk room, parlor and holding pen is 35 to 40 gallons per milking per lactating cow. Corresponding water requirements for dairies which employ manual udder washing practices are 23 to 25 gallons per milking per lactating cow.

Other milking center water uses may include coolant for vacuum pumps—2 gallons per milking per cow, cooling towers for precooling milk—0.25 gallons per milking per lactating cow, and cooling towers for refrigeration system condensers—3 gallons per day per lactating cow. Water used for cooling in dairies is generally recycled, however, a small amount of fresh water must be introduced to make up for evaporation losses.

There are many other water uses that may occur in a dairy operation. Water is used as an additive for the feed ration, for washing, for washing the milk truck ramp located forward of the milk

room, for separate maternity facilities, for laboratories, for the employees, for the occasional flushing of manure sump, for the cow hospital or treatment area, and for the occasional line breaks. Though most of these requirements are rather small, they are cumulatively significant I quantity. Ten gallons per day per lactating cow should be allotted for these water uses.

In some areas of the Southwest where summers are extremely hot (primarily Arizona) it is common practice to use evaporative shades to cool cattle down. Water may also be used to sprinkle traffic lanes and cattle corrals for dust control. However, these practices are not common in New Mexico.

Dairy wastewater from the holding areas, milking parlor, milk storage tank and equipment is routed to lagoons which typically have a surface area ranging from three to five acres. To comply with state regulations to protect groundwater quality, these lagoons may be evaporated. However, after primary treatment in holding ponds, irrigation systems are often used to dispose of the wastewater. Because of the salinity of wastewater may cause crop damage, freshwater may be introduced to dilute the wastewater before it is used for irrigation.

Water requirements for dairies are summarized in Tables 5.4 and 5.5. For the purpose of quantifying withdrawals and depletions for dairies in New Mexico's 2000 water use inventory, withdrawals are computed on the basis of 100 gallons per cow per day (gpcd) where metered withdrawals are unavailable, and depletions are taken as 100% of the withdrawal. All withdrawals are assumed to come from groundwater sources.

5.8. SUMMARY OF PER CAPITA WATER REQUIREMENTS FOR LIVESTOCK

Per capita water requirements used to quantify livestock withdrawals in New Mexico are summarized in Table 5.3.

Table 5.3. Drinking and miscellaneous water requirements for livestock in gallons per capita per day (gpcd). (Sources: Beef cattle—Sweeten, 1990a; horses—Van der Leeden, 1990; milk cows—Wiersma, 1988; all other—SCS, 1975 and USDA, 1955)

Species	Drinking	Miscellaneous	Total
Beef Cattle	9.00	1.00	10.00
Chickens	0.06	0.02	0.08
Hogs	2.00	1.00	3.00
Horses and Mules	12.00	1.00	13.00
Milk Cows	36.50	63.50	100.00
Sheep	2.00	0.20	2.20

Table 5.4. Estimated water requirements in gallons per cow per day (gpcd) for a modern dairy using manual udder washing practices.

Item	Withrawal (GPCD)	Scenerio 1		Scenerio 2	
		Depletion Factor	Depletion (GPCD)	Depletion Factor	Depletion (GPCD)
Drinking water for lactating cows	36.5	1.00	36.5	1.00	36.5
Drinking water for other animals	6.6	1.00	6.6	1.00	6.6
Sanitation in milking center	46.0	0.73	33.6	0.87	40.0
Coolant for vacuum pumps	(4.0)	0.00	0.0	0.00	0.0
Refrigeration in cooling towers	(3.5)	0.00	0.0	0.00	0.0
Miscellaneous	10.0	0.73	7.3	0.87	8.7
Net Totals	99.1		84.0		91.8

Table 5.5. Estimated water requirements in gallons per cow per day (gpcd) for a modern dairy using sprinkler udder washing practices.

Item	Withrawal (GPCD)	Scenerio 1		Scenerio 2	
		Depletion Factor	Depletion (GPCD)	Depletion Factor	Depletion (GPCD)
Drinking water for lactating cows	36.5	1.00	36.5	1.00	36.5
Drinking water for other animals	6.6	1.00	6.6	1.00	6.6
Sanitation in milking center	70.0	0.73	51.1	0.87	60.9
Coolant for vacuum pumps	(4.0)	0.00	0.0	0.00	0.0
Refrigeration in cooling towers	(3.5)	0.00	0.0	0.00	0.0
Miscellaneous	10.0	0.73	7.3	0.87	8.7
Net Totals	123.1		101.5		112.7

Scenario 1 assumes that wastewater is disposed of by flood irrigation with an on-farm irrigation efficiency of 70% and incidental depletions equal to 3% of withdrawals, yielding a total depletion of 73%. Scenario 2 assumes that wastewater is disposed of by sprinkler irrigation with an on-farm irrigation efficiency of 70% and incidental depletions equal to 17% of withdrawals, yielding a total depletion of 87%. See glossary for definition of incidental depletions. Depletions for each line item are computed by multiplying the withdrawal by the depletion factor. However, because the probability that the potential return flow will reach an aquifer is minimal, for the purpose of this inventory, the depletion is taken as 100% of the withdrawal. Numbers in parenthesis indicate water that is recycled. Water requirements for employee residences that are located on the dairy premises would be in addition to the water requirements shown in these tables.

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Chapter 6

Self-Supplied Commercial, Industrial, Mining, and Power

6.1. INTRODUCTION

The procedure presented in this report for quantifying withdrawals and depletions for Commercial, Industrial, Mining, and Power emphasizes the importance of metering to monitor water use. Guidelines for estimating water requirements for recreational facilities such as campgrounds are presented. Criteria used to categorize golf courses, the impact of the species of turfgrass on irrigation water requirements, and measures that may be taken to conserve water are discussed in detail. The nature of water use in the industrial sector is summarized, and the factors that affect the amount of water recirculated are identified. New Mexico's importance as one of the nation's leading mineral producers is noted.

6.2. COMPOSITION OF CATEGORIES

6.2.1. Commercial (CO). Includes self-supplied businesses (e.g., motels, restaurants, recreational resorts and campgrounds) and institutions (e.g., schools and hospitals), public or private, involved in the trade of goods or provision of services. Self-supplied golf courses that are not otherwise included in the Public Water Supply category are included as well as greenhouses and nurseries primarily engaged in selling products to the general public which are produced on the same premises from which they are sold. Off-stream fish hatcheries engaged in the production of fish for release are also included. This category is identified as **Major Groups 50-99** and includes numerous subgroups in the Standard Industrial Classification Manual (1987) some of which are associated with other Major Groups.

6.2.2. Industrial (IN). Includes self-supplied enterprises engaged in the processing of raw materials (organic or inorganic—solids, liquids, or gases) or the manufacturing of durable or nondurable goods. Water used for the construction of highways, subdivisions and other construction projects is also included. This category is identified as **Major Groups 15-17** and **20-48** and includes numerous subgroups in the Standard Industrial Classification Manual (1987).

6.2.3. Mining (MI). Includes self-supplied enterprises engaged in the extraction of minerals occurring naturally in the earth's crust: solids, such as coal and smelting ores; liquids, such as crude petroleum; and gases, such as natural gas. Water used for oil and gas well drilling,

secondary recovery of oil, quarrying, milling (crushing, screening, washing, flotation, etc.) and other processing done at the mine site, or as part of a mining activity is included as well as water removed from underground excavations and stored in, and evaporated from, tailing ponds. Mining also includes water used to irrigate new vegetative covers at former mine sites that are being reclaimed. It does not include the processing of raw materials such as smelting ores unless this activity occurs as an integral part of, and is physically contiguous with, a mining operation. This category is identified as **Major Groups 10-14** and includes numerous subgroups in the Standard Industrial Classification Manual (1987).

6.2.4. Power (PO). Includes all self-supplied power generating facilities. Water used in conjunction with coal mining operations that are contiguous with a power generating facility that owns and/or operates the mines is also included. This category is identified as **Major Group 49, Industry Group 491,** and **Industry 4911** in the Standard Industrial Classification Manual (1987).

6.3.GENERAL PROCEDURE FOR QUANTIFYING WITHDRAWALS AND DEPLETIONS

The procedure for quantifying withdrawals and depletions for self-supplied commercial, industrial, mining and power generating facilities is generally the same for each of these individual categories. This procedure is outlined in detail in the text that follows.

Step 1: Metered diversions for those enterprises that report to the New Mexico Office of the State Engineer Office are culled from the records.

Step 2: While most self-supplied commercial, industrial, mining, and power generating facilities are required to report their annual water use to the Office of the State Engineer, there are many that are continually delinquent in keeping their water use records up to date. When metered records for the water use inventory year are not complete, water use may be estimated by examining earlier records or prorating the water right.

Step 3: In some areas there may be establishments that are unmetered. These entities may be very difficult to identify, particularly where no declaration is required or no declaration has been filed with the Office of the State Engineer. It is acknowledged that many of these establishments are not captured in the water use inventory. However, whenever possible, directories maintained by various business associations and regulatory agencies are available and can be used to identify those entities that might otherwise be missed. It then becomes a matter of contacting these entities by phone or mail to get an estimate of the annual water use from the executive director or operator.

Step 4: Depletions for self-supplied commercial, industrial, mining, and power generating facilities vary from zero to 100% of withdrawals. Some water users such as refineries and power plants measure discharges and can thus determine depletions by taking the differences between measured withdrawals and discharges. Others have developed complex formulas for estimating depletions. Where depletions are not measured or computed using an empirical formula, they are estimated as a percentage of the withdrawals.

6.4. SELF-SUPPLIED COMMERCIAL

6.4.1. Schools

Withdrawals for high schools, junior high schools, and elementary schools, which are not metered are computed multiplying the student population by a per eapita water requirement. The per capita water requirements and depletion rates presented in Table 6.1 were used to quantify water use in unmetered schools in New Mexico's 2000 water use inventory.

Table 6.1. Water requirements in gallons per capita per day (gpcd) for schools without water conserving plumbing fixtures. (Source: U.S. Environmental Protection Agency, 1980; U.S. Public Health Service, 1962)

Type of Facility	GPCD	Percent Depleted
Day with cafeteria, gymnasiums, and showers	25	50
Day with cafeteria, but no gymnasiums or showers	20	50
Day without cafeteria, gymnasiums or showers	15	50

6.4.2. Campgrounds, Picnic Areas, and Visitor Centers

In the absence of metered data, water use at campgrounds, picnic areas, and visitor centers is estimated by multiplying visitor day counts by water use coefficients. Visitor day counts are obtained from the Bureau of Land Management, the National Park Service, New Mexico Parks and Recreation Department, and the U.S. Forest Service. When possible, visitor day statistics are separated into two distinct groups, i.e., overnight campers, and daytime visitors and picnickers. Over the years several studies have been conducted to develop guidelines for per capita water requirements in recreational areas. In chronological order these include: U.S. Public Health Service, 1962; Pacific Southwest Inter-Agency Committee, 1963; American Society of Civil Engineers, 1969; U.S. Environmental Protection Agency, 1980; U.S. Environmental Protection Agency, 1982. The per capita water requirements presented in Table 6.2 were used to quantify water use in unmetered recreational areas in New Mexico's 2000 water use inventory.

Table 6.2. Water requirements in gallons per capita per day (gpcd) for recreational areas without water conserving plumbing fixtures. (Source: U.S. Environmental Protection Agency, 1980)

Type of Facility	GPCD	Percent Depleted
Campground with showers and flush toilets	35	100
Campground with flush toilets	15	100
Campground with drinking water only	5	100
Picnic area with flush toilets	5	100
Visitor center	5	100

6.4.3. Golf Courses

In many communities, self-supplied golf courses represent the largest water users in the Commercial category. There are approximately 78 golf courses in New Mexico (Sun Country Amateur Golf Association, 2000) and they range from 9-hole par-three courses which cover as little as 40 acres to sprawling 18-hole courses which cover 200 acres or more. The amount of

water used at golf courses is as varied as the golf courses themselves. Water requirements range from less than 100, to more than 600 acre-feet per year depending upon the climate, species of turfgrass, irrigation management practices, number of ponds, and clubhouse facilities.

In the major urban areas there is generally a mix of both public and private golf courses. There are also several military installations which have their own golf course. Many of the well-established 18-hole private courses have clubhouse facilities which include snack bar and restaurant, locker rooms with shower facilities, and swimming pools. Golf courses are often the focal point of new subdivision developments which use the rich green turf as a means of creating an oasis in the desert to attract new home buyers.

There are some golf courses which divert water for irrigation directly from their own wells or a surface water source while also using treated municipal water in their clubhouse facilities as well as for irrigation in some months of the year. There are also several golf courses that irrigate with sewage effluent, however, these are not included in the Commercial category as the water used is already accounted for in the Public Water Supply category. There is a need to make a distinction in regard to how municipal golf courses that have their own wells are categorized. For the purpose of this water use inventory, self-supplied golf courses which are owned and operated by a municipality that is a public water supplier are included in the Public Water Supply category. Water used for the irrigation of self-supplied golf courses located within military installations is accounted for in the Public Water Supply category and is thus a transparent component of the total water use on a military installation. The intent here is to treat military installations as a distinct unit. Many universities also own and operate their own golf course; the water used to irrigate these golf courses is generally included with the water use reported for the university, in the Commercial category. All other self-supplied golf courses are included in Commercial. Private golf courses which irrigate from their own wells but also use municipal water for irrigation are also included in Commercial, however, the municipal water which is used for irrigation is included in Public Water Supply.

Many of the golf courses in the state are metered and report their annual diversions to the Office of the State Engineer. For those self-supplied golf courses that are not metered, withdrawals are estimated using the procedure outlined in Irrigated Agriculture for the quantification of crop water requirements. This necessarily requires that the acreage irrigated, as well as the species of turfgrass in the fairways, be obtained from the golf course superintendent. It is important that the species of turfgrass is identified because the irrigation water requirements for turfgrass will vary depending on the species of grass which is grown and climate conditions. From a practical perspective, turfgrasses can be separated into two categories.

Cool-Season Grasses. These grasses have a temperature optimum of 60-70 degrees Fahrenheit and are best suited to the cooler regions of New Mexico. They include Kentucky bluegrass, tall fescue, perennial ryegrass, and creeping bentgrass.

Warm-Season Grasses. These grasses have a temperature optimum of 80-95 degrees Fahrenheit or above and are best suited to southern New Mexico and elevations below 4,500 feet. They include bermudagrass, Tifgreen, Santa Ana, zoysiagrass, St. Augustinegrass, and buffalograss. Warm-season grasses are generally susceptible to injury by cold weather.

During the warmest months of the year, cool-season grasses normally exhibit evapotranspiration rates that are typically 30% to 40% higher than warm-season grasses (Borrelli, 1981; Texas Agricultural Experiment Station, 1986). Thus, warm-season grasses will consume less water than cool-season grasses. For the purpose of this inventory, consumptive irrigation requirements for

golf courses were computed using the original Blaney-Criddle method and the following consumptive use coefficient (K): For cool-season turfgrasses, 1.05 inside the frost-free period, and 0.50 outside the frost-free period; for warm-season turfgrasses, 0.80 and 0.50, respectively.

Where measured withdrawals are available, the irrigation efficiency on sprinkler irrigated golf courses is taken to be either the consumptive irrigation requirement (acre-feet) multiplied by 100 and divided by the withdrawal, or 80%, whichever value is lower. An irrigation efficiency of 70% is generally assumed when withdrawals are estimated. Incidental depletion factors (See glossary for definition of incidental depletions.) for sprinkler irrigated golf courses are generally assumed to be slightly less than for farm crops because the sprinkler heads discharge at a low angle and close to the ground, there is no interception by a plant canopy such as occurs when irrigating alfalfa or corn, there is no bare ground—runoff is zero, and the turf is generally irrigated during the night when temperatures are lower and winds are calm. For the purpose of this inventory, incidental depletions for sprinkler irrigated golf courses are estimated as 12% of the withdrawals. Thus, if the irrigation efficiency is assumed to be 70%, the total depletion would be 82% (70% + 12%) of the withdrawal. However, because the irrigation applications are light and frequent, the probability that the potential return flow will reach an aquifer is minimal. Therefore, for the purpose of this inventory, the depletion is taken as 100% of the withdrawal.

In 2000, self-supplied golf courses exclusive of those owned and operated by municipalities that are public water suppliers in New Mexico, accounted for approximately 32% of the withdrawals and 40% of the depletions in the Commercial category.

To keep irrigation water requirements to a minimum, developers who are planning the construction of a new golf course should explore the research that has been conducted on turfgrasses and adopt a species of grass which has low water requirements and is well adapted to the local climate. The importance of carefully selecting a turf grass cannot be overemphasized. In southern New Mexico, there are several golf courses planted in cool season grasses that are not suited to the climate. During the hot summer months, large volumes of water are required to prevent these grasses from wilting. The annual water demand and stress on the aquifer would be much less had these golf courses been seeded with warm season grasses. To prevent new developments from planting turfgrasses that have high water requirements where an alternative species of grass with low water requirements is viable, local governments and regulatory agencies can formulate guidelines which would discourage the use of certain species of turfgrass.

On a golf course with an irrigation system that has been carefully designed to conserve water, water is applied strictly according to plant needs. A vast array of electronic equipment is available to help maintenance personnel apply the right amount of water at the right time. Sprinklers can be turned on automatically by a system that measures soil moisture using tensiometers and applies water only when it is needed. Greens, fairways, and rough areas may be irrigated on different schedules to satisfy the water demands of each species of vegetation. To minimize evaporation, an anemometer may be installed to monitor windspeed and postpone irrigation until winds are calm.

These efforts may sound extreme, but the financial benefit to a business maintaining a large area of turfgrass can be substantial. A golf course in California that adopted the irrigation scheduling practices just described reduced its irrigation withdrawals by 70% and saved $32,000 per year in pumping costs. (California Department of Water Resources, 1984). An additional benefit resulting from the implementation of water conservation measures on a golf course is that when less water is applied, turf disease is minimized and fertilizer requirements are reduced because a smaller percentage of the nutrients percolate below the root zone.

6.5. SELF-SUPPLIED INDUSTRIAL

Water is used in the manufacturing industry for heating, cooling, conveying materials, washing, pollution control, and includes water sold as part of the product (AWWA, 1985). Water used for restrooms, showers, cafeterias, air conditioning, landscaping, fire protection, and other minor uses normally accounts for less than 5% of industrial intake water. Manufacturing-plant water intake depends on the type of raw material involved, the product produced, the design of the plant, and the efficiency of the industrial process (California Department of Water Resources, 1982). In many industrial plants, water is recirculated, particularly water used for cooling. The quantity of intake water recirculated is affected by: the availability and cost of water delivered to the plant; quality of raw water; plant processes and technology; recovery of materials, by-products, and energy; consumptive loss; air and water pollution control regulations; cost avoidance; and age of plant (Kollar and Brewer, 1980).

In 2000, self-supplied gas processing plants and oil refineries accounted for approximately 58% of the withdrawals and 79% of the depletions in the Industrial category. Water introduced into these facilities for cooling is generally recirculated. However, water used for other purposes, and water separated from petroleum during processing is generally discharged into lagoons where it is evaporated or it is injected into deep aquifers.

6.6. SELF-SUPPLIED MINING

New Mexico continues to be one of the leading mineral resource producing states in the nation, ranking first in the production of potash and perlite; second in pumice and mica; third in copper, carbon dioxide, and natural gas; sixth in uranium; seventh in crude oil; tenth in coal and silver; and twelfth in gold. (New Mexico Energy, Minerals and Natural Resources Department, 1996).

Ranked in order of 2000 water withdrawals from high to low, copper is first (31.6%), potash second (28.0%), secondary recovery of oil third (20.8%), uranium fourth (2.9%), coal fifth (1.7%), oil and gas well drilling sixth (1.3%), and sand and gravel washing seventh (1.1%). Very small amounts of water are used to mine other minerals in New Mexico.

Potash, which is used primarily in fertilizers (95%), is produced from five mines and mills which are located in Eddy and Lea counties. New Mexico accounted for 70% of U.S. potash production in 2000. Perlite, which is used primarily in construction materials, is produced from four mines and mills which are located in Cibola, Socorro, and Taos counties. Pumice, which is used primarily in building blocks (60%), is produced from four mines that are located in Bernalillo, Rio Arriba, Sandoval, and Santa Fe counties. New Mexico also produces significant quantities of sand and gravel for construction, and gypsum which is used in sheetrock. Copper, which is used primarily for electrical wire and pipes, is produced from mines and mills in Grant, Hidalgo, and Luna counties. Carbon dioxide, is produced from four sites in Harding and Union counties and all of this is used in New Mexico and Texas in enhanced oil recovery projects. Uranium is produced by only one mine in McKinley County and is used to fuel nuclear power plants. Coal is produced from mines in Cibola, Colfax, McKinely, and San Juan counties. About 67% of the coal is consumed in-state for electrical power generation and 33% is exported to power plants in other states.

Before the start of any mining operations, the operator must register the mine, mill, smelter, or pit with the Mining and Minerals Division of the New Mexico Energy, Minerals, and Natural Resources Department. A directory of all the mines and mills registered in the state is updated

annually. This directory is used to identify those mines and mills which are not required to report their annual withdrawals directly to the State Engineer Office. These mines and mills are then contacted by mail or phone.

Measured withdrawals for water used in the secondary recovery of oil may be obtained from the New Mexico Energy and Minerals Department, Oil and Gas Commission and State Engineer District Offices. Brine water pumped from a depth of 4,000 to 5,000 feet, which is returned by injection into deep brine aquifers, is not quantified in this inventory since its impact on the net supply of fresh water is zero. However, water pumped from freshwater aquifers for the secondary recovery of oil, which is later disposed of by injection into deep brine aquifers or is spread on the land surface where it evaporates, is treated as a 100% depletion.

6.7. SELF-SUPPLIED POWER

The New Mexico Public Service Commission maintains a directory of all power generating facilities in the state. This directory is used to identify electric utility companies which are not required to report their annual withdrawals directly to the State Engineer Office. These Companies are then contacted by mail or phone.

New Mexico continues to be among the largest energy producing states in the nation. There are 21 power generating facilities in New Mexico, however, only 18 of these facilities were active in 2000. Over 70% of the states generating capacity is located at the two largest coal-fired generating stations—Four Corners and San Juan, in San Juan County. Approximately 50% of the electricity generated in New is consumed in the state, and 50% is exported to other states, primarily Arizona, California, and Texas. (New Mexico Energy, Minerals and Natural Resources Department, 1996). In 2000, 88.3% of the state's generation was from coal. Electricity is also imported into southeastern New Mexico from power plants in Texas.

Due to the complexity of the water budget for BHP-Utah International in San Juan County, water used at BHP's Navajo coal mine, and evaporation from Morgan Lake, which is filled by water pumped from the San Juan River to supply the Four Corners Generating Station, is included in the Power category. The same also applies to the Public Service Company of New Mexico (PNM) with regards to their San Juan Generating Station in San Juan County, and the La Plata and the San Juan coal mines.

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Chapter 7

Reservoir Evaporation

7.1. INTRODUCTION

The quantity of water discharged by a stream is continuously changing throughout the year, from rainy season to dry, and the quantity of flow during any one season varies from year to year. Variability is characteristic of streamflow, as it is of weather. Streams and rivers that originate in the interior mountain areas are characterized by a high rate of discharge during the period of snowmelt, usually in May and June. The rate of flow both before and after the snowmelt period is usually low. The time of peak flow varies somewhat, depending on the time of snowmelt.

Because of the high variability in the flow of most streams, full utilization of surface water is possible only through regulation and control. Storage is necessary to provide for fuller utilization of annual flows. Dams and reservoirs which impound precious runoff from upstream areas capture and conserve water for irrigation, hydroelectric power, municipal and industrial demands, outdoor recreation, fish and wildlife enhancement, and improved water quality as well as providing flood control.

While reservoirs provide many benefits, evaporation from exposed water surfaces of reservoirs consumes a significant part of available surface water supplies. Average annual gross evaporation from reservoirs range from 30 inches in the mountains of Northern New Mexico to 80 inches in the valleys near the southern border of the state. Because water is a scarce and expensive commodity in New Mexico, evaporation losses attain special importance. Evaporation forecasts are needed for a variety of hydrologic problems such as forecasting water supplies and regulation of reservoirs. Where the management of streams and reservoirs is governed by interstate stream compacts, reservoir evaporation plays an important role in the accounting of inflows and outflows in the annual water budget.

In the text that follows, a general overview of the methods used to estimate reservoir evaporation is presented. Since evaporation from large reservoirs is most often estimated by using an evaporation rate determined from a Class A land pan, the pan approach is discussed in detail. An empirical method for estimating evaporation from small reservoirs where there is a paucity of data is also discussed as well as factors that affect reservoir evaporation.

7.2. COMPOSITION OF CATEGORY

Reservoir Evaporation (RE). Net evaporation from man-made reservoirs that have a storage capacity of approximately 5,000 acre-feet or more.

As a matter of convenience, net evaporation from the Bosque del Apache Wildlife Refuge is also included in this category due to the large volume of water that is diverted from the Rio Grande and ultimately evaporated from the wetlands.

7.3. OVERVIEW OF METHODS USED TO ESTIMATE RESERVOIR EVAPORATION

There are four generally accepted methods for computing lake or reservoir evaporation: (1) water budget, (2) energy budget, (3) mass transfer, and (4) coefficient applied to pan evaporation.

The water budget method consists of solving the mass balance contained in the hydrologic cycle, a perpetual sequence of events governing the depletion and replenishment of water in a basin, for the unknown evaporation component. It is an accounting of all incoming and outgoing water, such as inflow and outflow by rivers and streams, supply from storage in the ground, variation of water storage in the lake, overwater precipitation, and evaporation.

The energy budget method is based on the exchange of thermal energy between a body of water and the atmosphere. Disregarding minor energy sources (chemical, biological, conduction through the bottom, transformation of kinetic energy), there are six basic heating or cooling processes constituting the energy budget of a lake. These energy processes include heat gains or losses produced by shortwave and longwave radiation, heat transfer to the atmosphere through sensible and latent heat, heat advection caused by exchange of water masses, and heat storage within the lake. Data required includes solar radiation, daily maximum and minimum air temperatures and relative humidity, wind run, and water surface temperature.

The mass transfer method of computing evaporation is based on the removal of vapor from the water surface by turbulent diffusion. It consists of a modified application of Dalton's law, where evaporation is considered to be a function of the wind speed and the difference between the vapor pressure of saturated air at the water surface and the vapor pressure of the air above. While many equations have been developed for mass transfer analysis, the equation that was born out of the Lake Hefner study (U.S. Geological Survey, 1958) is most often used when the required data is available.

It is generally accepted that the most practical method of estimating reservoir evaporation is the pan approach, because the hydrologic and meteorological data required for the other procedures is generally not available. A description of the U.S. Weather Bureau Class A land pan and a procedure for application of the pan approach is outlined in detail in the sections which follow.

7.4. THE U.S. WEATHER BUREAU CLASS A LAND PAN

The U.S. Weather Bureau Class A land pan is four feet in diameter and 10 inches deep. It is made of 22-guage galvanized iron, is unpainted, and is supported on a wooden pallet so that the bottom of the pan is raised six inches above the ground surface to permit air circulation underneath the pan. Site requirements specify that the pan be located on level ground unobstructed by trees or buildings so maximum exposure to sunlight is possible. The pan is filled with water to within two

inches of the top and is refilled as soon as the water level drops one inch. The depth of water is measured with a micrometer hook gauge that is located in a stilling well which acts as a support for the gauge. Wind movement is measured by an anemometer that is mounted on the wooden pallet so that the cups are 24 inches above the pan. A rain gauge, and maximum and minimum thermometers which are kept in an instrument shelter, are also installed at the site. The entire installation is normally enclosed by a five foot high wire-mesh fence to protect the equipment. A reading is generally taken daily, usually in the morning.

Unlike a lake, the Class A pan permits considerable transfer of heat to and from its sides and bottom due to radiation exchange and to transfer of sensible heat caused by a difference in water and air temperature. The effects of pan color and water depth on emission and absorption of radiant energy, effects of pan rims on air turbulence, and the convection of heat within the water in the pan, produce an evaporation rate from the pan that is greater than that from a lake or reservoir surface. The ratio of lake evaporation to the pan evaporation is referred to as the pan coefficient.

Studies conducted by the U.S. Department of Agriculture indicate that coefficients for Class A land pans range from 0.60 to 0.82, however a coefficient of 0.70 is recommended for most applications (Subcommittee on Evaporation, 1934). A coefficient of 0.78 is used in the Pecos River Basin in New Mexico.

While the pan approach has a wide application, when it is used in cold climates consideration should be given to the fact that in winter months the pan may be frozen while the reservoir still remains open.

7.5. ESTIMATING RESERVOIR EVAPORATION USING THE PAN APPROACH

Step 1: Compute the average gage height of the water surface level or the average reservoir content for each month from daily observations reported by the agency responsible for the management of the reservoir. Sources of data include the U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, U.S. Geological Survey, National Oceanic and Atmospheric Administration (NOAA), irrigation districts and other organizations.

Step 2: Determine the average water surface area in acres for each month from a curve or equation that correlates gage height or content with surface area. Area-gage height or area-capacity data can be obtained from the agencies mentioned in Step 1.

Step 3: Winter evaporation estimates must take into account the possible effects of ice cover. Partial ice cover will inhibit evaporation; complete ice cover will reduce water surface evaporation to zero. Thus, the average surface area computed in Step 2 must be adjusted to reflect the exposed water surface area in the presence of ice. For large reservoirs, daily observations of ice cover may be available. Tables showing the percent ice cover by month have been developed by some agencies on the basis of historical records and may be used when no other data is available.

Step 4: Obtain Class A land pan evaporation data recorded for each month from the weather station which best represents climatological conditions in the study area. Measurements of monthly and annual evaporation from U.S. Weather Bureau Class A land pans are generally available from NOAA.

Step 5: The gross evaporation rate for each month is computed by multiplying the pan evaporation, which is expressed as a depth of water in feet, by the pan coefficient. To address those situations where the evaporation pan is iced over but the water surface of a nearby reservoir remains open, agencies such as the Bureau of Reclamation have developed empirical equations based on temperature to estimate gross evaporation under these conditions.

Step 6: Obtain the total rainfall recorded for each month. This data is published monthly for most weather stations operated by NOAA. When a reservoir is completely covered with ice for part of a month, recorded rainfall should be adjusted to reflect only those days when there was an exposed water surface.

Step 7: The net evaporation rate for each month, expressed as a depth of water in feet, is computed by subtracting the measured rainfall, in feet, from the gross evaporation rate computed in Step 4.

Step 8: The net volume of water evaporated in each month, expressed in acre-feet, is computed by multiplying the exposed surface area, expressed in acres, by the net evaporation rate, expressed in feet.

Step 9: Adding the net evaporation for each month yields the net evaporation for the calendar year.

7.6. ESTIMATING EVAPORATION FROM SMALL RESERVOIRS USING EMPIRICAL DATA

In some areas there are small reservoirs that are not monitored on a regular basis. Many of these reservoirs are not equipped with a gage to measure the water level, and area capacity curves are not available. Because these reservoirs are small and hydrologic and meteorologic data is typically scant, large expenditures of time and effort are generally not warranted to estimate annual evaporation. To estimate the evaporation from these reservoirs the following procedure may be used.

Step 1: Obtain the reservoir surface area at spillway elevation from the original design specifications and the normal surface area from historical records if they are available.

Step 2: If only the maximum surface area is known, multiply this area by a fullness factor that is based on the observations of someone who is familiar with the reservoir. If observations are unavailable, choose a fullness factor that in your best judgement reflects the runoff conditions for the time period under study. Water supply forecasts published by the U.S. Natural Resources Conservation Service may be helpful in choosing a fullness factor. If the average or normal water surface area of the reservoir is known, use this value in years when precipitation and runoff are considered normal. In drought years it may be necessary to multiply the normal water surface area by a fullness factor to account for low runoff.

Step 3: The annual gross evaporation is estimated by reading values from isopleths drawn on maps prepared by the U.S. Natural Resources Conservation Service and other agencies. The isopleths should represent annual evaporation from a lake or reservoir. If they only reflect pan evaporation, multiply the value read from the isopleth by an appropriate pan coefficient, usually 0.70 for large water bodies, and 0.80 for small water bodies such as ponds.

Step 4: The normal annual rainfall is estimated by reading values from isopleths on maps that are similar to those described in Step 3. Rainfall read from the isopleths may be reduced by some percentage to reflect drought conditions.

Step 5: Subtract the rainfall from the gross evaporation rate to get the net evaporation rate.

Step 6: Multiply the exposed water surface area, expressed in acres, by the net evaporation rate, expressed in feet, to get the net evaporation for the calendar year, in acre-feet.

7.7. FACTORS WHICH AFFECT THE EVAPORATION RATE

The body of water from which evaporation takes place may be small or large, exposed or protected from the wind, shallow or deep, high or low. It may have a high or low plant population or concentration of salts. If exposed to wind movements, or if small, shallow, or densely populated with plant growth, evaporation will be increased. In the summer, when evaporation is at a maximum, more water will evaporate from small and shallow bodies of water than from deep large bodies due to the increased temperature in the small bodies of water. The presence of aquatic plants will also add to the amount of water loss as evaporation will be augmented by the transpiration of the plants. Dissolved salts in saline bodies of water reduce the vapor pressure of the water surface, tending to promote condensation while inhibiting evaporation to a slight degree. Because air temperature decreases with altitude, evaporation from water bodies at high elevations will generally be less than from a body of water at the same latitude but at a lower elevation.

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Glossary

Acre-foot. The quantity of water required to cover one acre (43,560 square feet) of land with one foot of water. There are 325,851 gallons in an acre-foot of water.

Aquifer. A saturated underground formation of permeable materials capable of storing water and transmitting it to wells, springs, or streams.

Combined water. When both ground and surface water are used on-site for the same purpose, such as irrigation of a crop, the water supplied is referred to as combined water.

Consumptive irrigation requirement (CIR). The quantity of irrigation water expressed as a depth or volume, exclusive of effective rainfall, that is consumptively used by plants or is evaporated from the soil surface in a specific period of time. It does not include incidental depletions (See definition of incidental depletions) nor does it include water requirements for leaching, frost protection, wind erosion protection or plant cooling. Such requirements are accounted for in on-farm efficiency values. The consumptive irrigation requirement may be numerically determined by subtracting effective rainfall from consumptive use.

Consumptive use (U) or evapotranspiration (ET). The unit amount of water consumed on a given area in transpiration, building of plant tissue, and evaporated from adjacent soil, water surface, snow, or intercepted rainfall in a specific period of time. The term includes effective rainfall. Consumptive use may be expressed either in volume per unit area such as area-inches or acre-feet per acre, or depth, such as in inches or feet. Note however, that consumptive use of water by a crop does not include incidental depletions. (See definition of incidental depletions.)

County. The largest administrative division of a U.S. state. Counties may be identified by a two or three-digit code. These numerical codes are presented in "Counties and County Equivalents of the United States, Federal Information Processing Standards Publication 6-2," issued by the National Bureau of Standards (1973).

Cropping pattern. Distribution of the total irrigated acreage in a specific area according to the acreage planted in each individual crop.

Depletion. That part of a withdrawal that has been evaporated, transpired, incorporated into crops or products, consumed by man or livestock, or otherwise removed from the water environment. It includes that portion of ground water recharge resulting from seepage or deep percolation (in connection with a water use) that is not economically recoverable in a reasonable number of years, or is not usable.

Diversion. See withdrawal.

Diverted-setaside acreage. All of the acreage in the production adjustment programs administered by the Agricultural Stabilization and Conservation Service.

Effective rainfall (R_e). Rainfall occurring during the growing period of a crop that becomes available to meet the consumptive water requirements of the crop. It does not include rain that is intercepted by the plant canopy and evaporates, surface runoff, or deep percolation below the root zone.

Evapotranspiration (ET). See consumptive use.

Farm delivery requirement (FDR). The quantity of water exclusive of effective rainfall, that is delivered to the farm headgate or is diverted from a source of water which originates on the farm itself, such as a well or spring, to satisfy the consumptive irrigation requirements of crops grown on a farm in a specific period of time. The farm delivery requirement is computed by dividing the consumptive irrigation requirement, expressed as depth or volume, by the on-farm irrigation efficiency, expressed as a decimal.

Field application efficiency. The ratio of the low-quarter depth or volume of irrigation water added to the root zone to the depth or volume of water applied to the soil. The application efficiency does not account for the conveyance losses that may occur between the farm headgate and the fields which are irrigated. (See definition of on-farm irrigation efficiency.)

Ground water. Water stored underground, beneath the earth's surface. It is stored in cracks and crevices of rocks and in the pores of geologic materials that make up the earth's crust.

Hydrologic unit. A surface water drainage basin identified by an eight digit code such as 13020101. Starting from the left, there are 4 pairs of digits. The first pair specifies the region; the second pair, the subregion; the third pair, the accounting unit; and the last pair, the cataloging unit. These hydrologic units were established by the U.S. Water Resources Council in 1970 for use in the Second (1975) National Assessment of Water and Related Land Resources.

Idle and fallow. Acreage plowed and cultivated during the current year but left unseeded, or acreage that is left unused one or more years.

Incidental depletions, above-farm. Evaporation from canals and laterals that convey water from stream or reservoir to the farm headgate; transpiration by phreatophytes along canals and laterals; and evaporation of leakage from off-farm water supply pipelines.

Incidental depletions, on-farm. Evaporation from on-farm reservoirs used to store water for irrigation; evaporation from farm ditches and irrigated fields during surface application; transpiration by phreatophytes along farm ditches, evaporation of leakage from irrigation water pipes; sprinkler spray evaporation and drift losses; and evaporation from wetted crop canopies (interception).

Incidental depletions, below-farm. Evaporation of runoff and seepage from irrigated fields; evaporation from open drains and tailwater recovery pits; and transpiration by phreatophytes along drains and below irrigated fields.

Instream use. Water use taking place within a stream channel. The term "nonwithdrawal use" is frequently used interchangeably with instream use. Insteam use is a water use not dependent on a withdrawal or diversion from ground or surface water sources and it usually is classified as flow uses. Examples of flow uses that depend on water running freely in a channel are hydroelectric power generation, navigation, recreation, fish propagation, and water quality improvement.

Irrecoverable water losses. See depletion and incidental depletions.

Irrigable acreage. The sum of irrigated crop acreage, diverted-setaside acreage, and idle and fallow acreage. The term implies that such acreage is developed and that irrigation works exist to apply water to the land. It does not include farmstead, feedlots, area in roads, ditches and the like.

Irrigated acreage (net). Includes agricultural land to which water was artificially applied by controlled means to include preplant, partial, supplemental, and semi-irrigation, during the calendar year. Land flooded during high water periods is included as irrigation only if the water was diverted to agricultural land by dams, canal, or other works. It is equal to the sum of all crop acreage irrigated minus the multiple-cropped acreage.

Multiple-cropped acreage. The same acreage used to produce two or more crops in the same year. When conducting inventories of irrigated acreage, each irrigated crop is included as part of the planted acreage, but the multiple-cropped acreage is subtracted from the sum of all crop acreage to obtain the net acreage irrigated.

Off-farm conveyance efficiency (E_c). The ratio, expressed as a percentage of the quantity of water delivered to the farm headgate by an open or closed conveyance system, to the quantity of water introduced into the conveyance system at the source or sourees of supply.

On-farm distribution system. An on-farm distribution system may consist of a series of ditches or pipes, and related appurtenances, which eonvey the water delivered to the farm, to the appropriate field.

On-farm irrigation efficiency (E_f). The ratio, expressed as a percentage, of the average low-quarter depth or volume of irrigation water infiltrated and stored in the root zone to the depth or volume of water diverted from the farm headgate or a source of water originating on the farm itself, such as a well or spring. So that the reader may clearly understand what the low quarter means, let's assume that we have measured the change in soil moisture content in the root zone after an irrigation at 12 sampling sites on the field. The low quarter, would be the average of the three lowest values recorded. The on-farm efficiency reflects the efficieney of the on-farm distribution system and application system and includes deep percolation losses necessary as a beneficial use for leaching excess salts from the root zone. In the design and operation of an irrigation system and in the administration of water rights, it is the on-farm irrigation efficiency that is used in the determination of the farm delivery equipment.

Per capita use. The average quantity of water used per person or per head of livestock, per day.

Preplant irrigation. Water applied to fields before seed is sown to provide optimum soil moisture conditions for germination and to store water in the soil profile for consumptive use by plants during the growing season.

Project diversion requirement or off-farm diversion requirement (PDR). When the source of irrigation water does not originate on the farm, the project diversion requirement or off-farm diversion requirement is defined as the quantity of water exclusive of effective rainfall, that is diverted from an off-farm source to satisfy the farm delivery requirement in a specific period of time. An additional quantity of water must be diverted from the ultimate source of supply to make up for conveyance losses between the farm headgate and the source of water. Estimated conveyance losses are added to the farm delivery requirement to arrive at the project diversion requirement. The off-farm diversion requirement may also be computed by dividing the farm delivery requirement by the off-farm conveyance efficiency, expressed as a decimal.

Project or system irrigation efficiency (E_j). The combined efficiency of the entire irrigation system, from the ultimate diversion point to the crop root zone. In mathematical terms it is the product expressed as a percentage of the on-farm efficiency (E_f) and the off-farm conveyance efficiency (E_c). When the irrigation water originates on the farm itself, such as from a well or spring, the off-farm conveyance efficiency does not apply and thus the project or system efficiency is the same as the on-farm irrigation efficiency.

River basin. The entire area drained by a stream (or river) or system of connecting streams so that all the streamflow originating in the area is discharged through a single outlet.

Rural. Any community, incorporated or unincorporated with a population of less than 2,500 inhabitants and not within a larger community that is classified as urban, is classified as rural by the U.S. Bureau of the Census.

Self-supplied. Water users who withdraw water directly from a ground or surface water source.

Surface water. An open body of water such as a river, stream, or lake.

Transpiration. The process by which water in plants is transferred into water vapor in the atmosphere.

Urban. Any community, incorporated or unincorporated with a population of 2,500 inhabitants or more is classified as urban by the U.S. Bureau of the Census. A self-supplied subdivision or residence (single family home or multiple housing unit) with a population of less than 2,500 inhabitants is classified as urban if it is within the established boundaries of a larger community or metropolitan area which is classified as urban by the Bureau of the Census.

Withdrawal. The quantify of water taken from a ground or surface water source. A diversion is the same as a withdrawal.

TERMS OF CONFUSION

There are three terms that are frequently used in discussion pertaining to water which open the door to confusion and misunderstanding. They are (1) consumed, (2) consumption, and (3) consumptive use.

Water consumed and water consumption are often taken as meaning water delivered to a water user whether the user be a water utility, and individual household, or a commercial or industrial enterprise. When used in this sense, these terms do not mean the same thing as depletion as defined in this glossary. Furthermore, water consumption in this context is not synonymous with consumptive use as it is defined in this report.

When water consumed and water consumption are used in reference to a human or an animal taking a drink of water, or water that is evaporated from a water body or land surface, these terms become synonymous with a depletion of water and consumptive use.

2000 Water Use Tables

Table A-1. County code numbers established by the National Bureau of Standards and whole or part counties included in each river basin.

Table A-2. Acronyms for river basins.

Table 1. Summary of water use (acre-feet) in New Mexico, 2000.

Table 2. Water use by category expressed as a percent of state totals in New Mexico, 2000.

Table 3. Percent of withdrawals measured in each water use category in New Mexico, 2000.

Table 4. Summary of water use (acre-feet) in New Mexico counties, 2000.

Table 5. Summary of water use (acre-feet) in New Mexico river basins, 2000.

Table 6. Public Water Supply and Self-Supplied Domestic. Water systems, populations, per capita use, and withdrawals and depletions (acre-feet) in New Mexico counties, 2000.

Table 7. Populations in New Mexico River Basins, 2000.

Table 8. Irrigated Agriculture. Withdrawals (acre-feet) in New Mexico counties, 1999.

Table 9. Irrigated Agriculture. Depletions (acre-feet) in New Mexico counties, 1999.

Table 10. Irrigated Agriculture. Summary of acreage irrigated, withdrawals, conveyance losses, and depletions (acre-feet) in New Mexico river basins, 1999.

Table 11. Irrigated acreage and sources of irrigation water in New Mexico counties, 1999.

Table 12. Acreage irrigated by drip, flood, and sprinkler application methods and sources of irrigation water in New Mexico counties, 1999.

Table 13. Acreage irrigated by drip, flood, and sprinkler application methods and sources of irrigation water in New Mexico river basins, 1999.

Table A-1. County code numbers (CN) established by the National Bureau of Standards and whole or part counties included in each river basin. See Table A-2 for river basin acronymns.

		RIVER BASINS					
CN	COUNTY	AWR	TG	P	RG	UC	LC
1	Bernalillo				X		
3	Catron				X		X
5	Chaves			X			
6	Cibola				X		X
7	Colfax	X					
9	Curry	X	X				
11	De Baca			X			
13	Dona Ana				X		
15	Eddy			X			
17	Grant				X		X
19	Guadalupe	X		X			
21	Harding	X					
23	Hidalgo				X		X
25	Lea		X	X			
27	Lincoln			X	X		
28	Los Alamos				X		
29	Luna				X		X
31	McKinley				X	X	X
33	Mora	X					
35	Otero			X	X		
37	Quay	X		X			
39	Rio Arriba				X	X	
41	Roosevelt		X				
43	Sandoval				X	X	
45	San Juan					X	
47	San Miguel	X		X	X		
49	Santa Fe			X	X		
51	Sierra				X		
53	Socorro				X		
55	Taos				X		
57	Torrance			X	X		
59	Union	X					
61	Valencia				X		

Table A-2. River basin (RVB) acronymns.

AWR	Arkansas-White-Red
LC	Lower Colorado
P	Pecos
RG	Rio Grande
TG	Texas Gulf
UC	Upper Colorado

Table 1. Summary of water use (acre-feet) in New Mexico, 2000.

CATEGORY	WSW	WGW	TW	DSW	DGW	TD	RFSW	RFGW	TRF
Commercial (self-supplied)	1820.28	23348.83	25169.11	1357.81	19266.02	20623.83	462.47	4082.81	4545.28
Domestic (self-supplied)	0.00	35149.51	35149.51	0.00	35149.51	35149.51	0.00	0.00	0.00
Industrial (self-supplied)	1871.46	9837.91	11709.37	1871.46	5896.12	7767.58	0.00	3941.79	3941.79
Irrigated Agriculture	1847357.00	1376597.00	3223954.00	751475.00	1021476.00	1772951.00	1095882.00	355121.00	1451003.00
Livestock (self-supplied)	3838.82	39812.73	43651.55	3838.82	39812.73	43651.55	0.00	0.00	0.00
Mining (self-supplied)	3015.49	64853.13	67868.62	1000.92	46639.24	47640.16	2014.57	18213.89	20228.46
Power (self-supplied)	50449.88	12708.05	63157.93	44184.21	12410.43	56594.64	6265.67	297.62	6563.29
Public Water Supply	37875.85	293917.32	331793.17	19237.78	161521.39	180759.17	18638.07	132395.93	151034.00
Reservoir Evaporation	431437.40	0.00	431437.40	431437.40	0.00	431437.40	0.00	0.00	0.00
State Totals	2377666.18	1856224.48	4233890.66	1254403.40	1342171.44	2596574.84	1123262.78	514053.04	1637315.82

Table 2. Water use by category expressed as a percent of state totals in New Mexico, 2000.

CATEGORY	TW % of Total	TD % of Total
Commercial (self-supplied)	0.60	0.79
Domestic (self-supplied)	0.83	1.35
Industrial (self-supplied)	0.28	0.30
Irrigated Agriculture	76.14	68.28
Livestock (self-supplied)	1.03	1.68
Mining (self-supplied)	1.60	1.84
Power (self-supplied)	1.49	2.18
Public Water Supply	7.84	6.96
Reservoir Evaporation	10.19	16.62
State Totals	100.00	100.00

Table 3. Percent of withdrawals measured in each water use category in New Mexico, 2000.

CATEGORY	MSW	MGW	MTW
Commercial (self-supplied)	44.67	69.78	67.96
Domestic (self-supplied)	0.00	0.00	0.00
Industrial (self-supplied)	98.99	99.42	99.94
Irrigated Agriculture	69.80	29.37	52.54
Livestock (self-supplied)	0.00	23.18	21.14
Mining (self-supplied)	100.00	99.98	99.98
Power (self-supplied)	99.97	100.00	99.98
Public Water Supply	68.56	99.54	96.00
Reservoir Evaporation	95.77	0.00	95.77

Key: WSW=withdrawal surface water; WGW=withdrawal ground water; TW=total withdrawal; DSW=depletion surface water; DGW=depletion ground water; TD=total depletion; RFSW=return flow surface water; RFGW=return flow ground water; TRF=total return flow; MSW=percent of surface water withdrawals measured; MGW=percent of groundwater withdrawals measured; MTW=percent of total withdrawals that were measured.

Table 4. Summary of water use in acre-feet, in New Mexico counties, 2000.

CN	COUNTY	CATEGORY	WSW	WGW	TW	DSW	DGW	TD	RFSW	RFGW	TRF
1	Bernalillo	Commercial (self-supplied)	0.00	5503.14	5503.14	0.00	4575.47	4575.47	0.00	927.67	927.67
1	Bernalillo	Domestic (self-supplied)	0.00	5572.84	5572.84	0.00	5572.84	5572.84	0.00	0.00	0.00
1	Bernalillo	Industrial (self-supplied)	0.00	382.06	382.06	0.00	91.41	91.41	0.00	290.65	290.65
1	Bernalillo	Irrigated Agriculture	61932.00	3304.00	65236.00	16353.00	1876.00	18229.00	45579.00	1428.00	47007.00
1	Bernalillo	Livestock (self-supplied)	20.90	802.81	823.71	20.90	802.81	823.71	0.00	0.00	0.00
1	Bernalillo	Mining (self-supplied)	0.00	458.70	458.70	0.00	367.40	367.40	0.00	91.30	91.30
1	Bernalillo	Power (self-supplied)	0.00	839.53	839.53	0.00	541.91	541.91	0.00	297.62	297.62
1	Bernalillo	Public-Water Supply	66.63	118309.90	118376.50	33.32	52472.00	52505.32	33.31	65837.88	65871.20
1	Bernalillo	Reservoir Evaporation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		County Totals	62019.53	135172.96	197192.50	16407.22	66299.84	82707.06	45612.31	68873.12	114485.44
3	Catron	Commercial (self-supplied)	8.00	32.52	40.52	8.00	32.52	40.52	0.00	0.00	0.00
3	Catron	Domestic (self-supplied)	0.00	224.25	224.25	0.00	224.25	224.25	0.00	0.00	0.00
3	Catron	Industrial (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	Catron	Irrigated Agriculture	19624.00	339.00	19963.00	2738.00	196.00	2934.00	16886.00	143.00	17029.00
3	Catron	Livestock (self-supplied)	156.82	175.36	332.18	156.82	175.36	332.18	0.00	0.00	0.00
3	Catron	Mining (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	Catron	Power (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	Catron	Public Water Supply	0.00	169.40	169.40	0.00	71.86	71.86	0.00	97.54	97.54
3	Catron	Reservoir Evaporation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		County Totals	19788.82	940.53	20729.35	2902.82	699.99	3602.81	16886.00	240.54	17126.54

Key: CN=county number; WSW=withdrawal, surface water; WGW=withdrawal ground water; TW=total withdrawal; DSW=depletion, surface water; DGW=depletion, ground water; TD=total depletion; RFSW=return flow, surface water; RFGW=return flow, ground water; TRF=total return flow.

Table 4. Summary of water use in acre-feet, in New Mexico counties, 2000.

CN	COUNTY	CATEGORY	WSW	WGW	TW	DSW	DGW	TD	RFSW	RFGW	TRF
5	Chaves	Commercial (self-supplied)	0.00	1596.41	1596.41	0.00	629.97	629.97	0.00	966.44	966.44
5	Chaves	Domestic (self-supplied)	0.00	1039.95	1039.95	0.00	1039.95	1039.95	0.00	0.00	0.00
5	Chaves	Industrial (self-supplied)	0.00	545.74	545.74	0.00	396.94	396.94	0.00	148.80	148.80
5	Chaves	Irrigated Agriculture	24162.00	313305.00	337467.00	11877.00	211459.00	223336.00	12285.00	101846.00	114131.00
5	Chaves	Livestock (self-supplied)	237.61	10195.50	10433.11	237.61	10195.50	10433.11	0.00	0.00	0.00
5	Chaves	Mining (self-supplied)	0.00	168.75	168.75	0.00	117.39	117.39	0.00	51.36	51.36
5	Chaves	Power (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	Chaves	Public Water Supply	0.00	18204.59	18204.59	0.00	14645.54	14645.54	0.00	3559.05	3559 05
5	Chaves	Reservoir Evaporation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		County Totals	24399.61	345055.94	369455.55	12114.61	238484.29	250598.90	12285.00	106571.65	118856 65
6	Cibola	Commercial (self-supplied)	0.00	59.52	59.52	0.00	43.54	43.54	0.00	15 98	15.98
6	Cibola	Domestic (self-supplied)	0.00	1036.90	1036.90	0.00	1036.90	1036.90	0.00	0.00	0.00
6	Cibola	Industrial (self-supplied)	0.00	6.08	6.08	0.00	6.08	6.08	0.00	0.00	0.00
6	Cibola	Irrigated Agriculture	4357.00	492.00	4849.00	1942.00	316.00	2258.00	2415.00	176.00	2591.00
6	Cibola	Livestock (self-supplied)	54.66	222.47	277.13	54.66	222.47	277.13	0.00	0.00	0.00
6	Cibola	Mining (self-supplied)	0.00	0.14	0.14	0.00	0.08	0.08	0.00	0.06	0.06
6	Cibola	Power (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	Cibola	Public Water Supply	0.00	3140.68	3140.68	0.00	2150.96	2150.96	0.00	989.72	989.72
6	Cibola	Reservoir Evaporation	1080.00	0.00	1080.00	1080.00	0.00	1080.00	0.00	0.00	0.00
		County Totals	5491.66	4957.79	10449.45	3076.66	3776.03	6852.69	2415.00	1161.76	3596.76

Key: CN=county number; WSW=withdrawal, surface water; WGW=withdrawal ground water; TW=total withdrawal; DSW=depletion, surface water; DGW=depletion, ground water; TD=total depletion; RFSW=return flow, surface water; RFGW=return flow, ground water; TRF=total return flow.

Table 4. Summary of water use in acre-feet, in New Mexico counties, 2000.

CN	COUNTY	CATEGORY	WSW	WGW	TW	DSW	DGW	TD	RFSW	RFGW	TRF
7	Colfax	Commercial (self-supplied)	75.50	93.27	168.77	33.97	73.62	107.59	41.53	19.65	61.18
7	Colfax	Domestic (self-supplied)	0.00	88.81	88.81	0.00	88.81	88.81	0.00	0.00	0.00
7	Colfax	Industrial (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	Colfax	Irrigated Agriculture	48400.00	915.00	49315.00	19912.00	595.00	20507.00	28488.00	320.00	28808.00
7	Colfax	Livestock (self-supplied)	309.03	316.02	625.05	309.03	316.02	625.05	0.00	0.00	0.00
7	Colfax	Mining (self-supplied)	569.94	0.00	569.94	307.77	0.00	307.77	262.17	0.00	262.17
7	Colfax	Power (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	Colfax	Public Water Supply	2452.94	788.37	3241.31	1554.21	374.03	1928.24	898.73	414.34	1313.07
7	Colfax	Reservoir Evaporation	7204.20	0.00	7204.20	7204.20	0.00	7204.20	0.00	0.00	0.00
		County Totals	59011.61	2201.47	61213.08	29321.18	1447.48	30768.66	29690.43	753.99	30444.42
9	Curry	Commercial (self-supplied)	0.00	232.10	232.10	0.00	228.60	228.60	0.00	3.50	3.50
9	Curry	Domestic (self-supplied)	0.00	306.25	306.25	0.00	306.25	306.25	0.00	0.00	0.00
9	Curry	Industrial (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	Curry	Irrigated Agriculture	0.00	195886.00	195886.00	0.00	157883.00	157883.00	0.00	38003.00	38003.00
9	Curry	Livestock (self-supplied)	140.22	4626.40	4766.62	140.22	4626.40	4766.62	0.00	0.00	0.00
9	Curry	Mining (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	Curry	Power (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	Curry	Public Water Supply	0.00	8416.64	8416.64	0.00	4362.56	4362.56	0.00	4054.08	4054.08
9	Curry	Reservoir Evaporation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		County Totals	140.22	209467.39	209607.61	140.22	167406.81	167547.03	0.00	42060.58	42060.58

Key: CN=county number; WSW=withdrawal, surface water; WGW=withdrawal ground water; TW=total withdrawal; DSW=depletion, surface water; DGW=depletion, ground water; TD=total depletion; RFSW=return flow, surface water; RFGW=return flow, ground water; TRF=total return flow.

Table 4. Summary of water use in acre-feet, in New Mexico counties, 2000.

CN	COUNTY	CATEGORY	WSW	WGW	TW	DSW	DGW	TD	RFSW	RFGW	TRF
11	De Baca	Commercial (self-supplied)	0.00	3.56	3.56	0.00	3.56	3.56	0.00	0.00	0.00
11	De Baca	Domestic (self-supplied)	0.00	47.14	47.14	0.00	47.14	47.14	0.00	0.00	0.00
11	De Baca	Industrial (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	De Baca	Irrigetad Agriculture	39641.00	9839.00	49480.00	11240.00	8071.00	19311.00	28401.00	1768.00	30169.00
11	De Baca	Livestock (self-supplied)	85.85	350.06	435.91	85.85	350.06	435.91	0.00	0.00	0.00
11	De Baca	Mining (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	De Baca	Power (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	De Baca	Public Water Supply	0.00	397.11	397.11	0.00	234.43	234.43	0.00	162.68	162.68
11	De Baca	Reservoir Evaporation	13387.00	0.00	13387.00	13387.00	0.00	13387.00	0.00	0.00	0.00
		County Totals	53113.85	10836.87	63750.72	24712.85	8706.19	33419.04	28401.00	1930.68	30331.68
13	Dona Ana	Commercial (self-supplied)	153.91	4596.45	4750.36	153.91	3692.99	3846.90	0.00	903.46	903.46
13	Dona Ana	Domestic (self-supplied)	0.00	987.19	987.19	0.00	987.19	987.19	0.00	0.00	0.00
13	Dona Ana	Industrial (self-supplied)	0.00	73.57	73.57	0.00	38.76	38.76	0.00	34.81	34.81
13	Dona Ana	Irrigated Agriculture	413811.00	97105.00	510916.00	160677.00	65897.00	226574.00	253134.00	31208.00	284342.00
13	Dona Ana	Livestock (self-supplied)	92.34	4497.90	4590.24	92.34	4497.90	4590.24	0.00	0.00	0.00
13	Dona Ana	Mining (self-supplied)	0.00	26.78	26.78	0.00	5.36	5.36	0.00	21.42	21.42
13	Dona Ana	Power (self-supplied)	0.00	2775.25	2775.25	0.00	2775.25	2775.25	0.00	0.00	0.00
13	Dona Ana	Public Water Supply	0.00	38156.63	38156.63	0.00	21452.68	21452.68	0.00	16703.95	16703.95
13	Dona Ana	Reservoir Evaporation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		County Totals	414057.25	148218.77	562276.02	160923.25	99347.13	260270.38	253134.00	48871.64	302005.64

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Table 4. Summary of water use in acre-feet, in New Mexico counties, 2000.

CN	COUNTY	CATEGORY	WSW	WGW	TW	DSW	DGW	TD	RFSW	RFGW	TRF
15	Eddy	Commercial (self-supplied)	68.78	1197.10	1265.88	68.78	1182.72	1251.50	0.00	14.38	14.38
15	Eddy	Domestic (self-supplied)	0.00	243.52	243.52	0.00	243.52	243.52	0.00	0.00	0.00
15	Eddy	Industrial (self-supplied)	0.00	881.10	881.10	0.00	875.12	875.12	0.00	5.98	5.98
15	Eddy	Irrigated Agriculture	104715.00	122959.00	227674.00	49795.00	92016.00	141811.00	54920.00	30943.00	85863.00
15	Eddy	Livestock (self-supplied)	96.73	2083.43	2180.16	96.73	2083.43	2180.16	0.00	0.00	0.00
15	Eddy	Mining (self-supplied)	1851.65	4376.96	6228.61	555.50	3467.40	4022.90	1296.15	909.56	2205.71
15	Eddy	Power (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	Eddy	Public Water Supply	126.51	15991.00	16117.51	126.51	10970.42	11096.93	0.00	5020.58	5020.58
15	Eddy	Reservoir Evaporation	23306.00	0.00	23306.00	23306.00	0.00	23306.00	0.00	0.00	0.00
		County Totals	130164.67	147732.11	277896.78	73946.52	110838.61	184787.13	56216.15	36893.50	93109.65
17	Grant	Commercial (self-supplied)	0.00	242.10	242.10	0.00	144.34	144.34	0.00	97.76	97.76
17	Grant	Domestic (self-supplied)	0.00	778.01	778.01	0.00	778.01	778.01	0.00	0.00	0.00
17	Grant	Industrial (self-supplied)	0.00	10.58	10.58	0.00	10.58	10.58	0.00	0.00	0.00
17	Grant	Irrigated Agriculture	25771.00	4100.00	29871.00	4008.00	2402.00	6410.00	21763.00	1698.00	23461.00
17	Grant	Livestock (self-supplied)	201.63	217.20	418.83	201.63	217.20	418.83	0.00	0.00	0.00
17	Grant	Mining (self-supplied)	0.00	21458.18	21458.18	0.00	17187.54	17187.54	0.00	4270.64	4270.64
17	Grant	Power (self-supplied)	0.00	280.00	280.00	0.00	280.00	280.00	0.00	0.00	0.00
17	Grant	Public Water Supply	176.41	4084.08	4260.49	88.21	2583.82	2672.03	88.20	1500.26	1588.46
17	Grant	Reservoir Evaporation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		County Totals	26149.04	31170.15	57319.19	4297.84	23603.49	27901.33	21851.20	7566.66	29417.86

Key: CN=county number; WSW=withdrawal, surface water; WGW=withdrawal ground water; TW=total withdrawal; DSW=depletion, surface water; DGW=depletion, ground water; TD=total depletion; RFSW=return flow, surface water; RFGW=return flow, ground water; TRF=total return flow.

Table 4. Summary of water use in acre-feet, in New Mexico counties, 2000.

CN	COUNTY	CATEGORY	WSW	WGW	TW	DSW	DGW	TD	RFSW	RFGW	TRF
19	Guadalupe	Commercial (self-supplied)	0.00	29.28	29.28	0.00	25.43	25.43	0.00	3.85	3.85
19	Guadalupe	Domestic (self-supplied)	0.00	18.37	18.37	0.00	18.37	18.37	0.00	0.00	0.00
19	Guadalupe	Industrial (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	Guadalupe	Irrigated Agriculture	12685.00	1186.00	13871.00	5016.00	692.00	5708.00	7669.00	494.00	8163.00
19	Guadalupe	Livestock (self-supplied)	75.36	317.53	392.89	75.36	317.53	392.89	0.00	0.00	0.00
19	Guadalupe	Mining (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	Guadalupe	Power (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	Guadalupe	Public Water Supply	0.00	898.88	898.88	0.00	449.44	449.44	0.00	449.44	449.44
19	Guadalupe	Reservoir Evaporation	12888.00	0.00	12888.00	12888.00	0.00	12888.00	0.00	0.00	0.00
		County Totals	25648.36	2450.06	28098.42	17979.36	1502.77	19482.13	7669.00	947.29	8616.29
21	Harding	Commercial (self-supplied)	0.00	0.06	0.06	0.00	0.06	0.06	0.00	0.00	0.00
21	Harding	Domestic (self-supplied)	0.00	34.59	34.59	0.00	34.59	34.59	0.00	0.00	0.00
21	Harding	Industrial (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	Harding	Irrigated Agriculture	0.00	3654.00	3654.00	0.00	3167.00	3167.00	0.00	487.00	487.00
21	Harding	Livestock (self-supplied)	89.71	363.24	452.95	89.71	363.24	452.95	0.00	0.00	0.00
21	Harding	Mining (self-supplied)	0.00	0.30	0.30	0.00	0.30	0.30	0.00	0.00	0.00
21	Harding	Power (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	Harding	Public Water Supply	0.00	83.59	83.59	0.00	41.80	41.80	0.00	41.79	41.79
21	Harding	Reservoir Evaporation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		County Totals	69.71	4135.78	4225.49	89.71	3606.99	3696.70	0.00	528.79	528.79

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Table 4. Summary of water use in acre-feet, in New Mexico counties, 2000.

CN	COUNTY	CATEGORY	WSW	WGW	TW	DSW	DGW	TD	RFSW	RFGW	TRF
23	Hidalgo	Commercial (self-supplied)	0.00	512.40	512.40	0.00	508.53	508.53	0.00	3.87	3.87
23	Hidalgo	Domestic (self-supplied)	0.00	193.20	193.20	0.00	193.20	193.20	0.00	0.00	0.00
23	Hidalgo	Industrial (self-supplied)	0.00	6.19	6.19	0.00	3.12	3.12	0.00	3.07	3.07
23	Hidalgo	Irrigated Agriculture	8741.00	33143.00	41884.00	3931.00	20741.00	24672.00	4810.00	12402.00	17212.00
23	Hidalgo	Livestock (self-supplied)	60.49	259.02	319.51	60.49	259.02	319.51	0.00	0.00	0.00
23	Hidalgo	Mining (self-supplied)	0.00	4332.01	4332.01	0.00	4115.41	4115.41	0.00	216.60	216.60
23	Hidalgo	Power (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	Hidalgo	Public Water Supply	0.00	906.77	906.77	0.00	453.38	453.38	0.00	453.39	453.39
23	Hidalgo	Reservoir Evaporation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		County Totals	8801.49	39352.59	48154.08	3991.49	26273.66	30265.15	4810.00	13078.93	17888.93
25	Lea	Commercial (self-supplied)	0.00	1652.97	1652.97	0.00	1562.47	1562.47	0.00	90.50	90.50
25	Lea	Domestic (self-supplied)	0.00	1302.95	1302.95	0.00	1302.95	1302.95	0.00	0.00	0.00
25	Lea	Industrial (self-supplied)	0.00	3009.96	3009.96	0.00	2446.71	2446.71	0.00	563.25	563.25
25	Lea	Irrigated Agriculture	0.00	129792.00	129792.00	0.00	105861.00	105861.00	0.00	23931.00	23931.00
25	Lea	Livestock (self-supplied)	65.62	2732.10	2797.72	65.62	2732.10	2797.72	0.00	0.00	0.00
25	Lea	Mining (self-supplied)	0.00	28294.21	28294.21	0.00	19236.34	19236.34	0.00	9057.87	9057.87
25	Lea	Power (self-supplied)	0.00	5093.00	5093.00	0.00	5093.00	5093.00	0.00	0.00	0.00
25	Lea	Public Water Supply	0.00	14725.89	14725.89	0.00	7362.95	7362.95	0.00	7362.94	7362.94
25	Lea	Reservoir Evaporation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		County Totals	65.62	166603.08	186668.70	65.62	145597.52	145663.14	0.00	41005.56	41005.56

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Table 4. Summary of water use in acre-feet, in New Mexico counties, 2000.

CN	COUNTY	CATEGORY	WSW	WGW	TW	DSW	DGW	TD	RFSW	RFGW	TRF
27	Lincoln	Commercial (self-supplied)	0.00	1039.82	1039.82	0.00	906.10	906.10	0.00	133.72	133.72
27	Lincoln	Domestic (self-supplied)	0.00	310.95	310.95	0.00	310.95	310.95	0.00	0.00	0.00
27	Lincoln	Industrial (self-supplied)	0.00	1.67	1.67	0.00	1.67	1.67	0.00	0.00	0.00
27	Lincoln	Irrigated Agriculture	17151.00	6099.00	23250.00	6001.00	3147.00	9148.00	11150.00	2952.00	14102.00
27	Lincoln	Livestock (self-supplied)	294.82	309.76	604.58	294.82	309.76	604.58	0.00	0.00	0.00
27	Lincoln	Mining (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27	Lincoln	Power (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27	Lincoln	Public Water Supply	1922.76	2977.26	4900.02	573.71	1048.29	1622.00	1349.05	1928.97	3278.02
27	Lincoln	Reservoir Evaporation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		County Totals	19368.58	10738.46	30107.04	6869.53	5723.77	12593.30	12499.05	5014.69	17513.74
28	Los Alamos	Commercial (self-supplied)	0.00	1.22	1.22	0.00	1.22	1.22	0.00	0.00	0.00
28	Los Alamos	Domestic (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28	Los Alamos	Industrial (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28	Los Alamos	Irrigated Agriculture	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28	Los Alamos	Livestock (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28	Los Alamos	Mining (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28	Los Alamos	Power (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28	Los Alamos	Public Water Supply	0.00	4607.77	4607.77	0.00	4423.46	4423.46	0.00	184.31	184.31
28	Los Alamos	Reservoir Evaporation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		County Totals	0.00	4608.99	4608.99	0.00	4424.68	4424.68	0.00	184.31	184.31

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Table 4. Summary of water use in acre-feet, in New Mexico counties, 2000.

CN	COUNTY	CATEGORY	WSW	WGW	TW	DSW	DGW	TD	RFSW	RFGW	TRF
29	Luna	Commercial (self-supplied)	0.00	185.89	185.89	0.00	175.55	175.55	0.00	10.34	10.34
29	Luna	Domestic (self-supplied)	0.00	717.45	717.45	0.00	717.45	717.45	0.00	0.00	0 00
29	Luna	Industrial (self-supplied)	0.00	54.97	54.97	0.00	42.29	42.29	0.00	12.68	12 68
29	Luna	Irrigated Agriculture	22509.00	91674.00	114183.00	10425.00	57786.00	68211.00	12084.00	33888.00	45972.00
29	Luna	Livestock (self-supplied)	82.89	341.57	424.46	82.89	341.57	424.46	0.00	0.00	0.00
29	Luna	Mining (self-supplied)	0.00	41.37	41.37	0.00	26.63	26.63	0.00	14.74	14.74
29	Luna	Power (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29	Luna	Public Water Supply	0.00	4387.65	4387.65	0.00	2193.83	2193.83	0.00	2193.82	2193.82
29	Luna	Reservoir Evaporation	0.00	0.00	0.00	0.00	0.00	0.00	0 00	0.00	0.00
		County Totals	22591.89	97402.90	119994.79	10507.89	61283.32	71791.21	12084.00	36119.58	48203.58
31	McKinley	Commercial (self-supplied)	0.00	83.90	83.90	0.00	55.90	55.90	0.00	28.00	28.00
31	McKinley	Domestic (self-supplied)	0.00	3326.32	3326.32	0.00	3326.32	3326.32	0.00	0.00	0.00
31	McKinley	Industrial (self-supplied)	0.00	1005.24	1005.24	0.00	1005.24	1005.24	0.00	0.00	0.00
31	McKinley	Irrigated Agriculture	2534.00	0.00	2534.00	1142.00	0.00	1142.00	1392.00	0.00	1392.00
31	McKinley	Livestock (self-supplied)	105.61	426.99	532.60	105.61	426.99	532.60	0.00	0.00	0.00
31	McKinley	Mining (self-supplied)	0.00	2555.22	2555.22	0.00	1307.43	1307.43	0.00	1247.79	1247.79
31	McKinley	Power (self-supplied)	0.00	3703.31	3703.31	0.00	3703.31	3703.31	0.00	0 00	0.00
31	McKinley	Public Water Supply	0.00	5332.07	5332.07	0.00	4755.04	4755.04	0.00	577.03	577.03
31	McKinley	Reservoir Evaporation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		County Totals	2639.61	16433.05	19072.66	1247.61	14580.23	15827.84	1392.00	1852.82	3244.82

Key: CN=county number; WSW=withdrawal, surface water; WGW=withdrawal ground water; TW=total withdrawal; DSW=depletion, surface water; DGW=depletion, ground water; TD=total depletion; RFSW=return flow, surface water; RFGW=return flow, ground water; TRF=total return flow.

Table 4. Summary of water use in acre-feet, in New Mexico counties, 2000.

CN	COUNTY	CATEGORY	WSW	WGW	TW	DSW	DGW	TD	RFSW	RFGW	TRF
33	Mora	Commercial (self-supplied)	0.00	6.41	6.41	0.00	6.41	6.41	0.00	0.00	0.00
33	Mora	Domestic (self-supplied)	0.00	343.12	343.12	0.00	343.12	343.12	0.00	0.00	0.00
33	Mora	Industrial (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
33	Mora	Irrigated Agriculture	32626.00	45.00	32671.00	15196.00	38.00	15234.00	17430.00	7.00	17437.00
33	Mora	Livestock (self-supplied)	134.91	145.50	280.41	134.91	145.50	280.41	0.00	0.00	0.00
33	Mora	Mining (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
33	Mora	Power (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
33	Mora	Public Water Supply	0.00	305.27	305.27	0.00	176.58	176.58	0.00	128.69	128.69
33	Mora	Reservoir Evaporation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		County Totals	32760.91	845.30	33606.21	15330.91	709.61	16040.52	17430.00	135.69	17565.69
35	Otero	Commercial (self-supplied)	746.35	166.56	914.91	680.17	166.23	846.40	66.18	2.33	68.51
35	Otero	Domestic (self-supplied)	0.00	1127.09	1127.09	0.00	1127.09	1127.09	0.00	0.00	0.00
35	Otero	Industrial (self-supplied)	0.00	10.61	10.61	0.00	10.61	10.61	0.00	0.00	0.00
35	Otero	Irrigated Agriculture	9793.00	23980.00	33773.00	4695.00	19343.00	24038.00	5098.00	4637.00	9735.00
35	Otero	Livestock (self-supplied)	93.69	204.85	298.54	93.69	204.85	298.54	0.00	0.00	0.00
35	Otero	Mining (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
35	Otero	Power (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
35	Otero	Public Water Supply	6843.88	5486.14	12330.02	3423.37	2877.92	6301.29	3420.51	2608.22	6028.73
35	Otero	Reservoir Evaporation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		County Totals	17476.92	30977.25	48454.17	8892.23	23729.70	32621.93	8584.69	7247.55	15832.24

Key: CN=county number; WSW=withdrawal, surface water; WGW=withdrawal ground water; TW=total withdrawal; DSW=depletion, surface water; DGW=depletion, ground water; TD=total depletion; RFSW=return flow, surface water; RFGW=return flow, ground water; TRF=total return flow.

Table 4. Summary of water use in acre-feet, in New Mexico counties, 2000.

CN	COUNTY	CATEGORY	WSW	WGW	TW	DSW	DGW	TD	RFSW	RFGW	TRF
37	Quay	Commercial (self-supplied)	0.00	10.54	10.54	0.00	10.54	10.54	0.00	0.00	0.00
37	Quay	Domestic (self-supplied)	0.00	138.27	138.27	0.00	138.27	138.27	0.00	0.00	0.00
37	Quay	Industrial (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
37	Quay	Irrigated Agriculture	107954.00	6546.00	114500.00	34912.00	5523.00	40435.00	73042.00	1023.00	74065.00
37	Quay	Livestock (self-supplied)	86.50	791.90	878.40	86.50	791.90	878.40	0.00	0.00	0.00
37	Quay	Mining (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
37	Quay	Power (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
37	Quay	Public Water Supply	0.00	2172.44	2172.44	0.00	1255.65	1255.65	0.00	916.79	916.79
37	Quay	Reservoir Evaporation	32938.00	0.00	32938.00	32938.00	0.00	32938.00	0.00	0.00	0.00
		County Totals	140978.50	9659.15	150637.65	67936.50	7719.36	75655.86	73042.00	1939.79	74981.79
39	Rio Arriba	Commercial (self-supplied)	215.89	279.67	495.56	68.10	190.01	258.11	147.79	89.66	237.45
39	Rio Arriba	Domestic (self-supplied)	0.00	1950.57	1950.57	0.00	1950.57	1950.57	0.00	0.00	0.00
39	Rio Arriba	Industrial (self-supplied)	0.00	136.94	136.94	0.00	131.27	131.27	0.00	5.67	5.67
39	Rio Arriba	Irrigated Agriculture	110595.00	1258.00	111853.00	40615.00	679.00	41294.00	89980.00	579.00	70559.00
39	Rio Arriba	Livestock (self-supplied)	167.10	177.50	344.60	167.10	177.50	344.60	0.00	0.00	0.00
39	Rio Arriba	Mining (self-supplied)	0.00	96.61	96.61	0.00	12.44	12.44	0.00	84.17	84.17
39	Rio Arriba	Power (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
39	Rio Arriba	Public Water Supply	721.96	1718.67	2440.63	315.54	545.62	861.16	406.42	1173.05	1579.47
39	Rio Arriba	Reservoir Evaporation	25535.50	0.00	25535.50	25535.50	0.00	25535.50	0.00	0.00	0.00
		County Totals	137235.45	5617.96	142853.41	66701.24	3686.41	70387.65	70534.21	1931.55	72465.76

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Table 4. Summary of water use in acre-feet, in New Mexico counties, 2000.

CN	COUNTY	CATEGORY	WSW	WGW	TW	DSW	DGW	TD	RFSW	RFGW	TRF
41	Roosevelt	Commercial (self-supplied)	0.00	140.83	140.83	0.00	140.83	140.83	0.00	0.00	0.00
41	Roosevelt	Domestic (self-supplied)	0.00	239.71	239.71	0.00	239.71	239.71	0.00	0.00	0.00
41	Roosevelt	Industrial (self-supplied)	0.00	0.11	0.11	0.00	0.11	0.11	0.00	0.00	0.00
41	Roosevelt	Irrigated Agriculture	0.00	148714.00	148714.00	0.00	127396.00	127396.00	0.00	21318.00	21318.00
41	Roosevelt	Livestock (self-supplied)	69.77	4559.51	4629.28	69.77	4559.51	4629.28	0.00	0.00	0.00
41	Roosevelt	Mining (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
41	Roosevelt	Power (self-supplied)	0.00	16.96	16.96	0.00	16.96	16.96	0.00	0.00	0.00
41	Roosevelt	Public Water Supply	0.00	4524.90	4524.90	0.00	3021.41	3021.41	0.00	1503.49	1503.49
41	Roosevelt	Reservoir Evaporation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		County Totals	69.77	158196.02	158265.79	69.77	135374.53	135444.30	0.00	22821.49	22821.49
43	Sandoval	Commercial (self-supplied)	10.00	2079.14	2089.14	10.00	2000.03	2010.03	0.00	79.11	79.11
43	Sandoval	Domestic (self-supplied)	0.00	2829.84	2829.84	0.00	2829.84	2829.84	0.00	0.00	0.00
43	Sandoval	Industrial (self-supplied)	0.00	3611.81	3611.81	0.00	738.43	738.43	0.00	2873.38	2873.38
43	Sandoval	Irrigated Agriculture	61513.00	824.00	62337.00	17971.00	450.00	18421.00	43542.00	374.00	43916.00
43	Sandoval	Livestock (self-supplied)	124.02	134.57	258.59	124.02	134.57	258.59	0.00	0.00	0.00
43	Sandoval	Mining (self-supplied)	0.00	438.20	438.20	0.00	350.37	350.37	0.00	87.83	87.83
43	Sandoval	Power (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
43	Sandoval	Public Water Supply	159.16	12219.79	12378.95	59.48	9897.42	9956.90	99.68	2322.37	2422.05
43	Sandoval	Reservoir Evaporation	10370.00	0.00	10370.00	10370.00	0.00	10370.00	0.00	0.00	0.00
		County Totals	72176.18	22137.35	94313.53	28534.50	16400.66	44935.16	43641.68	5736.69	49378.37

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Table 4. Summary of water use in acre-feet, in New Mexico counties, 2000.

CN	COUNTY	CATEGORY	WSW	WGW	TW	DSW	DGW	TD	RFSW	RFGW	TRF
45	San Juan	Commercial (self-supplied)	152.86	61.68	214.54	143.18	45.18	188.36	9.68	16.50	26.18
45	San Juan	Domestic (self-supplied)	0.00	1316.39	1318.39	0.00	1318.39	1318.39	0.00	0.00	0.00
45	San Juan	Industrial (self-supplied)	1871.46	10.14	1881.60	1871.46	10.14	1881.60	0.00	0.00	0.00
45	San Juan	Irrigated Agriculture	221100.00	0.00	221100.00	171044.00	0.00	171044.00	50056.00	0.00	50056.00
45	San Juan	Livestock (self-supplied)	102.20	425.28	527.48	102.20	425.28	527.48	0.00	0.00	0.00
45	San Juan	Mining (self-supplied)	78.90	0.00	78.90	50.10	0.00	50.10	28.80	0.00	28.80
45	San Juan	Power (self-supplied)	50449.88	0.00	50449.88	44184.21	0.00	44184.21	6265.67	0.00	6265.67
45	San Juan	Public Water Supply	19024.83	331.35	19356.18	9926.94	165.68	10092.62	9097.89	165.67	9263.56
45	San Juan	Reservoir Evaporation	34323.50	0.00	34323.50	34323.50	0.00	34323.50	0.00	0.00	0.00
		County Totals	327103.63	2146.84	329250.47	261845.59	1964.67	263610.26	65458.04	182.17	65640.21
47	San Miguel	Commercial (self-supplied)	164.14	186.08	350.22	164.14	167.76	331.90	0.00	18.32	18.32
47	San Miguel	Domestic (self-supplied)	0.00	989.49	989.49	0.00	989.49	989.49	0.00	0.00	0.00
47	San Miguel	Industrial (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
47	San Miguel	Irrigated Agriculture	47838.00	0.00	47838.00	18370.00	0.00	18370.00	29468.00	0.00	29468.00
47	San Miguel	Livestock (self-supplied)	296.84	342.75	639.59	296.84	342.75	639.59	0.00	0.00	0.00
47	San Miguel	Mining (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
47	San Miguel	Power (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
47	San Miguel	Public Water Supply	2607.31	351.46	2958.77	921.79	197.21	1119.00	1685.52	154.25	1839.77
47	San Miguel	Reservoir Evaporation	47653.40	0.00	47653.40	47653.40	0.00	47653.40	0.00	0.00	0.00
		County Totals	98559.69	1869.78	100429.47	67406.17	1697.21	69103.38	31153.52	172.57	31326.09

Key: CN=county number; WSW=withdrawal, surface water; WGW=withdrawal ground water; TW=total withdrawal; DSW=depletion, surface water; DGW=depletion, ground water; TD=total depletion; RFSW=return flow, surface water; RFGW=return flow, ground water; TRF=total return flow.

Table 4. Summary of water use in acre-feet, in New Mexico counties, 2000.

CN	COUNTY	CATEGORY	WSW	WGW	TW	DSW	DGW	TD	RFSW	RFGW	TRF
49	Santa Fe	Commercial (self-supplied)	19.34	539.88	559.22	2.51	424.26	426.77	16.83	115.62	132.45
49	Santa Fe	Domestic (self-supplied)	0.00	3199.32	3199.32	0.00	3199.32	3199.32	0.00	0.00	0.00
49	Santa Fe	Industrial (self-supplied)	0.00	22.02	22.02	0.00	22.02	22.02	0.00	0.00	0.00
49	Santa Fe	Irrigated Agriculture	16791.00	16573.00	33364.00	7580.00	12208.00	19788.00	9211.00	4365.00	13576.00
49	Santa Fe	Livestock (self-supplied)	146.11	153.26	299.37	146.11	153.26	299.37	0.00	0.00	0.00
49	Santa Fe	Mining (self-supplied)	0.00	18.82	18.82	0.00	2.40	2.40	0.00	16.42	16.42
49	Santa Fe	Power (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
49	Santa Fe	Public Water Supply	3681.99	11474.75	15156.74	2198.58	6788.78	8987.36	1483.41	4685.97	6169.38
49	Santa Fe	Reservoir Evaporation	139.00	0.00	139.00	139.00	0.00	139.00	0.00	0.00	0.00
		County Totals	20777.44	31981.05	52758.49	10066.20	22798.04	32864.24	10711.24	9183.01	19894.25
51	Sierra	Commercial (self-supplied)	0.00	436.28	436.28	0.00	388.39	388.39	0.00	47.89	47.89
51	Sierra	Domestic (self-supplied)	0.00	101.62	101.62	0.00	101.62	101.62	0.00	0.00	0.00
51	Sierra	Industrial (self-supplied)	0.00	0.10	0.10	0.00	0.10	0.10	0.00	0.00	0.00
51	Sierra	Irrigated Agriculture	23869.00	11342.00	35211.00	11069.00	7149.00	18218.00	12800.00	4193.00	16993.00
51	Sierra	Livestock (self-supplied)	71.94	631.03	702.97	71.94	631.03	702.97	0.00	0.00	0.00
51	Sierra	Mining (self-supplied)	0.00	4.86	4.86	0.00	0.97	0.97	0.00	3.89	3.89
51	Sierra	Power (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
51	Sierra	Public Water Supply	0.00	1913.60	1913.80	0.00	1062.32	1062.32	0.00	851.28	851.28
51	Sierra	Reservoir Evaporation	245964.00	0.00	245964.00	245964.00	0.00	245964.00	0.00	0.00	0.00
		County Totals	269904.94	14429.49	284334.43	257104.94	9333.43	266438.37	12800.00	5096.06	17896.06

Key: CN=county number; WSW=withdrawal, surface water; WGW=withdrawal ground water; TW=total withdrewal; DSW=depletion, surface water; DGW=depletion, ground water; TD=total depletion; RFSW=return flow, surface water; RFGW=return flow, ground water; TRF=total return flow.

Table 4. Summary of water use in acre-feet, in New Mexico counties, 2000.

CN	COUNTY	CATEGORY	WSW	WGW	TW	DSW	DGW	TD	RFSW	RFGW	TRF
53	Socorro	Commercial (self-supplied)	0.00	1274.26	1274.26	0.00	898.47	896.47	0.00	377.79	377.79
53	Socorro	Domestic (self-supplied)	0.00	456.93	456.93	0.00	456.93	456.93	0.00	0.00	0.00
53	Socorro	Industrial (self-supplied)	0.00	1.86	1.86	0.00	1.86	1.86	0.00	0.00	0.00
53	Socorro	Irrigated Agriculture	143518.00	33530.00	177046.00	40411.00	18969.00	59380.00	103105.00	14561.00	117666.00
53	Socorro	Livestock (self-supplied)	59.36	1013.65	1073.01	59.36	1013.65	1073.01	0.00	0.00	0.00
53	Socorro	Mining (self-supplied)	0.00	1.86	1.86	0.00	1.86	1.86	0.00	0.00	0.00
53	Socorro	Power (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
53	Socorro	Public Water Supply	0.00	2575.87	2575.87	0.00	958.40	958.40	0.00	1617.47	1617.47
53	Socorro	Reservoir Evaporation	7570.00	0.00	7570.00	7570.00	0.00	7570.00	0.00	0.00	0.00
		County Totals	151145.36	38854.43	189999.79	48040.36	22298.17	70338.53	103105.00	16556.26	119661.26
55	Taos	Commercial (self-supplied)	205.51	204.35	409.86	25.05	176.31	201.36	180.46	28.04	208.50
55	Taos	Domestic (self-supplied)	0.00	1376.26	1376.26	0.00	1376.26	1376.26	0.00	0.00	0.00
55	Taos	Industrial (self-supplied)	0.00	2.54	2.54	0.00	2.54	2.54	0.00	0.00	0.00
55	Taos	Irrigated Agriculture	97461.00	2096.00	99557.00	37614.00	1654.00	39268.00	59847.00	442.00	60289.00
55	Taos	Livestock (self-supplied)	40.31	59.52	99.83	40.31	59.52	99.83	0.00	0.00	0.00
55	Teos	Mining (self-supplied)	515.00	2578.64	3093.64	87.55	438.40	525.95	427.45	2140.24	2567.69
55	Teos	Power (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
55	Taos	Public Water Supply	91.47	2133.66	2225.13	16.14	901.25	917.39	75.33	1232.41	1307.74
55	Taos	Reservoir Evaporation	578.00	0.00	578.00	578.00	0.00	578.00	0.00	0.00	0.00
		County Totals	98891.29	8450.97	107342.26	38361.05	4608.28	42969.33	60530.24	3842.69	64372.93

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Table 4. Summary of water use in acre-feet, in New Mexico counties, 2000.

CN	COUNTY	CATEGORY	WSW	WGW	TW	DSW	DGW	TD	RFSW	RFGW	TRF
57	Torrance	Commercial (self-supplied)	0.00	80.83	80.83	0.00	70.03	70.03	0.00	10.80	10.80
57	Torrance	Domestic (self-supplied)	0.00	1003.65	1003.65	0.00	1003.65	1003.65	0.00	0.00	0.00
57	Torrance	Industrial (self-supplied)	0.00	16.57	16.57	0.00	18.57	16.57	0.00	0.00	0.00
57	Torrence	Irrigated Agriculture	0.00	33609.00	33609.00	0.00	25890.00	25890.00	0.00	7719.00	7719.00
57	Torrance	Livestock (self-supplied)	51.63	475.96	527.59	51.63	475.96	527.59	0.00	0.00	0.00
57	Torrance	Mining (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
57	Torrance	Power (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
57	Torrance	Public Water Supply	0.00	939.07	939.07	0.00	469.54	469.54	0.00	469.53	469.53
57	Torrance	Reservoir Evaporation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		County Totals	51.63	36125.08	36176.71	51.63	27925.75	27977.38	0.00	8199.33	8199.33
59	Union	Commercial (self-supplied)	0.00	8.19	8.19	0.00	8.19	8.19	0.00	0.00	0.00
59	Union	Domestic (self-supplied)	0.00	130.12	130.12	0.00	130.12	130.12	0.00	0.00	0.00
59	Union	Industrial (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
59	Union	Irrigated Agriculture	6385.00	77185.00	83570.00	2919.00	66226.00	69145.00	3466.00	10959.00	14425.00
59	Union	Livestock (self-supplied)	176.06	1591.01	1767.07	176.06	1591.01	1767.07	0.00	0.00	0.00
59	Union	Mining (self-supplied)	0.00	0.12	0.12	0.00	0.12	0.12	0.00	0.00	0.00
59	Union	Power (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
59	Union	Public Water Supply	0.00	584.80	584.60	0.00	292.30	292.30	0.00	292.30	292.30
59	Union	Reservoir Evaporation	478.80	0.00	478.80	478.80	0.00	478.60	0.00	0.00	0.00
		County Totals	7039.86	79499.04	86538.90	3573.86	68247.74	71821.60	3466.00	11251.30	14717.30

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Table 4. Summary of water use in acre-feet, in New Mexico counties, 2000.

CN	COUNTY	CATEGORY	WSW	WGW	TW	DSW	DGW	TD	RFSW	RFGW	TRF
61	Valencia	Commercial (self-supplied)	0.00	810.42	810.42	0.00	732.79	732.79	0.00	77.63	77.63
61	Valencia	Domestic (self-supplied)	0.00	3716.42	3716.42	0.00	3716.42	3716.42	0.00	0.00	0.00
61	Valencia	Industrial (self-supplied)	0.00	48.05	48.05	0.00	44.55	44.55	0.00	3.50	3.50
61	Valencia	Irrigated Agriculture	161883.00	7103.00	168986.00	44022.00	3846.00	47868.00	117861.00	3257.00	121118.00
61	Valencia	Livestock (self-supplied)	48.08	869.06	917.14	48.08	869.06	917.14	0.00	0.00	0.00
61	Valencia	Mining (self-supplied)	0.00	1.40	1.40	0.00	1.40	1.40	0.00	0.00	0.00
61	Valencia	Power (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
61	Valencia	Public Water Supply	0.00	5607.49	5607.49	0.00	2864.83	2864.83	0.00	2742.66	2742.66
61	Valencia	Reservoir Evaporation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		County Totals	161931.08	18155.84	180086.92	44070.08	12075.05	56145.13	117861.00	6080.79	123941.79
		State Totals	2409644 17	1856224.44	4265868.61	1286381.41	1342171.41	2628552.82	1123262.76	514053.03	1637315.79

Key: CN=county number; WSW=withdrawal, surface water; WGW=withdrawal ground water; TW=total withdrawal; DSW=depletion, surface water; DGW=depletion, ground water; TD=total depletion; RFSW=return flow, surface water; RFGW=return flow, ground water; TRF=total return flow.

Table 5. Summary of water use in acre-feet, in New Mexico river basins, 2000.

RVB	CATEGORY	WSW	WGW	TW	DSW	DGW	TD	RFSW	RFGW	TRF
AWR	Commercial (self-supplied)	239.64	192.90	432.54	198.11	166.44	364.55	41.53	26.46	67.99
AWR	Domestic (self-supplied)	0.00	802.34	802.34	0.00	802.34	802.34	0.00	0.00	0.00
AWR	Industrial (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AWR	Irrigated Agriculture	206589.00	94771.00	301360.00	77435.00	79538.00	156973.00	129154.00	15233.00	144387 00
AWR	Livestock (self-supplied)	991.66	3686.72	4678.38	991.66	3686.72	4678.38	0.00	0 00	0.00
AWR	Mining (self-supplied)	569.94	0.42	570.36	307.77	0.42	308.19	262.17	0.00	262.17
AWR	Power (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AWR	Public Water Supply	2664.48	3931.73	6596.21	1659.98	2139.08	3799.06	1004.50	1792.65	2797.15
AWR	Reservoir Evaporation	80390.00	0.00	80390.00	80390.40	0.00	80390.40	-0.40	0.00	-0.40
	River Basin Totals	291444.72	103385.11	394829.83	160982.92	86333.00	247315.92	130461.80	17052.11	147513.91
LC	Commercial (self-supplied)	8.00	833.60	841.60	8.00	714.54	722.54	0.00	119.06	119.06
LC	Domestic (self-supplied)	0.00	2719.03	2719.03	0.00	2719.03	2719.03	0.00	0.00	0.00
LC	Industrial (self-supplied)	0.00	1020.32	1020.32	0.00	1017.25	1017.25	0.00	3.07	3.07
LC	Irrigated Agriculture	54292.00	34263.00	88555.00	10801.00	21346.00	32147.00	43491.00	12917 00	56408.00
LC	Livestock (self-supplied)	317.19	736.98	1054.17	317.19	736.97	1054.16	0.00	0.01	0.01
LC	Mining (self-supplied)	0.00	2877.10	2877.10	0.00	2357.36	2357.36	0.00	519.74	519.74
LC	Power (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LC	Public Water Supply	132.60	6311.91	6444.51	66.30	5232.11	5298 41	66.30	1079.80	1146.10
LC	Reservoir Evaporation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	River Basin Totals	54749.79	48761.94	103511.73	11192.49	34123.26	45315.75	43557.30	14638.68	58195.98

Key: CN=county number; WSW=withdrawal, surface water; WGW=withdrawal ground water; TW=total withdrawal; DSW=depletion, surface water; DGW=depletion, ground water; TD=total depletion; RFSW=return flow, surface water; RFGW=return flow, ground water; TRF=total return flow.

Table 5. Summary of water use in acre-feet, in New Mexico river basins, 2000.

RVB	CATEGORY	WSW	WGW	TW	DSW	DGW	TD	RFSW	RFGW	TRF
P	Commercial (self-supplied)	552.78	3978.36	4531.14	497.38	2848.46	3345.84	55.40	1129.90	1185.30
P	Domestic (self-supplied)	0.00	2969.82	2969.82	0.00	2969.82	2969.82	0.00	0.00	0.00
P	Industrial (self-supplied)	0.00	3643.36	3643.36	0.00	3068.94	3068.94	0.00	574.42	574.42
P	Irrigated Agriculture	236807.00	460093.00	696900.00	98639.00	321153.00	419792.00	138168.00	138940.00	277108.00
P	Livestock (self-supplied)	925.10	12254.17	13179.27	925.10	12254.17	13179.27	0.00	0.00	0.00
P	Mining (self-supplied)	1851.65	16240.26	18091.91	555.60	10246.94	10802.54	1296.05	5993.32	7289.37
P	Power (self-supplied)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P	Public Water Supply	4424.56	41245.03	45669.59	1506.00	28757.71	30263.71	2918.56	12487.32	15405.88
P	Reservoir Evaporation	52180.00	0.00	52180.00	52180.00	0.00	52180.00	0.00	0.00	0.00
	River Basin Totals	296741.09	540424.00	837165.09	154303.08	381299.04	535602.12	142438.01	159124.98	301562.97
RG	Commercial (self-supplied)	867.00	16483.60	17350.60	511.13	13786.68	14297.81	355.87	2696.92	3052.79
RG	Domestic (self-supplied)	0.00	24422.93	24422.93	0.00	24422.93	24422.93	0.00	0.00	0.00
RG	Industrial (self-supplied)	0.00	4335.97	4335.97	0.00	1120.94	1120.94	0.00	3215.03	3215.03
RG	Irrigated Agriculture	1126975.00	326916.00	1453891.00	392878.00	218532.00	611410.00	734097.00	108384.00	842481.00
RG	Livestock (self-supplied)	1215.66	11312.34	12528.20	1215.86	11312.34	12528.20	0.00	0.00	0.00
RG	Mining (self-supplied)	515.00	29135.68	29650.68	87.55	21460.33	21547.88	427.45	7675.35	8102.80
RG	Power (self-supplied)	0.00	7598.09	7598.09	0.00	7300.47	7300.47	0.00	297.62	297.62
RG	Public Water Supply	11131.08	216783.10	227914.20	5829.41	111656.50	117485.90	5301.67	105126.60	110428.30
RG	Reservoir Evaporation	264485.00	0.00	264485.00	264485.00	0.00	264485.00	0.00	0.00	0.00
	River Basin Totals	1405188.94	636987.72	2042176.66	665006.95	409592.19	1074599.14	740181.99	227395.53	967577.52

Key: CN=county number; WSW=withdrawal, surface water; WGW=withdrawal ground water; TW=total withdrawal; DSW=depletion, surface water; DGW=depletion, ground water; TD=total depletion; RFSW=return flow, surface water; RFGW=return flow, ground water; TRF=total return flow.

Table 5. Summary of water use in acre-feet, in New Mexico river basins, 2000.

RVB	CATEGORY	WSW	WGW	TW	DSW	DGW	TD	RFSW	RFGW	TRF
TG	Commercial (self-supplied)	0.00	1796.70	1796.70	0.00	1702.70	1702.70	0.00	94.00	94.00
TG	Domestic (self-supplied)	0.00	1635.64	1635.64	0.00	1635.64	1635.64	0.00	0.00	0.00
TG	Industrial (self-supplied)	0.00	795.21	795.21	0.00	651.61	651.61	0.00	143.60	143.60
TG	Irrigated Agriculture	0.00	460554.00	460554.00	0.00	380907.00	380907.00	0.00	79647.00	79647.00
TG	Livestock (self-supplied)	196.99	11208.34	11405.33	196.99	11208.34	11405.33	0.00	0.00	0.00
TG	Mining (self-supplied)	0.00	16599.66	16599.66	0.00	12574.19	12574.19	0.00	4025.47	4025.47
TG	Power (self-supplied)	0.00	5109.96	5109.96	0.00	5109.96	5109.96	0.00	0.00	0.00
TG	Public Water Supply	0.00	25264.41	25284.41	0.00	13555.41	13555.41	0.00	11729.00	11729.00
TG	Reservoir Evaporation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	River Basin Totals	196.99	522963.92	523180.91	196.99	427344.85	427541.84	0.00	95639.07	95639.07
UC	Commercial (self-supplied)	152.86	63.68	216.54	143.18	47.18	190.36	9.68	16.50	26.18
UC	Domestic (self-supplied)	0.00	2599.74	2599.74	0.00	2599.74	2599.74	0.00	0.00	0.00
UC	Industrial (self-supplied)	1871.46	43.04	1914.50	1871.46	37.37	1908.83	0.00	5.67	5.67
UC	Irrigated Agriculture	222694.00	0.00	222694.00	171722.00	0.00	171722.00	50972.00	0.00	50972.00
UC	Livestock (self-supplied)	192.01	614.19	806.20	192.01	614.19	806.20	0.00	0.00	0.00
UC	Mining (self-supplied)	78.90	0.00	78.90	50.10	0.00	50.10	28.80	0.00	28.80
UC	Power (self-supplied)	50449.68	0.00	50449.88	44184.21	0.00	44184.21	6265.67	0.00	6265.67
UC	Public Water Supply	19523.13	361.16	19884.29	10176.09	180.58	10356.67	9347.04	180.56	9527.62
UC	Reservoir Evaporation	34382.00	0.00	34382.00	34382.00	0.00	34382.00	0.00	0.00	0.00
	River Basin Totals	329344.24	3681.81	333026.05	262721.05	3479.06	266200.11	66623.19	202.75	66825.94

Key: CN=county number; WSW=withdrawal, surface water; WGW=withdrawal ground water; TW=total withdrawal; DSW=depletion, surface water; DGW=depletion, ground water; TD=total depletion; RFSW=return flow, surface water; RFGW=return flow, ground water; TRF=total return flow.

Table 5. Summary of water use in acre-feet, in New Mexico river basins, 2000.

RVB	CATEGORY	WSW	WGW	TW	DSW	DGW	TD	RFSW	RFGW	TRF
	State Totals	2377665.77	1856224.50	4233890.27	1254403.48	1342171.40	2598574.88	1123262.29	514053.10	1637315.39

Key: CN=county number; WSW=withdrawal, surface water; WGW=withdrawal ground water; TW=total withdrawal; DSW=depletion, surface water; DGW=depletion, ground water; TD=total depletion; RFSW=return flow, surface water; RFGW=return flow, ground water; TRF=total return flow.

Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
1	RG	Alamo Acres MHP	R	10	107	0		Y	0.00	1.20	0.00	0.50	0.00	0.60
1	RG	Albuquerque Water System	U	460000	204	4		Y	0.00	105352.30	0.00	0 42	0.00	44247.95
1	RG	Baker's/ Hamilton MHP	R	290	121	0		Y	0.00	39.24	0.00	0.50	0.00	19.62
1	RG	Barcelona MHP	R	205	120	0		Y	0.00	27.44	0.00	0.50	0.00	13.72
1	RG	Bearcat Homeowners Assn.(1995)	R	64	75	0		Y	0.00	5.36	0.00	0.50	0.00	2 68
1	RG	Carnual/Monticello/Juan Rd Water	R	35	99	0		Y	0.00	3.88	0.00	0.50	0.00	1.94
1	RG	Chilili WUA (1995)	R	90	70	0		Y	0.00	7.05	0.00	0.50	0.00	3 53
1	RG	Coronado Village MHP	U	800	88	0		Y	0.00	78.61	0.00	0.50	0.00	39 31
1	RG	Corrales--self-supplied homes (prt)	U	676	150	0	-	N	0.00	113.58	0.00	1.00	0.00	113 58
1	RG	Desert Palms MHP	R	153	51	0		Y	0.00	8.70	0.00	0.50	0.00	4.35
1	RG	Entranosa Wtr Co-Op (part)-Edgewood	U	4355	80	1		Y	0.00	389.46	0.00	0.50	0.00	194.73
1	RG	Forest Park Property Owners Co-Op	R	200	87	0		Y	0.00	19.46	0.00	0.50	0.00	9.73
1	RG	Fox Hills WUA	R	76	51	0		Y	0.00	4.30	0.00	0.50	0.00	2 15
1	RG	Green Acres MHP	R	120	121	0		Y	0.00	16.32	0.00	0.50	0.00	8.16
1	RG	Homestead Mobile Home Community	R	200	97	0		Y	0.00	21.63	0.00	0.50	0.00	10.81
1	RG	Independent Utility Co.	R	1500	45	0		Y	0.00	75.30	0.00	0.50	0.00	37.65
1	RG	Kirtland Air Force Base	U	5700	646	10,7		Y	0 00	4127.17	0.00	0.60	0.00	2476.30
1	RG	La Mesa MHP	R	10	107	0		N	0 00	1.20	0.00	0.50	0.00	0 60

Key: CN=county number; RVB=river basin; C=census classification (urban/rural); POP=population; GPCD=gallons per capita per day; WTC=water transfer code; MSW=surface water withdrawals are measured (y/n); MGW=groundwater withdrawals are measured (y/n); WSW=withdrawals, surface water; WGW=withdrawals, ground water; DFSW=depletion factor, surface water; DFGW=depletion factor, ground water; DSW=depletion, surface water; DGW=depletion, ground water.

Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
1	RG	Mountain View MHP	R	90	116	0		Y	0.00	11.68	0.00	0.50	0.00	5.84
1	RG	Oakland Heights Homeowners Assn.	U	29	160	0		Y	0.00	5.19	0.00	0.50	0.00	2.60
1	RG	Paradise Hills--NM Utilities	U	21800	273	0		Y	0.00	6662.62	0.00	0.70	0.00	4663.83
1	RG	Rural self-supplied homes	R	48737	100	0	-	N	0.00	5459.26	0.00	1.00	0.00	5459.26
1	RG	Sandia Peak Utility Company	U	7160	126	0		Y	0.00	1013.70	0.00	0.50	0.00	506 85
1	RG	Sierra Vista South Water Co-Op	R	150	90	0		Y	0.00	15.15	0 00	0.50	0.00	7.57
1	RG	Sierra Viste Utilidades Co-op	R	369	104	0		Y	0.00	42.97	0.00	0.50	0.00	21.49
1	RG	Sunburst Ranch--South Hills Wtr Co.	R	500	104	0		Y	0.00	58.44	0.00	0.50	0.00	29.22
1	RG	Sunset Hills Estates Homeowners Ass	R	90	255	0		Y	0.00	25.67	0.00	0.50	0.00	12 84
1	RG	Tierra Monte WUA	U	80	137	0		Y	0.00	12.27	0.00	0.50	0.00	6.14
1	RG	Tierra West Estates--MHP	R	1650	126	0		Y	0.00	233.38	0.00	0.50	0.00	116.69
1	RG	Tijeras Land Estates Water System	R	100	146	0		Y	0.00	16.40	0.00	0.50	0.00	8.20
1	RG	Tijeras Village	U	340	54	0		Y	20.64	0.00	0.50	0.00	10.32	0.00
1	RG	Tom's Mobile Home Park	R	49	56	0		Y	0.00	3.07	0.00	0.50	0.00	1.53
1	RG	Tranquillo Pines Water System	R	800	51	0		Y	45.99	0 00	0.50	0.00	23.00	0.00
1	RG	Valle Grande MHP	R	60	39	0		Y	0.00	2.61	0.00	0.50	0.00	1.30
1	RG	Ven Gelder Water System	R	20	41	0		Y	0.00	0.92	0.00	0.50	0.00	0.46
1	RG	Vista Bonita Water Co-op	R	50	55	0		Y	0.00	3.09	0.00	0 50	0.00	1 54

Key: CN=county number; RVB=river basin; C=census classification (urben/rural); POP=population; GPCD=gallons per cepita per day; WTC=water transfer code; MSW=surface water withdrawals are measured (y/n); MGW=groundwater withdrawals are measured (y/n); WSW=withdrawals, surface water; WGW=withdrawals, ground water; DFSW=depletion factor, surface water; DFGW=depletion factor, ground water; DSW=depletion, surface water; DGW=depletion, ground water.

Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
1	RG	Western Heights MHP	U	120	180	0		Y	0.00	24.13	0.00	0.50	0.00	12.06
		River Basin Subtotals		556676					66.63	123882.73			33.32	58044.84
		County Totals		556676					66.63	123882.73			33.32	58044.84
3	LC	Aragon	R	32	172	0		Y	0.00	8.16	0.00	0.50	0.00	3.08
3	LC	Homestead Land Owners Assoc	R	37	71	0		Y	0.00	2.94	0.00	0.50	0.00	1.47
3	LC	Quemado Water Works	R	125	72	0		Y	0.00	10.13	0.00	0.50	0.00	5.07
3	LC	Rancho Grande Water Assn.	R	172	267	0		Y	0.00	51.40	0.00	0.50	0.00	25.70
3	LC	Reserve Water Works	R	317	278	0		Y	0.00	98.77	0.00	0.37	0.00	36.54
3	LC	Rural self-supplied homes	R	2375	70	0	-	N	0.00	186.22	0.00	1.00	0.00	186.22
		River Basin Subtotals		3058					0.00	355.62			0.00	258.08
3	RG	Rural self-supplied homes	R	485	70	0	-	N	0.00	38.03	0.00	1.00	0.00	38.03
		River Basin Subtotals		485					0.00	38.03			0.00	38.03
		County Totals		3543					0.00	393.65			0.00	296.11
5	P	Berrendo WUA	U	4000	358	0		Y	0.00	1604.40	0.00	0.50	0.00	802.20
5	P	Cumberland WUA	R	650	237	0		Y	0.00	172.80	0.00	0.50	0.00	86.40
5	P	Dexter Municipal Water System	R	1500	699	0		Y	0.00	1174.90	0.00	0.40	0.00	469.96
5	P	Fambrough Water Co-Op	R	250	279	0		Y	0.00	78.00	0.00	0.50	0.00	39.00
5	P	Greenfield MDWCA	R	300	218	6		Y	0.00	73.20	0.00	0.50	0.00	36.60
5	P	Hagerman Water System	R	1168	343	3		Y	0.00	449.10	0.00	0.50	0.00	224.55

Key: CN=county number; RVB=river basin; C=census classification (urban/rural); POP=population; GPCD=gallons per capita per day; WTC=water transfer code; MSW=surface water withdrawals are measured (y/n); MGW=groundwater withdrawals are measured (y/n); WSW=withdrawals, surface water; WGW=withdrawals, ground water; DFSW=depletion factor, surface water; DFGW=depletion factor, ground water; DSW=depletion, surface water; DGW=depletion, ground water.

Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
5	P	Lake Arthur Water Co-Op	R	330	281	0		Y	0.00	103.79	0.00	0.50	0.00	51.90
5	P	Roswell Municipal Water System	U	45293	283	0		Y	0.00	14360.70	0.00	0.89	0.00	12781.02
5	P	Roswell--domestic irrigation wells	U	0	0	0	-	N	0.00	165.00	0.00	1.00	0.00	165.00
5	P	Rural self-supplied homes	R	7811	100	0	-	N	0.00	874.95	0.00	1.00	0.00	874.95
5	P	South Springs Acres	R	80	2095	0		Y	0.00	187.70	0.00	0.82	0.00	153.91
		River Basin Subtotals		61382					0.00	19244.54			0.00	15685.49
		County Totals		61382					0.00	19244.54			0.00	15685.49
6	LC	Rural self-supplied homes	R	3407	70	0	-	N	0.00	267.14	0.00	1.00	0.00	267.14
		River Basin Subtotals		3407					0.00	267.14			0.00	267.14
6	RG	Bluewater Acres Domestic WUA	R	290	69	0		Y	0.00	22.50	0.00	0.50	0.00	11.25
6	RG	Grants Domestic Water System	U	8806	235	0		Y	0.00	2322.49	0.00	0.75	0.00	1741.87
6	RG	Milan Community Water System	U	2385	252	4		Y	0.00	672.00	0.00	0.50	0.00	336.00
6	RG	Rural self-supplied homes	R	9817	70	0	-	N	0.00	769.75	0.00	1.00	0.00	769.75
6	RG	San Mateo MDWCA	R	190	82	0		Y	0.00	17.44	0.00	0.50	0.00	8.72
6	RG	San Rafael Water & Sanitation Dist.	R	700	136	0		Y	0.00	106.25	0.00	0.50	0.00	53.13
		River Basin Subtotals		22188					0.00	3910.43			0.00	2920.71
		County Totals		25595					0.00	4177.57			0.00	3187.86
7	AWR	Angel Fire MHE	R	45	52	0		Y	0.00	2.62	0.00	0.50	0.00	1.31
7	AWR	Angel Fire Services Corp.	R	2200	273	9		Y	0.00	671.72	0.00	0.47	0.00	315.71

Key: CN=county number; RVB=river basin; C=census classification (urban/rural); POP=population; GPCD=gallons per capita per day; WTC=water transfer code; MSW=surface water withdrawals are measured (y/n); MGW=groundwater withdrawals are measured (y/n); WSW=withdrawals, surface water; WGW=withdrawals, ground water; DFSW=depletion factor, surface water; DFGW=depletion factor, ground water; DSW=depletion, surface water; DGW=depletion, ground water.

Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
7	AWR	Cimarron Water System	R	920	158	0		Y	162.36	0.00	0.50	0.00	81.18	0.00
7	AWR	Eagle Nest Water & Sanitation Dist.	R	310	164	0		Y	0.00	56.93	0.00	0.50	0.00	28.47
7	AWR	Maxwell Cooperative Water	R	265	185	0		Y	0.00	55.06	0.00	0.50	0.00	27 53
7	AWR	Maxwell Water System	R	274	91	0		Y	27.92	0.00	0.50	0.00	13.96	0.00
7	AWR	Miami WUA	R	150	123	0		Y	20.73	0.00	0.50	0.00	10.36	0.00
7	AWR	Raton Domestic Water System	U	7282	236	4		Y	1927.88	0.00	0.67	0.00	1291.68	0.00
7	AWR	Rural self-supplied homes	R	991	80	0	-	N	0.00	88.81	0.00	1.00	0.00	88 81
7	AWR	Springer Water System	R	1675	167	4		Y	314.05	0.00	0.50	0.00	157.02	0.00
7	AWR	Valverde Water Assoc.	R	77	24	0		Y	0.00	2.03	0 00	0.50	0.00	1.01
		River Basin Subtotals		14189					2452.94	877.17			1554.21	462 84
		County Totals		14189					2452.94	877.17			1554 21	462.84
9	AWR	Grady Water System	R	100	101	0		Y	0.00	11.30	0.00	0.50	0 00	5 65
9	AWR	Rural self-supplied homes	R	414	100	0	-	N	0.00	46.37	0 00	1 00	0 00	46.37
		River Basin Subtotals		514					0.00	57.67			0.00	52 02
9	TG	Cannon Air Force Base	U	6200	222	10		Y	0.00	1542.44	0.00	0.60	0.00	925 46
9	TG	Desert Ranch Water System	R	60	168	0		Y	0.00	11.29	0.00	0.50	0.00	5.64
9	TG	Melrose Water System	R	725	211	0		Y	0.00	171.60	0.00	0.50	0.00	85 80
9	TG	NM American Water Co.--Clovis	U	34000	169	0		Y	0.00	6422.75	0.00	0.50	0.00	3211.38
9	TG	Rural self-supplied homes	R	2320	100	0	-	N	0.00	259.87	0.00	1.00	0.00	259 87

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Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
9	TG	Texico Water System	R	1065	199	0		Y	0.00	237.54	0.00	0.50	0.00	118.77
9	TG	Turquoise Estates Wtr Co-Op–Clovis	R	160	110	0		Y	0.00	19.72	0.00	0.50	0.00	9.86
		River Basin Subtotals		44530					0.00	8665.21			0.00	4616.79
		County Totals		45044					0.00	8722.89			0.00	4668.81
11	P	Fort Sumner Municipal Water System	R	1249	214	3		Y	0.00	298.98	0.00	0.62	0.00	185.37
11	P	Rural self-supplied homes	R	526	80	0		N	0.00	47.14	0.00	1.00	0.00	47.14
11	P	Valley WUA	R	465	188	6		Y	0.00	98.13	0.00	0.50	0.00	49.06
		River Basin Subtotals		2240					0.00	444.24			0.00	281.57
		County Totals		2240					0.00	444.24			0.00	281.57
13	RG	Alameda MHP	R	150	122	0		Y	0.00	20.47	0.00	0.50	0.00	10.23
13	RG	Alto de Las Flores MDWCA	R	780	106	0		Y	0.00	92.71	0.00	0.50	0.00	46.35
13	RG	Anthony Water Works	U	7904	113	0		Y	0.00	1003.00	0.00	0.49	0.00	491.47
13	RG	Berino WUA	R	1500	132	0		Y	0.00	222.20	0.00	0.50	0.00	111.10
13	RG	Brazito MDWCA	R	380	93	0		Y	0.00	39.70	0.00	0.50	0.00	19.85
13	RG	Butterfield Park MDWCA	R	1050	94	0		Y	0.00	111.09	0.00	0.50	0.00	55.54
13	RG	Chaparral Water System	U	8000	172	0		Y	0.00	1544.00	0.00	0.50	0.00	772.00
13	RG	Country Mobile Manor	R	168	125	0		Y	0.00	23.56	0.00	0.50	0.00	11.78
13	RG	Covered Wagon MHP(1995)	R	120	121	0		N	0.00	16.20	0.00	0.50	0.00	8.10
13	RG	Delara Estates MDWCA	R	1200	116	0		Y	0.00	155.66	0.00	0.50	0.00	77.83

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Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
13	RG	Desert Aire	R	462	75	0		Y	0.00	39.00	0.00	0.50	0.00	19.50
13	RG	Desert Sands MDWCA	R	1350	129	0		Y	0.00	194.89	0.00	0.50	0.00	97.44
13	RG	Dona Ana MDWCA	U	9800	139	0		Y	0.00	1529.09	0.00	0.50	0.00	764.54
13	RG	Fairview Estates Water System	U	125	148	0		N	0.00	20.69	0.00	0.50	0.00	10.35
13	RG	Ft Seldon Subdivision	R	1000	129	0		Y	0.00	145.00	0.00	0.50	0.00	72.50
13	RG	Garfield MDWCA	R	1900	111	0		Y	0.00	236.62	0.00	0.50	0.00	118.31
13	RG	Hacienda Acres Water System	U	2373	191	0		Y	0.00	507.47	0.00	0.50	0.00	253.74
13	RG	Hatch Water Supply System	U	2583	148	4		Y	0.00	426.00	0.00	0.41	0.00	175.48
13	RG	Hauger Lake Water System	R	125	67	0		Y	0.00	9.40	0.00	0.50	0.00	4.70
13	RG	Holly Gardens MHP	U	210	150	0		Y	0.00	35.24	0.00	0.50	0.00	17.62
13	RG	Johnson, Floyd--MHP	R	250	113	0		Y	0.00	31.68	0.00	0.50	0.00	15.84
13	RG	Jornada Water Co	U	1040	170	0		Y	0.00	198.30	0.00	0.50	0.00	99.15
13	RG	La Mesa MDWCA	R	450	79	0		Y	0.00	39.97	0.00	0.50	0.00	19.99
13	RG	La Quinta Water Company	R	235	126	0		Y	0.00	33.22	0.00	0.50	0.00	16.61
13	RG	Las Alturas Estates	R	777	247	0		Y	0.00	215.35	0.00	0.50	0.00	107.68
13	RG	Las Cruces Municipal Water System	U	71958	251	3		Y	0.00	20194.00	0.00	0.58	0.00	11712.52
13	RG	Leasburg MDWCA	R	800	115	0		Y	0.00	103.05	0.00	0.50	0.00	51.53
13	RG	Mesa Development Center	U	819	103	0		Y	0.00	94.30	0.00	0.50	0.00	47.15

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Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
13	RG	Mesilla Park Manor Water System	R	118	184	0		Y	0.00	24.26	0.00	0.50	0.00	12.13
13	RG	Mesilla Water System	U	2000	109	6		Y	0.00	244.69	0 00	0.50	0.00	122 35
13	RG	Mesquite MDWCA	U	3400	212	0		Y	0.00	809.01	0.00	0.50	0.00	404.51
13	RG	Miller's Mobile Manor	R	105	340	0		Y	0.00	39.98	0.00	0 50	0.00	19 99
13	RG	Moongate Water System	U	9480	105	0		Y	0.00	1118.08	0 00	0.50	0.00	559 04
13	RG	Mountain View MDWCA	R	600	184	0		Y	0.00	123.35	0.00	0.50	0.00	61.67
13	RG	Organ Water & Sewer Assn.	R	650	100	0		Y	0.00	72.88	0.00	0.50	0.00	36 44
13	RG	Picacho Hills Water System	R	980	244	4		Y	0.00	267.70	0.00	0.82	0.00	219.51
13	RG	Picacho MDWCA	R	755	144	0		Y	0.00	121.88	0.00	0.50	0.00	60.94
13	RG	Raasaf Hills Water System	R	154	155	0		Y	0.00	26.71	0.00	0.50	0.00	13 35
13	RG	Rancho Vista MHP	U	100	107	0		Y	0.00	12.00	0.00	0.50	0.00	6 00
13	RG	Rincon Water Consumers Co-Op	R	525	94	4		Y	0.00	55.50	0.00	0.50	0.00	27 75
13	RG	Rural self-supplied homes	R	8813	100	0		N	0.00	987 19	0.00	1.00	0.00	987.19
13	RG	San Andres Estates Water System	R	882	161	0		Y	0.00	159.02	0 00	0.50	0.00	79.51
13	RG	Santa Teresa Water System	U	5100	455	6		Y	0.00	2596 95	0.00	0.79	0.00	2051 59
13	RG	Silver Spur MHP	R	150	235	0		Y	0.00	39.44	0.00	0.50	0.00	19 72
13	RG	Skoshi Mobile Home Park	R	125	101	0		Y	0.00	14.21	0.00	0 50	0.00	7 11
13	RG	St John's MHP	R	400	157	0		Y	0.00	70.16	0.00	0 50	0.00	35.08

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Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
13	RG	Sunland Park Water System	U	13300	84	6		Y	0.00	1250.29	0.00	0.30	0.00	375.09
13	RG	Talavera Water Co-Op	R	280	77	0		Y	0.00	24 06	0.00	0.50	0.00	12.03
13	RG	University Estates/San Pablo MDWCA	U	3906	210	0		Y	0.00	918.72	0.00	0.50	0.00	459.36
13	RG	Vado MDWCA	R	380	87	7		Y	0.00	36.82	0.00	0.50	0.00	18 41
13	RG	Val Verde MHP	R	170	193	0		Y	0 00	36 80	0 00	0.50	0.00	18 40
13	RG	Valle de Rio Water System	R	230	260	0		Y	0.00	67.00	0.00	0.50	0.00	33.50
13	RG	Vista Real MHP	R	120	145	0		Y	0.00	19.48	0.00	0.50	0 00	9.74
13	RG	West Mesa System	U	2000	240	0		Y	0.00	537.00	0.00	0.50	0.00	268.50
13	RG	White Sands Missile Range	U	2450	797	10		Y	0.00	2186.78	0.00	0.60	0.00	1312.07
		River Basin Subtotals		174682					0.00	39143.81			0.00	22439.87
		County Totals		174682					0.00	39143.81			0.00	22439.87
15	P	Artesia Domestic Water System	U	10692	390	3		Y	0.00	4672.00	0.00	1 00	0.00	4672.00
15	P	Artesia Rural Water Co-Op	R	1700	224	0		Y	0.00	426.74	0.00	0.50	0.00	213 37
15	P	Carlsbad Municipal Water System	U	27156	277	4		Y	126.51	8290 41	1.00	0.58	126.51	4784.13
15	P	Cottonwood Water Cooperative	R	1030	210	0		Y	0.00	242.50	0 00	0.50	0.00	121.25
15	P	Happy Valley Water Co-Op	R	810	141	0		Y	0.00	128.33	0.00	0.50	0.00	64.17
15	P	Hope Water System	R	150	309	0		Y	0.00	51.87	0 00	0.50	0 00	25 93
15	P	Jewel St. Water Co-op	R	22	222	0		Y	0.00	5.47	0.00	0 50	0.00	2 73

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Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
15	P	Loving Water System	R	1243	347	3		Y	0.00	483.59	0.00	0.50	0.00	241.79
15	P	Malaga Water Users Co-Op	R	570	210	6		Y	0.00	134.04	0.00	0.50	0.00	67 02
15	P	Morningside Water Cooperative	R	370	189	6		Y	0.00	78.35	0.00	0.50	0.00	39 17
15	P	Otis Water Co-Op	U	5000	232	7		Y	0.00	1298.17	0.00	0.50	0.00	649 09
15	P	Riverside WUA	R	161	191	0		Y	0.00	34.50	0.00	0.50	0.00	17.25
15	P	Rural self-supplied homes	R	2174	100	0	-	N	0.00	243.52	0.00	1.00	0.00	243.52
15	P	Westwind Mobile Home Park	R	100	259	0		Y	0.00	29.03	0.00	0.50	0.00	14.52
15	P	White's City	R	480	216	0		Y	0.00	116.00	0.00	0.50	0.00	58 00
		River Basin Subtotals		51658					126.51	16234.52			126.51	11213.94
		County Totals		51658					126.51	16234.52			126.51	11213.94
17	LC	Pinos Altos MDWCA	R	300	86	6		Y	0.00	28.82	0.00	0.50	0.00	14.41
17	LC	Rural self-supplied homes	R	2165	80	0	-	N	0.00	194.01	0.00	1.00	0.00	194.01
17	LC	Tyrone Water System	R	787	150	6		Y	132.60	0.00	0.50	0.00	66.30	0.00
		River Basin Subtotals		3252					132.60	222.83			66.30	208 42
17	RG	Arenas Valley MDWCA	R	1152	84	6		Y	0.00	107.90	0.00	0.50	0.00	53 95
17	RG	Bayard Municipal Water System	U	2581	123	0		Y	0.00	356 72	0.00	0.50	0.00	178.36
17	RG	Casas Adobes Water Company	R	224	75	0		Y	0.00	18 91	0.00	0.50	0 00	9 45
17	RG	Central Water System	R	2074	117	0		Y	0.00	271 49	0.00	0 86	0.00	233 48
17	RG	Ft Bayard Medical Center	R	310	50	0		Y	17.48	0.00	0.50	0 00	8.74	0 00

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Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
17	RG	Hachita Water System	R	90	89	0		Y	0.00	8.94	0.00	0.50	0.00	4.47
17	RG	Hanover MDWCA	R	300	65	0		Y	0.00	21.68	0.00	0.50	0.00	10.84
17	RG	Heights Water Usera Assoc.	R	27	119	0		Y	0.00	3.60	0.00	0.50	0.00	1.80
17	RG	Hurley Water Supply System	R	1100	145	6		Y	0.00	178.40	0.00	0.50	0.00	89.20
17	RG	Lake Roberts Subdivision	R	60	26	0		Y	0.00	1.76	0.00	0.50	0.00	0.88
17	RG	North Hurley MDWCA	R	320	93	6		Y	0.00	33.36	0.00	0.50	0.00	16.68
17	RG	Rosedale WUA	R	350	48	6		Y	0.00	18.80	0.00	0.50	0.00	9.40
17	RG	Rural self-supplied homes	R	6517	80	0	-	N	0.00	584.00	0.00	1.00	0.00	584.00
17	RG	Santa Clara Village	R	2000	121	0		Y	26.33	245.00	0.50	0.50	13.16	122.50
17	RG	Silver City Water System	U	10545	235	3		Y	0.00	2775.30	0.00	0.66	0.00	1831.70
17	RG	Whiskey Creak Mobile Ranch	R	100	120	0		Y	0.00	13.40	0.00	0.50	0.00	6.70
		River Basin Subtotals		27750					43.81	4639.26			21.90	3153.41
		County Totals		31002					176.41	4862.09			88.21	3361.83
19	AWR	Rural self-supplied homes	R	109	80	0	-	N	0.00	9.77	0.00	1.00	0.00	9.77
		River Basin Subtotals		109					0.00	9.77			0.00	9.77
19	P	Anton Chico MDWCA	R	300	58	0		Y	0.00	19.40	0.00	0.50	0.00	9.70
19	P	Los Sisneros MDWCA	R	35	50	0		Y	0.00	1.96	0.00	0.50	0.00	0.98
19	P	Puerto de Luna MDWCA	R	210	138	0		Y	0.00	32.42	0.00	0.50	0.00	16.21
19	P	Rio Pecos Villa WUA	R	30	91	6		Y	0.00	3.07	0.00	0.50	0.00	1.53

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Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
19	P	Rural self-supplied homes	R	96	80	0	-	N	0.00	8.60	0.00	1.00	0.00	8.60
19	P	Sangre de Cristo MDWCA	R	100	99	0		Y	0.00	11.08	0.00	0.50	0.00	5.54
19	P	Santa Rosa Water Supply	R	2500	222	3		Y	0.00	621.13	0.00	0.50	0.00	310.57
19	P	Vaughn Water System	R	1300	144	2,3		Y	0.00	209.82	0.00	0.50	0.00	104.91
		River Basin Subtotals		4571					0.00	907.48			0.00	458.04
		County Totals		4680					0.00	917.25			0.00	467.81
21	AWR	Mosquero Water System	R	120	164	0		Y	0.00	22.03	0.00	0.50	0.00	11.02
21	AWR	Roy Water Works	R	304	181	0		Y	0.00	61.56	0.00	0.50	0.00	30.78
21	AWR	Rural self-supplied homes	R	386	80	0	-	N	0.00	34.59	0.00	1.00	0.00	34.59
		River Basin Subtotals		810					0.00	118.18			0.00	76.39
		County Totals		810					0.00	118.18			0.00	76.39
23	LC	Glen Acres Community Water System	R	170	255	0		Y	0.00	48.51	0.00	0.50	0.00	24.25
23	LC	Lordsburg Water Supply System	U	3379	216	0		Y	0.00	818.00	0.00	0.50	0.00	409.00
23	LC	Rodeo WUA	R	122	115	0		Y	0.00	15.66	0.00	0.50	0.00	7.83
23	LC	Rural self-supplied homes	R	1097	80	0	-	N	0.00	98.30	0.00	1.00	0.00	98.30
23	LC	Virden Water System	R	105	209	0		Y	0.00	24.60	0.00	0.50	0.00	12.30
		River Basin Subtotals		4873					0.00	1005.07			0.00	551.69
23	RG	Rural self-supplied homes	R	1059	80	0	-	N	0.00	94.90	0.00	1.00	0.00	94.90
		River Basin Subtotals		1059					0.00	94.90			0.00	94.90

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Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
		County Totals		5932					0.00	1099.97			0.00	646.59
25	P	Eunice Water Supply System	U	2562	538	5		Y	0.00	1544.99	0.00	0.50	0.00	772.49
25	P	Jal Water Supply System	R	2165	293	0		Y	0.00	711.37	0.00	0.50	0.00	355.68
25	P	Maljamar Water	R	61	101	0		Y	0.00	6.87	0.00	0.50	0.00	3.43
25	P	Monument WUA	R	175	553	0		Y	0.00	108.49	0.00	0.50	0.00	54.24
25	P	Rural self-supplied homes	R	1182	100	0	-	N	0.00	132.40	0.00	1.00	0.00	132.40
		River Basin Subtotals		6145					0.00	2504.12			0.00	1318.26
25	TG	Hobbs Municipal Water Supply	U	28657	284	0		Y	0.00	9120.69	0.00	0.50	0.00	4560.35
25	TG	Lovington Municipal Water Supply	U	9471	289	0		Y	0.00	3069.20	0.00	0.50	0.00	1534.60
25	TG	Rural self-supplied homes	R	10450	100	0	-	N	0.00	1170.55	0.00	1.00	0.00	1170.55
25	TG	Tatum Water System	R	883	198	0		Y	0.00	151.28	0.00	0.50	0.00	75.64
25	TG	Triple J Trailer Park–Hobbs	R	105	111	0		Y	0.00	13.00	0.00	0.50	0.00	6.50
		River Basin Subtotals		49366					0.00	13524.72			0.00	7347.64
		County Totals		55511					0.00	16028.85			0.00	8665.90
27	P	Agua Fria Water Company	R	200	105	0		Y	23.50	0.00	0.50	0.00	11.75	0.00
27	P	Alpine Village Sanitation District	R	100	116	9		Y	0.00	13.00	0.00	0.50	0.00	6.50
27	P	Alto Lakes Water Co-op	R	2300	178	0		Y	0.00	457.91	0.00	0.50	0.00	228.96
27	P	Alto North Water Co-Op	R	65	111	0		Y	0.00	8.08	0.00	0.50	0.00	4.04
27	P	Apple Blossom & White Angel Mesa	R	25	135	0		Y	0.00	3.78	0.00	0.50	0.00	1.89

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Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
27	P	Capitan Water System	R	1443	122	7		Y	0.00	197.00	0.50	0.50	0.00	98.50
27	P	Corona Water System	R	210	116	0		Y	0.00	27.18	0.00	0.50	0.00	13.59
27	P	Fawn Ridge Homeowners Asso.	R	100	67	0		Y	0.00	7.53	0.00	0.50	0.00	3.77
27	P	Ft Stanton Medical Center	R	250	273	6		Y	0.00	76.39	0.00	0.50	0.00	38.19
27	P	High Sierra Estates	R	55	70	0		Y	0.00	4.34	0.00	0.50	0.00	2.17
27	P	Lincoln MDWCA	R	75	181	0		Y	0.00	15.24	0.00	0.50	0.00	7.62
27	P	Rancho Ruidoso Village	R	200	247	0		Y	0.00	55.36	0.00	0.50	0.00	27 68
27	P	Rocky Mountain Mobile Home & RV Pk	R	90	30	0		Y	0.00	3.00	0.00	0.50	0.00	1.50
27	P	Ruidoso Downs Water System	R	1824	271	9		Y	0.00	554.32	0.18	0.18	0 00	99 78
27	P	Ruidoso Water System	U	7698	359	9		Y	1841 46	1252.19	0.29	0.29	533.06	363.14
27	P	Rural self-supplied homes	R	2099	80	0	-	N	0.00	188.10	0.00	1.00	0.00	188 10
27	P	Sun Valley Sanitation Dist.	R	200	79	9		Y	0.00	17.64	0.00	0.50	0.00	8.82
		River Basin Subtotals		16934					1864.96	2881.05			544.81	1094.23
27	RG	Carrizozo Water System	R	1036	291	7	Y	Y	53.90	284.30	0.50	0.50	26.95	142.15
27	RG	Nogal WUA	R	70	50	6		Y	3.90	0.00	0.50	0.00	1.95	0.00
27	RG	Rural self-supplied homes	R	1371	80	0	-	N	0.00	122.86	0.00	1 00	0 00	122.86
		River Basin Subtotals		2477					57.80	407.16			28.90	265.01
		County Totals		19411					1922.76	3288.21			573.71	1359.24
28	RG	Los Alamos & White Rock Mun Wtr Sys	U	18343	224	4		Y	0.00	4807.77	0.00	0.96	0.00	4423.46

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Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
		River Basin Subtotals		18343					0.00	4607.77			0.00	4423.46
		County Totals		18343					0.00	4607.77			0.00	4423.46
29	RG	Columbus Water System	R	2100	106	0		Y	0.00	249.38	0.00	0.50	0.00	124.69
29	RG	Deming Municipel Water System	U	16401	223	0		Y	0.00	4101.97	0.00	0.50	0.00	2050.99
29	RG	Gunter's Mobile Home Rentals	R	32	41	0		Y	0.00	1.47	0.00	0.50	0.00	0 74
29	RG	Pecan Park MDWCA	R	78	399	0		Y	0.00	34.83	0.00	0.50	0.00	17 42
29	RG	Rural self-supplied homes	R	6405	100	0	-	N	0.00	717.45	0.00	1.00	0.00	717.45
		River Basin Subtotals		25016					0.00	5105.10			0.00	2911.28
		County Totals		25016					0.00	5105.10			0.00	2911.28
31	LC	Coal Basin Water Assn.	R	100	107	0		Y	0.00	12.02	0.00	0 50	0.00	6 01
31	LC	Ft Wingate Army Depot	R	69	99	7		Y	0 00	7.68	0.00	0 50	0 00	3.64
31	LC	Gallup Water System	U	20209	179	3,5		Y	0.00	4059.30	0.00	1 00	0.00	4059 30
31	LC	Gamerco Water & Sanitation District	R	1370	77	6		Y	0.00	118.70	0.00	1.00	0.00	118.70
31	LC	Ramah Water & Sanitation Dist.	R	133	319	0		N	0.00	47.57	0.00	0.50	0.00	23.78
31	LC	Rural self-supplied homes	R	25167	70	0	-	N	0.00	1973.35	0.00	1.00	0.00	1973.35
31	LC	Whispering Cedars Water Assoc.	R	300	84	0		Y	0.00	28.35	0.00	0.50	0.00	14.18
31	LC	Zuni Pueblo Water Works(1995)	U	8332	100	0		N	0.00	933.30	0.00	0.50	0.00	466.65
		River Basin Subtotals		55680					0.00	7180.27			0.00	6665.81
31	RG	Rural self-supplied homes	R	3799	70	0	-	N	0.00	297.88	0.00	1.00	0.00	297.88

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Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
31	RG	Thoreau Water & Sanitation District	R	1863	60	0		Y	0.00	125.15	0.00	0.50	0.00	62.58
		River Basin Subtotals		5662					0.00	423.03			0.00	360.46
31	UC	Rural self-supplied homes	R	13456	70	0	-	N	0.00	1055.09	0.00	1.00	0.00	1055.09
		River Basin Subtotals		13456					0.00	1055.09			0.00	1055.09
		County Totals		74798					0.00	8658.39			0.00	8081.36
33	AWR	El Alto MDWCA	R	85	233	0		Y	0.00	22.21	0.00	0.50	0.00	11.10
33	AWR	Holman	R	110	59	0		Y	0.00	7.32	0.00	0.50	0.00	3.66
33	AWR	La Cordillera	R	50	74	0		Y	0.00	4.17	0.00	0.50	0.00	2.09
33	AWR	Mora MDWCA	R	680	286	0		Y	0.00	217.67	0.00	0.61	0.00	132.78
33	AWR	Rural self-supplied homes	R	3829	80	0	-	N	0.00	343.12	0.00	1.00	0.00	343.12
33	AWR	Upper Holman	R	110	34	0		Y	0.00	4.20	0.00	0.50	0.00	2.10
33	AWR	Wagon Mound MDWCA	R	316	140	0		Y	0.00	49.70	0.00	0.50	0.00	24.85
		River Basin Subtotals		5180					0.00	648.39			0.00	519.70
		County Totals		5180					0.00	648.39			0.00	519.70
35	P	Cloud Country Estates WUA	R	150	134	0	Y	Y	15.65	6.85	0.50	0.50	7.82	3.42
35	P	Cloud Country West Water System	R	250	68	0		Y	0.00	19.03	0.00	0.50	0.00	9.51
35	P	Mayhill Water Supply Company	R	135	54	0		Y	0.00	8.12	0.00	0.50	0.00	4.06
35	P	Pinon WUA	R	140	213	0		Y	0.00	33.38	0.00	0.50	0.00	16.69
35	P	Ponderosa Pines	R	102	58	0		Y	0.00	6.63	0.00	0.50	0.00	3.31

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Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
35	P	Robinhood Park WUA	R	290	67	0		Y	21.67	0.00	0.50	0.00	10.84	0.00
35	P	Rural self-supplied homes	R	2810	80	0	-	N	0.00	251.81	0.00	1.00	0.00	251.81
35	P	Silver Cloud WUA	R	140	89	0		Y	0.00	14.03	0.00	0.50	0.00	7.01
35	P	Weed WUA	R	32	81	0		Y	0.00	2.92	0.00	0.50	0.00	1.46
		River Basin Subtotals		4049					37.32	342.76			18.66	297.29
35	RG	Alamogordo Domestic Water System	U	35582	207	3	Y	Y	5567.37	2689.04	0.50	0.50	2783.69	1344.52
35	RG	Boles Acres Water System	R	1000	131	0		Y	0.00	146.18	0.00	0.50	0.00	73.09
35	RG	Canyon Hills WUA	R	41	238	0		Y	0.00	10.91	0.00	0.50	0.00	5.46
35	RG	Cider Mill Farms WUA	R	40	120	0		Y	0.00	5.36	0.00	0.50	0.00	2.68
35	RG	Cloudcroft Water System	R	749	235	9		Y	0.00	197.19	0.00	0.43	0.00	84.79
35	RG	Dungan MDWCA	R	85	88	0		Y	0.00	8.34	0.00	0.50	0.00	4.17
35	RG	Enchanted Valley Water Users	R	45	221	0		Y	0.00	11.13	0.00	0.50	0.00	5.57
35	RG	Freeman's / Crossroads MHP	R	45	247	0		Y	0.00	12.43	0.00	0.50	0.00	6.21
35	RG	High Rolls	R	375	82	0		Y	0.00	34.59	0.00	0.50	0.00	17.30
35	RG	Holloman Air Force Base	U	5550	377	10	Y	Y	222.47	2123.58	0.57	0.57	126.81	1210.44
35	RG	Karr Canyon Estates	R	98	76	0	Y		8.34	0.00	0.50	0.00	4.17	0.00
35	RG	La Luz MDWCA	R	2050	78	0	Y	Y	76.00	103.00	0.50	0.50	38.00	51.50
35	RG	Lakeside de la Luz	R	52	110	0		Y	0.00	6.40	0.00	0.50	0.00	3.20

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Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
35	RG	Mountain Orchard WUA	R	79	96	0		Y	0.00	8.53	0.00	0.50	0.00	4 26
35	RG	Orogrande MDWCA	R	52	486	5	Y		28.29	0.00	0.00	0.00	0.00	0.00
35	RG	Piney Woods WUA	R	220	98	0	Y	Y	11.63	12.48	0.50	0 50	5.82	6.24
35	RG	Rural self-supplied homes	R	7814	100	0	-	N	0.00	875.28	0.00	1.00	0.00	875.28
35	RG	Timberon Water & Sanitation Distric	R	1428	137	0	Y		218.35	- 0.00	0.50	0.00	109.18	0.00
35	RG	Tularosa Water System	U	2864	210	0		Y	674.11	0.00	0.50	0.50	337.05	0.00
35	RG	Waterfall Community Water Users Ass	R	80	290	0		Y	0.00	26.03	0.00	0.50	0.00	13.02
		River Basin Subtotals		58249					6806.56	6270.47			3404.71	3707.72
		County Totals		62298					6843.88	6613.23			3423.37	4005 01
37	AWR.	Liberty MDWUA	R	182	115	0		Y	0.00	23.50	0.00	0.50	0.00	11 75
37	AWR	Logan Water System	R	1094	308	8		Y	0.00	377.20	0 00	0.50	0.00	188 60
37	AWR	Nara Visa Water Co-Op(1995)	R	75	97	0		N	0.00	8.15	0.00	0.50	0.00	4 07
37	AWR	Rural self-supplied homes	R	1372	80	0	-	N	0.00	122 95	0 00	1.00	0 00	122 95
37	AWR	San Jon Water Supply	R	306	162	0		Y	0.00	55.49	0.00	0.50	0.00	27.75
37	AWR	Tucumcari Water System	U	6855	221	4		Y	0.00	1694.26	0.00	0.60	0.00	1016.56
		River Basin Subtotals		9884					0.00	2281.55			0.00	1371.67
37	P	House Water System	R	100	124	0		Y	0.00	13.84	0.00	0.50	0 00	6.92
37	P	Rural self-supplied homes	R	171	80	0	-	N	0.00	15.32	0 00	1.00	0.00	15.32
		River Basin Subtotals		271					0.00	29.16			0.00	22.24

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Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
		County Totals		10155					0.00	2310.71			0.00	1393.92
39	RG	Alcalde MDWCA	R	377	109	0		Y	0.00	46.20	0.00	0.50	0.00	23.10
39	RG	Barranco MDWCA	R	50	49	0		Y	2.76	0.00	0.50	0.00	1.38	0.00
39	RG	Brazos MDWCA	R	146	87	0		Y	0.00	14.30	0.00	0.50	0.00	7.15
39	RG	Canjilon MDWCA	R	380	49	0		Y	0.00	20.80	0.00	0.50	0.00	10.40
39	RG	Cebola MDWCA	R	300	65	0		Y	0.00	21.75	0.00	0.50	0.00	10.88
39	RG	Chama Water System	R	1199	161	0		Y	216.40	0.00	0.29	0.00	62.76	0.00
39	RG	Chemita MDWCA	R	700	88	0		Y	0.00	69.13	0.00	0.50	0.00	34.56
39	RG	Chili	R	51	133	0		Y	0.00	7.62	0.00	0.50	0.00	3.81
39	RG	Cordova MDWCA	R	240	66	0		Y	0.00	17.82	0.00	0.50	0.00	8.91
39	RG	Dixon MDWCA	R	400	83	0		Y	0.00	37.18	0.00	0.50	0.00	18.59
39	RG	El Llano MDWCA	R	115	61	0		Y	0.00	7.82	0.00	0.50	0.00	3.91
39	RG	El Rito MDWCA	R	220	44	0		Y	0.00	10.94	0.00	0.50	0.00	5.47
39	RG	Enchanted Mesa MHP	R	180	75	0		Y	0.00	15.21	0.00	0.50	0.00	7.60
39	RG	Ensenada WUA--Los Ojos	R	151	57	0		Y	0.00	9.59	0.00	0.50	0.00	4.80
39	RG	Espanola Water System (part)	U	8070	116	0		Y	0.00	1045.74	0.00	0.20	0.00	209.15
39	RG	Lo Puebla MDWCA	R	260	250	0		Y	0.00	72.78	0.00	0.50	0.00	36.39
39	RG	Los Brazos MDWCA	R	30	49	0		Y	0.00	1.65	0.00	0.50	0.00	0.82

Key: CN=county number; RVB=river basin; C=census classification (urban/rural); POP=population; GPCD=gallons per capita per day; WTC=water transfer code; MSW=surface water withdrawals are measured (y/n); MGW=groundwater withdrawals are measured (y/n); WSW=withdrawals, surface water; WGW=withdrawals, ground water; DFSW=depletion factor, surface water; DFGW=depletion factor, ground water; DSW=depletion, surface water; DGW=depletion, ground water.

Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
39	RG	Los Ojos	R	125	66	0		Y	0.00	9.20	0.00	0.50	0.00	4.60
39	RG	Ojo Caliente	R	110	104	0		Y	0.00	12.80	0.00	0.50	0.00	6.40
39	RG	Ojo Sarco MDWCA	R	116	84	0		Y	0.00	10.93	0.00	0.50	0.00	5.47
39	RG	Placitas MDWCA	R	220	54	0		Y	0.00	13.20	0.00	0 50	0.00	6.60
39	RG	Rural self-supplied homes	R	21112	80	0	-	N	0.00	1891.88	0.00	1.00	0.00	1891.88
39	RG	Rutheron	R	230	56	0		Y	4.50	9.98	0.50	0.50	2.25	4.99
39	RG	South Hills Water Company	R	220	100	0		Y	0.00	24.87	0.00	0.50	0.00	12.33
39	RG	South Ojo Caliente MDWCA	R	170	85	0		Y	0.00	16.27	0.00	0.50	0.00	8.13
39	RG	Tierra Amarilla MDWCA	R	400	83	0		Y	0.00	37.11	0.00	0.50	0.00	18.55
39	RG	Truchas MDWCA	R	650	47	0		Y	0.00	33.88	0.00	0.50	0.00	16.94
39	RG	Upper Canoncito MDWCA	R	75	36	0		Y	0.00	3.06	0.00	0.50	0.00	1.53
39	RG	Valley Estetes MDWCA	R	148	258	0		Y	0.00	42.50	0.00	0.50	0.00	21.25
39	RG	Velarde MDWCA	R	500	121	0		Y	0.00	67.74	0.00	0.50	0.00	33 87
39	RG	Youngsville MDWCA(est.)	R	85	95	0		N	0.00	9.00	0.00	0.50	0 00	4.50
		River Basin Subtotals		37030					223.66	3580.74			66.39	2422 59
39	UC	Dulce--BIA, Jicarilla Agency	U	3280	136	0	Y		498.30	0.00	0.50	0.00	249.15	0 00
39	UC	Lindrith Community Water Co-Op	R	70	54	0		Y	0 00	4.22	0.00	0 50	0.00	2 11
39	UC	Lybrook WUA	R	155	147	0		Y	0.00	25 59	0 00	0 50	0 00	12 80

Key: CN=county number; RVB=river basin; C=census classification (urban/rural); POP=population; GPCD=gallons per capita per day; WTC=water transfer code; MSW=surface water withdrawals are measured (y/n); MGW=groundwater withdrawals are measured (y/n); WSW=withdrawals, surface water; WGW=withdrawals, ground water; DFSW=depletion factor, surface water; DFGW=depletion factor, ground water; DSW=depletion, surface water; DGW=depletion, ground water.

Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
39	UC	Rural self-supplied homes	R	655	80	0	-	N	0.00	58.69	0.00	1.00	0.00	58.69
		River Basin Subtotals		4160					498.30	88.50			249.15	73.59
		County Totals		41190					721.96	3669.24			315.54	2496 19
41	P	Rural self-supplied homes	R	308	100	0	-	N	0.00	34.50	0.00	1.00	0.00	34.50
		River Basin Subtotals		308					0.00	34.50			0.00	34.50
41	TG	Causey Water Association	R	45	99	0		N	0.00	5.00	0.00	0 50	0.00	2.50
41	TG	Dora Water Assn.	R	200	180	0		Y	0.00	40.34	0.00	0.50	0.00	20 17
41	TG	Elida Water System	R	202	181	0		Y	0.00	41.02	0.00	0.50	0.00	20.51
41	TG	Floyd Water Co-Op	R	300	89	0		Y	0.00	29.88	0.00	0.50	0.00	14.94
41	TG	Portales Water System	U	11131	304	3		Y	0.00	3794.80	0.00	0.70	0.00	2656.36
41	TG	Roosevelt County Water Co-Op	U	4000	137	6		Y	0.00	613.86	0.00	0.50	0.00	306.93
41	TG	Rural self-supplied homes	R	1832	100	0	-	N	0.00	205.21	0.00	1.00	0.00	205.21
		River Basin Subtotals		17710					0.00	4730.11			0.00	3226.62
		County Totals		18018					0.00	4764.61			0.00	3261.12
43	RG	Algodones WUA	R	675	72	0		Y	0.00	54.26	0.00	0.50	0.00	27.13
43	RG	Bernalillo Water System	U	6000	154	0		Y	0.00	1035.01	0.00	0.51	0.00	527.86
43	RG	Canyon MDWUA	R	250	129	0		Y	0.00	36.14	0.00	0.50	0.00	18.07
43	RG	Cochiti Lake Water System	R	450	124	0		Y	0.00	62.70	0.00	0.50	0.00	31 35
43	RG	Corrales Village	U	50	89	0		Y	0.00	4.96	0.00	0.50	0.00	2 48

Key: CN=county number; RVB=river basin; C=census classification (urban/rural); POP=population; GPCD=gallons per capita per day; WTC=water transfer code; MSW=surface water withdrawals are measured (y/n); MGW=groundwater withdrawals are measured (y/n); WSW=withdrawals, surface water; WGW=withdrawals, ground water; DFSW=depletion factor, surface water; DFGW=depletion factor, ground water; DSW=depletion, surface water; DGW=depletion, ground water.

Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
43	RG	Corrales--self-supplied homes (prt)	U	6608	150	0	-	N	0.00	1110.29	0.00	1.00	0.00	1110.29
43	RG	Cuba Water System	R	765	127	0		Y	0.00	108.78	0.00	0.50	0.00	54.39
43	RG	Hidden Valley Water System	R	23	56	0		Y	0.00	1.45	0.00	0.50	0.00	0.73
43	RG	Jemez Springs Water Co-Op	R	375	239	0		Y	100.50	0.00	0.30	0.00	30.15	0.00
43	RG	La Jara	R	350	44	0		Y	17.30	0.00	0.50	0.50	8.65	0.00
43	RG	La Mesa Water Co-Op	R	380	136	0		Y	0.00	57.73	0.00	0.50	0.00	28.86
43	RG	La Puerta	R	30	256	0		Y	8.59	0.00	0.50	0.50	4.30	0.00
43	RG	North Ranchos de Placitas	R	325	185	0		Y	0.00	67.35	0.00	0.50	0.00	33.67
43	RG	Orchard Estates	R	42	194	0		Y	0.00	9.12	0.00	0.50	0.00	4.56
43	RG	Overlook Water Cooparative	R	105	104	0		Y	0.00	12.21	0.00	0.50	0.00	6.11
43	RG	Pena Blanca MDWCA	R	400	120	0		Y	0.00	53.92	0.00	0.50	0.00	26.96
43	RG	Placitas Trails Ltd Partnership	R	350	105	0		Y	0.00	41.35	0.00	0.50	0.00	20.67
43	RG	Placitas West Water Co-Op	R	100	148	0		Y	0.00	16.62	0.00	0.50	0.00	8.31
43	RG	Ponderosa MDWCA	R	350	84	0	Y		32.77	0.00	0.50	0.00	16.39	0.00
43	RG	Pueblo Los Cerros Browood	U	160	177	0		Y	0.00	31.70	0.00	0.50	0.00	15.85
43	RG	Ranchos de Placitas Sanitation Dist	R	260	139	0		Y	0.00	40.50	0.00	0.50	0.00	20.25
43	RG	Regina MDWCA	R	500	44	0		Y	0.00	24.90	0.00	0.50	0.00	12.45
43	RG	Rio Rancho--Albuquerque Utilities	U	51765	181	1,7		Y	0.00	10492.17	0.00	0.86	0.00	9023.26

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Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
43	RG	Rural self-supplied homes	R	17319	80	0	-	N	0.00	1551.98	0.00	1.00	0.00	1551.98
43	RG	San Ysidro	R	240	149	0		Y	0.00	40.07	0.00	0 50	0.00	20 03
43	RG	Sile MDWCA	R	130	170	0		Y	0 00	24.72	0.00	0.50	0.00	12 36
43	RG	Vista del Oro de Placitas	R	36	103	0		Y	0.00	4.14	0 00	0.50	0.00	2 07
		River Basin Subtotals		88038					159.16	14882.06			59 48	12559 70
43	UC	Rural self-supplied homes	R	1870	80	0	-	N	0.00	167.57	0 00	1.00	0.00	167.57
		River Basin Subtotals		1870					0.00	167.57			0.00	167.57
		County Totals		89908					159.16	15049.64			59 48	12727.27
45	UC	Aztec Domestic Water System	U	5217	226	3	Y		1320.83	0.00	0.47	0.00	620.79	0.00
45	UC	Blanco Water Association	R	952	56	0	Y		59.88	0.00	0.50	0.00	29.94	0.00
45	UC	Bloomfield Water Supply System	U	6417	147	0	Y		1054.25	0.00	0.32	0 00	337.36	0.00
45	UC	Farmington Water System	U	37844	260	3	Y		11004.02	0.00	0.55	0.00	6052.21	0.00
45	UC	Flora Vista WUA	R	2300	159	7	Y	Y	77.81	331.35	0.50	0.50	38.90	165 68
45	UC	Harvest Gold Subdivision	R	350	105	6	Y		41.26	0.00	0.50	0.00	20.63	0.00
45	UC	Kirtland	U	8666	105	0	Y		1021.36	0.00	0.50	0.00	510.68	0.00
45	UC	La Plata	R	1890	69	6	Y		146.15	0.00	0.50	0.00	73.07	0.00
45	UC	Lee Acres WUA	U	3400	124	0	Y		471.82	0.00	0.40	0 00	188.73	0.00
45	UC	Lower Valley WUA	U	8700	112	7	Y		1087.80	0 00	0 50	0.00	543.90	0 00
45	UC	Morningstar WUA	U	4200	88	3	Y		412.95	0.00	0.50	0 00	206.48	0 00

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Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
45	UC	Navajo Dam MDWCA	R	578	49	0	Y		31.99	0.00	0.00	0.00	0.00	0.00
45	UC	North Star WUA	U	1800	69	0	Y		138.79	0.00	0.50	0.00	69.39	0.00
45	UC	Rosa Joint Venture	R	180	311	0	Y		62.64	0.00	0.50	0.00	31.32	0.00
45	UC	Rural self-supplied homes	R	16814	70	0	-	N	0.00	1318.39	0.00	1.00	0.00	1318.39
45	UC	Shiprock--NTUA	U	8156	170	6	Y		1551.09	0.00	0.62	0.00	961.68	0.00
45	UC	Southside WUA	R	1200	77	6	Y		104.00	0.00	0 50	0 00	52.00	0.00
45	UC	Upper La Plata WUA	R	1710	76	6	Y		145.76	0.00	0.50	0.00	72.88	0.00
45	UC	West Hammond MDWCA	R	3427	76	6	Y		292.43	0.00	0.40	0.00	116.97	0.00
		River Basin Subtotals		113601					19024.63	1649.74			9926.94	1484 07
		County Totals		113801					19024.83	1649.74			9926.94	1484.07
47	AWR	Big Mesa Water Co-Op	R	500	150	9	Y		83.92	0.00	0.50	0.00	41.96	0.00
47	AWR	Conchas Dam	R	400	207	0	Y		92.89	0.00	0.50	0.00	46.44	0.00
47	AWR	Pendaries Water System	R	300	103	0	Y		34.73	0.00	0.50	0.00	17.36	0.00
47	AWR	Rural self-supplied homes	R	297	80	0	-	N	0.00	26.61	0.00	1 00	0.00	26.61
		River Basin Subtotals		1497					211.54	26.61			105.77	26.61
47	P	East Pecos MDWCA (1990)	R	600	69	0		N	0.00	46.40	0.00	0.50	0.00	23.20
47	P	El Coruco Domestic(est)	R	100	80	0		N	0.00	9.00	0.00	0.50	0.00	4.50
47	P	Ilfield MDWCA	R	160	99	0		Y	0.00	17.80	0.00	0.50	0.00	8.90
47	P	La Pasada MDWCA	R	150	51	0		Y	0.00	8.61	0 00	0 50	0 00	4 30

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Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
47	P	Las Vegas Water Supply System	U	14565	146	0		Y	2386.63	0.00	0.34	0.00	811.45	0.00
47	P	Pecos Water System	R	1441	121	0		Y	0.00	195.28	0.00	0.61	0.00	119.12
47	P	Ribera MDWCA	R	140	75	0		N	0.00	11.79	0.00	0.50	0.00	5.89
47	P	Rowe MDWCA	R	103	76	0		Y	0.00	8.76	0.00	0.50	0.00	4.38
47	P	Rural self-supplied homes	R	10745	80	0	-	N	0.00	962.88	0.00	1.00	0.00	962 88
47	P	San Jose MDWCA	R	160	51	0		Y	9.14	0.00	0.50	0.00	4.57	0 00
47	P	San Miguel	R	40	97	0		Y	0.00	4.35	0.00	0.50	0.00	2 17
47	P	Sena Water System	R	55	193	0		Y	0.00	11.87	0.00	0.50	0.00	5.93
47	P	Tecolote Domestic Water Ussers Asso	R	120	124	0		Y	0.00	16.70	0.00	0.50	0.00	8.35
47	P	Tecolotito MDWCA	R	250	75	0		Y	0.00	20 90	0.00	0.50	0.00	10.45
		River Basin Subtotals		28629					2395.77	1314.34			816.02	1160 09
		County Totals		30126					2607.31	1340.95			921.79	1186 70
49	P	Glorieta Baptist Conference Center	R	300	603	9		Y	0.00	202.70	0.00	0.50	0.00	101.35
49	P	Glorieta Estates Water Co-Op	R	67	91	0		Y	0.00	6.80	0.00	0.50	0.00	3 40
49	P	Rural self-supplied homes	R	254	80	0	-	N	0.00	22.76	0.00	1.00	0.00	22.76
		River Basin Subtotals		621					0.00	232.26			0.00	127 51
49	RG	Agua Fria MHP	U	100	116	0		Y	0.00	13.01	0.00	0.50	0.00	6 51
49	RG	Canoncito MDWCA (1990)	R	120	100	0		Y	0.00	13.43	0 00	0.50	0.00	6 72
49	RG	Casitas de Santa Fe	U	800	73	0		Y	0.00	65.06	0 00	0 50	0.00	32.53

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Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
49	RG	Cerillos MDWCA	R	300	57	0		Y	0.00	19.30	0.00	0.50	0.00	9.65
49	RG	Chimayo MDWCA	R	150	111	0		Y	0.00	18.69	0.00	0.50	0.00	9.35
49	RG	Cielo Lindo MHP	R	34	52	0		Y	0.00	1.99	0.00	0.50	0.00	1.00
49	RG	Country Club Estates	R	85	162	0		Y	0.00	15.41	0.00	0.50	0.00	7.70
49	RG	Country Club Gardens MHP	U	800	88	0		Y	0.00	78.53	0.00	0.50	0.00	39.26
49	RG	East Glorieta MDWCA	R	50	83	0		Y	0.00	4.63	0.00	0.50	0.00	2.32
49	RG	Edgewood Water Inc.	U	1893	233	2		Y	0.00	494.93	0.00	0.50	0.00	247.46
49	RG	El Rancho MHP	R	60	67	0		Y	0.00	4.48	0.00	0.50	0.00	2.24
49	RG	El Vadito de Los Cerrillos MDWCA	R	200	81	0		Y	0.00	18.18	0.00	0.50	0.00	9.09
49	RG	Eldorado de Santa Fe	R	6000	75	0		Y	0.00	501.86	0.00	0.50	0.00	250.93
49	RG	Entranosa Wtr Co-Op (part)-Edgewood	U	2345	80	2		Y	0.00	209.70	0.00	0.50	0.00	104.85
49	RG	Espanola Water System (part)	U	1616	116	0		Y	0.00	210.40	0.00	0.20	0.00	42.08
49	RG	Galisteo WUA	R	200	143	0		Y	0.00	32.13	0.00	0.50	0.00	16.07
49	RG	Glorieta MDWCA	R	92	120	0		Y	0.00	12.32	0.00	0.50	0.00	6.16
49	RG	Hyde Park Estates	R	150	32	0		Y	0.00	5.30	0.00	0.50	0.00	2.65
49	RG	Juniper Hills MHP	R	50	67	0		N	0.00	3.73	0.00	0.50	0.00	1.87
49	RG	Juniper Hills PT Ranch	R	60	25	0		Y	0.00	1.70	0.00	0.50	0.00	0.85
49	RG	La Cienega Lakeside MHP	R	60	51	0		Y	0.00	3.42	0.00	0.50	0.00	1.71

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Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
49	RG	La Cienega MDWCA	R	250	76	0		Y	0.00	21.42	0.00	0.50	0.00	10.71
49	RG	La Puebla MDWCA	R	300	56	0		Y	0.00	18.88	0.00	0.50	0.00	9.44
49	RG	La Vista Homeowners Assn.	R	45	137	0		Y	0.00	6.90	0.00	0.50	0.00	3.45
49	RG	Las Campanas	R	750	992	6		Y	0.00	833.54	0.00	0.90	0.00	750.19
49	RG	Madrid Water Co-Op	R	250	52	0		Y	0.00	14.44	0.00	0.50	0.00	7.22
49	RG	Penitentiary of New Mexico	R	960	226	0		Y	0.00	243.02	0.00	0.50	0.00	121.51
49	RG	Pojoaque Terraces MHP	R	160	82	0		Y	0.00	14.73	0.00	0.50	0.00	7.36
49	RG	Ranchitos de Galisteo WUA	R	60	198	0		Y	0.00	13.30	0.00	0.50	0.00	6.65
49	RG	Rio Chiquito MDWCA	R	120	25	0		Y	0.00	3.31	0.00	0.50	0.00	1.66
49	RG	Rio En Medio MDWCA(1995)	R	120	45	0		N	0.00	6.03	0.00	0.50	0.00	3.02
49	RG	Rufina Apartments	U	50	69	0		Y	0.00	3.84	0.00	0.50	0.00	1.92
49	RG	Rural self-supplied homes	R	33498	80	0	-	N	0.00	3001.81	0.00	1.00	0.00	3001.81
49	RG	Sangre de Cristo Water Company	U	70250	145	4		Y	3575.85	7811.11	0.60	0.60	2145.51	4686.67
49	RG	Santa Cruz MDWCA	R	280	47	0		N	0.00	14.84	0.00	0.50	0.00	7.42
49	RG	Santa Fe Country Club Apartments	R	120	114	0		Y	0.00	15.35	0.00	0.50	0.00	7.66
49	RG	Santa Fe County Utilities	R	621	166	6		Y	106.14	9.45	0.50	0.50	53.07	4.72
49	RG	Santa Fe Mobile Home Hacienda	R	330	52	0		Y	0.00	19.34	0.00	0.50	0.00	9.67
49	RG	Santa Fe West MHP	R	200	55	0		Y	0.00	12.22	0.00	0.50	0.00	6.11

Key: CN=county number; RVB=river basin; C=census classification (urban/rural); POP=population; GPCD=gallons per capita per day; WTC=water transfer code; MSW=surface water withdrawals are measured (y/n); MGW=groundwater withdrawals are measured (y/n); WSW=withdrawals, surface water; WGW=withdrawals, ground water; DFSW=depletion factor, surface water; DFGW=depletion factor, ground water; DSW=depletion, surface water; DGW=depletion, ground water.

Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
49	RG	Santa Fe--urban self-supplied homes	U	1200	130	0	-	N	0.00	174.74	0.00	1.00	0.00	174.74
49	RG	Shalom MHP	R	50	89	0		Y	0.00	5.00	0.00	0.50	0.00	2.50
49	RG	Solacito Homeowners Assn.	R	27	153	0		Y	0.00	4.62	0.00	0.50	0.00	2.31
49	RG	Sunlit Hills of Santa Fe	R	900	134	0		Y	0.00	134.90	0.00	0.50	0.00	67.45
49	RG	Sunset Mobile Home Park (1990)	R	135	77	0		Y	0.00	11.68	0.00	0.50	0.00	5.84
49	RG	Tesuque MDWCA (1990)	R	370	60	0		N	0.00	24.66	0.00	0.50	0.00	12.43
49	RG	Thunder Mtn Water Co.--Edgewood	R	1500	92	0		Y	0.00	155.00	0.00	0.50	0.00	77.50
49	RG	Trailer Ranch MHP	U	175	95	0		Y	0.00	18.57	0.00	0.50	0.00	9.28
49	RG	Valle Vista Subdivision	R	410	153	0		Y	0.00	70.38	0.00	0.50	0.00	35.19
49	RG	Valle Vista/Pueblo Garcia	R	55	42	0		Y	0.00	2.61	0.00	0.50	0.00	1.30
49	RG	Valley Cove MHP	R	75	135	0		N	0.00	11.34	0.00	0.50	0.00	5.67
49	RG	Village MHP	R	120	97	0		Y	0.00	13.01	0.00	0.50	0.00	6.51
49	RG	Vista Redonda MDWCA	R	125	167	0		Y	0.00	23.38	0.00	0.50	0.00	11.69
		River Basin Subtotals		128671					3681.99	14441.81			2198.58	9860.59
		County Totals		129292					3681.99	14674.07			2198.58	9988.10
51	RG	Desertaire Water Company	U	35	142	0		Y	0.00	5.57	0.00	0.50	0.00	2.79
51	RG	Hillsboro	R	150	91	0		Y	0.00	15.30	0.00	0.50	0.00	7.65
51	RG	Lakeshore Sanitation District	R	900	157	9		Y	0.00	157.89	0.00	0.50	0.00	78.94

Key: CN=county number; RVB=river basin; C=census classification (urban/rural); POP=population; GPCD=gallons per capita per day; WTC=water transfer code; MSW=surface water withdrawals are measured (y/n); MGW=groundwater withdrawals are measured (y/n); WSW=withdrawals, surface water; WGW=withdrawals, ground water; DFSW=depletion factor, surface water; DFGW=depletion factor, ground water; DSW=depletion, surface water; DGW=depletion, ground water.

Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
51	RG	National Utilities--Elephant Butte	R	1500	100	9		Y	0.00	167.68	0.00	0.50	0.00	83.84
51	RG	National Utilities--Meadow Lake	R	1735	128	0		Y	0.00	248.16	0.00	0.50	0.00	124 08
51	RG	Rural self-supplied homes	R	1134	80	0	-	N	0.00	101.62	0.00	1.00	0.00	101.62
51	RG	Truth or Consequences	U	7816	151	4		Y	0.00	1319.00	0.00	0.58	0.00	765.02
		River Basin Subtotals		13270					0.00	2015.22			0.00	1163.94
		County Totals		13270					0.00	2015.22			0.00	1163.94
53	RG	La Joya MDWCA	R	132	69	0		Y	0.00	10.17	0.00	0.50	0.00	5.09
53	RG	Magdalena Water Supply System	R	913	169	0		Y	0.00	172.43	0.00	0 50	0.00	86.21
53	RG	New Mexico Boys Ranch	R	82	298	0		N	0.00	27.35	0.00	0.50	0.00	13 68
53	RG	Polvadera MDWCA	R	1350	103	0		N	0.00	156.21	0.00	0.50	0.00	78.11
53	RG	Rural self-supplied homes	R	5099	80	0	-	N	0.00	456.93	0.00	1.00	0.00	456.93
53	RG	San Acacia MDWCA	R	125	117	0		Y	0.00	16.43	0.00	0 50	0.00	8 22
53	RG	San Antonio MDWCA	R	1500	80	0		Y	0.00	133.70	0.00	0.50	0.00	66.85
53	RG	Socorro	U	8677	207	0		Y	0.00	2059.58	0 00	0.34	0.00	700.26
		River Basin Subtotals		18078					0.00	3032.80			0.00	1415.33
		County Totals		18078					0.00	3032.80			0.00	1415.33
55	RG	Canon MDWCA	R	360	131	0		Y	0.00	52.86	0.00	0.50	0.00	26.43
55	RG	El Prado Water & Sanitation Dist.	R	1000	60	0		Y	0.00	67.67	0.00	0.50	0.00	33.83
55	RG	El Salto MDWCA	R	216	73	0		Y	0.00	17.58	0.00	0.50	0.00	8.79

Key: CN=county number; RVB=river basin; C=census classification (urban/rural); POP=population; GPCD=gallons per capita per day; WTC=water transfer code; MSW=surface water withdrawals are measured (y/n); MGW=groundwater withdrawals are measured (y/n); WSW=withdrawals, surface water; WGW=withdrawals, ground water; DFSW=depletion factor, surface water; DFGW=depletion factor, ground water; DSW=depletion, surface water; DGW=depletion, ground water.

Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
55	RG	Juniper Hills Mobile Home Park	R	60	93	0		Y	0.00	6.26	0.00	0.50	0.00	3.13
55	RG	La Lomita Mobile Home Park	R	100	78	0		Y	0.00	8.70	0.00	0.50	0.00	4.35
55	RG	Llano Quemado MDWCA	R	650	54	0		Y	0.00	39.64	0.00	0.50	0.00	19.82
55	RG	Lower Arroyo Hondo MDWCA	R	210	60	0		Y	0.00	14.22	0.00	0.50	0.00	7.11
55	RG	Ojo Caliente MDWCA	R	277	130	0		Y	0.00	40.47	0.00	0.50	0.00	20.23
55	RG	Penasco MDWCA	R	437	183	0		Y	0.00	89.37	0.00	0.50	0.00	44.69
55	RG	Questa Water System	R	1864	101	0		Y	0.00	210.42	0.00	0.50	0.00	105.21
55	RG	Ranchos de Taos MDWCA	R	720	78	0		Y	0.00	63.01	0.00	0.50	0.00	31.51
55	RG	Red River Water System	R	484	1059	9		Y	87.06	487.00	0.16	0.16	13.93	77.92
55	RG	Rio Lucio MDWCA	R	360	56	0		Y	0.00	22.70	0.00	0.50	0.00	11.35
55	RG	Rural self-supplied homes	R	15358	80	0		N	0.00	1376.26	0.00	1.00	0.00	1376.26
55	RG	San Cristobal MDWCA	R	110	36	0		Y	4.41	0.00	0.50	0.00	2.21	0.00
55	RG	Talpa	R	880	78	0		Y	0.00	76.81	0.00	0.50	0.00	38.40
55	RG	Taos Municipal Water System	U	4700	141	0		Y	0.00	743.31	0.00	0.50	0.00	371.65
55	RG	Trampas MDWCA	R	120	43	0		Y	0.00	5.72	0.00	0.50	0.00	2.86
55	RG	Tres Piedras MDWCA	R	117	95	0		Y	0.00	12.50	0.00	0.50	0.00	6.25
55	RG	Twining Water Sys--Taos Ski Valley	R	1000	93	9		Y	0.00	104.35	0.50	0.50	0.00	52.17
55	RG	Upper Arroyo Hondo MDWCA(1995)	R	176	44	0		Y	0.00	8.70	0.00	0.50	0.00	4.35

Key: CN=county number; RVB=river basin; C=census classification (urban/rural); POP=population; GPCD=gallons per capita per day; WTC=water transfer code; MSW=surface water withdrawals are measured (y/n); MGW=groundwater withdrawals are measured (y/n); WSW=withdrawals, surface water; WGW=withdrawals, ground water; DFSW=depletion factor, surface water; DFGW=depletion factor, ground water; DSW=depletion, surface water; DGW=depletion, ground water.

Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
55	RG	Upper Des Montes MDWCA(1995)	R	240	45	0		Y	0.00	12.13	0.00	0.50	0.00	6.07
55	RG	Upper Ranchitos MDWCA	R	190	87	0		Y	0.00	18.57	0.00	0.50	0.00	9.28
55	RG	Valle Escondido Water System	R	250	81	0		Y	0.00	22.63	0.00	0.50	0.00	11.31
55	RG	Vigils Trailer Park	R	100	81	0		Y	0.00	9.04	0.00	0.50	0.00	4.52
		River Basin Subtotals		29979					91.47	3509.92			16.14	2277.51
		County Totals		29979					91.47	3509.92			16.14	2277.51
57	P	Clines Corners Water System	R	40	381	0		Y	0.00	17.07	0.00	0.50	0.00	8.53
57	P	Duran Water System(1995)	R	70	76	1,6		Y	0.00	5.96	0.00	0.50	0.00	2.98
57	P	Rural self-supplied homes	R	255	80	0	-	N	0.00	22.85	0.00	1.00	0.00	22.85
		River Basin Subtotals		365					0.00	45.88			0.00	34.37
57	RG	Echo Valley Water Co.	R	100	103	0		Y	0.00	11.56	0.00	0.50	0.00	5.78
57	RG	Encino Water System(1995)	R	94	196	1,6		Y	0.00	20.59	0.00	0.50	0.00	10.30
57	RG	Estancia Water System	R	1584	170	0		Y	0.00	301.48	0.00	0.50	0.00	150.74
57	RG	Homestead Estates	R	154	165	0		Y	0.00	28.41	0.00	0.50	0.00	14.20
57	RG	Moriarty Water System	R	1765	207	0		Y	0.00	408.94	0.00	0.50	0.00	204.47
57	RG	Mountainair	R	1116	60	0		Y	0.00	75.11	0.00	0.50	0.00	37.56
57	RG	Rural self-supplied homes	R	10945	80	0	-	N	0.00	980.80	0.00	1.00	0.00	980.80
57	RG	Sunset Acres Subdivision	R	288	97	0		Y	0.00	31.16	0.00	0.50	0.00	15.58
57	RG	Torreon MDWCA	R	300	40	0		Y	0.00	13.39	0.00	0.50	0.00	6.70

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Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
57	RG	Willard Water Supply System	R	200	113	0		Y	0.00	25.40	0.00	0.50	0.00	12.70
		River Basin Subtotals		16546					0.00	1896.84			0.00	1438.82
		County Totals		16911					0.00	1942.72			0.00	1473.19
59	AWR	Clayton Municipal Supply	R	2524	196	0		Y	0.00	554.50	0.00	0 50	0.00	277.25
59	AWR	Des Moines Water System(1995)	R	168	150	0		Y	0.00	28.16	0.00	0.50	0 00	14.08
59	AWR	Grenville Water System	R	30	58	0		Y	0.00	1.94	0.00	0.50	0.00	0.97
59	AWR	Rural self-supplied homes	R	1452	80	0		N	0.00	130.12	0.00	1.00	0.00	130.12
		River Basin Subtotals		4174					0.00	714.72			0.00	422.42
		County Totals		4174					0.00	714.72			0.00	422.42
61	RG	Belen Water System	U	6901	226	0		Y	0.00	1747.78	0.00	0.42	0.00	734.07
61	RG	Bosque Farms Water Supply System	R	3180	109	0		Y	0.00	389.13	0.00	0.75	0.00	291.85
61	RG	Cyprus Gardens Water System	R	648	141	0		Y	0.00	102.67	0.00	0.50	0.00	51.33
61	RG	El Shaddi Water Co-Op	R	70	153	0		Y	0.00	12.00	0.00	0.50	0.00	6.00
61	RG	Highland Meadows	R	250	112	0		Y	0.00	31.28	0.00	0 50	0.00	15 64
61	RG	Hi-Mesa Estates MHP	R	200	63	0		Y	0.00	14.08	0.00	0.50	0.00	7 04
61	RG	JC Mobile Home Park	R	34	130	0		Y	0.00	4.97	0.00	0.50	0.00	2.48
61	RG	Los Lunas Correctional Center	R	1151	39	0		Y	0.00	50.82	0.00	0.50	0.00	25 41
61	RG	Los Lunas Water System	U	10034	184	0		Y	0.00	2072.54	0.00	0.55	0.00	1139 90
61	RG	Meadow Lake	R	2399	87	0		Y	0.00	234.00	0.00	0 50	0 00	117 00

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Table 6. Public Water Suppy and Self-Supplied Domestic. Water systems, population, per capita use, and withdrawals and depletions in acre-feet, in New Mexico counties, 2000.

CN	RVB	Water Supplier	C	POP	GPCD	WTC	MSW	MGW	WSW	WGW	DFSW	DFGW	DSW	DGW
61	RG	Monterey Mobile Home Estates(1995)	R	1050	81	0		Y	0.00	95.22	0.00	0.50	0 00	47 61
61	RG	Rio Grande Utilities	U	7000	108	0		Y	0.00	849.30	0.00	0.50	0.00	424.65
61	RG	Rural self-supplied homes	R	33178	100	0	-	N	0.00	3716.42	0.00	1.00	0.00	3716 42
61	RG	Trinity MHP--Bosque Farms	R	57	58	0		Y	0.00	3.70	0.00	0.50	0.00	1 85
		River Basin Subtotals		66152					0 00	9323.92			0 00	6581 26
		County Totals		66152					0.00	9323.92			0 00	6581 26
		State Totals		1819046					37875.85	329066.82			19237 78	196670 90

Key: CN=county number; RVB=river basin; C=census classification (urban/rural); POP=population; GPCD=gallons per capita per day; WTC=water transfer code; MSW=surface water withdrawals are measured (y/n); MGW=groundwater withdrawals are measured (y/n); WSW=withdrawals, surface water; WGW=withdrawals, ground water; DFSW=depletion factor, surface water; DFGW=depletion factor, ground water; DSW=depletion, surface water; DGW=depletion, ground water.

Table 7. Populations in New Mexico river basins, 2000.

RIVER BASIN	CATEGORY	POPULATION	URBAN POPULATION	RURAL POPULATION
Arkansas-White-Red	Public Water Supply	27507	14137	13370
Arkansas-White-Red	Domestic (self-supplied)	8850	0	8850
River Basin Totals		36357	14137	22220
Texas Gulf	Public Water Supply	97004	93459	3545
Texas Gulf	Domestic (self-supplied)	14602	0	14602
River Basin Totals		111606	93459	18147
Pecos	Public Water Supply	148742	116966	31776
Pecos	Domestic (self-supplied)	28431	0	28431
River Basin Totals		177173	116966	60207
Rio Grande	Public Water Supply	1049409	939426	109983
Rio Grande	Domestic (self-supplied)	240944	8484	232460
River Basin Totals		1290353	947910	342443
Upper Colorado	Public Water Supply	100492	87680	12812
Upper Colorado	Domestic (self-supplied)	32795	0	32795
River Basin Totals		133287	87680	45607
Lower Colorado	Public Water Supply	36059	31920	4139
Lower Colorado	Domestic (self-supplied)	34211	0	34211
River Basin Totals		70270	31920	38350
State Totals		1819046	1292072	526974

Table 8. Irrigated Agriculture. Withdrawals in acre-feet, in New Mexico counties, 1999. Data compiled by A. A. Lucero, New Mexico Office of the State Engineer.

CN	RVB	LOCALE	T	CIRSW	CIRGW	ASWO	AGWO	ASWC	AGWC	TAI	EF	EC	EJ	MSW	MGW	TFWSW	CLSW	TPWSW	TPWGW
1	RG	Estancia Basin	F	0.000	0.783	0	20	0	0	20	0.6000	0.0000	0.0000	N	N	0			26
1	RG	Inside MRGCD but exclusive of MRG	D	0.000	1.115	0	130	0	0	130	0.8500	0.0000	0.0000	-	N	0			171
1	RG	MRGCD only	F	1.782	1.782	5558	0	2403	801	8760	0.4798	0.4775	0.2290	Y	N	29572	32359	61932	2976
1	RG	Outside MRGCD	D	0.000	1.115	0	100	0	0	100	0.8500	0.0000	0.0000	-	N	0			131
			River Basin Subtotals			5558	250	2403	801	9010						29572	32359	61932	3304
			County Totals			5558	250	2403	801	9010						29572	32359	61932	3304
3	LC	Quemado & Vicinity	F	1.333	0.000	595	0	0	0	595	0.5500	0.7000	0.3850	N	-	1442	618	2060	0
3	LC	San Francisco River--Apache-Aragon	F	0.272	0.000	294	0	0	0	294	0.4000	0.9000	0.3600	Y	-	200	22	222	0
3	LC	San Francisco River--Glenwood	F	2.000	0.000	513	0	0	0	513	0.4000	0.2124	0.0850	Y	-	2565	9511	12076	0
3	LC	San Francisco River--Luna	F	0.885	0.000	95	0	0	0	95	0.4000	0.5000	0.2000	Y	-	211	211	422	0
3	LC	San Francisco River--Reserve	F	1.272	0.000	340	0	0	0	340	0.4000	0.2232	0.0893	Y	-	1081	3763	4844	0
			River Basin Subtotals			1837	0	0	0	1537						5499	14125	19624	0
3	RG	San Augustin Plains	F	0.000	1.866	0	100	0	0	100	0.5500	0.0000	0.0000	-	N	0			339
			River Basin Subtotals			0	100	0	0	100						0			339
			County Totals			1837	100	0	0	1937						5499	14125	19624	339
5	P	Rio Hondo	F	1.241	0.000	1264	0	0	0	1264	0.5500	0.7000	0.3850	N	-	2652	1222	4074	0
5	P	Rio Hondo	S	0.000	1.138	0	283	0	0	283	0.6500	0.0000	0.0000	-	N	0			495
5	P	Rio Penasco	F	1.341	1.341	39	59	942	236	1275	0.5500	0.7000	0.3850	N	N	2392	1025	3417	719
5	P	Roswell Basin North	D	0.000	2.268	0	40	0	0	40	0.8500	0.0000	0.0000	-	Y	0			107
5	P	Roswell Basin North	S	0.000	2.070	0	18500	0	0	18500	0.7000	0.0000	0.0000	-	Y	0			54707

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CN	RVB	LOCALE	T	CIRSW	CIRGW	ASWO	AGWO	ASWC	AGWC	TAI	EF	EC	EJ	MSW	MGW	TFWSW	CLSW	TPWSW	TPWGW
5	P	Roswell Basin North (part)	F	1.920	0.000	789	0	2813	0	3602	0.6000	0.7500	0.4500	Y	-	11528	3842	15369	0
5	P	Roswell Basin North (part)	F	0.000	1.920	0	71641	0	7952	79593	0.6000	0.0000	0.0000	-	Y	0			254698
5	P	Scattered	F	2.813	2.813	0	50	250	500	800	0.6000	0.9000	0.5400	N	N	1172	130	1302	2579
			River Basin Subtotals			2092	90573	4005	8688	105358						17942	6219	24162	313305
			County Totals			2092	90573	4005	8688	105358						17942	6219	24162	313305
6	LC	Scattered	D	0.000	1.064	0	50	0	0	50	0.8500	0.0000	0.0000	-	N	0			84
6	LC	Scattered	F	1.656	0.000	512	0	0	0	512	0.5500	0.7000	0.3850	N	N	1542	661	2202	0
			River Basin Subtotals			512	50	0	0	562						1542	661	2202	84
6	RG	Scattered	D	0.000	0.834	0	20	0	0	20	0.8500	0.0000	0.0000	-	N	0			20
6	RG	Scattered	F	0.387	0.387	1608	350	536	230	2724	0.5500	0.7000	0.3850	N	N	1509	647	2155	408
			River Basin Subtotals			1608	370	536	230	2744						1509	647	2155	428
			County Totals			2120	420	536	230	3306						3051	1308	4357	492
7	AWR	Canadian River	F	1.119	0.000	5210	0	0	0	5210	0.5500	0.6000	0.3300	N	-	10900	7067	17967	0
7	AWR	Canadian River	S	1.262	0.000	600	0	0	0	600	0.6500	0.6000	0.3900	N	-	1165	777	1942	0
7	AWR	Cimarron River	F	0.640	0.000	8500	0	0	0	8500	0.5500	0.6000	0.3300	N	-	9891	6594	16485	0
7	AWR	Cimarron River	S	0.000	1.112	0	535	0	0	536	0.6500	0.0000	0.0000	-	-	0			915
7	AWR	Dry Cimarron	F	1.432	0.000	505	0	0	0	505	0.5500	0.7000	0.3850	N	-	1315	564	1878	0
7	AWR	Near Capulin	F	1.236	0.000	380	0	0	0	380	0.5500	0.7000	0.3850	N	-	854	366	1220	0
7	AWR	Purgatoire	F	1.368	0.000	180	0	0	0	180	0.5500	0.7000	0.3850	N	-	398	171	569	0
7	AWR	Vermejo Conservancy District	F	0.555	0.000	5808	0	0	0	5808	0.5500	0.6897	0.3793	Y	-	5871	2642	8513	0

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CN	RVB	LOCALE	T	CIRSW	CIRGW	ASWO	AGWO	ASWC	AGWC	TAI	EF	EC	EJ	MSW	MGW	TFWSW	CLSW	TPWSW	TPWGW
7	AWR	Vermejo Conservancy District	S	0.583	0.000	100	0	0	0	100	0.8500	0.6897	0.4483	Y	-	87	39	126	0
			River Basin Subtotals			21263	535	0	0	21798						30181	18220	48400	915
			County Totals			21263	535	0	0	21798						30181	18220	48400	915
9	AWR	Scattered	F	0.000	0.765	0	4110	0	0	4110	0.6500	0.0000	0.0000	-	N	0			5717
9	AWR	Scattered	S	0.000	0.788	0	5610	0	0	5610	0.8000	0.0000	0.0000	-	N	0			5526
			River Basin Subtotals			0	9720	0	0	9720						0			11243
9	P	Scattered	S	0.000	0.809	0	1350	0	0	1350	0.8000	0.0000	0.0000	-	N	0			1365
			River Basin Subtotals			0	1350	0	0	1350						0			1365
9	TG	Scattered	D	0.000	0.964	0	190	0	0	190	0.8500	0.0000	0.0000	-	N	0			215
9	TG	Scattered	F	0.000	0.935	0	21510	0	0	21510	0.6000	0.0000	0.0000	-	N	0			33520
9	TG	Scattered	S	0.000	1.062	0	112650	0	0	112650	0.8000	0.0000	0.0000	-	N	0			149543
			River Basin Subtotals			0	134350	0	0	134350						0			183278
			County Totals			0	145420	0	0	145420						0			195886
11	P	Fort Sumner Irrigation District	F	1.572	0.000	5219	0	0	0	5219	0.2710	0.7637	0.2070	Y	-	30274	9367	39641	0
11	P	Scattered	S	0.000	1.870	0	3420	0	0	3420	0.8500	0.0000	0.0000	-	N	0			9839
			River Basin Subtotals			5219	3420	0	0	8639						30274	9367	39641	9839
			County Totals			5219	3420	0	0	8639						30274	9367	39641	9839
13	RG	EBID Only	D	2.088	0.000	300	0	0	0	300	0.8500	0.5518	0.3311	N	-	737	599	1336	0
13	RG	EBID Only	F	2.606	2.415	0	0	52403	17323	69726	0.6000	0.5518	0.3311	Y	N	227804	184671	412475	69725
13	RG	Hueco Basin	F	0.000	2.788	0	155	0	0	155	0.6000	0.0000	0.0000	-	N	0			715

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CN	RVB	LOCALE	T	CIRSW	CIRGW	ASWO	AGWO	ASWC	AGWC	TAI	EF	EC	EJ	MSW	MGW	TPWSW	CLSW	TPWSW	TPWGW
13	RG	Huaco Basin	S	0.000	2.433	0	25	0	0	25	0.6500	0.0000	0.0000	-	N	0			94
13	RG	Inside EBID but exclusive of EBID	D	0.000	2.088	0	240	0	0	240	0.8500	0.0000	0.0000	-	N	0			590
13	RG	Inside EBID but exclusive of EBID	S	0.000	3.025	0	1360	0	0	1360	0.6000	0.0000	0.0000	-	N	0			6857
13	RG	Nutt-Hockett	F	0.000	1.572	0	10	0	0	10	0.8000	0.0000	0.0000	-	N	0			26
13	RG	Nutt-Hockett	S	0.000	1.898	0	170	0	0	170	0.8500	0.0000	0.0000		N	0			496
13	RG	Outside EBID	F	0.000	2.690	0	3844	0	0	3844	0.6000	0.0000	0.0000	-	N	0			17234
13	RG	Outside EBID--Sante Teresa Sod Far	S	0.000	3.944	0	200	0	0	200	0.5766	0.0000	0.0000	-	Y	0			1368
			River Basin Subtotals			300	6004	52403	17323	76030						228341	185470	413811	97105
			County Totals			300	6004	52403	17323	76030						228341	185470	413811	97105
15	P	Black River	F	2.761	2.761	47	538	292	292	1169	0.6500	0.8000	0.4400	N	N	1702	425	2127	4167
15	P	Carlsbad Basin Scattered	S	0.000	2.571	0	93	0	0	93	0.6500	0.0000	0.0000	-	N	0			368
15	P	Carlsbad Basin--Scattered	F	2.742	2.742	326	1118	0	0	1444	0.5500	0.8000	0.4400	Y	N	1625	406	2032	5574
15	P	Carlsbad Irrigation District	F	2.772	2.772	2503	0	12800	4358	19461	0.6000	0.8939	0.4163	Y	-	69778	30780	100558	20134
15	P	Rio Penasco	F	0.000	0.902	0	38	0	0	38	0.5500	0.7000	0.3850	N	N	0	0	0	62
15	P	Roswell Basin South	F	0.000	1.890	0	9884	0	0	9884	0.6000	0.0000	0.0000	-	Y	0			27840
15	P	Roswell Basin South	S	0.000	2.000	0	22685	0	0	22685	0.7000	0.0000	0.0000	-	Y	0			64814
			River Basin Subtotals			2876	34356	12892	4650	54774						73103	31611	104715	122959
			County Totals			2876	34356	12892	4650	54774						73103	31611	104715	122959
17	LC	Gila River--Cliff Gila	F	1.886	1.886	1033	0	42	42	1117	0.4000	0.2509	0.1004	Y	-	5074	15149	20223	198
17	LC	Gila River--Red Rock	F	2.083	2.083	0	0	88	53	141	0.4000	0.3847	0.1459	Y	N	458	798	1257	276

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17	LC	Gila River--Upper Gila	F	0.907	0.000	63	0	0	0	63	0.4000	0.1454	0.0582	Y	-	143	839	982	0
17	LC	Lordsburg Valley	F	0.000	1.695	0	189	0	0	189	0.6500	0.0000	0.0000	-	N	0			582
		River Basin Subtotals				1096	169	130	95	1510						5675	16766	22462	1056
17	RG	Mimbres River	F	1.509	1.509	382	750	402	268	1802	0.5500	0.6500	0.3575	N	N	2151	1158	3309	2793
17	RG	Mimbres River	S	0.000	1.482	0	110	0	0	110	0.6500	0.0000	0.0000	-	N	0			251
		River Basin Subtotals				382	860	402	268	1912						2151	1158	3309	3044
		County Totals				1478	1049	532	363	3422						7826	17944	25771	4100
19	P	Anton Chico	F	1.297	0.000	2547	0	0	0	2547	0.5500	0.6000	0.3300	N	-	6008	4004	10010	0
19	P	Colonias	F	0.000	1.415	0	223	0	0	223	0.5500	0.0000	0.0000	-	N	0			574
19	P	Puerto de Luna	F	1.469	0.000	601	0	0	0	601	0.5500	0.6000	0.3300	N	-	1605	1070	2675	0
19	P	Scattered	F	0.000	1.162	0	274	0	0	274	0.5500	0.0000	0.0000	-	N	0			579
19	P	Scattered	S	0.000	1.450	0	15	0	0	15	0.6500	0.0000	0.0000	-	N	0			33
		River Basin Subtotals				3148	512	0	0	3660						7611	5074	12685	1186
		County Totals				3148	512	0	0	3660						7611	5074	12685	1188
21	AWR	Scattered	F	0.000	1.032	0	20	0	0	20	0.5500	0.0000	0.0000	-	N	0			36
21	AWR	Scattered	S	0.000	1.031	0	2280	0	0	2280	0.6500	0.0000	0.0000	-	N	0			3616
		River Basin Subtotals				0	2300	0	0	2300						0			3654
		County Totals				0	2300	0	0	2300						0			3654
23	LC	Animas Valley	F	0.000	1.982	0	4426	0	0	4426	0.5500	0.0000	0.0000	-	N	0			15957
23	LC	Animas Valley	S	0.000	1.619	0	2168	0	0	2168	0.6500	0.0000	0.0000	-	N	0			5400

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CN	RVB	LOCALE	T	CIRSW	CIRGW	ASWO	AGWO	ASWC	AGWC	TAI	EF	EC	EJ	MSW	MGW	TFWSW	CLSW	TPWSW	TPWGW
23	LC	Gila River--Virden Valley	F	2.031	2.031	0	0	1657	703	2360	0.5500	0.7000	0.3850	N	N	6119	2622	8741	2598
23	LC	Lordsburg Valley	F	0.000	2.001	0	1613	0	0	1613	0.5500	0.0000	0.0000	-	N	0			5888
23	LC	Playas	F	0.000	2.908	0	375	0	0	375	0.5500	0.0000	0.0000	-	N	0			1983
23	LC	San Simon Valley	F	0.000	1.111	0	368	0	0	368	0.5500	0.0000	0.0000	-	Y	0			739
23	LC	San Simon Valley	S	0.000	1.230	0	317	0	0	317	0.6500	0.0000	0.0000	-	N	0			600
			River Basin Subtotals			0	9267	1657	703	11627						6119	2622	8741	33143
			County Totals			0	9267	1657	703	11627						6119	2622	8741	33143
25	P	Scattered	D	0.000	1.953	0	220	0	0	220	0.8500	0.0000	0.0000	-	N	0			505
			River Basin Subtotals			0	220	0	0	220						0			505
25	TG	Scattered	D	0.000	2.082	0	605	0	0	605	0.8500	0.0000	0.0000	-	N	0			1488
25	TG	Scattered	F	0.000	1.650	0	1000	0	0	1000	0.5500	0.0000	0.0000	-	N	0			3000
25	TG	Scattered	S	0.000	1.399	0	57993	0	0	57993	0.6500	0.0000	0.0000	-	N	0			124819
			River Basin Subtotals			0	59598	0	0	59598						0			129287
			County Totals			0	69818	0	0	59918						0			129792
27	P	Rio Hondo & Tributaries	F	2.004	2.004	1455	606	1181	506	3748	0.4400	0.7000	0.3500	N	N	12008	5145	17151	5065
27	P	Rio Hondo & Tributaries	S	0.000	2.059	0	100	0	0	100	0.6500	0.0000	0.0000	-	N	0			317
27	P	Rio Hondo Tributaries	D	0.000	0.979	0	5	0	0	5	0.8500	0.0000	0.0000	-	N	0			8
27	P	Scattered	F	0.000	0.979	0	2	0	0	2	0.4500	0.7000	0.3150	N	N	0	0	0	4
			River Basin Subtotals			1456	713	1181	506	3855						12008	5145	17151	5392
27	RG	Carrizozo & Vicinity	D	0.000	1.384	0	30	0	0	30	0.8500	0.0000	0.0000	-	N	0			49

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CN	RVB	LOCALE	T	CIRSW	CIRGW	ASWO	AGWO	ASWC	AGWC	TAI	EF	EC	EJ	MSW	MGW	TFWSW	CLSW	TPWSW	TPWGW
27	RG	Carrizozo & Vicinity	F	0.000	1.859	0	130	0	0	130	0.5500	0.0000	0.0000	-	N	0			439
27	RG	Carrizozo & Vicinity	S	0.000	2.033	0	70	0	0	70	0.6500	0.0000	0.0000	-	N	0			219
		River Basin Subtotals				0	230	0	0	230						0			707
		County Totals				1456	943	1161	508	4065						12008	5145	17151	6099
29	RG	Mimbres Basin	S	0.000	2.160	0	783	0	0	783	0.8500	0.0000	0.0000	-	N	0			2602
29	RG	Mimbres River	D	0.000	1.626	0	1879	0	0	1879	0.8500	0.0000	0.0000	-	N	0			3594
29	RG	Mimbres River	F	1.713	1.713	200	21589	600	600	22989	0.5500	0.6500	0.3575	N	N	2492	1342	3833	69046
29	RG	Mimbres River--Floodwater Area	F	0.812	0.000	10350	0	0	0	10350	0.4500	1.0000	0.4500	N	-	18676	0	18676	0
29	RG	Nutt-Hockett	D	0.000	1.530	0	1381	0	0	1381	0.8500	0.0000	0.0000	-	N	0			2450
29	RG	Nutt-Hockett	F	0.000	1.654	0	1735	0	0	1735	0.6000	0.0000	0.0000	-	N	0			4783
29	RG	Nutt-Hockett	S	0.000	1.854	0	3225	0	0	3225	0.8500	0.0000	0.0000	-	N	0			9199
		River Basin Subtotals				10550	30552	600	600	42302						21168	1342	22509	91874
		County Totals				10550	30552	600	600	42302						21168	1342	22509	91874
31	LC	Zuni & Ramah	F	0.150	0.000	3242	0	0	0	3242	0.5500	0.7000	0.3850	N	-	884	379	1263	0
		River Basin Subtotals				3242	0	0	0	3242						884	379	1263	0
31	RG	Scattered	F	1.662	0.000	150	0	0	0	150	0.5500	0.8000	0.4400	N	-	426	106	532	0
		River Basin Subtotals				150	0	0	0	150						426	106	532	0
31	UC	Scattered	F	0.166	0.000	1715	0	0	0	1715	0.5500	0.7000	0.3850	N	-	518	222	739	0
		River Basin Subtotals				1715	0	0	0	1715						518	222	739	0
		County Totals				5107	0	0	0	5107						1828	707	2534	0

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33	AWR	Scattered	D	0.000	0.762	0	50	0	0	50	0.6500	0.0000	0.0000	-	N	0			45
33	AWR	Scattered	F	0.847	0.000	13730	0	0	0	13730	0.5500	0.7000	0.3850	N	-	21144	9062	30206	0
33	AWR	Scattered	S	1.001	0.000	1100	0	0	0	1100	0.6500	0.7000	0.4550	N	-	1694	726	2420	0
			River Basin Subtotals			14830	50	0	0	14880						22838	9788	32626	45
			County Totals			14830	50	0	0	14880						22838	9788	32626	45
35	P	Rio Penasco	F	1.133	0.000	625	0	0	0	625	0.5500	0.7000	0.3850	N	-	1287	552	1839	0
			River Basin Subtotals			625	0	0	0	625						1287	552	1839	0
35	RG	Salt Basin	F	0.000	2.178	0	397	0	0	397	0.6000	0.0000	0.0000	-	N	0			1441
35	RG	Salt Basin	S	0.000	2.192	0	1730	0	0	1730	0.6500	0.0000	0.0000	-	N	0			5834
35	RG	Tularosa Basin	D	0.000	2.584	0	1621	0	0	1621	0.8500	0.0000	0.0000	-	N	0			5536
35	RG	Tularosa Basin	F	2.529	2.629	250	0	1071	357	1678	0.6000	0.7000	0.4200	N	N	5568	2386	7954	1505
35	RG	Tularosa Basin	S	0.000	2.817	0	2230	0	0	2230	0.6500	0.0000	0.0000	-	N	0			9684
			River Basin Subtotals			250	6178	1071	357	7856						5568	2386	7954	23980
			County Totals			875	6178	1071	357	8481						6855	2938	9793	23980
37	AWR	Arch Hurley Conservancy District	F	0.861	0.000	27098	0	0	0	27098	0.6000	0.4274	0.2564	Y	-	38883	52092	90975	0
37	AWR	Arch Hurley Conservancy District	S	0.848	0.000	5561	0	0	0	5561	0.6500	0.4274	0.2564	Y	-	7257	9722	16979	0
37	AWR	Inside AHCD but exclusive of AHCD	D	0.000	1.750	0	17	0	0	17	0.8500	0.0000	0.0000	-	N	0			35
37	AWR	Outside AHCD	S	0.000	1.247	0	883	0	0	883	0.6500	0.0000	0.0000	-	N	0			1694
			River Basin Subtotals			32657	900	0	0	33557						46140	61814	107954	1729
37	P	House & Vicinity	F	0.000	1.029	0	310	0	0	310	0.5500	0.0000	0.0000	-	N	0			580

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37	P	House & Vicinity	S	0.000	1.172	0	2350	0	0	2350	0.6500	0.0000	0.0000	-	N	0			4237
			River Basin Subtotals			0	2660	0	0	2660						0			4817
			County Totals			32657	3560	0	0	36217						46140	61814	107954	6546
39	RG	Rio Chama	F	1.072	1.072	21030	500	210	70	21810	0.5000	0.6000	0.3000	N	N	45539	30359	75898	1222
39	RG	Santa Cruz & Vicinity	F	1.153	0.000	4250	0	0	0	4260	0.5500	0.7000	0.3850	N	-	8931	3827	12758	0
39	RG	Truchas & Vicinity	F	1.132	0.000	2882	0	0	0	2882	0.4000	0.7000	0.2800	N	-	8156	3495	11652	0
39	RG	Velarde & Vicinity	D	0.000	0.888	0	35	0	0	35	0.8500	0.0000	0.0000	-	N	0			36
39	RG	Velarde & Vicinity	F	1.342	0.000	2460	0	0	0	2460	0.5000	0.7000	0.3500	N	-	6603	2830	9432	0
			River Basin Subtotals			30632	535	210	70	31447						69229	40511	109740	1258
39	UC	Dulce & Vicinity	F	0.748	0.000	400	0	0	0	400	0.5000	0.7000	0.3500	N	-	598	256	855	0
			River Basin Subtotals			400	0	0	0	400						598	256	855	0
			County Totals			31032	535	210	70	31847						69827	40767	110595	1258
41	P	Scattered	S	0.000	1.128	0	450	0	0	450	0.7000	0.0000	0.0000	-	N	0			725
			River Basin Subtotals			0	450	0	0	450						0			725
41	TG	Causey-Lingo	F	0.000	0.989	0	730	0	0	730	0.6000	0.0000	0.0000	-	N	0			1203
41	TG	Causey-Lingo	S	0.000	0.985	0	2750	0	0	2750	0.7000	0.0000	0.0000	-	N	0			3870
41	TG	Portales Basin	D	0.000	1.127	0	123	0	0	123	0.8500	0.0000	0.0000	-	N	0			163
41	TG	Portales Basin	F	0.000	1.094	0	3901	0	0	3901	0.6000	0.0000	0.0000	-	N	0			7113
41	TG	Portales Basin	S	0.000	1.196	0	79388	0	0	79388	0.7000	0.0000	0.0000	-	N	0			135640
			River Basin Subtotals			0	86892	0	0	88892						0			147989

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				County Totals		0	87342	0	0	87342						0			148714
43	RG	Cuba & Vicinity	F	0.976	0.976	1865	70	0	0	1855	0.8000	0.7000	0.3500	N	N	3100	1329	4429	137
43	RG	Jemez Basin	F	1.278	0.000	1570	0	0	0	1570	0.5000	0.7000	0.3500	N	-	4013	1720	5733	0
43	RG	MRGCD only	F	1.985	1.985	5410	0	499	166	6075	0.4796	0.4775	0.2290	Y	N	24457	26761	51218	687
43	RG	Outside MRGCD (Dixon Apples)	S	1.591	0.000	50	0	0	0	50	0.6000	1.0000	0.0000	N	-	133	0	133	0
			River Basin Subtotals			8615	70	499	166	9350						31703	29810	61513	824
				County Totals		8615	70	499	166	9350						31703	29810	61513	824
45	UC	Animas River	F	1.808	0.000	4000	0	0	0	4000	0.5500	0.7000	0.3850	N	-	13149	5635	18784	0
45	UC	Animas River	S	2.072	0.000	978	0	0	0	978	0.6500	0.7000	0.4550	N	-	3118	1336	4454	0
45	UC	Chaco River	F	1.791	0.000	306	0	0	0	306	0.4500	0.7000	0.3150	N	-	1218	522	1740	0
45	UC	Hammond Irrigation District	F	2.088	0.000	141	0	0	0	141	0.5500	0.7200	0.3960	Y	-	535	208	743	0
45	UC	Hammond Irrigation District	S	1.963	0.000	3157	0	0	0	3157	0.6500	0.7200	0.4680	Y	-	9534	3708	13242	0
45	UC	La Plata River	F	1.572	0.000	2055	0	0	0	2055	0.5500	0.7000	0.3850	N	-	5874	2517	8391	0
45	UC	La Plata River	S	1.482	0.000	612	0	0	0	812	0.6500	0.7000	0.4550	N	-	1395	598	1993	0
45	UC	Navajo Indian Irrigation Project	S	1.344	0.000	49745	0	0	0	49745	0.5852	0.9360	0.4252	Y	-	114247	7812	122059	0
45	UC	Navajo--Colorado River Storage Prj.	F	1.803	0.000	163	0	0	0	163	0.6000	0.7500	0.3750	Y	-	620	207	827	0
45	UC	Pine River Irrigation District	F	0.758	0.000	411	0	0	0	411	0.5000	0.7481	0.3740	Y	-	623	210	833	0
45	UC	San Juan River	F	1.679	0.000	9630	0	0	0	9630	0.5500	0.7000	0.3850	N	-	29398	12599	41997	0
45	UC	San Juan River	S	1.884	0.000	1458	0	0	0	1458	0.6500	0.7000	0.4550	N	-	4226	1811	6037	0
			River Basin Subtotals			72656	0	0	0	72656						183937	37163	221100	0

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				County Totals		72656	0	0	0	72656						183937	37163	221100	0
47	AWR	Canadian River	F	1.234	0.000	1085	0	0	0	1085	0.5500	0.7000	0.3850	N	-	2389	1024	3414	0
47	AWR	Sapello River	F	1.528	0.000	1610	0	0	0	1610	0.4500	0.7000	0.3150	N	-	5467	2343	7810	0
			River Basin Subtotals			2675	0	0	0	2675						7856	3387	11224	0
47	P	Scattered	F	0.860	0.000	3447	0	0	0	3447	0.5000	0.6000	0.3000	N	-	6067	4044	10111	0
47	P	Storrie Irrigation Project	F	1.707	0.000	4353	0	0	0	4353	0.8000	0.6000	0.3000	N	-	14861	9907	24769	0
47	P	Storrie Irrigation Project	S	1.682	0.000	670	0	0	0	670	0.6500	1.0000	0.6500	N	-	1734	0	1734	0
			River Basin Subtotals			8470	0	0	0	8470						22662	13951	36614	0
				County Totals		11145	0	0	0	11145						30516	17318	47838	0
49	RG	Estancia Basin	D	0.000	1.876	0	40	0	0	40	0.8500	0.0000	0.0000	-	N	0			88
49	RG	Estancia Basin	F	0.000	1.022	0	3866	0	0	3866	0.8000	0.0000	0.0000	-	N	0			6565
49	RG	Estancia Basin	S	0.000	1.184	0	5197	0	0	5197	0.8500	0.0000	0.0000	-	N	0			9307
49	RG	Pojoaque Valley	D	0.000	1.079	0	20	0	0	20	0.8500	0.0000	0.0000	-	N	0			25
49	RG	Pojoaque Valley Irrigation District	F	0.910	0.910	1917	0	280	100	2297	0.8500	0.7530	0.4141	Y	N	3835	1192	4827	165
49	RG	Santa Cruz & Vicinity	F	0.740	0.000	4600	0	0	0	4600	0.5500	0.7000	0.3850	N	-	6169	2652	8942	0
49	RG	Santa Fe & Vicinity	F	1.550	1.550	585	20	110	110	835	0.5000	0.7000	0.3500	N	N	2165	937	3122	403
			River Basin Subtotals			7112	9143	390	210	16855						12009	4781	16791	16573
				County Totals		7112	9143	390	210	16855						12009	4781	16791	16573
51	RG	Above Elephant Butte--Alamosa Creek	F	1.990	1.990	300	631	742	247	1920	0.6000	0.7000	0.4200	N	N	3456	1481	4937	2912
51	RG	Above Elephant Butte--Engle	D	0.000	0.000	0	0	0	0	0	0.8500	1.0000	0.8500	N	-	0	0	0	0

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51	RG	EBID only	F	2.102	2.101	0	0	3077	586	3663	0.6000	0.6500	0.3900	Y	N	10780	5804	16584	2052
51	RG	Lake Valley & Vicinity	F	0.000	1.871	0	131	0	0	131	0.5500	0.0000	0.0000	-	N	0			446
51	RG	Los Animas Creek and others	F	2.102	2.102	200	558	230	80	1066	0.5500	0.7000	0.3850	N	N	1643	704	2348	2431
51	RG	Nutt-Hockett	F	0.000	1.836	0	180	0	0	180	0.6000	0.0000	0.0000	-	N	0			551
51	RG	Truth or Consequences	F	0.000	2.102	0	842	0	0	642	0.6000	0.0000	0.0000	-	N	0			2950
			River Basin Subtotals			500	2340	4049	913	7802						15879	7989	23869	11342
			County Totals			500	2340	4049	913	7802						15879	7989	23869	11342
53	RG	Bosque del Apache	F	2.282	0.000	2304	0	0	0	2304	0.6500	0.7000	0.3850	N	-	9560	4097	13656	0
53	RG	La Jolla	F	2.478	2.478	30	40	154	103	327	0.5500	0.7000	0.3850	N	N	829	355	1184	644
53	RG	MRGCD only	F	2.868	2.868	3073	0	7972	5318	16360	0.4796	0.4775	0.2290	Y	N	51443	67233	128676	29567
53	RG	Outside MRGCD	D	0.000	1.284	0	80	0	0	80	0.6500	0.0000	0.0000	-	N	0			121
53	RG	San Augustine Plains	S	0.000	1.856	0	1120	0	0	1120	0.6500	0.0000	0.0000	-	N	0			3198
			River Basin Subtotals			5407	1240	8126	5416	20191						71832	71885	143516	33530
			County Totals			5407	1240	8126	5416	20191						71832	71885	143516	33530
55	RG	Cerro-Quasia	F	1.109	0.000	4245	0	0	0	4245	0.5000	0.6000	0.3000	N	-	9415	6277	15692	0
55	RG	Cerro-Questa	S	0.000	1.182	0	600	0	0	600	0.6500	0.0000	0.0000	-	N	0			1091
55	RG	Costilla	F	0.562	0.000	5515	0	0	0	5515	0.5000	0.6000	0.3000	N	-	7302	4868	12170	0
55	RG	Costilla	S	0.000	1.228	0	100	0	0	100	0.6500	0.0000	0.0000	N	-	0			189
55	RG	Embudo & Vicinity	F	1.180	0.000	5020	0	0	0	5020	0.5000	0.7000	0.3500	N	-	11646	4991	16638	0
55	RG	Embudo & Vicinity	S	0.000	1.212	0	250	0	0	250	0.6500	0.0000	0.0000	N	-	0			466

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55	RG	Pilar & Ojo Caliente	F	1.159	0.000	60	0	0	0	60	0.6000	0.8000	0.4500	N	-	185	21	206	0
55	RG	Taos & Vicinity	F	1.338	1.336	13650	40	150	50	13890	0.5000	0.7000	0.3500	N	N	36929	15827	52755	241
55	RG	Taos & Vicinity	S	0.000	1.418	0	50	0	0	50	0.6500	0.0000	0.0000	N	-	0			109
		River Basin Subtotals				28510	1040	150	50	29750						65477	31984	97461	2096
		County Totals				28510	1040	150	50	29750						65477	31984	97461	2096
57	RG	Estancia Basin	D	0.000	0.709	0	30	0	0	30	0.6500	0.0000	0.0000	-	N	0			25
57	RG	Estancia Basin	F	0.000	1.366	0	3877	0	0	3877	0.6000	0.0000	0.0000	-	N	0			8827
57	RG	Estancia Basin	S	0.000	1.210	0	13299	0	0	13299	0.6500	0.0000	0.0000	-	N	0			24757
		River Basin Subtotals				0	17206	0	0	17206						0			33609
		County Totals				0	17206	0	0	17206						0			33609
59	AWR	Clayton & Vicinity	D	0.000	2.166	0	15	0	0	15	0.6500	0.0000	0.0000	-	N	0			39
59	AWR	Clayton & Vicinity	F	0.000	1.108	0	472	0	0	472	0.6000	0.0000	0.0000	-	N	0			870
59	AWR	Clayton & Vicinity	S	0.000	0.922	0	50233	0	0	50233	0.6500	0.0000	0.0000	-	N	0			71254
59	AWR	Dry Cimarron	F	1.253	1.253	1595	500	190	190	2575	0.5500	0.7000	0.3850	N	N	4067	1743	5809	1600
59	AWR	Dry Cimarron	S	0.000	1.006	0	2000	0	0	2000	0.6500	0.0000	0.0000	N	-	0			3102
59	AWR	Tramperos Creek	F	0.822	0.822	270	80	0	0	350	0.5500	0.7000	0.3850	N	N	404	173	576	120
		River Basin Subtotals				1865	53400	190	190	55645						4471	1916	6385	77185
		County Totals				1865	53400	190	190	55645						4471	1916	6385	77185
61	RG	Inside MRGCD but exclusive of CD	D	0.000	1.128	0	35	0	0	35	0.6500	0.0000	0.0000	-	N	0			46
61	RG	MRGCD only	F	2.026	2.028	13838	0	5220	1740	20798	0.5000	0.4775	0.2467	Y	N	77299	84584	161883	7057

Key: CN=county number; RVB=river basin; T=type of irrigation system, i.e., drip (D), flood (F), or sprinkler (S); CIRSW=consumptive irrigation requirement for acreage irrigated with surface water; CIRGW=consumptive irrigation requirment for acreage irrigated with ground water; ASWO=acreage irrigated with surface water only; AGWO=acreage irrigated with ground water only; ASWC=surface water component of acreage irrigated with combined water, i.e., both surface and ground water; AGWC=ground water component of acreage irrigated with combined water; TAI=total acreage irrigated; EF=on-farm irrigation efficiency; EC=off-farm conveyance efficiency; EJ=project efficiency; MSW=surface water withdrawals are measured (y/n); MGW=groundwater withdrawals are measured (y/n); TFSW=total farm withdrawal, surface water; CLSW=surface water conveyance losses from stream or reservoir to farm headgate; TPWSW=total project withdrawals, surface water; TPWGW=total project withdrawals, ground water.

Table 9. Irrigated Agriculture. Withdrawals in acre-feet, in New Mexico counties, 1999. Data compiled by A. A. Lucero, New Mexico Office of the State Engineer.

CN	RVB	LOCALE	T	CIRSW	CIRGW	ASWO	AGWO	ASWC	AGWC	TAI	EF	EC	EJ	MSW	MGW	TFWSW	CLSW	TPWSW	TPWGW
		River Basin Subtotals				13838	35	5220	1740	20833						77299	84584	161883	7103
		County Totals				13838	35	5220	1740	20833						77299	84584	161883	7103
		State Totals				292043	567658	98114	42978	998793						1113306	734050	1847357	1376597

Key: CN=county number; RVB=river basin; T=type of irrigation system, i.e., drip (D), flood (F), or sprinkler (S); CIRSW=consumptive irrigation requirement for acreage irrigated with surface water; CIRGW=consumptive irrigation requirment for acreage irrigated with ground water; ASWO=acreage irrigated with surface water only; AGWO=acreage irrigated with ground water only; ASWC=surface water component of acreage irrigated with combined water, i.e., both surface and ground water; AGWC=ground water component of acreage irrigated with combined water; TAI=total acreage irrigated; EF=on-farm irrigation efficiency; EC=off-farm conveyance efficiency; EJ=project efficiency; MSW=surface water withdrawals are measured (y/n); MGW=groundwater withdrawals are measured (y/n); TFSW=total farm withdrawal, surface water; CLSW=surface water conveyance losses from stream or reservoir to farm headgate; TPWSW=total project withdrawals, surface water; TPWGW=total project withdrawals, ground water.

Table 9. Irrigated Agriculture. Depletions in acre-feet, in New Mexico counties, 1999. Data compiled by A. A. Lucero, New Mexico Office of the State Engineer.

CN	RVB	LOCALE	T	CIRSW	CIRGW	IDFCL	IDFOF	IDFBF	IDFSW	IDFGWO	IDFGWC	ASWO	AGWO	ASWC	AGWC	TAI	TPDSW	TPDGW
1	RG	Estancia Basin	F	0.000	0.783	0.000	0.050	0.000	0.000	0.050	0.000	0	20	0	0	20	0	16
1	RG	Inside MRGCD but exclusive of MRG	D	0.000	1.115	0.000	0.000	0.000	0.000	0.000	0.000	0	130	0	0	130	0	145
1	RG	MRGCD only	F	1.782	1.782	0.030	0.050	0.073	0.153	0.000	0.123	5556	0	2403	801	8760	16353	1603
1	RG	Outside MRGCD	O	0.000	1.116	0.000	0.000	0.000	0.000	0.000	0.000	0	100	0	0	100	0	112
											River Basin Subtotals	5556	250	2403	801	9010	16353	1676
											County Totals	5556	250	2403	801	9010	16353	1576
3	LC	Quemado & Vicinity	F	1.333	0.000	0.020	0.050	0.030	0.100	0.000	0.000	595	0	0	0	595	872	0
3	LC	San Francisco River--Apache-Aragon	F	0.272	0.000	0.020	0.050	0.080	0.150	0.000	0.000	294	0	0	0	294	92	0
3	LC	San Francisco River--Glenwood	F	2.000	0.000	0.020	0.050	0.080	0.150	0.000	0.130	513	0	0	0	513	1180	0
3	LC	San Francisco River--Luna	F	0.888	0.000	0.020	0.050	0.080	0.150	0.000	0.000	95	0	0	0	95	97	0
3	LC	San Francisco River--Reserve	F	1.272	0.000	0.020	0.050	0.080	0.150	0.000	0.000	340	0	0	0	340	497	0
											River Basin Subtotals	1637	0	0	0	1637	2738	0
3	RG	San Augustin Plains	F	0.000	1.868	0.000	0.050	0.000	0.000	0.050	0.000	0	100	0	0	100	0	196
											River Basin Subtotals	0	100	0	0	100	0	196
											County Totals	1637	100	0	0	1937	2738	196
5	P	Rio Hondo	F	1.241	0.000	0.010	0.050	0.024	0.084	0.000	0.000	1264	0	0	0	1264	1700	0
5	P	Rio Hondo	S	0.000	1.138	0.000	0.262	0.000	0.000	0.262	0.000	0	283	0	0	283	0	406
5	P	Rio Penasco	F	1.341	1.341	0.030	0.050	0.100	0.180	0.000	0.150	39	59	942	238	1278	1552	443
5	P	Roswell Basin North	D	0.000	2.288	0.000	0.000	0.000	0.000	0.000	0.000	0	40	0	0	40	0	91

Key: CN=county number; RVB=river basin; T=type of irrigation system, i.e., drip (D), flood (F), sprinkler (S); CIRSW=consumptive irrigation requirement for acreage irrigated with surface water; CIRGW=consumptive irrigation requirement for acreage irrigated with ground water; IDFCL=incidental depletion factor, canals and laterals, from stream or reservoir to farm headgate; IDFOF=incidental depletion factor, on-farm; IDFBF=incidental depletion factor, below farm; IDFSW=sum of incidental depletion factors which apply to surface water withdrawals; IDFGWO=incidental depletion factor which applies to withdrawals of ground water only; IDFGWC=sum of incidental depletion factors which apply to the groundwater component of withdrawals where both surface and ground water are applied (combined water); ASWO=acreage irrigated with surface water only; AGWO=acreage irrigated with ground water only; ASWC=surfaced water component of acreage irrigated with combined water; AGWC=groundwater component of acreage irrigated with combined water; TAI=total irrigated acreage; TPDSW=total project depletion, surface water, TPDGW=total project depletion, ground water. Note that incidental depletion factors are expressed as a function of the CIR.

Table 9. Irrigated Agriculture. Depletions in acre-feet, in New Mexico counties, 1999. Data compiled by A. A. Lucero, New Mexico Office of the State Engineer.

CN	RVB	LOCALE	T	CIRSW	CIRGW	IDFCL	IDFOF	IDFBF	IDFSW	IDFGWO	IDFGWC	ASWO	AGWO	ASWC	AGWC	TAI	TPDSW	TPDGW
5	P	Roswell Basin North	S	0.000	2.070	0.000	0.243	0.000	0.000	0.243	0.000	0	18500	0	0	18500	0	47601
5	P	Roswell Basin North (part)	F	1.920	0.000	0.032	0.050	0.050	0.132	0.000	0.000	789	0	2813	0	3602	7629	0
5	P	Roswell Basin North (part)	F	0.000	1.920	0.000	0.050	0.050	0.000	0.050	0.100	0	71641	0	7952	79593	0	161223
5	P	Scattered	F	2.813	2.813	0.032	0.050	0.050	0.132	0.050	0.100	0	50	250	500	800	798	1895
											River Basin Subtotals	2092	90573	4005	8688	105358	11877	211459
											County Totals	2092	90573	4005	8688	105358	11877	211459
6	LC	Scattered	D	0.000	1.084	0.000	0.000	0.000	0.000	0.000	0.000	0	50	0	0	50	0	54
8	LC	Scattered	F	1.856	0.000	0.040	0.050	0.050	0.140	0.000	0.000	512	0	0	0	512	967	0
											River Basin Subtotals	512	50	0	0	562	967	54
6	RG	Scattered	D	0.000	0.834	0.000	0.000	0.000	0.000	0.000	0.000	0	20	0	0	20	0	17
8	RG	Scattered	F	0.367	0.367	0.025	0.050	0.100	0.175	0.050	0.150	1608	350	536	230	2724	975	245
											River Basin Subtotals	1608	370	536	230	2744	975	262
											County Totals	2120	420	536	230	3306	1942	316
7	AWR	Canadian River	F	1.119	0.000	0.030	0.050	0.120	0.200	0.000	0.000	5210	0	0	0	5210	6996	0
7	AWR	Canadian River	S	1.262	0.000	0.030	0.292	0.000	0.292	0.000	0.000	600	0	0	0	600	978	0
7	AWR	Cimarron River	F	0.640	0.000	0.030	0.050	0.120	0.200	0.000	0.000	8500	0	0	0	8500	6528	0
7	AWR	Cimarron River	S	0.000	1.112	0.030	0.292	0.000	0.292	0.000	0.000	0	535	0	0	535	0	595
7	AWR	Dry Cimarron	F	1.432	0.000	0.043	0.050	0.100	0.193	0.000	0.000	505	0	0	0	505	863	0
7	AWR	Near Capulin	F	1.236	0.000	0.030	0.050	0.120	0.200	0.000	0.000	360	0	0	0	380	564	0

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CN	RVB	LOCALE	T	CIRSW	CIRGW	IDFCL	IDFOF	IDFBF	IDFSW	IDFGWO	IDFGWC	ASWO	AGWO	ASWC	AGWC	TAI	TPDSW	TPDGW
7	AWR	Purgatoire	F	1.368	0.000	0.030	0.050	0.120	0.200	0.000	0.000	160	0	0	0	160	263	0
7	AWR	Vermejo Conservancy District	F	0.556	0.000	0.030	0.050	0.050	0.130	0.000	0.000	5808	0	0	0	5808	3849	0
7	AWR	Vermejo Conservancy District	S	0.563	0.000	0.030	0.262	0.000	0.262	0.000	0.000	100	0	0	0	100	71	0
											River Basin Subtotals	21263	535	0	0	21798	19912	595
											County Totals	21263	535	0	0	21798	19912	595
9	AWR	Scattered	F	0.000	0.765	0.000	0.050	0.000	0.000	0.050	0.000	0	4110	0	0	4110	0	3301
9	AWR	Scattered	S	0.000	0.788	0.000	0.065	0.000	0.000	0.065	0.000	0	5610	0	0	5610	0	4708
											River Basin Subtotals	0	9720	0	0	9720	0	8009
9	P	Scattered	S	0.000	0.809	0.000	0.065	0.000	0.000	0.065	0.000	0	1350	0	0	1350	0	1163
											River Basin Subtotals	0	1350	0	0	1350	0	1163
9	TG	Scattered	D	0.000	0.984	0.000	0.000	0.000	0.000	0.000	0.000	0	190	0	0	190	0	183
9	TG	Scattered	F	0.000	0.935	0.000	0.050	0.000	0.000	0.050	0.000	0	21510	0	0	21510	0	21117
9	TG	Scattered	S	0.000	1.082	0.000	0.066	0.000	0.000	0.065	0.000	0	112850	0	0	112850	0	127411
											River Basin Subtotals	0	134350	0	0	134350	0	148711
											County Totals	0	145420	0	0	145420	0	157883
11	P	Fort Sumner Irrigation District	F	1.872	0.000	0.030	0.050	0.290	0.370	0.000	0.000	5219	0	0	0	5219	11240	0
11	P	Scattered	S	0.000	1.870	0.000	0.262	0.000	0.000	0.262	0.000	0	3420	0	0	3420	0	8071
											River Basin Subtotals	5219	3420	0	0	8639	11240	8071
											County Totals	5219	3420	0	0	8639	11240	8071

Key: CN=county number; RVB=river basin; T=type of irrigation system, i.e., drip (D), flood (F), sprinkler (S); CIRSW=consumptive irrigation requirement for acreage irrigated with surface water; CIRGW=consumptive irrigation requirement for acreage irrigated with ground water; IDFCL=incidental depletion factor, canals and laterals, from stream or reservoir to farm headgate; IDFOF=incidental depletion factor, on-farm; IDFBF=incidental depletion factor, below farm; IDFSW=sum of incidental depletion factors which apply to surface water withdrawals; IDFGWO=incidental depletion factor which applies to withdrawals of ground water only; IDFGWC=sum of incidental depletion factors which apply to the groundwater component of withdrawals where both surface and ground water are applied (combined water); ASWO=acreage irrigated with surface water only; AGWO=acreage irrigated with ground water only; ASWC=surfaced water component of acreage irrigated with combined water; AGWC=groundwater component of acreage irrigated with combined water; TAI=total irrigated acreage; TPDSW=total project depletion, surface water, TPDGW=total project depletion, ground water. Note that incidental depletion factors are expressed as a function of the CIR.

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CN	RVB	LOCALE	T	CIRSW	CIRGW	IDFCL	IDFOF	IDFBF	IDFSW	IDFGWO	IDFGWC	ASWO	AGWO	ASWC	AGWC	TAI	TPDSW	TPDGW
13	RG	EBID Only	D	2.088	0.000	0.000	0.000	0.000	0.000	0.000	0.000	300	0	0	0	300	626	0
13	RG	EBID Only	F	2.606	2.415	0.040	0.050	0.082	0.172	0.000	0.132	0	0	52403	17323	69726	160051	47357
13	RG	Hueco Basin	F	0.000	2.768	0.000	0.050	0.000	0.000	0.050	0.000	0	155	0	0	155	0	450
13	RG	Hueco Basin	S	0.000	2.433	0.000	0.262	0.000	0.000	0.262	0.000	0	25	0	0	25	0	77
13	RG	Inside EBID but exclusive of EBID	D	0.000	2.088	0.000	0.000	0.000	0.000	0.000	0.000	0	240	0	0	240	0	501
13	RG	Inside EBID but exclusive of EBID	S	0.000	3.025	0.000	0.283	0.000	0.000	0.283	0.000	0	1360	0	0	1360	0	5278
13	RG	Nutt-Hockett	F	0.000	1.672	0.000	0.050	0.000	0.000	0.050	0.000	0	10	0	0	10	0	17
13	RG	Nutt-Hockett	S	0.000	1.896	0.000	0.262	0.000	0.000	0.262	0.000	0	170	0	0	170	0	407
13	RG	Outside EBID	F	0.000	2.690	0.000	0.020	0.000	0.000	0.050	0.000	0	3844	0	0	3844	0	10857
13	RG	Outside EBID--Santa Teresa Sod Far	S	0.000	3.944	0.000	0.208	0.000	0.000	0.208	0.000	0	200	0	0	200	0	953
											River Basin Subtotals	300	6004	52403	17323	76030	160677	65897
											County Totals	300	6004	52403	17323	76030	160677	65897
15	P	Black River	F	2.781	2.781	0.030	0.050	0.050	0.130	0.050	0.100	47	538	292	292	1169	1058	2447
15	P	Carlsbad Basin Scattered	S	0.000	2.571	0.000	0.282	0.000	0.000	0.282	0.000	0	93	0	0	93	0	302
15	P	Carlsbad Basin--Scattered	F	2.742	2.742	0.030	0.050	0.050	0.130	0.050	0.100	326	1118	0	0	1444	1010	3219
15	P	Carlsbad Irrigation District	F	2.772	2.772	0.040	0.050	0.050	0.140	0.000	0.000	2503	0	12600	4358	19461	47727	12080
15	P	Rio Penasco	F	0.000	0.902	0.030	0.050	0.100	0.180	0.000	0.160	0	38	0	0	38	0	34
15	P	Roswell Basin South	F	0.000	1.690	0.000	0.050	0.000	0.000	0.050	0.000	0	9884	0	0	9884	0	17539
15	P	Roswell Basin South	S	0.000	2.000	0.000	0.243	0.000	0.000	0.243	0.000	0	22885	0	0	22885	0	56395

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CN	RVB	LOCALE	T	CIRSW	CIRGW	IDFCL	IDFOF	IDFBF	IDFSW	IDFGWO	IDFGWC	ASWO	AGWO	ASWC	AGWC	TAI	TPDSW	TPDGW
											River Basin Subtotals	2676	34356	12892	4650	54774	49795	92016
											County Totals	2676	34356	12892	4650	54774	49795	92016
17	LC	Gila River–Cliff Gila	F	1.888	1.888	0.020	0.050	0.080	0.150	0.130	0.130	1033	0	42	42	1117	2334	90
17	LC	Gila River–Red Rock	F	2.083	2.083	0.020	0.050	0.080	0.150	0.050	0.130	0	0	88	53	141	211	125
17	LC	Gila River–Upper Gila	F	0.907	0.000	0.020	0.050	0.080	0.150	0.000	0.000	63	0	0	0	63	66	0
17	LC	Lordsburg Valley	F	0.000	1.895	0.000	0.050	0.000	0.000	0.050	0.000	0	189	0	0	189	0	336
											River Basin Subtotals	1096	189	130	95	1510	2611	551
17	RG	Mimbres River	F	1.509	1.509	0.051	0.050	0.080	0.161	0.050	0.130	382	750	402	268	1802	1397	1645
17	RG	Mimbres River	S	0.000	1.482	0.000	0.262	0.000	0.000	0.262	0.000	0	110	0	0	110	0	206
											River Basin Subtotals	382	880	402	265	1912	1397	1851
											County Totals	1478	1049	532	383	3422	4008	2402
19	P	Anton Chico	F	1.297	0.000	0.030	0.050	0.118	0.198	0.000	0.000	2547	0	0	0	2547	3958	0
19	P	Colonias	F	0.000	1.415	0.000	0.050	0.000	0.000	0.050	0.000	0	223	0	0	223	0	331
19	P	Puerto de Luna	F	1.469	0.000	0.030	0.050	0.118	0.198	0.000	0.000	801	0	0	0	801	1058	0
19	P	Scattered	F	0.000	1.162	0.000	0.050	0.000	0.000	0.050	0.000	0	274	0	0	274	0	334
19	P	Scattered	S	0.000	1.450	0.000	0.262	0.000	0.000	0.262	0.000	0	15	0	0	15	0	27
											River Basin Subtotals	3148	512	0	0	3860	5016	692
											County Totals	3148	512	0	0	3860	5016	692
21	AWR	Scattered	F	0.000	1.032	0.000	0.050	0.000	0.000	0.050	0.000	0	20	0	0	20	0	22

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21	AWR	Scattered	S	0.000	1.031	0.000	0.338	0.000	0.000	0.338	0.000	0	2280	0	0	2280	0	3145
										River Basin Subtotals		0	2300	0	0	2300	0	3167
											County Totals	0	2300	0	0	2300	0	3167
23	LC	Animas Valley	F	0.000	1.982	0.000	0.050	0.000	0.000	0.050	0.000	0	4428	0	0	4428	0	9215
23	LC	Animas Valley	S	0.000	1.618	0.000	0.262	0.000	0.000	0.262	0.000	0	2168	0	0	2168	0	4430
23	LC	Gila River–Virden Valley	F	2.031	2.031	0.038	0.050	0.080	0.168	0.000	0.130	0	0	1657	703	2360	3931	1613
23	LC	Lordsburg Valley	F	0.000	2.001	0.000	0.050	0.000	0.000	0.050	0.000	0	1613	0	0	1613	0	3389
23	LC	Playas	F	0.000	2.908	0.000	0.050	0.000	0.000	0.050	0.000	0	375	0	0	375	0	1145
23	LC	San Simon Valley	F	0.000	1.111	0.000	0.050	0.000	0.000	0.050	0.000	0	366	0	0	366	0	427
23	LC	San Simon Valley	S	0.000	1.230	0.000	0.338	0.000	0.000	0.338	0.000	0	317	0	0	317	0	522
										River Basin Subtotals		0	9287	1657	703	11627	3931	20741
											County Totals	0	9267	1657	703	11627	3931	20741
25	P	Scattered	D	0.000	1.953	0.000	0.000	0.000	0.000	0.000	0.000	0	220	0	0	220	0	430
										River Basin Subtotals		0	220	0	0	220	0	430
25	TG	Scattered	D	0.000	2.082	0.000	0.050	0.000	0.000	0.050	0.000	0	605	0	0	605	0	1310
25	TG	Scattered	F	0.000	1.650	0.000	0.050	0.000	0.000	0.050	0.000	0	1000	0	0	1000	0	1732
25	TG	Scattered	S	0.000	1.399	0.000	0.262	0.000	0.000	0.262	0.000	0	57993	0	0	57993	0	102389
										River Basin Subtotals		0	59598	0	0	59598	0	105431
											County Totals	0	59618	0	0	59618	0	105861

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27	P	Rio Hondo & Tributaries	F	2.004	2.004	0.023	0.050	0.083	0.136	0.050	0.113	1455	608	1181	506	3748	6001	2404
27	P	Rio Hondo & Tributaries	S	0.000	2.059	0.000	0.262	0.000	0.000	0.262	0.000	0	100	0	0	100	0	280
27	P	Rio Hondo Tributaries	D	0.000	0.979	0.000	0.000	0.000	0.000	0.000	0.000	0	5	0	0	5	0	5
27	P	Scattered	F	0.000	0.979	0.023	0.050	0.050	0.123	0.050	0.000	0	2	0	0	2	0	2
											River Basin Subtotals	1455	713	1181	506	3855	6001	2671
27	RG	Carrizozo & Vicinity	D	0.000	1.384	0.000	0.000	0.000	0.000	0.000	0.000	0	30	0	0	30	0	42
27	RG	Carrizozo & Vicinity	F	0.000	1.859	0.000	0.050	0.000	0.000	0.050	0.000	0	130	0	0	130	0	254
27	RG	Carrizozo & Vicinity	S	0.000	2.033	0.000	0.262	0.000	0.000	0.262	0.000	0	70	0	0	70	0	180
											River Basin Subtotals	0	230	0	0	230	0	476
											County Totals	1455	943	1181	506	4085	6001	3147
29	RG	Mimbres Basin	S	0.000	2.160	0.000	0.262	0.000	0.000	0.262	0.000	0	783	0	0	783	0	2134
29	RG	Mimbres River	D	0.000	1.826	0.000	0.000	0.000	0.000	0.000	0.000	0	1879	0	0	1879	0	3055
29	RG	Mimbres River	F	1.713	1.713	0.038	0.050	0.080	0.168	0.050	0.130	200	21589	600	800	22989	1601	39956
29	RG	Mimbres River–Floodwater Area	F	0.812	0.000	0.000	0.050	0.000	0.050	0.000	0.000	10350	0	0	0	10350	8824	0
29	RG	Nutt-Hockett	D	0.000	1.530	0.000	0.000	0.000	0.000	0.000	0.000	0	1361	0	0	1361	0	2082
29	RG	Nutt-Hockett	F	0.000	1.854	0.000	0.050	0.000	0.000	0.050	0.000	0	1735	0	0	1735	0	3013
29	RG	Nutt-Hockett	S	0.000	1.854	0.000	0.262	0.000	0.000	0.262	0.000	0	3225	0	0	3225	0	7546
											River Basin Subtotals	10550	30552	600	600	42302	10425	57786
											County Totals	10550	30552	600	600	42302	10425	57786

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31	LC	Zuni & Ramah	F	0.160	0.000	0.030	0.050	0.080	0.140	0.000	0.000	3242	0	0	0	3242	554	0
											River Basin Subtotals	3242	0	0	0	3242	554	0
31	RG	Scattered	F	1.562	0.000	0.030	0.050	0.050	0.130	0.000	0.000	150	0	0	0	150	265	0
											River Basin Subtotals	150	0	0	0	150	265	0
31	UC	Scattered	F	0.166	0.000	0.025	0.050	0.060	0.135	0.000	0.000	1715	0	0	0	1715	323	0
											River Basin Subtotals	1715	0	0	0	1715	323	0
											County Totals	5107	0	0	0	5107	1142	0
33	AWR	Scattered	D	0.000	0.762	0.000	0.000	0.000	0.000	0.000	0.000	0	50	0	0	50	0	38
33	AWR	Scattered	F	0.847	0.000	0.034	0.050	0.100	0.184	0.000	0.000	13730	0	0	0	13730	13769	0
33	AWR	Scattered	S	1.001	0.000	0.034	0.262	0.000	0.296	0.000	0.000	1100	0	0	0	1100	1427	0
											River Basin Subtotals	14830	50	0	0	14880	15196	38
											County Totals	14830	50	0	0	14880	15196	38
35	P	Rio Penasco	F	1.133	0.000	0.030	0.050	0.100	0.180	0.000	0.000	625	0	0	0	625	836	0
											River Basin Subtotals	625	0	0	0	625	836	0
35	RG	Salt Basin	F	0.000	2.178	0.000	0.050	0.000	0.000	0.050	0.000	0	397	0	0	397	0	906
35	RG	Salt Basin	S	0.000	2.192	0.000	0.262	0.000	0.000	0.262	0.000	0	1730	0	0	1730	0	4786
35	RG	Tularosa Basin	D	0.000	2.584	0.000	0.000	0.000	0.000	0.000	0.000	0	1821	0	0	1821	0	4705
35	RG	Tularosa Basin	F	2.529	2.529	0.030	0.050	0.075	0.155	0.000	0.125	250	0	1071	357	1678	3559	1016
35	RG	Tularosa Basin	S	0.000	2.817	0.000	0.262	0.000	0.000	0.262	0.000	0	2230	0	0	2230	0	7926

Key: CN=county number; RVB=river basin; T=type of irrigation system, i.e., drip (D), flood (F), sprinkler (S); CIRSW=consumptive irrigation requirement for acreage irrigated with surface water; CIRGW=consumptive irrigation requirement for acreage irrigated with ground water; IDFCL=incidental depletion factor, canals and laterals, from stream or reservoir to farm headgate; IDFOF=incidental depletion factor, on-farm; IDFBF=incidental depletion factor, below farm; IDFSW=sum of incidental depletion factors which apply to surface water withdrawals; IDFGWO=incidental depletion factor which applies to withdrawals of ground water only; IDFGWC=sum of incidental depletion factors which apply to the groundwater component of withdrawals where both surface and ground water are applied (combined water); ASWO=acreage irrigated with surface water only; AGWO=acreage irrigated with ground water only; ASWC=surfaced water component of acreage irrigated with combined water; AGWC=groundwater component of acreage irrigated with combined water; TAI=total irrigated acreage; TPDSW=total project depletion, surface water, TPDGW=total project depletion, ground water. Note that incidental depletion factors are expressed as a function of the CIR.

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										River Basin Subtotals		250	6178	1071	357	7856	3859	19343
										County Totals		675	6178	1071	357	8481	4695	19343
37	AWR	Arch Hurley Conservancy District	F	0.861	0.000	0.084	0.050	0.099	0.213	0.000	0.000	27098	0	0	0	27096	28299	0
37	AWR	Arch Hurley Conservancy District	S	0.848	0.000	0.084	0.336	0.000	0.402	0.000	0.000	5561	0	0	0	5561	6813	0
37	AWR	Inside AHCD but exclusive of AHCD	D	0.000	1.750	0.000	0.000	0.000	0.000	0.000	0.000	0	17	0	0	17	0	30
37	AWR	Outside AHCD	S	0.000	1.247	0.000	0.338	0.000	0.000	0.338	0.000	0	883	0	0	883	0	1473
										River Basin Subtotals		32657	900	0	0	33557	34912	1503
37	P	House & Vicinity	F	0.000	1.029	0.000	0.050	0.000	0.000	0.050	0.000	0	310	0	0	310	0	335
37	P	House & Vicinity	S	0.000	1.172	0.000	0.338	0.000	0.000	0.338	0.000	0	2350	0	0	2350	0	3685
										River Basin Subtotals		0	2660	0	0	2660	0	4020
										County Totals		32657	3560	0	0	36217	34912	5523
39	RG	Rio Chama	F	1.072	1.072	0.038	0.050	0.097	0.185	0.050	0.147	21030	500	210	70	21810	26982	649
39	RG	Santa Cruz & Vicinity	F	1.153	0.000	0.029	0.050	0.100	0.179	0.000	0.000	4260	0	0	0	4260	5791	0
39	RG	Truchas & Vicinity	F	1.132	0.000	0.013	0.050	0.050	0.113	0.000	0.000	2682	0	0	0	2682	3631	0
39	RG	Velarde & Vicinity	D	0.000	0.868	0.000	0.000	0.000	0.000	0.000	0.000	0	35	0	0	35	0	30
39	RG	Velarde & Vicinity	F	1.342	0.000	0.038	0.050	0.080	0.168	0.000	0.000	2460	0	0	0	2460	3856	0
										River Basin Subtotals		30632	535	210	70	31447	40260	679
39	UC	Dulce & Vicinity	F	0.748	0.000	0.038	0.050	0.097	0.185	0.000	0.000	400	0	0	0	400	355	0
										River Basin Subtotals		400	0	0	0	400	355	0

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											County Totals	31032	535	210	70	31847	40615	679
41	P	Scattered	S	0.000	1.128	0.000	0.243	0.000	0.000	0.243	0.000	0	450	0	0	450	0	631
											River Basin Subtotals	0	450	0	0	450	0	631
41	TG	Causey-Lingo	F	0.000	0.989	0.000	0.050	0.000	0.000	0.050	0.000	0	730	0	0	730	0	758
41	TG	Causey-Lingo	S	0.000	0.986	0.000	0.243	0.000	0.000	0.243	0.000	0	2750	0	0	2750	0	3367
41	TG	Portales Basin	D	0.000	1.127	0.000	0.000	0.000	0.000	0.000	0.000	0	123	0	0	123	0	139
41	TG	Portales Basin	F	0.000	1.094	0.000	0.050	0.000	0.000	0.050	0.000	0	3901	0	0	3901	0	4481
41	TG	Portales Basin	S	0.000	1.198	0.000	0.243	0.000	0.000	0.243	0.000	0	79388	0	0	79388	0	118020
											River Basin Subtotals	0	86892	0	0	86892	0	128765
											County Totals	0	87342	0	0	87342	0	127396
43	RG	Cuba & Vicinity	F	0.978	0.978	0.018	0.050	0.060	0.128	0.050	0.000	1585	70	0	0	1655	1749	72
43	RG	Jemez Basin	F	1.278	0.000	0.038	0.050	0.060	0.148	0.000	0.000	1570	0	0	0	1570	2303	0
43	RG	MRGCD only	F	1.985	1.965	0.030	0.050	0.098	0.178	0.000	0.148	5410	0	499	166	5075	13817	378
43	RG	Outside MRGCD (Dixon Apples)	S	1.591	0.000	0.000	0.283	0.000	0.283	0.000	0.000	50	0	0	0	50	102	0
											River Basin Subtotals	8615	70	499	166	8350	17971	450
											County Totals	8615	70	499	166	8350	17971	450
45	UC	Animas River	F	1.808	0.000	0.044	0.050	0.090	0.184	0.000	0.000	4000	0	0	0	4000	8563	0
45	UC	Animas River	S	2.072	0.000	0.044	0.262	0.000	0.306	0.000	0.000	978	0	0	0	978	2646	0
45	UC	Chaco River	F	1.791	0.000	0.044	0.050	0.060	0.154	0.000	0.000	306	0	0	0	306	832	0

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45	UC	Hammond Irrigation District	F	2.068	0.000	0.044	0.050	0.100	0.194	0.000	0.000	141	0	0	0	141	352	0
45	UC	Hammond Irrigation District	S	1.963	0.000	0.044	0.262	0.000	0.306	0.000	0.000	3157	0	0	0	3157	8094	0
45	UC	La Plata River	F	1.572	0.000	0.044	0.050	0.060	0.154	0.000	0.000	2055	0	0	0	2055	3728	0
45	UC	La Plata River	S	1.482	0.000	0.044	0.262	0.000	0.306	0.000	0.000	612	0	0	0	612	1185	0
45	UC	Navajo Indian Irrigation Project	S	1.344	0.000	0.020	0.808	0.000	0.828	0.000	0.000	49745	0	0	0	49745	122215	0
45	UC	Navajo--Colorado River Storage Prj.	F	1.803	0.000	0.044	0.050	0.090	0.184	0.000	0.000	163	0	0	0	163	367	0
45	UC	Pine River Irrigation District	F	0.758	0.000	0.044	0.050	0.090	0.184	0.000	0.000	411	0	0	0	411	369	0
45	UC	San Juan River	F	1.679	0.000	0.044	0.050	0.100	0.194	0.000	0.000	9630	0	0	0	9630	19308	0
45	UC	San Juan River	S	1.884	0.000	0.044	0.262	0.000	0.306	0.000	0.000	1458	0	0	0	1458	3587	0
											River Basin Subtotals	72656	0	0	0	72656	171044	0
											County Totals	72656	0	0	0	72656	171044	0
47	AWR	Canadian River	F	1.234	0.000	0.034	0.050	0.100	0.194	0.000	0.000	1065	0	0	0	1065	1559	0
47	AWR	Sapello River	F	1.528	0.000	0.034	0.050	0.106	0.190	0.000	0.000	1610	0	0	0	1610	2927	0
											River Basin Subtotals	2675	0	0	0	2675	4486	0
47	P	Scattered	F	0.680	0.000	0.034	0.050	0.106	0.190	0.000	0.000	3447	0	0	0	3447	3610	0
47	P	Storrie Irrigation Project	F	1.707	0.000	0.034	0.050	0.106	0.190	0.000	0.000	4353	0	0	0	4353	8842	0
47	P	Storrie Irrigation Project	S	1.682	0.000	0.000	0.262	0.000	0.262	0.000	0.000	670	0	0	0	670	1422	0
											River Basin Subtotals	8470	0	0	0	8470	13874	0
											County Totals	11145	0	0	0	11145	18370	0

Key: CN=county number; RVB=river basin; T=type of irrigation system, i.e., drip (D), flood (F), sprinkler (S); CIRSW=consumptive irrigation requirement for acreage irrigated with surface water; CIRGW=consumptive irrigation requirement for acreage irrigated with ground water; IDFCL=incidental depletion factor, canals and laterals, from stream or reservoir to farm headgate; IDFOF=incidental depletion factor, on-farm; IDFBF=incidental depletion factor, below farm; IDFSW=sum of incidental depletion factors which apply to surface water withdrawals; IDFGWO=incidental depletion factor which applies to withdrawals of ground water only; IDFGWC=sum of incidental depletion factors which apply to the groundwater component of withdrawals where both surface and ground water are applied (combined water); ASWO=acreage irrigated with surface water only; AGWO=acreage irrigated with ground water only; ASWC=surfaced water component of acreage irrigated with combined water; AGWC=groundwater component of acreage irrigated with combined water; TAI=total irrigated acreage; TPDSW=total project depletion, surface water, TPDGW=total project depletion, ground water. Note that incidental depletion factors are expressed as a function of the CIR.

Table 9. Irrigated Agriculture. Depletions in acre-feet, in New Mexico counties, 1999. Data compiled by A. A. Lucero, New Mexico Office of the State Engineer.

CN	RVB	LOCALE	T	CIRSW	CIRGW	IDFCL	IDFOF	IDFBF	IDFSW	IDFGWO	IDFGWC	ASWO	AGWO	ASWC	AGWC	TAI	TPDSW	TPDGW
49	RG	Estancia Basin	D	0.000	1.876	0.000	0.000	0.000	0.000	0.000	0.000	0	40	0	0	40	0	75
49	RG	Estancia Basin	F	0.000	1.022	0.000	0.050	0.000	0.000	0.050	0.000	0	3866	0	0	3866	0	4149
49	RG	Estancia Basin	S	0.000	1.164	0.000	0.282	0.000	0.000	0.252	0.000	0	5197	0	0	5197	0	7634
49	RG	Pojoaque Valley	D	0.000	1.079	0.000	0.000	0.000	0.000	0.000	0.000	0	20	0	0	20	0	22
49	RG	Pojoaque Valley Irrigation District	F	0.910	0.910	0.030	0.050	0.060	0.140	0.000	0.110	1917	0	280	100	2297	2279	101
49	RG	Santa Cruz & Vicinity	F	0.740	0.000	0.029	0.050	0.100	0.179	0.000	0.000	4600	0	0	0	4600	4013	0
49	RG	Santa Fe & Vicinity	F	1.550	1.550	0.029	0.050	0.100	0.179	0.000	0.150	595	20	110	110	835	1288	227
											River Basin Subtotals	7112	9143	390	210	16855	7580	12208
											County Totals	7112	9143	390	210	16855	7580	12208
51	RG	Above Elephant Butte--Alamosa Creek	F	1.990	1.990	0.040	0.050	0.082	0.172	0.050	0.132	300	631	742	247	1920	2430	1875
51	RG	Above Elephant Butte--Engle	D	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0	0	0	0
51	RG	EBID only	F	2.102	2.101	0.040	0.050	0.082	0.172	0.000	0.132	0	0	3077	586	3663	7580	1394
51	RG	Lake Valley & Vicinity	F	0.000	1.871	0.000	0.050	0.000	0.000	0.050	0.000	0	131	0	0	131	0	257
51	RG	Los Animas Creek and others	F	2.102	2.102	0.040	0.050	0.082	0.172	0.050	0.132	200	656	230	80	1066	1059	1418
51	RG	Nutt-Hockett	F	0.000	1.838	0.000	0.050	0.000	0.000	0.050	0.000	0	180	0	0	180	0	347
51	RG	Truth or Consequences	F	0.000	2.102	0.000	0.050	0.000	0.000	0.050	0.000	0	842	0	0	842	0	1858
											River Basin Subtotals	500	2340	4049	913	7802	11069	7149
											County Totals	500	2340	4049	913	7802	11069	7149
53	RG	Bosque del Apache	F	2.282	0.000	0.030	0.050	0.050	0.130	0.000	0.000	2304	0	0	0	2304	5941	0

Key: CN=county number; RVB=river basin; T=type of irrigation system, i.e., drip (D), flood (F), sprinkler (S); CIRSW=consumptive irrigation requirement for acreage irrigated with surface water; CIRGW=consumptive irrigation requirement for acreage irrigated with ground water; IDFCL=incidental depletion factor, canals and laterals, from stream or reservoir to farm headgate; IDFOF=incidental depletion factor, on-farm; IDFBF=incidental depletion factor, below farm; IDFSW=sum of incidental depletion factors which apply to surface water withdrawals; IDFGWO=incidental depletion factor which applies to withdrawals of ground water only; IDFGWC=sum of incidental depletion factors which apply to the groundwater component of withdrawals where both surface and ground water are applied (combined water); ASWO=acreage irrigated with surface water only; AGWO=acreage irrigated with ground water only; ASWC=surfaced water component of acreage irrigated with combined water; AGWC=groundwater component of acreage irrigated with combined water; TAI=total irrigated acreage; TPDSW=total project depletion, surface water, TPDGW=total project depletion, ground water. Note that incidental depletion factors are expressed as a function of the CIR

Table 9. Irrigated Agriculture. Depletions in acre-feet, in New Mexico counties, 1989. Data compiled by A. A. Lucero, New Mexico Office of the State Engineer.

CN	RVB	LOCALE	T	CIRSW	CIRGW	IDFCL	IDFOF	IDFBF	IDFSW	IDFGWO	IDFGWC	ASWO	AGWO	ASWC	AGWC	TAI	TPDSW	TPDGW
53	RG	La Jolla	F	2.478	2.478	0.030	0.050	0.068	0.148	0.050	0.118	30	40	154	103	327	523	389
53	RG	MRGCD only	F	2.668	2.668	0.034	0.050	0.068	0.152	0.000	0.118	3073	0	7972	5315	16360	33947	15854
53	RG	Outside MRGCD	D	0.000	1.284	0.000	0.000	0.000	0.000	0.000	0.000	0	80	0	0	80	0	103
53	RG	San Augustine Plains	S	0.000	1.658	0.000	0.262	0.000	0.000	0.262	0.000	0	1120	0	0	1120	0	2623
											River Basin Subtotals	5407	1240	8126	5418	20191	40411	18969
											County Totals	5407	1240	8126	5418	20191	40411	18969
55	RG	Cerro-Questa	F	1.109	0.000	0.040	0.050	0.050	0.140	0.000	0.000	4245	0	0	0	4245	5367	0
55	RG	Cerro-Questa	S	0.000	1.152	0.000	0.262	0.000	0.000	0.262	0.000	0	800	0	0	800	0	895
55	RG	Costilla	F	0.862	0.000	0.040	0.050	0.050	0.140	0.000	0.000	5515	0	0	0	5515	4162	0
55	RG	Costilla	S	0.000	1.226	0.000	0.262	0.000	0.000	0.262	0.000	0	100	0	0	100	0	155
55	RG	Embudo & Vicinity	F	1.160	0.000	0.022	0.050	0.080	0.152	0.000	0.000	5020	0	0	0	5020	6708	0
55	RG	Embudo & Vicinity	S	0.000	1.212	0.000	0.262	0.000	0.000	0.262	0.000	0	250	0	0	250	0	382
55	RG	Pilar & Ojo Caliente	F	1.159	0.000	0.038	0.050	0.050	0.138	0.000	0.000	80	0	0	0	80	106	0
55	RG	Taos & Vicinity	F	1.338	1.338	0.022	0.050	0.080	0.152	0.050	0.130	13650	40	150	50	13890	21271	132
55	RG	Taos & Vicinity	S	0.000	1.419	0.000	0.262	0.000	0.000	0.262	0.000	0	80	0	0	80	0	90
											River Basin Subtotals	28510	1040	150	50	29750	37614	1654
											County Totals	28510	1040	150	50	29750	37614	1654
57	RG	Estancia Basin	D	0.000	0.709	0.000	0.000	0.000	0.000	0.000	0.000	0	30	0	0	30	0	21
57	RG	Estancia Basin	F	0.000	1.368	0.000	0.050	0.000	0.000	0.050	0.000	0	3877	0	0	3877	0	5561

Key: CN=county number; RVB=river basin; T=type of irrigation system, i.e., drip (D), flood (F), sprinkler (S); CIRSW=consumptive irrigation requirement for acreage irrigated with surface water; CIRGW=consumptive irrigation requirement for acreage irrigated with ground water; IDFCL=incidental depletion factor, canals and laterals, from stream or reservoir to farm headgate; IDFOF=incidental depletion factor, on-farm; IDFBF=incidental depletion factor, below farm; IDFSW=sum of incidental depletion factors which apply to surface water withdrawals; IDFGWO=incidental depletion factor which applies to withdrawals of ground water only; IDFGWC=sum of incidental depletion factors which apply to the groundwater component of withdrawals where both surface and ground water are applied (combined water); ASWO=acreage irrigated with surface water only; AGWO=acreage irrigated with ground water only; ASWC=surfaced water component of acreage irrigated with combined water; AGWC=groundwater component of acreage irrigated with combined water; TAI=total irrigated acreage; TPDSW=total project depletion, surface water, TPDGW=total project depletion, ground water. Note that incidental depletion factors are expressed as a function of the CIR.

Table 9. Irrigated Agriculture. Depletions in acre-feet, in New Mexico counties, 1999. Data compiled by A. A. Lucero, New Mexico Office of the State Engineer.

CN	RVB	LOCALE	T	CIRSW	CIRGW	IDFCL	IDFOF	IDFBF	IDFSW	IDFGWO	IDFGWC	ASWO	AGWO	ASWC	AGWC	TAI	TPDSW	TPDGW
57	RG	Estancia Basin	S	0.000	1.210	0.000	0.262	0.000	0.000	0.262	0.000	0	13299	0	0	13299	0	20308
											River Basin Subtotals	0	17206	0	0	17206	0	25890
											County Totals	0	17206	0	0	17206	0	25890
59	AWR	Clayton & Vicinity	D	0.000	2.168	0.000	0.000	0.000	0.000	0.000	0.000	0	15	0	0	15	0	33
59	AWR	Clayton & Vicinity	F	0.000	1.106	0.000	0.050	0.000	0.000	0.050	0.000	0	472	0	0	472	0	548
59	AWR	Clayton & Vicinity	S	0.000	0.922	0.000	0.338	0.000	0.000	0.338	0.000	0	50233	0	0	50233	0	61989
59	AWR	Dry Cimarron	F	1.253	1.253	0.043	0.050	0.100	0.193	0.050	0.150	1595	800	190	190	2575	2668	1063
59	AWR	Dry Cimarron	S	0.000	1.008	0.000	0.262	0.000	0.000	0.262	0.000	0	2000	0	0	2000	0	2544
59	AWR	Tramperos Creek	F	0.822	0.822	0.040	0.050	0.040	0.130	0.050	0.000	270	80	0	0	350	251	89
											River Basin Subtotals	1865	53400	190	190	55645	2919	66226
											County Totals	1865	53400	190	190	55645	2919	66226
61	RG	Inside MRGCD but exclusive of CO	D	0.000	1.126	0.000	0.000	0.000	0.000	0.000	0.000	0	35	0	0	35	0	39
61	RG	MRGCD only	F	2.028	2.028	0.060	0.050	0.029	0.139	0.000	0.079	13838	0	5220	1740	20798	44022	3807
											River Basin Subtotals	13838	35	5220	1740	20833	44022	3846
											County Totals	13838	35	5220	1740	20833	44022	3846
											State Totals	292043	567858	96114	42978	998793	751475	1021476

Key: CN=county number; RVB=river basin; T=type of irrigation system, i.e., drip (D), flood (F), sprinkler (S); CIRSW=consumptive irrigation requirement for acreage irrigated with surface water; CIRGW=consumptive irrigation requirement for acreage irrigated with ground water; IDFCL=incidental depletion factor, canals and laterals, from stream or reservoir to farm headgate; IDFOF=incidental depletion factor, on-farm; IDFBF=incidental depletion factor, below farm; IDFSW=sum of incidental depletion factors which apply to surface water withdrawals; IDFGWO=incidental depletion factor which applies to withdrawals of ground water only; IDFGWC=sum of incidental depletion factors which apply to the groundwater component of withdrawals where both surface and ground water are applied (combined water); ASWO=acreage irrigated with surface water only; AGWO=acreage irrigated with ground water only; ASWC=surfaced water component of acreage irrigated with combined water; AGWC=groundwater component of acreage irrigated with combined water; TAI=total irrigated acreage; TPDSW=total project depletion, surface water, TPDGW=total project depletion, ground water. Note that incidental depletion factors are expressed as a function of the CIR.

Table 10. Irrigated Agriculture. Summary of acreage irrigated, withdrawals, conveyance losses, and depletions (acre-feet) in New Mexico river basins, 1999.

RIVER BASIN	T	ASWO	AGWO	ASWC	AGWC	TASW	TAGW	TAI	TFWSW	CLSW	TPWSW	TPWGW	TPDSW	TPDGW
Arkansas-White-Red	D	0	82	0	0	0	82	82	0	0	0	119	0	101
Arkansas-White-Red	F	65929	5282	190	190	66119	5472	71591	101283	83841	185122	8545	68346	5003
Arkansas-White-Red	S	7361	61541	0	0	7361	61541	68902	10203	11264	21467	86107	9089	74434
Basin Totals		73290	66905	190	190	73480	67095	140575	111486	95105	206589	94771	77435	79538
Texas Gulf	D	0	918	0	0	0	918	918	0	0	0	1846	0	1632
Texas Gulf	F	0	27141	0	0	0	27141	27141	0	0	0	44836	0	28088
Texas Gulf	S	0	252781	0	0	0	252781	252781	0	0	0	413872	0	351187
Basin Totals		0	280840	0	0	0	280840	280840	0	0	0	460554	0	380907
Pecos	D	0	265	0	0	0	265	265	163151	71919	235073	618	0	526
Pecos	F	23215	84743	18078	13844	41293	98587	139880	1734	0	1734	322575	97217	202086
Pecos	S	670	49246	0	0	670	49246	49916	0	0	0	136900	1422	118541
Basin Totals		23885	134254	18078	13844	41963	148098	190061	164885	71919	236807	460093	98639	321153
Rio Grande	D	300	5821	0	0	300	5821	6121	737	599	1336	12882	626	10949
Rio Grande	F	113080	39813	76059	28146	189119	67959	257078	631293	494213	1125506	238333	392150	146001
Rio Grande	S	50	30519	0	0	50	30519	30569	133	0	133	75701	102	61582
Basin Totals		113410	76153	76059	28146	189469	104299	293768	632163	494812	1126975	326916	392878	218532
Upper Colorado	D	0	0	0	0	0	0	0	0	0	0	0	0	0
Upper Colorado	F	18821	0	0	0	18821	0	18821	52533	22376	74909	0	33995	0
Upper Colorado	S	55950	0	0	0	55950	0	55950	132520	15265	147785	0	137727	0
Basin Totals		74771	0	0	0	74771	0	74771	185053	37641	222694	0	171722	0
Lower Colorado	D	0	50	0	0	0	50	50	0	0	0	64	0	54
Lower Colorado	F	6687	6971	1787	798	8474	7769	16243	19719	34573	54292	28199	10801	16340
Lower Colorado	S	0	2485	0	0	0	2485	2485	0	0	0	6000	0	4952
Basin Totals		6687	9506	1787	798	8474	10304	18778	19719	34573	54292	34263	10801	21346
State Totals		292043	567658	96114	42978	388157	610636	998793	1113306	734050	1847357	1376597	751475	1021476

Key: T=type of irrigation system, i.e., drip (D), flood (F), or sprinkler (S); ASWO=acreage irrigated with surface water only; AGWO=acreage irrigated with ground water only; ASWC=surface water component of acreage irrigated with combined water, i.e., both surface and ground water; AGWC=ground water component of acreage irrigated with combined water; TASW=total acreage irrigated with surface water; TAGW=total acreage irrigated with ground water; TAI=total acreage irrigated; TFWSW=total farm withdrawal, surface water; CLSW=surface water conveyance losses from stream or reservoir to farm headgate; TPWSW=total project withdrawal, surface water; TPWGW=total project withdrawal, ground water; TPDSW=total project depletion, surface water; TPDGW=total project depletion, ground water.

Table 11. Irrigated acreage and sources of irrigation water in New Mexico counties, 1999.

COUNTY	ASWO	AGWO	ASWC	AGWC	TAI
Bernalillo	5556	250	2403	801	9010
Catron	1837	100	0	0	1937
Chaves	2092	90573	4005	8688	105358
Cibola	2120	420	536	230	3306
Colfax	21263	535	0	0	21798
Curry	0	145420	0	0	145420
De Baca	5219	3420	0	0	8639
Dona Ana	300	6004	52403	17323	76030
Eddy	2876	34356	12892	4650	54774
Grant	1478	1049	532	363	3422
Guadalupe	3148	512	0	0	3660
Harding	0	2300	0	0	2300
Hidalgo	0	9267	1657	703	11627
Lea	0	59818	0	0	59818
Lincoln	1455	943	1181	506	4085
Los Alamos	0	0	0	0	0
Luna	10550	30552	600	600	42302
McKinley	5107	0	0	0	5107
Mora	14830	50	0	0	14880
Otero	875	6178	1071	357	8481
Quay	32657	3560	0	0	36217
Rio Arriba	31032	535	210	70	31847
Roosevelt	0	87342	0	0	87342
Sandoval	8615	70	499	166	9350
San Juan	72656	0	0	0	72656
San Miguel	11145	0	0	0	11145
Santa Fe	7112	9143	390	210	16855
Sierra	500	2340	4049	913	7802
Socorro	5407	1240	8126	5418	20191
Taos	28510	1040	150	50	29750
Torrance	0	17206	0	0	17206
Union	1865	53400	190	190	55645
Valencia	13838	35	5220	1740	20833
Total	292043	567658	96114	42978	998793

Key: ASWO=acreage irrigated with surface water only; AGWO= acreage irrigated with ground water only; ASWC=surface water component of acreage irrigated with combined water; AGWC= groundwater component of acreage irrigated with combined water; TAI=total acreage irrigated.

Table 12. Acreage irrigated by drip, flood, and sprinkler application methods and sources of irrigation water in New Mexico counties, 1999.

COUNTY	DASW	DAGW	TDA	FASW	FAGW	TFA	SASW	SAGW	TSA	TAI
Bernalillo	0	230	230	7959	821	8780	0	0	0	9010
Catron	0	0	0	1837	100	1937	0	0	0	1937
Chaves	0	40	40	6097	80438	86535	0	18783	18783	105358
Cibola	0	70	70	2656	580	3236	0	0	0	3306
Colfax	0	0	0	20563	0	20563	700	535	1235	21798
Curry	0	190	190	0	25620	25620	0	119610	119610	145420
De Baca	0	0	0	5219	0	5219	0	3420	3420	8639
Dona Ana	300	240	540	52403	21332	73735	0	1755	1755	76030
Eddy	0	0	0	15768	16228	31996	0	22778	22778	54774
Grant	0	0	0	2010	1302	3312	0	110	110	3422
Guadalupe	0	0	0	3148	497	3645	0	15	15	3660
Harding	0	0	0	0	20	20	0	2280	2280	2300
Hidalgo	0	0	0	1657	7485	9142	0	2485	2485	11627
Lea	0	825	825	0	1000	1000	0	57993	57993	59818
Lincoln	0	35	35	2636	1244	3880	0	170	170	4085
Los Alamos	0	0	0	0	0	0	0	0	0	0
Luna	0	3240	3240	11150	23904	35054	0	4008	4008	42302
McKinley	0	0	0	5107	0	5107	0	0	0	5107
Mora	0	50	50	13730	0	13730	1100	0	1100	14880
Otero	0	1821	1821	1946	754	2700	0	3960	3960	8481
Quay	0	17	17	27096	310	27406	5561	3233	8794	36217
Rio Arriba	0	35	35	31242	570	31812	0	0	0	31847
Roosevelt	0	123	123	0	4631	4631	0	82588	82588	87342
Sandoval	0	0	0	9064	236	9300	50	0	50	9350
San Juan	0	0	0	16706	0	16706	55950	0	55950	72656
San Miguel	0	0	0	10475	0	10475	670	0	670	11145
Santa Fe	0	60	60	7502	4096	11598	0	5197	5197	16855
Sierra	0	0	0	4549	3253	7802	0	0	0	7802
Socorro	0	80	80	13533	5458	18991	0	1120	1120	20191
Taos	0	0	0	28660	90	28750	0	1000	1000	29750
Torrance	0	30	30	0	3877	3877	0	13299	13299	17206
Union	0	15	15	2055	1342	3397	0	52233	52233	55645
Valencia	0	35	35	19058	1740	20798	0	0	0	20833
Total	300	7136	7436	323826	206928	530754	64031	396572	460603	998793

Key: DASW=drip irrigated acreage supplied by surface water; DAGW=drip irrigated acreage supplied by ground water; TDA=total drip irrigated acreage; FASW=flood irrigated acreage supplied by surface water; FAGW=flood irrigated acreage supplied by ground water; TFA=total flood irrigated acreage; SASW=sprinkler irrigated acreage supplied by surface water; SAGW=sprinkler irrigated acreage supplied by ground water; TSA=total sprinkler irrigated acreage; TAI=total acres irrigated.

Table 13. Acreage irrigated by drip, flood, and sprinkler application methods and sources of irrigation water in New Mexico river basins, 1999.

RIVER BASIN	DASW	DAGW	TDA	FASW	FAGW	TFA	SASW	SAGW	TSA	TAI
Arkansas-White-Red	0	82	82	66119	5472	71591	7361	61541	68902	140575
Texas Gulf	0	918	918	0	27141	27141	0	252781	252781	280840
Pecos	0	265	265	41293	98587	139880	670	49246	49916	190061
Rio Grande	300	5821	6121	189119	67959	257078	50	30519	30569	293768
Upper Colorado	0	0	0	18821	0	18821	55950	0	55950	74771
Lower Colorado	0	50	50	8474	7769	16243	0	2485	2485	18778
State Totals	300	7136	7436	323826	206928	530754	64031	396572	460603	998793

Key:DASW=drip irrigated acreage supplied by surface water; DAGW=drip irrigated acreage supplied by ground water; TDA=total drip irrigated acreage; FASW=flood irrigated acreage supplied by surface water; FAGW=flood irrigated acreage supplied by ground water; TFA=total flood irrigated acreage; SASW=sprinkler irrigated acreage supplied by surface water; SAGW=sprinkler irrigated acreage supplied by ground water; TSA=total sprinkler irrigated acreage; TAI=total acres irrigated.

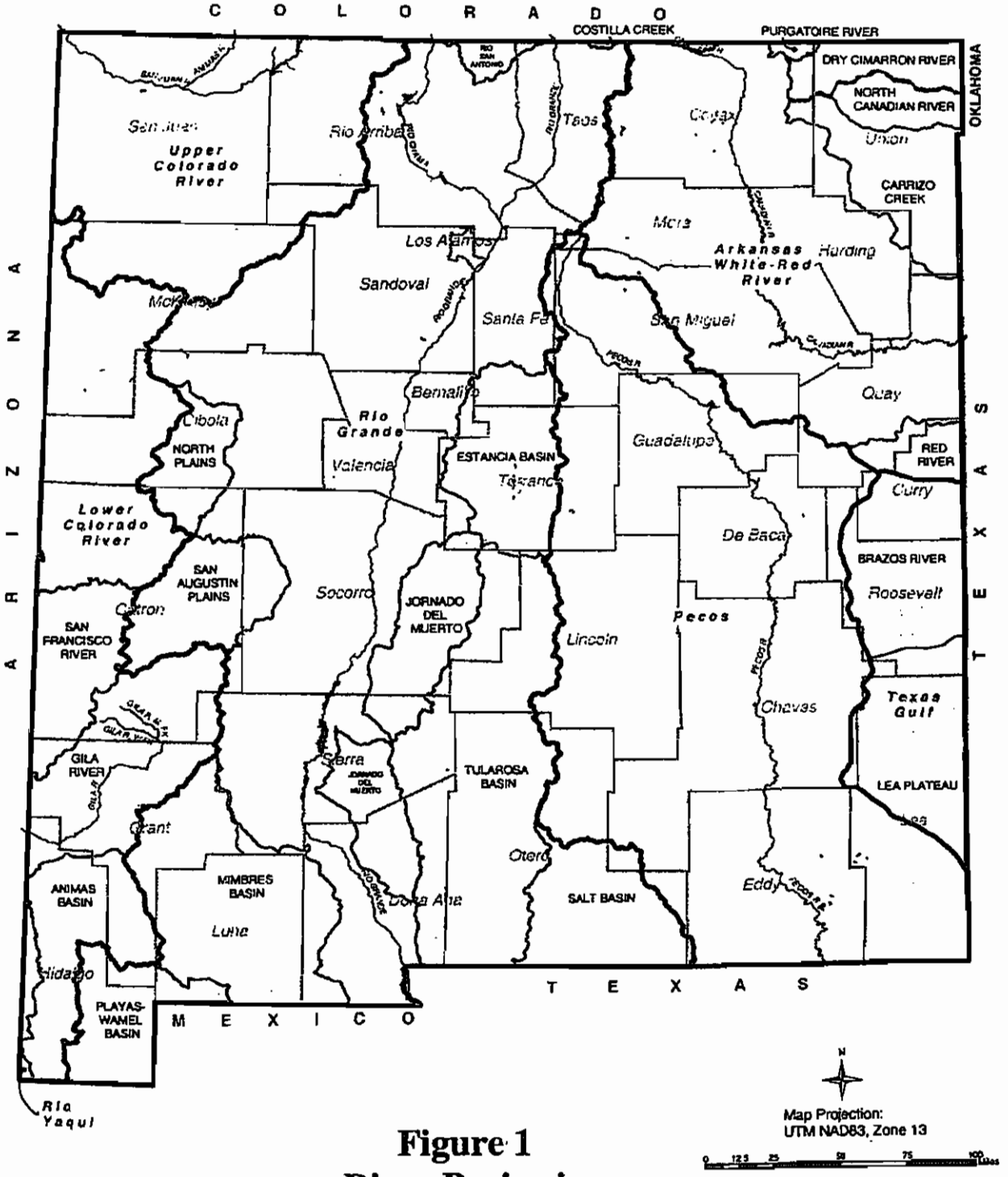
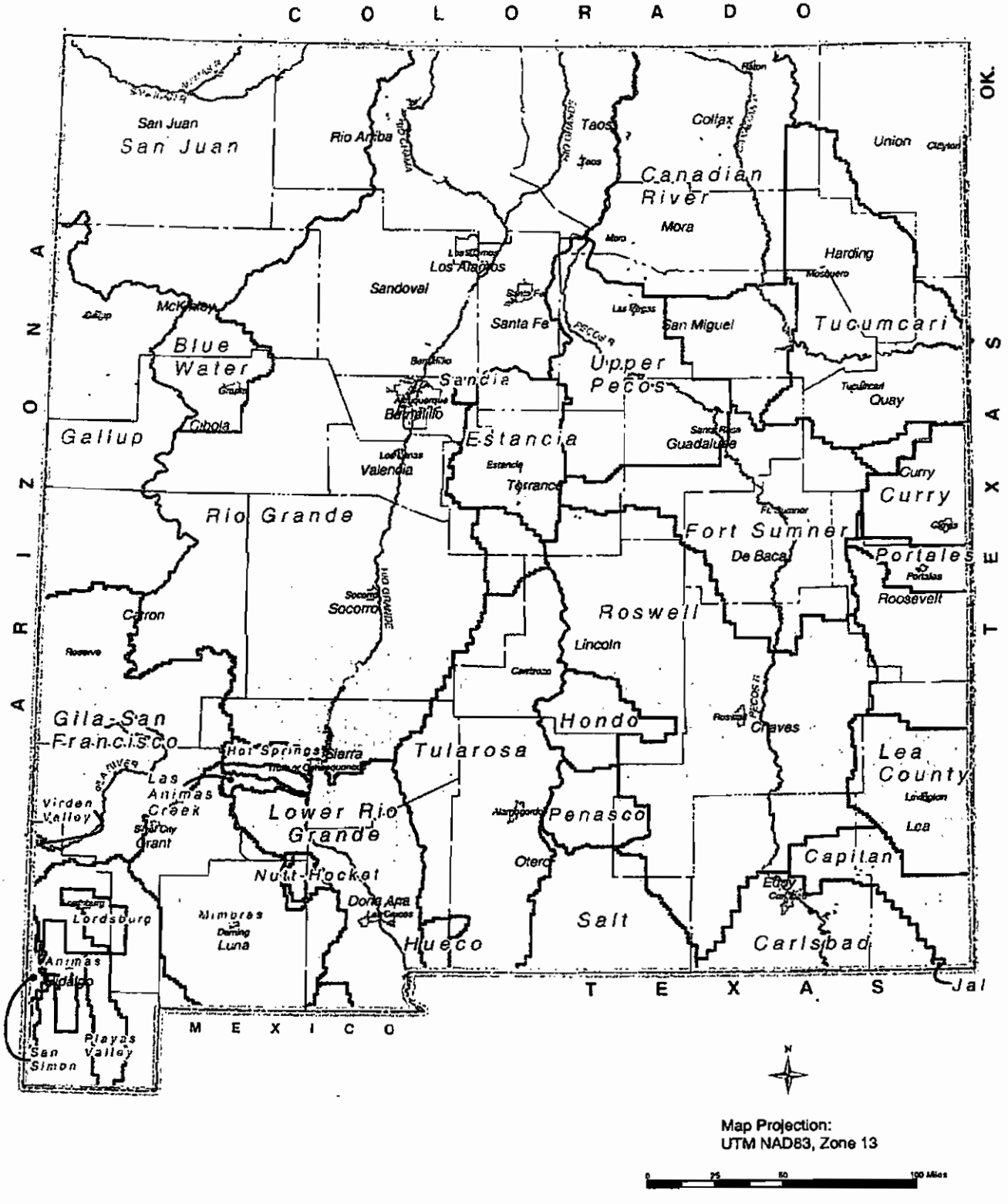


Figure 1
River Basins in New Mexico



Map Projection:
UTM NAD83, Zone 13

Figure 2
Groundwater Basins in New Mexico

Water Conservation and Quantification of Water Demands in Subdivisions

A Guidance Manual for Public Officials and Developers

Prepared by
Brian C. Wilson, P.E.

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Water Conservation and Quantification of Water Demands in Subdivisions

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New Mexico State Engineer Office

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1. PURPOSE

To facilitate the review and approval process of new subdivisions, and to prevent the establishment of subdivisions with inadequate: water supply and fire suppression systems; liquid and solid waste disposal; gas, electric, and telecommunication services; and roads; and to mitigate risks to the public health and welfare and the pollution of water resources, it is imperative that development guidelines which can be consistently applied in every county and locale throughout the state be made available to county planners, county commissions, developers, and state agencies.

The purpose of this document is to provide guidelines for the preparation and review of subdivision water supply proposals and associated water right applications. Criteria upon which an evaluation of such proposals may be made by the reviewing authority are presented for Water Conservation Measures, Water Demand Analysis, Design Requirements for Community Water Distribution Systems, and Water Right Requirements and Limitations.

2. THE NEW MEXICO SUBDIVISION ACT NMSA 1978, AS AMENDED IN 1995

2.1. Classification of Subdivisions

Type One: 500 or more parcels, any one of which is less than 10 acres.
Type Two: 25-499 parcels, any one of which is less than 10 acres.
Type Three: 24 or less parcels, any one of which is less than 10 acres.
Type Four: 25 or more parcels, each of which is greater than 10 acres.
Type Five: 24 or less parcels, each of which is greater than 10 acres.

2.2. Statutory Responsibilities of County Commissions

Section 47-6-9(A) requires that County Commissions adopt regulations setting forth the County's requirements for: (1) water conservation measures; (2) quantifying the maximum annual water requirements of subdivisions, including water for indoor and outdoor uses; (3) assessing water availability to meet the maximum water requirements of subdivisions; and (4) water of an acceptable quality for human consumption and for protecting the water supply from contamination.

Section 47-6-9(C) requires that Bernalillo, Dona Ana and Santa Fe counties adopt regulations pursuant to Section 47-6-9(A) on or before July 1, 1996; and **Section 47-6-9(D)** requires that all other counties adopt regulations by July 1, 1997.

Section 47-6-9(E) states that nothing in the New Mexico Subdivision Act shall be construed to limit the authority of counties to adopt subdivision regulations with requirements that are more stringent than the requirements set forth in the Subdivision Act, provided the County has adopted a comprehensive plan in accordance with Section 3-21-5 NMSA 1978 and those regulations are consistent with such plan.

Section 47-6-11(C) requires the County Commission to: (1) determine whether the subdivider can fulfill the proposals in his disclosure statement required by Section 47-6-17; and (2) determine whether the subdivision will conform with the New Mexico Subdivision Act and the County's subdivision regulations.

2.3. Statutory Responsibilities of the State Engineer Office

Section 47-6-10(A) requires that prior to adopting, amending or repealing any regulation, the County Commission shall consult with representatives of the State Engineer Office to give consideration to the conditions peculiar to the county and submit written guidelines to the County Commission for its consideration in formulating regulations governing subdivision water supply requirements.

Section 47-6-11(F)(1) requires that for preliminary plat approval of Type-One, Type-Two, Type-Three (except for those with 5 or less parcels--these are subject to summary review procedures), and Type-Four subdivisions, County Commissions request an opinion from the State Engineer to determine: (a) whether the subdivider can furnish water sufficient in quantity to fulfill the maximum annual water requirements of the subdivision, including water for indoor and outdoor domestic uses; and (b) whether the subdivider can fulfill the proposals in his disclosure statement concerning water, excepting water quality.

Prior to final plat approval of Type-Three subdivisions with 5 or less parcels, and Type-Five subdivisions, County Commissions may request an opinion from the State Engineer, however, this is not specifically required by the Subdivision Act.

Section 47-6-20(A) states that any public agency receiving a request from the County Commission for an opinion pursuant to Section 47-6-11 shall provide the Commission with the requested opinion within the time period set forth in Section 47-6-22(A). The County Commission shall provide the appropriate public agency with all relevant information that the Commission has received from the subdivider on the subject for which the Commission is seeking an opinion. If the public agency does not have sufficient information upon which to base an opinion, the public agency shall notify the Commission.

Section 47-6-20(B) states that all opinion requests mailed by the County Commissions shall be by certified mail "return receipt requested." County Commissions delivering opinion requests shall obtain receipts showing the day the opinion request was received by the particular public agency.

Section 47-6-11(H) states that if in the opinion of the appropriate public agency, a subdivider cannot fulfill the requirements of Section 47-6-11(F), or if the agency does not have sufficient information upon which to base an opinion: (1) the County Commission shall give the subdivider a copy of the opinion; (2) the subdivider shall be given 30 days from the date of notification, to submit additional information to the public agency through the County Commission; and (3) the public agency shall have 30 days from the date the subdivider submits additional information to change its opinion, or issue an opinion if none was previously offered due to insufficient information. Where the public agency has rendered an adverse opinion, the subdivider has the burden of showing that the adverse opinion is incorrect either as to factual or legal matters.

2.4. Time Limit on Administrative Action

Section 47-6-22(A) states that all opinions required of public agencies shall be submitted to the County Commissions within 30 days after the public agencies receive the written request and accompanying information from the County Commission. If the County Commission does not receive an opinion with the 30 day period, the Commission shall proceed in accordance with its own best judgement concerning the subject of the opinion request. The failure of a public agency to provide an opinion when requested by a County Commission does not indicate that the subdivider's provisions concerning the subject of the opinion request were acceptable or unacceptable or adequate or inadequate.

2.5. Contents of Disclosure Statement

Section 47-6-17(B) requires that the disclosure statement for subdivisions with not fewer than 5 and not more than 100 parcels include: (1) a statement describing the maximum annual water requirements of the subdivision, including water for indoor and outdoor domestic uses, and describing the availability of water to meet the maximum annual water requirements; (2) a statement describing the quality of water in the subdivision available for human consumption; (3) a description of the means of water delivery within the subdivision; and (4) the average depth of water within the subdivision if water is available only from subterranean sources.

Section 47-6-17(C) requires that the disclosure statement for subdivisions with 100 or more parcels shall contain all of the information required in Section 47-6-17(B)

3. PROTOCOL FOR SUBMISSION OF PROPOSALS AND COMMENTS FROM PUBLIC AGENCIES

Subdivision proposals prepared by developers and their consultants are normally submitted to the office of the County Commission where they are date stamped. The Commission then prepares a cover letter and sends proposal packets to the appropriate public agencies for review and comment by certified mail with return receipt requested.

The Subdivision Act specifically requires proposals to be routed through the County Commission to ensure that they have an opportunity to review and comment on all correspondence pertaining to the subdivider's proposal, and to ensure that all correspondence is entered into the public record so that it may be examined by members of the public.

In instances where time is critical, the State Engineer Office may provide its opinion directly to a subdivider if the County Commission is contacted by the State Engineer Office, and the Commission agrees that such action is prudent under the circumstances.

4. REQUIRED CONTENTS OF SUBDIVISION PROPOSALS

Except for those subdivisions which are subject to summary review procedures (See Section 2.3), a subdivision proposal should generally include the following documents:

(1) Executive Summary, including:
- (a) location by township, range, and sections, or land grant, and proximity to existing communities and transportation routes
- (b) number of lots; minimum, maximum, and average lot size; total acreage in each phase of development; projected time frame for project completion
- (c) type of dwellings to be constructed, e.g. single family detached, or multi-family including apartments, condominiums, and townhouses
- (d) overview of community facilities that will be provided
- (e) a paragraph summary for each of Items (3)-(11) which follow

(2) Disclosure Statement

(3) Land and Water Use Covenants and Restrictions, including water conservation measures

(4) Water Supply Plan, including, if appropriate:
- (a) water demand analysis
- (b) preliminary engineering plans
- (c) letter from water purveyor
- (d) proof of an existing water right

(5) Water Availability Assessment, including, if appropriate:
- (a) well records, including drilling logs
- (b) history of observed water levels and well yields
- (c) aquifer pump test data, including drawdown and recovery tables
- (d) description and results of computer models

(6) Water Quality Analysis, including results from laboratory analysis of primary and secondary contaminants

(7) Fire Protection Plan, including, if appropriate, letter from the local fire authority having jurisdiction

(8) Liquid Waste Disposal Plan, including, if appropriate, letter from wastewater utility

(9) Solid Waste Disposal Plan, including if appropriate, letter from sanitation utility

(10) Terrain Management Plan, including:
- (a) soil survey and land use limitations
- (b) grading plan
- (c) flood plain management plan
- (d) drainage plan
- (e) erosion control plan
- (f) landscaping and revegetation plan

(11) Transportation Plan, including, if appropriate:
- (a) traffic impact analysis
- (b) specifications for road construction
- (c) specifications for lighting, signage, speed limits, and traffic control signals
- (d) letters from appropriate transportation authorities

(12) Vicinity map showing location and boundaries of the subdivision relative to existing communities, transportation routes, and natural features

(13) Site plan (plat) showing lot envelopes and location of wells if a community water system is proposed

The State Engineer Office is responsible for reviewing Items (1)-(5) and (7). Items (6), (8) and (9) are reviewed by the New Mexico Environment Department. Item (10) is reviewed by the local Soil and Water Conservation District Office; and Item (11) is reviewed by the New Mexico Highway Department.

5. PROTOCOL FOR REVIEW OF PROPOSALS

County Commissions should examine proposal packages received to determine if all required documents have been included before copies are distributed to public agencies for review and comment. This can prevent unnecessary delays in the review process. Upon receiving a proposal from a County Commission, the State Engineer Office date stamps the proposal packet and then examines it to determine if all of the documents required by the county subdivision regulations for the type of subdivision proposed have been included. If there are omissions, the County Commission is contacted to obtain the missing documents. Complete proposals are then routed to the appropriate section in the agency for evaluation.

The first document examined in the proposal package is generally the disclosure statement. The disclosure statement should be comprised of concise factual responses, carefully tailored to provide prospective lot purchasers with information required to make an informed decision. The proposed means of providing water to the subdivision will determine what additional information should be included in the disclosure statement to conform with the state and county subdivision regulations. Omissions or inadequate responses are carefully noted.

To determine if the information presented in the disclosure statement is accurate and reliable, the next documents to be examined are the land and water use covenants and restrictions. Any restrictions that will affect water use will be important in evaluating the water demand analysis, and should also be reflected in the disclosure statement. Contradictions or omissions are carefully noted.

Having gained an overview of the proposed restrictions which may affect water use, the water demand analysis is reviewed to determine if it is technically correct and reasonable. Sources of data and all assumptions should be documented. Deficiencies in documentation, erroneous assumptions, omissions, and all computational errors are noted. In addition, if a letter is required from a water purveyor indicating they are ready, willing, and able to provide water to a proposed subdivision, and if a letter is required from the County Fire Marshall or local fire fighting unit, these documents are examined and any conditional requirements that the subdivider will have to qualify for the service applied for are noted. It is important that the water demand analysis be complete and accurate, because the estimate of the maximum annual water requirement is important in determining the amount of the water right required, where applicable, and, because it will be an essential element in the water availability assessment. Flow rates computed in the water demand analysis for average day, maximum day, and maximum day plus fire flow are important in sizing pumps, pipelines, and storage tanks.

The proposal is then examined for proof of an existing water right sufficient to meet the maximum annual water requirement. The State Engineer may question water right claims to determine if they have been exercised in accordance with state law and court decisions, and this may require the evaluation of a water right to determine if it is still valid after successive years of non-use. If the subdivider does not have a water right, or his water rights are inadequate, this is noted. If change of ownership of a water right, or an application to change the point of diversion, or place or purpose of use is required, this is investigated to determine if the subdivider has filed an application with the

Water Rights Division of the State Engineer Office to do so, and whether or not such application has been approved.

After reviewing the water demand analysis, the water availability assessment is evaluated, to determine if it is complete, accurate, technically sound, and the conclusions reasonable. The primary purpose of this evaluation is to determine whether or not the subdivider can demonstrate that sufficient water is available to meet the demand for the proposed subdivision in the long-term. Where water is extremely scarce, it is of the utmost importance to determine how much water can be practically recovered, and whether or not the yield, which may diminish over time, will be sufficient to meet the projected demand. Data in the water availability assessment is compared with data in the water demand analysis and disclosure statement to make sure they are consistent.

Water quality data is reviewed to determine whether drinking water standards established by the U.S. Environmental Protection Agency (USEPA) are met. If acceptable contaminant levels are exceeded, the water supply may not be suitable for drinking water. Secondary water quality parameters such as iron, sodium, sulfate, hardness (calcium and magnesium), pH, total dissolved solids, and odor, which are not regulated by USEPA, may also need to be analyzed to determine if there is a potential problem and whether or not the more stringent water quality standards adopted by some counties are met. While the New Mexico Environment Department (NMED) is responsible for the water quality review, State Engineer Office staff also review the water quality data to determine if there is a need for water softening or other treatment that may effect the water demand, and to note any details that may be important in the water availability assessment.

Upon completing the review of the proposal, all notes are compiled into a memorandum in which the State Engineer offers an opinion as to whether or not the subdivider can provide water sufficient in quantity to fulfill the maximum annual water requirements of the subdivision and whether the subdivider can fulfill the water supply proposal in his disclosure statement. A cover letter is then prepared, and the completed memorandum is transmitted to the appropriate county officials by certified mail.

Time permitting, State Engineer Office staff may attend County Commission meetings where subdividers present their proposals, to present the State Engineer's opinions on proposals, field questions from the Commission and the public, and to note any specific concerns expressed by those present which may require further investigation by State Engineer Office staff.

6. WATER CONSERVATION MEASURES

Water conservation may be defined as any beneficial reduction in water use or water losses (American Public Works Association, 1981; Prasifka, 1988). Water waste may be defined as the indiscriminate, unreasonable, or excessive running or dissipation of potable water; and non-essential water use may be defined as the indiscriminate, or excessive dissipation of potable water which is unproductive, or does not reasonably sustain economic benefits or life forms, where there is a shortage of potable water (Monterey Peninsula Water Management District, 1988).

Drought is not the only circumstance under which water shortages occur. Population growth or migration can also cause shortages by overburdening water supplies that were once abundant. Thus, water conservation is an important consideration in water supply planning for any new subdivision. Reducing the water demand in subdivisions may add years to the life of aquifers that are being mined, reduce the cost of wastewater treatment, save energy, postpone or eliminate the expansion of water treatment and distribution systems, and decrease the volume of wastewater discharged into rivers and streams.

Indoor water use can be reduced without household members having to make any changes in their daily habits by installing water-saving plumbing fixtures and appliances in new construction. Outdoor water use can be kept to a minimum by installing low-water use landscaping and by careful consideration of any use of hot tubs, swimming pools and water gardens. Controlling excessive water pressure, metering and rate structures (water pricing), and the establishment of a good accounting and auditing system, may be integrated into the design and operation of water systems to reduce water waste.

The purpose of this section is to describe practical water conservation criteria for the design of subdivisions. These criteria can be applied to single-family homes, apartments, condominiums, townhouses, and mobile home parks.

6.1. Indoor Plumbing Fixtures

6.1.1. Toilets. In the United States, most toilets used 7.0 to 8.0 gallons per flush (gpf) until the 1950s, when the 5.5 gpf toilet entered the market; by the early 1980s, the 3.5 gpf toilet became the standard (Vickers, 1989, 1990.). These figures do not include toilet leakage, which is estimated to be as high as 20%. **The National Energy Policy Act of 1992 (NEPA) now requires that toilets manufactured after January 1, 1994 for dwelling units, use no more than 1.6 gpf.** It may be of interest to note that the average family of four flushes 16 to 28 times per day; and 6 flushes per capita per day is a reasonable assumption for estimating water use (Brown and Caldwell, 1984; Karpiscak, 1990).

6.1.2. Showerheads. The maximum flow rate of pre-1980 showerheads in the United States is 5.0 to 8.0 gallons per minute (gpm). However, studies indicate (Brown and Caldwell, 1984), that the average measured flow rate of pre-1980 showerheads is more often about 3.4 gpm because people run these showers at about two-thirds of maximum capacity. In the 1980s, 3.0 gpm showerheads became the industry standard. **NEPA now requires that the maximum flow rate of showerheads shall not exceed 2.5 gpm.**

6.1.3. Faucets. Conventional kitchen and bathroom faucets have a maximum flow rate of 3.0 to 7.0 gpm. **NEPA now requires that the maximum flow rate of kitchen and bathroom faucets shall not exceed 2.5 gpm, and 2.0 gpm faucets are recommended for bathroom sinks.** But, no matter how thrifty a faucet's flow rate, leaving the tap running constantly is really the most wasteful practice. There are faucets available however, which shut-off automatically, including some that use infrared sensors to detect any object that enters the beams' range.

6.1.4. Insulated Hot Water Pipes. Insulation reduces loss of heat from hot water pipes and reduces water wasted while users wait for the flow of hot water at the tap. A 1-4% reduction in water use and energy savings can result (Whipple, 1994, p. 57)

6.2. Appliances

6.2.1. Air Conditioners. An evaporative cooler (swamp cooler) installed in a 1,700 square foot single-family dwelling may consumptively use (evaporate) 10,758 gallons of water during a 1,130 hour cooling season in Albuquerque; and 16,355 gallons in a 1,718 hour cooling season in Las Cruces. (See Appendix B). Bleed-off water that is used to reduce mineral build-up on the pads inside the cooler may increase the total water use by 67% (Watt, 1986, pp. 105, 110) in coolers without pumped bleed-off recirculation. **To conserve water, evaporative coolers that recirculate bleed-off water, or refrigerated air conditioning systems, which require no water, can be installed in new construction; and bleed-off water from evaporative coolers without recirculation can be used for landscape irrigation.**

6.2.2. Dishwashers. To meet U.S. energy-efficiency standards, dishwashers manufactured since mid-1994 save energy by eliminating a hot water wash and rinse cycle, which reduces the total water use. Many of these models use about half the water that dishwashers used 20 years ago. Dishwashers manufactured in the U.S. use 7.5 to 12.5 gallons per wash in the normal cycle; European models which are typically more frugal with water, use 5.5 to 8.5 gallons (Consumer Reports, 1993, 1995a, 1995b). Note that a study conducted by Ohio State University showed that 16 gallons of water are typically used to hand wash 8 place settings and serving pieces (Buzzelli, 1991, p. 57). **To conserve water, low-water use dishwashers which require no more than 13 gallons in the regular cycle, and have a cycle adjustment which reduces the water used for small loads, can be installed in new construction.**

6.2.3. Hot Water Heaters. There are no noteworthy ways to save water in the selection or use of a typical hot water heater. However, installing a point-of-use water heater which produces hot water instantaneously, can reduce water waste (Buzzelli, 1991, p. 39). This can be especially important in homes or apartments where the hot water tank is a long way from the bathroom, and occupants have to run the water a long time before it gets hot enough for a bath or shower.

6.2.4. Washing Machines. To meet U.S. energy-efficiency standards, washing machines manufactured since mid-1994 save energy by eliminating hot water rinses, which reduces the total water use. In the regular cycle, top-loaders use 40 to 45 gallons per load; the front loaders 25 to 30 gallons. In the permanent-press cycle, water use increases by 5 to 10 gallons for top loaders, but is about the same for the front loaders (Consumer Reports, 1995a, 1995c). Some washers use as much as 68 gallons in the heavy duty cycle. Suds-saver washing machines which spew wash water into a tub or sink next to the machine, and then suck it up again to be reused for one or more additional wash-water fills can save laundry detergent and up to 17 gallons of water for each reuse (Consumer Reports, 1993). **To conserve water, low-water use washing machines which require no more than 43 gallons in the regular cycle and 53 gallons in the permanent-press cycle, and have a**

cycle or water-level adjustment which reduces the water used for small loads, can be installed in new construction.

6.2.5. Water Softeners. A softener is designed to remove hardness, i.e., calcium and magnesium, the minerals that lead to soap-curd deposits in the bathtub and sinks, dull-looking laundry, spots on dishes, scaly deposits on faucets and showerheads, and scale inside the water heater and pipes. A softener is not intended to make water any safer to drink. Water requirements for regeneration vary from 15 to 120 gallons per 1,000 gallons of water softened (Consumer Reports, 1990). The Environmental Protection Agency (1980) has reported that water softener regeneration typically occurs once or twice a week, discharging 30 to 88 gallons per regeneration; and that water requirements for this purpose range from 2.3 to 15.7 gallons per capita per day (gpcd), but average about 5 gallons per capita per day (gpcd). A softener controlled only by a timer regenerates at regular intervals and may use more salt and water than necessary because they regenerate whether or not the resin needs it. On the other hand, demand-control softeners monitor water flow or changes in hardness to adjust regeneration more precisely to the actual demand for water. There are also softeners which have electronic controls, that can calculate the average number of gallons of water used in the previous 7 days or track abnormal variations in average water use, and call for regeneration accordingly. **To conserve water, product specifications can be compared and a softener selected that regenerates automatically with a low regeneration water requirement per 1,000 gallons of water softened.**

6.3. Landscaping

6.3.1. Xeriscape. In 1980, the Denver Water Department coined the term **xeriscape** as a systematic approach to landscaping to conserve water (Knox, 1989). Xeriscape, from the Greek word "xeri" for dry, is a style of landscaping based on seven common-sense steps to create a beautiful, yet low-water use landscape. A well-designed xeriscape minimizes the area in irrigated turf; only trees, shrubs, flowers and groundcovers with low water requirements are planted; and plants are zoned in the landscape according to their different water needs so they can be irrigated separately, and efficiently. The goal in developing a water wise landscape is to reduce the need for irrigation, irregardless of whether it is in turf or ornamental areas of the landscape. As the irrigated area is reduced, water savings increase. Xeriscape can reduce outdoor water use by 50% or more without sacrificing the quality and beauty of a home environment. It is environmentally sound, requiring less fertilizer and chemicals, and it is low-maintenance. The seven steps to xeriscaping are:

> **Step 1: Planning and Design.** A landscape design is developed to suit homeowner's needs, life style, and climate. A well-planned xeriscape can increase the value of property and reduce water use. Prepare a site plan drawn to scale showing the location of the house, its orientation to the sun, other structures, utilities, and existing vegetation. Delineate those areas that will be developed for specific uses. Limit the disturbance of native vegetation on slopes and the perimeter of lots to eliminate the need for planting vegetation that must be watered. Divide the landscape into water use zones. High water-use zones are small, highly-visible areas, that receive the most care and require frequent watering. The high water-use

zone is normally the area nearest to the house and is typically where most family activity occurs; plants in this zone are functional, i.e., attractive and durable, such as turfgrass. The moderate water-use zone blends verdant areas with the more arid parts of the landscape; plants in this zone are watered only occasionally. The low water-use zone requires the least care; plants are only irrigated during establishment (typically 12-18 months); and thereafter, they survive on rainfall only. It is important to avoid abrupt changes from low to high water-use zones because this results in overwatering along the edge of the low water-use zone.

Step 2: Soil Analysis. Evaluate the soil, including its structure, texture, water-holding capacity and drainage. The physical and chemical characteristics of the existing soil will determine the type of soil improvement needed. When most homes are built, the soil around them is usually altered. The area against the foundation of the house is especially likely to be filled with poor soil and debris and may be far from ideal for growing turf, perennials and other plants.

Step 3: Appropriate Plant Selection. Select plants that are well-suited to the site and local environment. Soil type and exposure to direct sunlight are important considerations. Match the water use zones with the condition of the planting site. Place high water-use plants in areas of the landscape that stay moist, and low water-use plants in areas that stay drier naturally. In order to avoid waste, plants with similar light and water requirements should be grouped together. The irrigation system should then be designed to deliver the amount of water that each grouping needs to be healthy.

Step 4: Practical Turf Areas. Use turf for a specific function or aesthetic benefit. A small "oasis" of turf near the entrance to the home or a playing surface of durable turf in recreational areas, are all examples of practical turf areas. Avoid planting a steep slope with turf because it will be difficult to water and maintain sufficient soil moisture to keep the turf green (Christopher, 1994, p. 63). Design turf areas in practical shapes that can be efficiently irrigated and maintained. Avoid sharp angles and long narrow strips that are difficult to mow and water (Christopher, 1994, p. 63; University of Georgia, 1992, p. 10). Minimize the area of irrigated turf where possible; restrict turfgrass to low-water use varieties that are well adapted to the climate, soil, exposure, intended use, and expected level of care they will receive. Acclimation to sunny or shady exposures, heat, frost and drought tolerance, resiliency under wear, aesthetic appeal, and maintenance requirements--cutting, watering, fertilizing, and weeding, are all important considerations in selecting a turfgrass.

Step 5: Efficient Irrigation. A water-wise landscape requires a minimal amount of irrigation water, and water should be applied efficiently and effectively to make every drop count. Just as plants are zoned in the landscape according to their different water needs, zone the irrigation system so that plants with different water needs are irrigated separately. Water turfgrass, for instance, separately from shrubs and flowers. Using irrigation water efficiently also requires the selection of an appropriate type of irrigation system for the plants and for each area of the landscape. Trees and shrubs in the low water-use zone would need supplemental water only during establishment, while plants in moderate water-use

zones require water only during periods of limited rainfall. For these plants, a temporary system such as a soaker hose or hand watering may be all that is required. On the other hand, high water-use zones require frequent watering and may warrant a permanent system with automatic controls. Whenever possible, use highly efficient watering techniques, such as drip irrigation. Soil moisture sensors such as gypsum blocks and tensiometers may be used to determine when to irrigate. Irrigation controllers may be used to water plants on time and in sequence, day by week by month, but they must be properly programmed to reflect seasonal changes in plant water requirements, otherwise water may be wasted. Bermadon valves are generally preferable to clock-type controllers; the Bermadon valve must be turned on manually but it turns itself off after a set amount of water passes through it (Christopher, 1994, p. 38). Sensors which automatically turn the irrigation system off if rain falls or if the soil is too wet to need watering, can improve irrigation efficiency and reduce waste. Considerable water savings can be realized by studying the water needs of plants, breaking bad watering habits, and learning how to water, when to water, and the most efficient ways to water. Use the following guidelines for lawn watering: (1) Water only when the grass really needs it; (2) deep-soak the roots and water less frequently--daily sprinkling may result in a shallow root system and weakens the grass, making it more susceptible to disease and more fragile in dry conditions and during winter; (3) water during the cool, early morning hours to minimize evaporation; (4) avoid watering on windy days to minimize wind drift and evaporation; (5) aim sprinklers--don't waste water on open dirt, sidewalks or driveways; (6) adjust sprinklers to throw a low pattern of water to minimize evaporation; and (7) monitor the amount of water applied (Buzzelli, 1991, p. 89).

Research conducted by the Rodale Institute indicates that for uniformity, efficiency, and range (distance) of coverage, the impulse- or impact-type sprinklers are the best (Ellefson, 1992, p. 107). Inexpensive revolving sprinklers (with revolving arms that move by water pressure), as well as fixed sprinklers that shoot water through a pattern of holes in their tops, give the least uniform coverage, often leaking and/or distributing most of the water near the sprinkler. Oscillating sprinklers cover a square area, but often deposit too much water at the ends of their oscillations, where they pause to reverse direction. In addition, though oscillating sprinklers may be great for children to play in, throwing water high in the air increases evaporation and wind drift losses. Traveling sprinklers (the ones that look like little tractors) have revolving arms and move across the lawn for better distribution and efficiency.

Step 6: Use of Mulches. Mulching is a very beneficial landscape practice. Mulches conserve moisture by preventing evaporative water loss from the soil surface and reducing the need for irrigation during periods of limited rainfall. By maintaining an even moisture supply in the soil, mulches prevent fluctuations in soil moisture that can damage roots. Mulches also prevent crusting of the soil surface and allow water to penetrate readily to plant roots. They insulate the roots of plants from summer heat and winter cold and help control weeds that compete with plants for moisture. By serving as a barrier between the plant and soil, mulches help discourage soil-borne diseases that stress plants and cause them to use more water. A 3-4 inch depth of mulch is normally optimum. Depending on the mulch and

growing conditions, a depth greater than 5 inches will discourage plants from growing and retard the percolation of water down to the soil. Use fine-textured, organic non-matting mulches when possible. Fall leaves, pine straw pine bark nuggets, and shredded hardwood bark are excellent choices. Mulch as large an area as possible under trees and shrubs. Islands of unplanted mulch require no water and little routine maintenance.

Step 7: Appropriate Maintenance. Keep plants healthy, but do not encourage water-demanding new growth. Once plants are established, reduce the amount of nitrogen applied as well as the application rate and frequency of application. Avoid plant stress by mowing properly, by thinning shrubs instead of shearing, and by controlling weeds and pests before they affect plant health.

6.3.2. Landscape Design Requirements

In the text which follows, a procedure to implement a program for landscape requirements in new developments is presented. Model landscape ordinances which have been effectively implemented by water utilities and districts in the U.S. are included in Appendix A.

Procedure for Enacting an Ordinance
Governing Landscape Design Guidelines
(Center for the Study of Law and Politics, 1990, p. 61)

Step 1: Prepare an ordinance for adoption and use it as a part of city or county building permit approval process. The ordinance may include:

(1) Limits on turf area size by percentage of landscapable area (typically 20-50%). The landscapable area is the total lot or project area less the footprint of all buildings, driveways, non-irrigated portions of parking lots, hardscape such as decks, patios, walkways, and other non-porous paved areas, and utility easements. Water features are included in the calculation of landscapable area, but areas dedicated to the production of food crops such as vegetable gardens and orchards are not (California Department of Water Resources, 1992, p. 8).

(2) The prohibition of turf and high water-using plants in areas next to buildings, along narrow pathways or median islands, in the drip line area of native trees, or in sloping locations.

Step 2: Prepare landscaping design guidelines, which are a detailed explanation of how landscapers can comply with the ordinance. Include:

(1) A list of plants with low water requirements

(2) Descriptions of the recommended types of irrigation control systems, methods of irrigation, soil preparation methods, lower water-use varieties of turf, a maintenance and watering schedule, and proper placement of plants in the landscape. Remember that plants with similar light and water needs should be grouped together.

Step 3: Present the ordinance and guidelines to city and county governments for review and comment. Solicit comments from landscape architects, planners, developers, and water purveyors and incorporate comments received into the proposed ordinance and guidelines.

Step 4: Adopt the ordinance and guidelines. Incorporate them into the building permit approval process and apply them to all new construction.

Step 5: Enforce the ordinance and guidelines. Landscape design requirements are most effective when accompanied by a design review service offered through the city or county planning office, or local water utility. Such services can help subdividers and homeowners develop landscaping plans that are consistent with community water conservation goals. Some communities designate review boards, usually consisting of landscape architects or planners, to evaluate and approve landscape designs for certain types of new development. For example, a city or county may use a review board to ensure that new landscaping and irrigation systems comply with its xeriscape requirements. After the landscape project has been completed, the site is visited and a certificate of compliance is issued if all landscape design requirements are met. To provide an incentive for low water use landscaping, a credit or rebate may be offered toward the connection fee if homeowners comply with landscaping guidelines.

A prototype for landscaping guidelines which must be met to qualify for a rebate is presented in the text which follows.

Prototype for Landscape Rebate Program Requirements
(Center for the Study of Law and Politics, 1990, p. 69)

(1) There is 20% less turf area than traditional landscapes and not more than:
- 800 square feet of irrigated turf per single-family detached dwelling
- 500 square feet of irrigated turf per condominium or townhouse
- 300 square feet of irrigated area per apartment or mobile home dwelling

(2) Not more than 40% of the total irrigated landscaped area is turf.

(3) In planned unit developments, turf areas are consolidated into large, relatively flat areas creating "oases of green" surrounded by dwelling unit clusters, thereby producing the greatest visual impact and optimizing irrigation efficiency. Turf is not used adjacent to building foundations, along narrow paths or median strips, or within the drip line of native trees.

(4) Low water-use shrubs and ground covers are used in landscaped areas where turf is not used.

(5) Water-loving plants generally are confined to drainage areas and patios or other intensively used or highly lighted areas.

(6) Rock plants and other colorful low water-use plants are used to add seasonal color highlight, visual interest, and balance.

(7) Prior to landscaping, soil tests are conducted, and the ground is carefully prepared. At a minimum, ground beneath planting is scarified and covered with a mixture of not less than 4-6 inches of topsoil amended with at least 4 cubic yards of organic material per 1,000

square feet and other soil amendments in a quantity and type approved by a landscape architect.

(8) Well-designed underground sprinkler systems are installed in landscaped areas. Turf heads are on a system that is separately controlled from shrub and other nonturf areas. Design of the turf-area system provides uniform application. Low-discharge heads are used in nonturf areas or where slopes present a runoff problem. Automatic water timers and rain sensing shut-offs are used at all stations.

(9) In nonturf areas, a 3-inch surface layer of organic mulch is installed around all plants except for low ground covers.

6.3.3. Training Landscape Maintenance Personnel. A training program for landscape maintenance personnel will make them much more effective water conservers. A training program should include:

Irrigation scheduling. This should include an overview of the water requirements of different species of plants, signs of plant stress, use of soil probes and soil cores to check soil moisture, installation and use of soil moisture sensors such as gypsum blocks and tensiometers, determination of how much water to apply, best time of day to irrigate, duration of irrigation, and use of automatic controllers to turn water on and off.

Irrigation system maintenance. How to spot problems in irrigation equipment and make, contract for, or recommend to site managers the needed repairs.

Landscape maintenance practices that reduce the need for irrigation water. These practices include:

(1) Proper height for turf mowing
(2) Proper frequency of turf aeration and thatching to increase water retention
(3) Proper fertilization schedule to maintain plant health and drought tolerance
(4) Soil preparation and mulching practices to increase water retention

6.3.4. Irrigation with Reclaimed Wastewater

A complete evaluation of all the factors involved in the reuse of reclaimed wastewater must be performed to determine if it is feasible to use such waters for landscape irrigation in a proposed subdivision, and the results of the feasibility study should be thoroughly documented in the subdivision proposal. A general overview of this subject is provided in the text which follows. More detailed information may be obtained from federal guidelines, state regulations, municipal ordinances, engineering texts, and journal articles.

Regulation. There are no federal standards governing water reuse in the U.S., however, the U.S. Environmental Protection Agency has published guidelines for water reuse (USEPA, 1992) that address all important aspects of water reuse, including recommended wastewater treatment processes, treatment reliability provisions, reclaimed water quality limits, monitoring frequencies, setback distances, and other controls for various water reuse

applications. Regulations that do exist have been developed at the state level, and these normally include acceptable levels of constituents of reclaimed water and prescribe means for assurance of reliability in the production of reclaimed water to ensure that the use of reclaimed water for the specified purposes does not impose undue risks to health (Crook, 1994, p. 67). Higher treatment standards are usually specified for the irrigation of food crops, golf courses, parks, and playgrounds, than for forage produced for non-milk-producing cattle, and roadway landscaping. Where the risk of human exposure is high, regulations may specify treatment and water quality requirements that will produce an effluent that is essentially free of measurable levels of pathogens, including viruses. General guidelines for the reuse of domestic wastewater in New Mexico have been prepared by the New Mexico Environment Department, and these may be obtained by contacting that agency.

Water Quality. The presence of toxic chemicals and pathogenic microorganisms in untreated wastewater creates the potential for adverse health effects where there is contact, inhalation, or ingestion of chemical or microbiological constituents of health concern. Thus, acceptability of reclaimed water for landscape irrigation depends on its physical, chemical and microbiological quality. The quality of reclaimed water depends on the source water quality, wastewater treatment processes and treatment effectiveness, treatment reliability, and distribution system design and operation. Factors that affect the source water quality include use of water softeners (increases sodium) and detergents (increases boron) in dwelling units, presence of industrial waste, infiltration into the sewage collection system, and seasonal variations in flows caused by stormwater.

Treatment Reliability. The need for reclamation facilities to reliably and consistently produce and distribute reclaimed water of adequate quality and quantity is essential and dictates that careful attention be given to reliability features during the design, construction, and operation of the facilities. Reliability requirements include standby power supplies; alarm systems; multiple or standby treatment process units and equipment to prevent treatment upsets during power and equipment failures, flooding, peak loads, and maintenance shutdowns; emergency storage or disposal of inadequately treated wastewater; elimination of treatment process bypassing; design flexibility of piping and pumping to permit rerouting of flows under emergency conditions; monitoring devices and automatic controllers; and provisions for uninterrupted chlorine feed. Non-design reliability features include provisions for qualified personnel, an effective monitoring program, a quality assurance program, and an effective maintenance and process control program (Crook, 1994, pp. 60-61, 70). An industrial pretreatment program and enforcement of sewer use ordinances to prevent illicit dumping of hazardous materials into the collection system, are generally required to ensure treatment reliability.

Conveyance and Distribution Facilities. The distribution network includes pipelines and appurtenances, pumping stations, and storage facilities. The major concern which guides design, construction, and operation of a reclaimed water distribution system is the prevention of cross-connections. A cross-connection is a physical connection between a potable water

system and any source containing nonpotable water through which potable water could be contaminated. Another major concern of regulatory agencies is improper use or inadvertent use of reclaimed water. Typical regulatory controls to prevent cross-connections and intentional or unintentional misuse of reclaimed water include the following: color-coding of pipes and appurtenances (pumps, outlets, and valve boxes); horizontal and vertical separation of potable and reclaimed water lines; prevention of ability to tie into reclaimed water lines; backflow protection devices on potable water lines; and pipeline design and construction criteria (Crook, 1994, p. 61-62). The color purple is generally used to identify reclaimed water lines and appurtenances. Other design, operation, and safety requirements include: certified operator on duty at reclamation plant 24-hours per day; adequate storage or rerouting of excess flows during rainy periods and winter months; lining of detention ponds; key operated valves and outlets; use area controls including groundwater monitoring, surface runoff control, and prohibition of irrigation when the ground is saturated or frozen; fencing; signs; setback distances (from dwellings, public roads, wells, and reservoirs); control of windblown spray; and provisions for worker protection (Crook, 1994, p. 70-71). It is important to emphasize that in locales where groundwater is the source of potable water for residents, the installation of groundwater monitoring wells will be necessary to determine the impact, if any, of the application of reclaimed water on water quality and water levels.

Water Rights to Reclaimed Water. It is important to establish who has the legal right to the water--the supplier of the water entering the wastewater treatment plant, the treatment plant owner, or the public. The reuse of wastewater is subject to the administrative requirements which normally apply to changes in freshwater diversions, and the impact on return flow and downstream users must be taken into consideration. Depending upon the situation, it may be necessary to file an application with the State Engineer Office for a new appropriation of water, or to change the place and purpose of use.

Feasibility Studies. Before a plan for the reuse of reclaimed water is adopted as a part of a new subdivision development, a feasibility study should be prepared that would include an evaluation of environmental regulations; ownership, appropriation of water rights, and impact on return flow; legal liability; quality of water required for the proposed use; contractual provisions which set forth the responsibilities and liabilities of the provider and users; public acceptance; past reuse experience; environmental conditions (climate, soil, topography, groundwater levels and quality) at the point of use; economics; and technical feasibility. Conditions that must be met before reclaimed water is a viable option generally require that the reclaimed water is of adequate quality for the use, considering all relevant factors; that it is provided at a reasonable cost to the user, which is comparable to, or less than the cost of potable domestic water; that the use will not be detrimental to public health; and that the use will not adversely affect downstream water rights, will not degrade water quality, and is determined not to be injurious to plantlife, fish and wildlife (Thomas, 1994, p. 94-95).

6.3.5. Water Harvesting

Downspout Collection. A 1,000 square foot roof will yield 150 gallons of water during a 0.25-inch rain. By extending downspouts from gutters into the ground and adding on a section of solid pipe followed by a perforated pipe, water can be directed into planting beds.

Grading. Design paved surfaces to slope into turfgrass areas, planting beds, holding ponds, or cisterns; on steeply sloping sites, use terraces to slow down and collect the runoff; create small depressions or swales at the bottom of slopes to catch runoff (Ellefson, 1992, p. 104).

Collection Basins, Ponds, and Cisterns: These may be used to store runoff and should be lined with either hard-packed clay, concrete, or nonporous vinyl liners to prevent the water from percolating into the soil. A pump with a filtration system or gravity flow siphons can be used to withdraw water for landscape irrigation. Small cisterns, adequately elevated, work well with drip irrigated planting beds. Ponds and cisterns may also be a source of water for fire fighting provided that sufficient storage can be maintained. However, in regions that experience cold winters, ice cover may preclude the use of ponds and cisterns for this purpose.

Swales. These are long, level excavations, which can vary greatly in width and form from small ridges in gardens, rock piles placed across slope, or deliberately excavated hollows at the base of slopes or in flatlands (Mollison, 1992, p. 167). The purpose of a swale is to intercept overland flow, to hold it for a few hours or days, so that it can be absorbed by the soil and recharge the ground water. Swales are built on contour or on dead level survey lines, and it is important to emphasize that they are not designed to be a watercourse. The base is ripped, graveled, sanded, loosened, or dressed with gypsum to increase infiltration. Runoff from slopes, roofs, roads, and other paved areas, and flows in diversion drains, may be directed into the swale. The interswale may be left bare, however, it is generally seeded with cereal grasses and covered with a mulch to increase infiltration, reduce evaporation, and prevent soil erosion. Trees are normally planted on the outer banks, and will shed about 25% of their root system each year, and this, together with leaf litter and soil micro-organisms, becomes organic matter (humus), which increases water retention in the soil (Morrow, 1993, p. 42).

6.4. Recreational Water Facilities and other Water Features

It is recommended that the water use estimate for hot tubs, swimming pools, ponds, and water gardens be consistent with the procedure in Step 4 on page 23 of this manual, and be carefully considered in the water conservation measures for new subdivisions. From the perspective of water conservation, such facilities may be more appropriate where they will serve an aesthetic or recreational purpose which benefits all inhabitants of a community. Fountains or other types of decorative water bodies where water is sprayed into the air are discouraged.

6.5. Design and Operation of Water System

6.5.1. Pressure Reduction. Over-pressurized water systems can result in inefficient water use. Pressure-reducing valves (PRV) should be installed when static pressures exceed 100 pounds per square inch (psi) in the transmission lines and distribution mains, and where pressure exceeds 80 psi at customer meters. (Center for the Study of Law and Politics, 1990, p. 43; Great Lakes Upper Mississippi Board, 1987, p. 108; Rocky Mountain Institute, 1991, p. 26). The static pressure at a residential service connection where a PRV is installed will generally be maintained at 45-55 psi. Note that in some areas particularly where dwellings are built on slopes, differences in elevation and friction losses in the piping system may require working pressures at the street of up to 80 psi to ensure that automatic indoor fire sprinkler systems and landscape irrigation sprinklers function properly (American Water Works Association, 1989, p. 41). Pressure reduction at a service connection can reduce water use by 5% or more (Whipple, 1994, p. 57)

6.5.2. Metering. Metering is an essential element of any residential water-conservation initiative. Without water meters, individual users cannot tell how much water they are using or how much they are saving. By installing water meters and basing billings on water use, local utilities create a strong incentive for consumers to use less water. Metering is a more equitable means of billing for water use, and water-conserving customers will benefit directly. The cost of installing a water meter in new construction is generally much less than retrofitting a service connection with a meter later. Labor costs are the biggest factor in meter retrofit programs, and account for the cost variation. The cost of installing meters will generally be recovered in savings in the water purveyor's supply and delivery costs in 3 to 4 years.

6.5.3. Rate Structures (Water Pricing). It is important that water is priced to reflect the true cost of producing it. Water rates should be designed to recover all costs including construction of water supply facilities, heavy equipment, management, training, operation and maintenance, water quality laboratory tests, depreciation, interest on debt or capital, and taxes; and must provide for the establishment of a reserve fund for future improvements, extensions, and enlargements, and the replacement of system components that wearout with age. **The ability to recover all costs is extremely important in determining the viability of proposed new systems, or of old systems needing assistance (Whipple, 1995, p. 77)**. The rate structure should generate revenues sufficient to allow the utility to operate on a self-sustaining basis; provide assurance that there will be a stable and predictable stream of revenue over time and as circumstances change; and provide incentives for conservation (Mitchell, 1994, p. 13-14). Water subsidies and other price breaks lead to profligate water use. Flat rate billing systems do not promote water conservation, and metering without a use-based water rate will not reduce demand. To conserve water, customers should be billed on the basis of a fixed monthly charge plus a charge per unit of water used. An increasing block-rate structure may be effective in preventing waste. Water and sewer rates should not be lumped together so that water use can be monitored.

6.5.4. Recordkeeping and Water Audits. It is imperative that a recordkeeping system be established to monitor operation and maintenance costs, revenues, and the use of water. A water audit is a detailed examination of where and how much water enters the system, and where and how

much leaves it. Water system audits facilitate the assessment of current water uses and provide data needed to reduce water losses, revenue losses, and forecast future demand. With this information, the water utility is better equipped to target conservation efforts and system improvements where they are most needed. Estimating and reducing unaccounted-for water is a major objective of a water system audit. Unaccounted-for water includes distribution-system losses through leaks, unmetered water delivered through fire hydrants, water taken illegally from the distribution system, inoperative system controls (for example, blowoff valves and altitude-control valves), and water used in flushing water mains or sewers (Center for the Study of Law and Politics, 1990, p. 35). Unauthorized use of hydrants includes theft by chemical lawn service companies, building contractors, and water haulers who have the tools needed to open hydrants without permission.

7. WATER DEMAND ANALYSIS

7.1. Classification of Water Systems

7.1.1. Individual Domestic Well. Groundwater is diverted from one Section 72-12-1 NMSA 1978 domestic well to serve one residential connection, which may be a single-family dwelling, or a multi-family dwelling. Each lot purchaser is usually responsible for drilling their own well, installing a pump, pressure tank, and water line, and maintaining the system. The annual diversion from the well is limited to 3 acre-feet in any year.

7.1.2. Shared Well. Groundwater is diverted from one Section 72-12-1 NMSA 1978 domestic well to serve at least 2 residential connections. The subdivider may drill the well that will serve each cluster of homes, install the pump and pressure tank, and water distribution line to the perimeter of each lot. Lot purchasers are generally responsible for installing a water service line from the distribution line to the home they build. Land and water use covenants and restrictions prepared by the subdivider will stipulate that lot purchasers in each cluster of homes will be entitled to use an equitable portion of the permitted water right associated with each well; and lot purchasers will be responsible for the assessment and collection of fees, and the operation and maintenance of the water system. A water meter is required at the wellhead, and the annual diversion from each well is limited to 3 acre-feet or less in any year.

7.1.3. Community Water System. Includes any existing or proposed water supply system which relies upon surface and/or groundwater diversions other than wells permitted by the State Engineer Office under Section 72-12-1 NMSA 1978, and which consists of common storage and/or distribution facilities operated for the delivery of water to multiple service connections. All diversions must be metered at the source, and it is recommended that each service connection be metered. The annual diversion must not exceed the water right.

7.2. Community Water System

To evaluate the ability of a subdivider to provide water sufficient in quantity to satisfy all water uses in a subdivision from a community water system, it is first necessary to quantify the maximum annual water requirements for indoor domestic uses including water for evaporative cooling and water softening, landscape irrigation, fire fighting, and other uses including distribution system losses. For subdivisions that will be developed in phases, it is important that the water production and delivery capacity be adequate to meet the water demand at full development. Inadequate design capacity may result in shortages in water deliveries. The maximum annual water requirement for the subdivision is computed using the following procedure.

Step 1: Determine a reasonable occupancy rate for the proposed dwelling units. Review housing and population data published by the U.S. Department of Commerce, Bureau of the Census, for the county and locale under study; also contact local water utilities to obtain data for similar residential customers. Data obtained from these sources may be used as general guide. The occupancy rate used for the design of a new subdivision should reflect a margin of safety to avoid underestimating the water demand. U.S. Census Bureau data indicate that the average occupancy rate per dwelling unit is 2.7 capita (Vickers, 1990). For design purposes, a minimum occupancy rate of 3.0 capita may be assumed; however, a higher rate (3.1-5.0), may be more appropriate for some residential developments. A lower occupancy rate may be appropriate for developments such as retirement communities provided that there is a reasonable assurance that the lower occupancy rate will continue in the future.

Step 2: Compute total indoor water requirements for each dwelling unit. For dwelling units with water conserving plumbing fixtures and appliances, assume a water requirement of 60 gallons per capita per day (gpcd) for normal household purposes such as drinking, food preparation, bathing, flushing toilets, washing clothes and dishes, and cleaning (See Table 1 which follows for a breakdown of this figure). Water requirements for evaporative cooling may be computed using the procedure presented in Appendix B which takes into consideration the volume of indoor living space, air flow requirements, design dry and wet bulb temperatures, and the annual number of cooling hours. In lieu of using this procedure, water requirements for evaporative cooling in New Mexico may be estimated at 20 gpcd. Water requirements for water softener backwash and regeneration will depend on the total hardness of the water, daily water use, and the frequency of regenerations, but may be estimated at 5 gpcd (See Section 6.2.5). **On the basis of this criteria, the total indoor water use for a dwelling unit equipped with an evaporative cooler and water softener would be 85 gpcd.** The total indoor water requirement (W_I), expressed in gallons per year for each dwelling unit, is computed using Equation (1).

$$W_I=(CPU)(GPCD)(365\ \text{days/yr}) \qquad \text{(Eq. 1)}$$

CPU is the number of capita per dwelling unit; and GPCD is gallons per capita per day.

Table 1. Indoor water use in single and multi-family dwelling units with water conserving plumbing fixtures and appliances, in gallons per capita per day (gpcd). The prototype for this table is based on data published in a report prepared by Brown and Caldwell (1984) for the U.S. Department of Housing and Urban Development, Washington, DC.

Item and Assumptions	GPCD
Toilets (1.6 gal/flush x 6 flush/capita day)	9.6
Toilet leakage (0.17 x 24 gal/capita day)	4.1
Showers (2.5 gpm x 4.8 minute)	12.0
Baths (50 gal/bath x .14 bath/capita day)	7.0
Faucets (Estimated)	9.0
Dishwasher (13 gal/load x .17 load/capita day)	2.2
Washing machine (50 gal/load x .30 load/capita day	15.0
Subtotal	58.9
Evaporative cooling	20.0
Water softening	5.0
Total	83.9

Step 3: Compute landscape irrigation water requirements for each dwelling unit. The maximum irrigated area on each lot and restrictions on the type of turfgrass should be stipulated in the land and water use covenants and restrictions. Irrigation water requirements expressed in gallons per square foot per year for Kentucky bluegrass, Bermuda grass, Buffalo grass, ornamental trees and shrubs, and herb and vegetable gardens for selected locations in New Mexico counties are provided in Appendix C. Consumptive irrigation water requirements were computed by staff in the New Mexico State Engineer Office using the Original Blaney-Criddle Method and 30-year temperature and precipitation normals for the 1951-80 period of record. Dividing the consumptive irrigation requirements by an application efficiency of 50% for flood and sprinkler irrigation, and 85% for drip, yielded the water requirements shown in the table in Appendix C. The sprinkler irrigation efficiency reflects a worst-case condition where the application rate, frequency of irrigation, and overthrow of sprinkler spray onto sidewalks, driveways, other paved surfaces, and structures, is poorly controlled.

The total irrigation water requirement (W_2), in gallons per year, for each dwelling unit, is computed using Equation (2).

$$W_2=A_1I_1+A_2I_2+A_3I_3+A_4I_4+A_5I_5 \qquad \text{(Eq. 2)}$$

where A_1, A_2, and A_3, are the areas in square feet of (1) turfgrass, (2) trees and shrubs, and (3) herb and vegetable gardens, that are irrigated by flood or sprinklers on one lot; and I_1, I_2, and I_3 are the corresponding flood or sprinkler application requirements in gallons per square foot per year which are obtained from the table in Appendix C; A_4 and A_5 are the areas in square feet of (4) trees and shrubs, and (5) herb and vegetable gardens, that are irrigated by drip; and I_4 and I_5 are the corresponding drip application requirements in gallons per square foot per year.

Step 4: Compute water requirements for ornamental ponds, water gardens, and swimming pools, for each dwelling unit. The calculation of these water requirements includes: volume of pool, number of times pool is completely drained and refilled in one calendar year, surface area, net evaporation rate, and makeup water for evaporation losses. Each dwelling unit will not necessarily have any recreational water facilities; and in regions that experience cold winters, small water bodies may be iced over for several months. These factors should be taken into consideration in the calculation. The total water requirement for these recreational water facilities (W_3), in gallons per year, for each dwelling unit, is computed using Equation (3).

$$W_3=(NPU)/(NDU)[(NR)(V)+(SA)(ENR)(7.48\ gal/ft^3)] \qquad \text{(Eq. 3)}$$

where NPU is the number of pool units; NDU is the number of dwelling units; SA is the average surface area of the pool in square feet; ENR is the net evaporation rate in feet per year; NR is the number of complete refills in one calendar year; and V is the volume of the pool in gallons.

If pan evaporation data is available for the area under study, the gross evaporation for a small water body may be computed by multiplying the pan evaporation by a coefficient of 0.85. The annual gross evaporation may also be estimated by reading values from isopleths drawn on maps prepared by the U.S. Natural Resources Conservation Service (formerly the U.S. Soil Conservation Service) and other agencies. The isopleths normally represent annual evaporation from a large water body such as a lake or reservoir. Since small water bodies have a higher evaporation rate, the value taken from the isopleth should be divided by 0.70 to yield the pan evaporation; multiplying the pan evaporation by 0.85 will yield the gross evaporation for a small water body. The normal annual rainfall may be obtained from long-term weather data (e.g. 30-year normals) published by the National Oceanic and Atmospheric Administration or by reading values from isopleths on precipitation maps. Subtracting the rainfall (R) from the gross evaporation rate (EGR) yields the net evaporation rate (ENR=EGR-R).

Step 5: Compute the total maximum allowable water use for each dwelling unit.

$$W_4 = (W_1+W_2+W_3) \qquad \text{(Eq. 4)}$$

Step 6: Compute the total maximum allowable water use for all dwelling units.

$$W_5 = (NDU)(W_4) \qquad \text{(Eq. 5).}$$

Step 7: Compute fire fighting water requirements. Water requirements for fire suppression have a significant impact on sizing the distribution system components, including water lines, appurtenances, and storage facilities. The ideal way to develop a fire suppression system is to construct a distribution system that will serve the short and long-range development of the service area so that fire protection will be adequate at full development. Needed fire flow (NFF) is defined as the rate of water flow at a residual pressure of 20 pounds per square inch (psi) and for a specified duration, that is necessary to control a major fire in a specific structure (American Water Works Association, 1989, pp. 1-2). Assuming one structural fire in the subdivision per year, the total water requirement for fire suppression (W_6), in gallons per year, is computed using Equation (6):

$$W_6=(NFF)(T) \qquad \text{(Eq. 6)}$$

where NFF is the needed fire flow in gpm; and T is the duration in minutes.

Needed fire flows can be easily calculated using the Insurance Services Office (ISO) methodology which is widely accepted throughout the United States. The ISO is a nonprofit association of insurance companies which provides statistical, actuarial, and survey information for numerous affiliated insurance companies; it compiles data that are used to establish rates for fire protection policies for both residential and commercial properties; and it sets standards for public fire protection systems to minimize the loss of life and property.

For one- and two-family dwellings not exceeding two stories in height, the NFF shown in Table 2 should be used assuming a minimum duration of two hours (120 minutes). For other habitable buildings such as apartments, condominiums, and townhouses, the procedure in Appendix D should be used.

Table 2. Needed fire flow (NFF) for one- and two-family dwellings based on Insurance Services Office standards.

Distance Between Buildings (ft)	Needed Fire Flow (gpm)
Over 100	500
31-100	750
11-30	1000
Less than 11	1500

Step 8. Compute the maximum annual water requirement for the subdivision. Distribution system losses in small water systems typically range from 5-10% of the total withdrawal (American Water Works Association, 1993, p. 2-4; Prasifka, 1988, p. 50). For design purposes, 5% losses may be assumed for subdivisions with less than 50 homes; and 10% losses for subdivisions with more than 50 homes. Distribution system losses do not apply to water requirements for fire fighting because of the short duration (typically 2 hours) of this water demand. The maximum annual water requirement (W_7) in gallons per year, for all purposes in a subdivision, is computed using Equation (7).

$$W_7=[(W_5)/E_c]+W_6 \qquad \text{(Eq. 7)}$$

where E_c is the conveyance efficiency of the distribution system expressed as a decimal. For subdivisions with less than 50 homes, E_c is 0.95; and for more than 50 homes E_c is 0.90.

Water requirements for other uses such as guest houses, day care centers, dormitories, cafeterias, health spas, parks, greenbelts, playing fields, golf courses, and other community facilities; and livestock watering, should be estimated separately using the same concepts presented in the procedure in this section. These water requirements are subject to the application of the conveyance efficiency factor, E_c, and should be included in the estimate of the maximum annual water requirement, (W_7).

7.2.1. Example Calculation of Maximum Allowable Subdivision Water Use

The application of the method to estimate water demands and maximum allowable subdivision water use is illustrated for hypothetical subdivisions in Taos and Las Cruces as follows:

(1) Indoor water use, normal household purposes

(a) Taos (3 occupants, no evaporative cooler or water softener)
60 gpcd
65,700 gallons per year
(0.20 acre-feet per year)

(b) Las Cruces (3 occupants, with evaporative cooler and water softener)
85 gpcd
93,075 gallons per year
(0.29 acre-feet per year)

(2) Landscape water use, per dwelling unit. Landscape water use for 1,600 square feet of sprinkler irrigated Kentucky bluegrass (Appendix C) will vary from:

(a) Taos — 48,200 gallons per year (0.15 acre-feet per year)

(b) Las Cruces — 89,400 gallons per year (0.27 acre-feet per year)

(3) Other outdoor water use, per dwelling unit — None

(4) Total maximum water use per dwelling unit, exclusive of fire flow requirements.

(a) Taos — 113,900 gallons per year (0.35 acre-feet per year)

(b) Las Cruces — 182,475 gallons per year (0.56 acre-feet per year)

(5) Total maximum allowable water use for all dwelling units, assuming 20 homes.

(a) Taos — 2,278,000 gallons per year (6.99 acre-feet per year)

(b) Las Cruces — 3,649,500 gallons per year (11.20 acre-feet per year)

(6) Water demands for other water uses, such as guest houses, day care centers, dormitories, cafeterias, health spas; parks, greenbelts, playing fields and golf courses; and livestock watering, shall be estimated separately. For this example, these are assumed to equal — 0 gallons

(7) Water demands for fire fighting, assuming NFF is 500 gallons per minute for 120 minutes — 60,000 gallons

(8) Total maximum allowable subdivision water use for the 20 dwelling units assumed in this example is the sum of Items (5) and (6) divided by an assumed conveyance efficiency of 0.95 plus Item (7).

(a) Taos — 2,397,895 gallons per year (7.36 acre-feet per year)

(b) Las Cruces — 3,841,579 gallons per year (11.79 acre-feet per year)

7.3. Shared Well

Water requirements for small clusters of homes (generally 6 or less) which are served by a shared well may be computed using the same procedure outlined for Community Water Systems. For small subdivisions, water requirements for fire suppression may not be necessary if a fire department located within close proximity will provide emergency service and can do so in a timely manner. In addition, distribution system losses may be considered negligible for design purposes. Because the total diversion from a Section 72-12-1 domestic well that serves a cluster of homes cannot exceed 3 acre-feet in any calendar year, the question which may need to be answered is how much water will be available to each lot owner for landscape irrigation and other outdoor water uses. To make this determination, the following procedure is used.

Step 1: Determine a reasonable occupancy rate for the proposed dwelling units.

Step 2: Compute total indoor water requirements (W_8), in gallons per year, for the dwelling units using Equation (8).

$$W_8=(NDU)(CPU)(GPCD)(365\ days/yr) \qquad \text{(Eq. 8)}$$

Step 3: Compute the amount of water (W_9), in gallons per year, that could be used for landscape irrigation on each lot using Equation (9). The diversion from each well which serves a cluster of homes cannot exceed 3 acre-feet per year, or 977,553 gallons per year.

$$W_9=(977{,}553\ gal/yr-W_8)/(NDU) \qquad \text{(Eq. 9)}$$

Step 4: Compute the maximum area, in square feet, that can be used by a lot owner for landscape irrigation using Equation (10).

$$A_x=(W_9/I) \qquad \text{(Eq. 10)}$$

where A_x is the area in square feet that is irrigated by flood or sprinklers on one lot; and (I) is the flood or sprinkler application requirement in gallons per square foot per year for a specific type of vegetation and locale shown in the table in Appendix C. The higher the value of (I), the smaller the area which can be irrigated; and conversely, the lower the value of (I), the greater the area which can be irrigated. Using the (I) for Kentucky bluegrass, which has the highest water requirement, will result in the smallest area that can be irrigated with the amount of water available.

Step 5: Compute the maximum area, in square feet, that can be used for landscape irrigation using the procedures presented earlier computing limitations on maximum allowable subdivision water use.

Step 6: The maximum allowable area, in square feet, that can be used for landscape irrigation is the lesser of the areas computed using Steps 4 or 5 above.

7.4. Methods for Limiting Maximum Allowable Subdivision Water Use

Water use in the proposed subdivision should be limited to the maximum allowable subdivision water use, either by regulating metered water deliveries or by limiting outdoor water use. Enforcement would be by county regulation, if applicable, or by land and water use covenants. In cases where subdivision water supplies will be provided from new appropriations of groundwater or individual domestic wells within declared underground water basins, and provided that statutory criteria are met, the water right permit may be issued by the State Engineer in an amount not to exceed the maximum allowable subdivision water use approved for the subdivision. SEO recommended guidelines permit the subdivider and County to specify methods of ensuring compliance with the maximum allowable subdivision water use. There are three options for limiting the maximum annual water use of a subdivision which may be considered by the County and the subdivider.

Method A: Water supplies to the subdivision and to each dwelling unit limited only by metered water deliveries. Under Method A, the total amount of water provided to each lot in the subdivision in any year would be limited to the total maximum water use, as computed in Section 7.2.1. Each lot purchaser would be allowed to use water for whatever purpose he chooses within the permitted amount, including any distribution of outdoor landscaping and, possibly, pools or ornamental water bodies. Other than the limitation on water use, covenants would not be required.

Method B: Water supplies to the subdivision and to each dwelling unit limited by the adoption of a standard water conservative landscape covenant for the subdivision, or as may be adopted by the County. The maximum irrigated area on each lot (e.g., 1,600 square feet for single family detached dwellings) and restrictions on the type of turfgrass and other types of vegetation must be included in the water demand analysis, and stipulated in the disclosure statement and in the land and water use covenants and restrictions. Examples of such criteria and ordinances are included in Appendix A.

Method C: Recommended allowable subdivision water use based on an allocation meeting water conservation criteria with detailed design provisions regarding landscape water use and detailed restrictive covenants. Under Method C, the subdivider would submit a detailed landscape plan (generally from a landscape architect) including area designations for plant groups with similar light and water requirements, layout of irrigation system, and calculation of irrigation water requirements. Components of such use would be calculated by the subdivider based on the SEO tables of irrigation water requirements. The maximum irrigated area on each lot and restrictions on the type of turfgrass and other types of vegetation must be included in the water demand analysis, and stipulated in the disclosure statement and in the land and water use covenants and restrictions. Such designs may result in a lower demand for water than the SEO recommended maximum allowable, and are generally intended to make the maximum possible beneficial use of a limited supply.

8. DESIGN REQUIREMENTS FOR COMMUNITY WATER DISTRIBUTION SYSTEMS

The water distribution system internal to the development shall be sized to meet both the initial and future demands for the proposed development. Oversizing for future extensions may be required. In constructing the internal water distribution system, the following design provisions are recommended.

8.1. Design Flow

A water utility must continue to serve its customers during a fire. The Insurance Services Office recommends that the fire suppression system be able to operate with the remainder of the potable water system operating at the maximum daily rate (Lindeburg, 1986, p. 7-16). Therefore, the distribution system shall be sized for maximum daily demand plus the fire flow requirement, or, maximum hourly demand, whichever is greater (American Water Works Association, 1989, p. 16).

8.1.1. Average Day Demand. The average of the total amount of water used each day during a 1-year period. The average daily demand (Q_{AD}) in gallons per day (gpd) and in gallons per minute (gpm) is computed using Equation (11a) and Equation (11b) respectively.

$$Q_{AD} \text{ in gpd} = (W_5)/(365 \text{ days/yr}) \qquad \text{(Eq. 11a)}$$

$$Q_{AD} \text{ in gpm} = (W_5)/(525{,}600 \text{ min/yr}) \qquad \text{(Eq. 11b)}$$

8.1.2. Maximum Day Demand. The maximum total amount of water used during any 24 hour period in a 3-year period. Maximum daily demand (Q_{MD}) is typically 1.5-2.0 times average daily demand (Lindeburg, 1986, p. 7-17); and for design purposes, shall not be less than 1.5 times the average daily demand. It is important that the multiplier used is justified by the registered professional engineer designing the water supply system. The maximum daily demand (Q_{MD}) in gpd and gpm is computed using Equation (12a) and Equation (12b) respectively.

$$Q_{MD} \text{ in gpd} = (F_{MD})(Q_{AD} \text{ in gpd}) \qquad \text{(Eq. 12a)}$$

$$Q_{MD} \text{ in gpm} = (F_{MD})(Q_{AD} \text{ in gpm}) \qquad \text{(Eq. 12b)}$$

where F_{MD} is the demand multiplier for the maximum daily demand.

8.1.3. Maximum Hour Demand. The maximum amount of water used in any single hour, of any day, in a 3-year period. Maximum hourly demand (Q_{MH}) is typically 2.0-6.0 times average daily demand; and for design purposes, shall not be less than 2.0 times the average daily demand. It is important that the multiplier used is justified by the registered professional engineer designing the

water supply system. The maximum hourly demand (Q_{MH}) in gpm is computed using Equation (13).

$$Q_{MH} \text{ in gpm} = (F_{MH})(Q_{AD} \text{ in gpm}) \qquad \text{(Eq. 13)}$$

where F_{MH} is the demand multiplier for the maximum hourly demand.

8.1.4. Maximum Day Plus Fire Flow. The aggregated demand for maximum daily demand plus fire flow (Q_{MDF}) in gpm is computed using Equation (14).

$$Q_{MDF} \text{ in gpm} = Q_{MD} + NFF \qquad \text{(Eq. 14)}$$

8.2. Pipe Flow Velocity

Velocities in water distribution lines typically range from 5-10 feet per second (fps) at the design flow rate (Gagliardi, 1992, p. C.21; Tullis, 1989, p. 22). Pipe flow velocities are limited by design to avoid a number of potential operating problems. If the velocity is less than 3.0 fps, problems may occur due to suspended solids settling out or trapped air that cannot be removed. However, velocities in pump suction lines must be kept low enough to maintain the pump's required net positive suction head (NPSH). On the other hand, high velocities may cause cavitation and erosion of the pipe wall or liner, water hammer which may damage pumps and valves, and increase pumping costs. **Design criteria published by the Crane Company (1988, p. 3-6) suggest that pipe flow velocities of up to 7 fps are reasonable for municipal water distribution lines.** The pipe flow velocity in the service line from the distribution water main to the customer water meter should not exceed 15 fps (American Water Works Association, 1975, p. 48)

8.3. Pressure

The pressure in the distribution system is affected by the water demand in the area; size of mains and design of the distribution grid system; elevation of the main and the customer's piping; distance from the utility's pumps; and pressure zones (American Water Works Association, 1975, p. 38). The system should be designed to maintain a minimum pressure of 20 psi at ground level at all points in the distribution system under all conditions of flow. If future connection to a different supply system is anticipated, critical pressure in that system may be used as initial design pressure. See also Section 6.5.1 on **Pressure Reduction** for more on this subject.

8.4. Sizing Pipelines

The purpose of the design flow analysis is to determine the minimum acceptable inside diameter of each segment of the piping system that will accommodate the design flow rate while maintaining the pressure drop and flow velocity within reasonable limits (Casiglia, 1992, p. B.63). Except for short cul-de-sacs, the minimum size of water mains that must provide required fire flows at fire

hydrants, is 6 inches in diameter (American Water Works Association, 1989, p. 19; Great Lakes Upper Mississippi River Board, 1987, p. 111). Where the external supply or pressure is not adequate to meet requirements, larger pipe diameter, parallel or looping lines, or additional storage or pumping shall be provided to meet requirements (Boulder County Land Use Department, 1995, p. 7-4.). If friction head losses are ignored, an initial estimate of the required inside pipe diameter (D) in inches, is computed using Equation (15).

$$D=(0.6393)(Q/V)^{0.5} \qquad \text{(Eq. 15)}$$

where Q is the maximum daily demand plus the fire flow requirement in gpm, or, the maximum hourly demand in gpm, whichever is greater; and V is the flow velocity in the pipe in feet per second.

8.5. Hydrant Flow Rate and Location

The minimum flow rate for each fire hydrant shall be 500 gpm. A higher flow rate may be required to suppress fires at multiple-family dwellings such as apartments and condominiums. The maximum distance between hydrants, as measured along the roadway, should not exceed 300 ft in high density residential areas and 600 ft in areas of moderate density (American Water Works Association, 1989, p. 20). In low density areas where homes are built on large lots spacing criteria adopted by the authority having jurisdiction may permit up to 1,000 ft between hydrants along the roadway. However, no lot should be more than 500 ft from the nearest hydrant, in any area. Hydrants should be installed at each street intersection; in the middle of long blocks, particularly when required flow exceeds 1,300 gpm; and near the end of long dead-end streets. The planning of hydrant locations should be a cooperative effort between the water utility and the fire department.

8.6. Storage

New water systems should be designed with sufficient treatment and storage capacity to meet the maximum daily demand plus the required fire flow for the specified duration. Distribution storage equalizes demands on supply sources, production works, and transmission and distribution mains. As a result, the sizes or capacities of these components need not be so large. In addition, system flow and pressures are improved and stabilized to better serve customers throughout the service area; and reserve supplies are provided in the distribution system for emergencies, such as fire fighting and power outages. In normal system operations, some water from storage should be used each day not only to maintain uniformity in production and pumping, but also to ensure circulation of the stored water (American Water Works Association, 1989, p. 24). Storage in the distribution system is normally brought to full capacity each night and is increased during low-demand periods of the day. By pumping at night, water utilities can take advantage of reduced electrical rates for off-peak power.

8.7. Adequacy and Reliability of System

A water supply system is considered to be fully adequate if it can deliver the required fire flows to all points in the distribution system with usage at the maximum daily rate. When the delivery is also possible with the most critical limiting component out of service for a specified length of time, depending on the type of component, the system is considered to be reliable (American Water Works Association, 1989, p. 32).

Distribution system components are often taken out of service for maintenance. In addition, system components fail on occasion. For this reason, utilities should construct their distribution systems with loops, backup pumps, backup power supplies, and storage tanks so that if any component fails or is out of service the effect on the availability of water is minimized.

9. WATER RIGHT REQUIREMENTS AND LIMITATIONS

9.1. Doctrine of Prior Appropriation

In New Mexico, water resources are administered under the Doctrine of Prior Appropriation. A person who takes water and applies it to beneficial use is an appropriator; and the taking of the water constitutes the appropriation, which includes a priority date. This priority entitles the appropriator to receive a full appropriation before those with junior, or more recent water rights receive their appropriations.

9.2. Owning a Water Right

All natural waters in streams and watercourses, or underground, belong to the public and are subject to appropriation. An appropriation water right, like equipment or furniture, is considered property and can be separated from the land and transferred to another location subject to statutory requirements. The appropriator "owns" only the right to use the water and not the "corpus," or body of water itself. Beneficial use is the basis, the measure and the limit of the right and priority in time gives the better right. All beneficial uses are considered equal regardless of the value resulting from the use. Municipalities, county governments, and certain other political subdivisions of the state may condemn water rights for public purposes provided that this action is approved by the court and original owners are reasonably compensated.

9.3. Obtaining a Water Right

To obtain a right, an application must be filed with the State Engineer for a permit to appropriate water. The applicant must specify the source of water, purpose and place of use, point of diversion, and amount of water to be used. After the application is filed, the applicant presents all essential facts in a legal notice which is published in a newspaper circulated in the area where the water will

be appropriated, once a week for 3 consecutive weeks. Protests to the application must be filed with the State Engineer within 10 days of the last date of the published notice. If a protest is filed, a hearing may be required before the State Engineer before the application is acted upon. An application will be denied if unappropriated water is not available, if the new use will impair existing water rights, or would be contrary to the conservation of water in the state, or detrimental to the public welfare of the state. If the State Engineer concludes that unappropriated water is available and that other criteria are met, the application is approved and it becomes a permit to appropriate water. The permit states when construction should be completed and when the water will be applied to beneficial use. The completion deadline depends on the size and complexity of the project; and an additional period of time may be allowed for the application of water to beneficial use. When construction is completed, or at the construction deadline, the site is inspected, and a certificate of completion is issued provided that all requirements are met.

This procedure applies to all surface waters, but only to ground water in declared underground basins. When the State Engineer finds that the water of an underground source has reasonably ascertainable boundaries, he can assume jurisdiction over the appropriation and use of such water by declaring the basin. Within a declared underground water basin, no well may be drilled without a permit and drilling may be done only by a well driller licensed by the State Engineer Office. The State Engineer declares and extends basins to protect prior appropriations, to guarantee the water's beneficial use and to ensure the orderly development of the resource. A basin may be declared without prior notice, however, after declaring the basin, a public hearing is required on the declaration within a specified time. The State Engineer has no jurisdiction outside declared underground basins, except to prevent waste. Declaring a basin has no effect on water rights initiated before the declaration date. After that date, however, those wanting a water right or wanting to drill additional wells to fulfill an existing right must apply to the State Engineer for a permit. If the water in a basin has been fully appropriated, no new water rights can be issued. The important effect of declaring an underground basin is that applicants bear the burden of proof to show that unappropriated water is available and that the appropriation will not impair existing surface or groundwater rights, would not be contrary to the conservation of water in the state, or detrimental to the public welfare of the state. Water right owners outside the underground basin boundaries are protected by the appropriation doctrine. If they believe their water right may be impaired, they have recourse to the courts, not the State Engineer.

Applications to appropriate small amounts of underground water for individual domestic use, livestock watering, public works projects such as the construction of highways, and mineral exploration, are exempt from normal administrative procedures which require the advertisement of the application and public hearings, except where there are judicial constraints imposed by state or federal courts. The diversion from a well permitted for any of these purposes is limited to a maximum of 3 acre-feet in any year.

9.4. Quantifying a Water Right

The amount allocated to a new right depends on reasonable need and water availability. For community water systems that will be supplied by groundwater, consideration should be given to economic constraints, maintenance requirements, and limitations of aquifer performance, that may effect the feasibility of pumping a well continuously for extended periods of time. It may also be prudent to provide a margin of safety in the determination of the sustainable yield which allows for some diminishment in well yield over time. Therefore, as a matter of practicality, the diversion right for some community water systems may be taken as a percentage of the production capacity of the existing well, provided that this value does not exceed the amount of water specified in the water right application.

9.5. Changing Ownership

If the seller of a parcel of land has water rights that the buyer expects to obtain with the property, the buyer should require that the water right be conveyed in the property deed and that all documents related to the water right be conveyed to the buyer. Under a 1996 state law, the buyer must file a change of ownership form in the State Engineer Office and then at the county clerk's office in the county where the water right is located. Those who inherit or purchase water rights must also complete and file a change of ownership form.

9.6. Separating a Right from the Land

Although the right to water is conveyed with the sale of irrigated land, unless reserved in the deed, a water right can be sold separately from the land and applied to a new use in another area provided that the transfer will not impair other rights in the move-to location, would not be contrary to the conservation of water in the state, or detrimental to the public welfare of the state.

9.7. Changing the Place or Purpose of Use

A water right transfer does not always mean a new owner. A transfer can mean that the owner wants to change the use of the water, the amount of the allocation, or the location of a well under a recognized right. Changes in place and purpose of use or changing the location of a well require filing an application with the State Engineer and proof that the change will not impair existing rights, would not be contrary to the conservation of water in the state, or detrimental to the public welfare of the state.

9.8. Specification of Water Right and Water Use Limitations in Disclosure Statements

County subdivision regulations usually require that the subdivider's disclosure statement include any limitation, physical or legal, anticipated for each water use. The content of these statements will depend upon the classification of the proposed water supply system.

9.8.1. Individual Domestic Well. For subdivisions where each lot purchaser will be responsible for drilling their own well the following text should be included in the disclosure statement: *The State Engineer will grant a domestic permit under Section 72-12-1 NMSA 1978 only to the person, who in good faith, intends to use the well for household or other domestic purpose. The permit is limited to the maximum allowable water use stated herein. If the total withdrawal is to exceed 3 acre-feet per annum from any well or group of wells that supply a common system, it will be necessary for the subdivider or users to obtain water rights.*

9.8.2. Shared Well. For subdivisions where the subdivider or homeowners will drill one or more wells each which will serve a cluster of homes (generally 2-6), it is important that all parties understand that the State Engineer does not grant domestic well permits to supply clusters of lots in any subdivision in the name of the subdivider or developer. The following text should be included in the disclosure statement: *A "conditional Section 72-12-1 NMSA 1978 well" may be drilled in the name of the developer (Article 1-15.5, Groundwater Rules and Regulations) after State Engineer approval of an application. This will allow the well to be drilled and tested but no water may be diverted for any use. Upon the sale of the lot on which the well is located, the owner may file application under Section 72-12-1 (Article 1-15.5, Groundwater Rules and Regulations), specifying the lots to be served from the well. The State Engineer will grant the application previously described, with a requirement that the well be metered and reports of use will be required to be submitted to the State Engineer on at least a quarterly if not monthly basis. The diversion from the well will be limited to a maximum of 3 acre-feet in any year.*

To ensure that the total amount of water diverted in any calendar year from a well which provides water to more than one lot does not exceed 3 acre-feet, the subdivider's disclosure statement should also include a restriction on the total area, expressed in square feet, that a lot owner can plant in lawn grasses, ornamental shrubbery and trees, and gardens, which would require irrigation; and prohibit hot tubs, swimming pools, and ponds or water gardens, where the area irrigated (square feet) is the maximum permitted under the criteria adopted. And finally, the total amount of water each lot owner will be entitled to should be specified. The entitlement is determined by dividing the domestic water right by the number of residential connections served by each individual well. However, in counties where more stringent restrictions have been placed on the amount of water each lot owner can use in any calendar year, if the entitlement allowed by the county is less than the result of the previous calculation, the lower figure should be specified in the disclosure statement.

9.8.3. Community Water System. For subdivisions where groundwater will be diverted from one or more wells exclusive of those permitted under Section 72-12-1 NMSA 1978, or where surface water will be diverted to supply the subdivision, proof of an existing water right sufficient in quantity to meet the water demand in the subdivision shall be provided in the development plan and the maximum annual water requirement and limitation of the right shall be included in the disclosure statement. This statement may be written as follows: *Proof that (name of subdivider) is owner of (number of acre-feet) of water rights that will meet the requirements of the proposed subdivision is included in (identify section) of the development plan.*

9.8.4. Extended Community Water System. For subdivisions where water is diverted from the distribution mains of an established water purveyor, a letter of intention indicating that the water purveyor is ready, willing, and able to provide water, and proof of a valid water right sufficient in quantity to meet the water demand of its current customers as well as the new subdivision shall be provided in the development plan; and the highest annual water use recorded by the water purveyor during the most recent 3 years, the maximum annual water requirement for the new subdivision, and the limitation of the right, shall be included in the disclosure statement. This statement may be written as follows: *Data provided by (name of water purveyor) indicate that the maximum annual water requirement for current customers is (number of acre-feet) per year and the maximum annual water requirement for (name of new subdivision) is estimated at (number of acre-feet) per year, which brings the total demand to (acre-feet) per year. Proof that (name of water purveyor) is owner of (number of acre-feet) of water rights that will meet both existing commitments and the requirements of the proposed subdivision is included (identify section) of the development plan.*

9.8.5. Metering Requirements. The following text should also be included in the disclosure statement where applicable. *In declared underground water basins, for any well which serves two or more connections, a totalizing meter must be installed before the first branch of the discharge line from the well and the installation shall be acceptable to the State Engineer. A written document shall be submitted to the State Engineer with the name of the manufacturer, model, serial number, date of installation, and initial reading of the meter prior to appropriation of water; and records of the amount of water diverted shall be submitted quarterly to the State Engineer Office on or before the 10th of January, April, July and October of each year.*

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Appendix A

Model Ordinances Governing Landscape Design Requirements

Marin Municipal Water District, California
City of Palo Alto, California

ORDINANCE NO. 326

MANUAL

FALL 1991

marin municipal water district

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MARIN MUNICIPAL WATER DISTRICT

ORDINANCE NO. 326

AN ORDINANCE REVISING WATER CONSERVATION REQUIREMENTS

BE IT ORDAINED BY THE BOARD OF DIRECTORS OF THE MARIN MUNICIPAL WATER DISTRICT AS FOLLOWS:

Section 1. Section 11.04.080 of the Marin Municipal Water District (MMWD) Code is repealed and Chapter 11.60 is added to Title 11 of the District's code to read as follows:

11.60.010 Purpose. All applicants for new, increased, or modified service shall comply with the requirements set forth in this chapter in addition to those set forth in Chapter 11.04 of this Code as a condition of receiving service.

11.60.020 Definitions. Definitions used in this chapter are as follows:

(1) **Developed landscape area:** All outdoor areas under irrigation, surrounding hardscape areas, swimming pools, and decorative pools and fountains.

(2) **Hardscape:** Patios, decks and paths. Does not include driveways and sidewalks.

(3) ***High-water-use plants:*** Annuals, plants in containers, and plants not on MMWD's list of low-water-use plants.

(4) **Landscape Plans:** This includes a planting plan, an irrigation plan, and a grading plan. All plans must be drawn at a scale that clearly and accurately identifies plants, irrigation layout, equipment, and finish grades. Landscape plans shall include the following:

(A) **Planting Plan:** Planting plans must accurately identify and locate, but are not limited to the following:

(i) New and existing trees, shrubs, groundcovers and turf areas within the developed landscape area;

(ii) Plants by botanical name, common name, container size, spacing and quantities;

(iii) Property lines, streets and street names;

(iv) Driveway(s), sidewalk(s) and other hardscape features as necessary;

(v) Pool(s), fountain(s), fence(s) and retaining wall(s);

(vi) Existing and proposed buildings;

(vii) The square footage(s) of the various landscape hydrozones on the plan. Hydrozones are separate portions of the landscape area having plants with similar water needs that are served by a valve or set of valves with the same setting. These hydrozones include, but are not limited to turf, high-water-use plants with overhead irrigation, low-water-use plants with overhead irrigation, drip irrigation and fountain and pool areas. If more than one water meter serves the site, the individual hydrozones must be identified with the meter providing water service.

(B) Irrigation Plan: The irrigation plan shall be drawn at the same scale as the planting plan. The irrigation plan will be separate from but in the same format as the planting plan. The irrigation plan shall show but not be limited to the following:

(i) Irrigation system point of connection;

(ii) Water service pressure at point of irrigation system connection;

(iii) Water meter size;

(iv) Backflow prevention devices;

(v) Major components of the irrigation system;

(vi) Total precipitation rate in inches per hour for each overhead irrigation circuit;

(vii) Total flow rate (gph) and operating pressure (psi) for each irrigation circuit;

(viii) Irrigation legend will have the following elements: Symbols for various irrigation equipment, general description of equipment, manufacture name and model number, operating pressure, manufacturer's irrigation nozzle rating in gallons per minute (gpm) or gallons per hour (gph) as necessary, minimum and maximum spray radius, manufacturer's rated precipitation rate per nozzle;

(ix) Reclaimed water piping and guidelines as required.

(C) Grading Plan: The grading plan shall be drawn at the same scale as the planting and irrigation plan. The grading plan must show all finish grades,

spot elevations as necessary and existing, and new contours within the developed landscape area.

(5) **Landscape Architect:** A person who holds a certificate to practice landscape architecture in the state of California under the authority of the California State Board of Landscape Architects.

(6) **Low-water-use plants:** Plants on MMWD low-water-use plant list, or any other plant approved by MMWD. (Generally, a plant that once established, can survive on two irrigations per month during the summer months.)

(7) **Overhead Irrigation:** An irrigation method that delivers water to the landscape in a spray or stream-like manner from above-ground spray heads (includes micro-misters, does not include bubblers).

(8) **Overspray:** Water that is delivered beyond the targeted landscape area during windless hours onto adjacent pavements, walks, structures, or other non-landscaped areas during an irrigation cycle.

(9) **Runoff:** Irrigation water that is not absorbed by the soil or landscape area to which it is applied and which flows onto other areas.

11.60.030 Requirements For All Services

(1) **Pressure Regulation.** A pressure-regulating valve shall be installed and maintained by the consumer if static service pressure exceeds 80 pounds per square inch. The pressure-regulating valve shall be located between the meter and the first point of water use, or first point of division in the pipe, and set at not more than 50 pounds per square inch when measured at the most elevated fixture in the structure served. This requirement may be waived if the consumer presents evidence satisfactory to the District that excessive pressure has been considered in the design of water-using devices and that no water will be wasted as a result of high pressure operation.

(2) **Interior Plumbing Fixtures.** All plumbing installed, replaced or moved in any new or existing service must meet the following requirements:

(A) Toilets shall use 1.6 gallons, or less, of water per flush;

(B) Shower heads shall use 3 gallons, or less, of water per minute;

(C) Kitchen and lavatory faucets shall use 2.5 gallons, or less, of water per minute;

(D) Non-residential services with more than one showerhead or one sink (lavatory) per bathroom facility shall equip these fixtures with self-closing valves.

(3) Pool Covers. Pool covers are required for all new outdoor swimming pools.

11.60.040 Landscape Requirements For Single-Family Residences (New and Modified Landscapes).

The combined size of turf areas and swimming pools for new single family residences shall be limited to not more than 25% of the total developed landscape area. When existing landscape areas are modified by the addition of turf and/or a pool, the total combined area of the turf and pool shall be no more than 25% of the total developed landscape area.

11.60.050 Landscape Requirements For All Services Other Than Single-Family Residences (New and Modified Landscapes).

(1) Turf and Swimming Pools. The combined size of turf areas and swimming pools shall be limited to not more than 25% of the total developed landscape area in services irrigated with potable water. In landscapes irrigated with reclaimed water, the combined size of turf areas and swimming pools shall be limited to not more than 40% of the total developed landscape area. In areas designated for future reclaimed water service, the 40% turf/pool limit will be allowed only if the service will have reclaimed water available within one year of the service agreement date.

(2) High-Water-Use Plants and Features. High-water-use plants, decorative pools (non-swimming), fountains, and water features shall be limited to not more than 10% of the total developed landscape area.

(3) Other Plants. All other plantings shall be composed of low-water-use plant materials. The District may waive this requirement if sufficient evidence is presented that the site is not suitable for such plants.

(4) Irrigation Systems. All irrigated landscaped areas will be irrigated by an automatic irrigation system which meets these requirements:

(A) Electric controller with repeat start time and multiple program potential, set for irrigation between the hours of 6 pm and 11 am for potable water and 10 pm and 7 am for reclaimed water;

(B) Automatic rain shut-off unit for each controller;

(C) In areas with slopes exceeding 15%, the precipitation rate shall not exceed .85 inches per hour;

(D) Under-the-head check valves, built-in spray head check valves, or in-line check valves must be installed as needed to prevent low head drainage and puddling;

(E) Separate irrigation circuit(s) must be provided for each of the following: turf, high-water-use plants, low-water-use plants, plants on drip irrigation, planting areas with different exposures, slopes and soils with different infiltration rates;

(F) Use a point application (drip, bubbler, etc.) or subsurface irrigation system where overspray, angle of slope, soil texture, or widely spaced plants make overhead irrigation impractical due to overspray, runoff, or inefficiency. (Overhead irrigation is inefficient when less than 50% of spray pattern of any head will hit mature plants.)

(G) Overhead irrigation must meet the following additional requirements:

(i) Distance between spray heads on turf shall not exceed 55% of the spray diameter;

(ii) Distance between spray heads elsewhere shall not exceed 70% of the spray diameter;

(iii) Spray heads must be adjusted so spray radius or special pattern is within 25% of the manufacturer's rating;

(iv) Spray heads must be located so that overspray will not accumulate and flow off adjacent pavements, walkways, structures, and other non-landscaped areas during an irrigation cycle.

(v) Overhead irrigation is prohibited in median strips and parking islands less than eight feet wide;

(vi) Planted areas which are acutely angled or irregularly shaped and which are adjacent to hardscape surfaces shall not be irrigated by an overhead system unless they are at least 120% of the spray diameter of the irrigation heads being used.

(vii) Precipitation rates for all heads within each valve circuit must be matched to within 20% of one another;

(5) Soil Preparation. For overhead irrigation, soil preparation must meet the recommendations of a soils laboratory report or otherwise meet the following minimum requirements:

(A) Areas with slope ratios greater than 3:1 must be amended as recommended by a landscape architect;

(B) Areas with slope ratios of 3:1 or less must meet the following soil preparation requirements:

(i) Rip or rotary cultivate existing soil to a depth of *six (6) inches;*

(ii) Incorporate an organic amendment at the rate of 5 cubic yards per 1000 square feet into the top six (6) inches of soil.

(6) Mulching. All exposed soil surfaces of non-turf areas within the developed landscape area must be mulched with a minimum two (2) inch deep layer of organic material.

(7) Plan Review, Certification and Site Inspections.

(A) Plan Review and Certification.

(i) For all services other than single family residences, applicants shall obtain approval for landscape plans for new or modified landscapes from MMWD before construction begins.

(ii) All landscape plans submitted must be certified by a landscape architect that they are in compliance. The landscape architect must also sign and return a District checklist *indicating* compliance with District requirements. Each page of plans must also be stamped to certify compliance.

(B) It shall be the responsibility of the owner or the owner's agent to:

(i) Schedule a site inspection with a landscape architect prior to installation of the irrigation system. The inspection is to verify that the installing contractor is using District approved plans for the site and that the soil preparation requirements of this section have been met. The landscape architect must complete and submit to the District a District verification form within 10 days of this inspection;

(ii) Schedule an inspection with a landscape architect within 10 days of completion of work to verify compliance with the approved landscape plans. The landscape architect must complete and submit to the District a District verification form within 10 day of this inspection.

(C) District reserves the right to perform site inspections at any time before, during, or after irrigation system and landscape installation and to require corrective measures if requirements of this ordinance are not satisfied.

11.60.060 Other Provisions.

The District will consider and may allow the substitution of well-designed conservation alternatives or innovations which may equally reduce water consumption for any of the forgoing requirements of this chapter.

Section 2. The severability provisions of sections 1.10.110 of the Marin Municipal Water District Code are applicable to this Ordinance.

PASSED AND ADOPTED THIS 28th DAY OF August 1991, by the following vote of the Board:

AYES: Boessenecker, Cronin, Miller, Morrison, Wray

NOES: None

ABSENT: None

Charles Wray

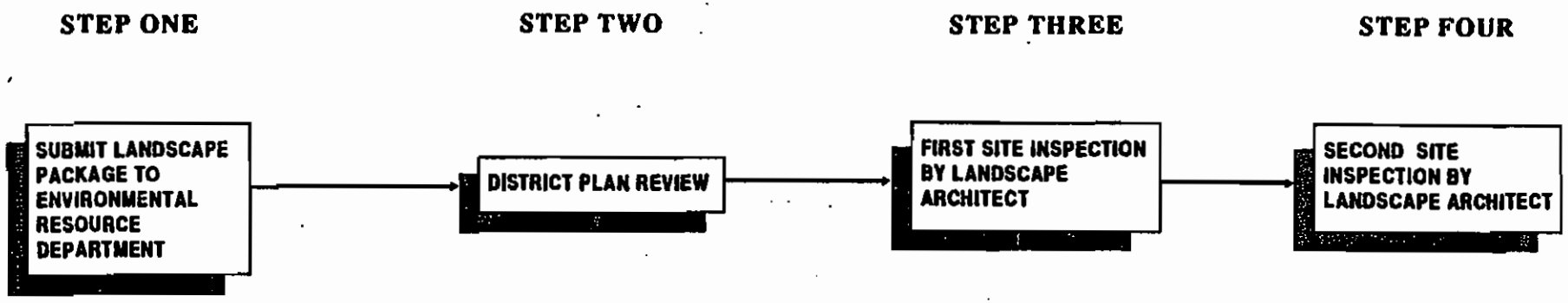
President, Board of Directors

ATTEST:

Jules Thom

Secretary, Board of Directors

LANDSCAPE CERTIFICATION PATHWAY FOR ORDINANCE 326



LANDSCAPE CERTIFICATE PATHWAY

APPENDIX C
FIGURE 1
(EFFECTIVE 10/91)

MARIN MUNICIPAL
WATER DISTRICT

220 Nellen Avenue
Corte Madera, CA 94925-1169
415.924.4600
FAX 415.927.4953

LANDSCAPE ARCHITECT'S CHECKLIST & CERTIFICATION FOR ORDINANCE No. 326

LANDSCAPE PLAN REVIEW

GENERAL PROJECT INFORMATION

Please complete the following information:

DISTRICT PLAN REVIEW NUMBER: _____

PROJECT NAME: _____

PROJECT ADDRESS: _____

_____

LANDSCAPE PLAN REVIEW INSTRUCTIONS

All landscape plans submitted to the District must be certified by a landscape architect that they are in compliance with Ordinance 326. All plans must pass this review process and receive District approval before beginning construction. This checklist is for the landscape architect's review.

Please check all the boxes and fill in the appropriate blanks below. Unchecked boxes and blanks require the landscape architect to submit a written explanation why the District should consider a variance and why that requirement cannot be met.

The District will consider and may allow the substitution of well designed conservation alternatives or innovations which may equally reduce water consumption for any of the Ordinance 326 requirements. However, all written explanations, variances, substitutions, alternatives or innovations must be reviewed and approved by the District before construction begins.

An Equal Opportunity/Affirmative Action Employer

Please submit the following information to the District's Environmental Resources Division for their review:

1. **Completed Project Data Sheet (PDS).**
2. **Completed Landscape Plan Review (LPR).**
3. **One complete set of landscape plans.**

The District will notify applicant if the plans pass or fail the review. All plans that pass the review will receive a District stamp of approval on all sepia reproducible drawings before beginning construction. The plans not passing review will be resubmitted to the District until those plans do pass review.

GENERAL PLAN REQUIREMENTS

Please show plan page number(s) and drawing date of plans.

1. [ ] Planting plan(s) _____

2. [ ] Irrigation plan(s) _____

3. [ ] Grading plan(s) _____

IRRIGATION REQUIREMENTS:

1. [ ] The irrigation plan is drawn at the same scale as the planting plan. The irrigation plan is separate from but in the same format as the planting plan.

2. The irrigation plan has the following information:
   a. [ ] Irrigation system point of connection;
   b. [ ] Water service pressure at point of irrigation system connection;
   c. [ ] Water meter size;
   d. [ ] Backflow prevention device(s);
   e. [ ] Major components of the irrigation system;
   f. [ ] Total precipitation rate shown in inches per hour for each valve circuit using over-head irrigation.
   g. [ ] Total flow rate (GPM) and operating pressure (PSI) for each irrigation circuit.

3. Pressure regulation valve(s) are shown.
   a. [ ] A pressure regulation valve(s) is indicated where water pressure exceeds 80 psi. The water service pressure is ____ psi.
   b. [ ] A pressure regulation valve was not needed because water service pressure less than 80 psi. The irrigation design pressure is ____ psi.

4. [ ] Automatic controller with repeat start times and multiple program potential are shown on plan.

5. [ ] Automatic rain shut-off unit(s) are shown on plan for each controller.

6. [ ] Precipitation rates do not exceed .85 inches per hour on slopes exceeding 15%.

7. [ ] Check valves are shown on plan.

8. Separate irrigation circuit(s) are provided for the following:
   a. [ ] Turf;
   b. [ ] High-water use plants;
   c. [ ] Low-water use plants;
   d. [ ] Plants on drip;
   e. [ ] Exposure variations;
   f. [ ] Slope variations;
   g. [ ] Soils with different infiltration rates;
   h. [ ] Different precipitation rates.

9. [ ] Point application or subsurface irrigation systems are used where overspray, angle or slope, soil texture, or widely spaced plants make overhead irrigation impractical due to overspray, runoff, or inefficiency.

10. Irrigation legend has the following information:

    a. [ ] Symbols for all irrigation equipment;
    b. [ ] General description of equipment;
    c. [ ] Manufacturer name and model number;
    d. [ ] Operating pressure;
    e. [ ] Manufacturer's rated gpm per nozzle;
    f. [ ] Minimum and maximum spray radius;
    g. [ ] Manufacturer's rated precipitation rate per nozzle.

11. Overhead irrigation satisfies the following criteria:
    a. [ ] Distance between spray heads on turf does not exceed 55% of the spray diameter;
    b. [ ] Distance between spray heads elsewhere does not exceed 70% of spray diameter;
    c. [ ] Spray heads are adjusted so spray radius or special pattern is within 25% of the manufacturer's rating;
    d. [ ] Spray heads are located so overspray will not accumulate and flow off adjacent pavements, walkways, structures and other non-landscaped areas during an irrigation cycle;

e. [ ] Median strips and parking islands less than eight feet wide have no overhead irrigation;
f. [ ] Planted areas which are acutely angled or irregularly shaped and which are adjacent to hardscape surfaces are not irrigated by an overhead system unless they are at least 120% ofthe spray diameter of the irrigation heads being used;
g. [ ] Precipitation rates within each overhead circuit are matched to within 20% of one another.

12. [ ] All reclaimed water piping and guidelines have been met.

GRADING REQUIREMENTS:

1. [ ] The grading plan is drawn at the same scale as the planting and irrigation plans.

2. The grading plan shows the following information:

a. [ ] Finish grades;
b. [ ] Spot elevations as necessary;
c. [ ] Existing and new contours within the developed landscape area.

PLANTING REQUIREMENTS:

1. [ ] The planting plan is drawn at the same scale as the irrigation and grading plan.

2. The planting plan shows the following information:
a. [ ] New and existing trees, shrubs, groundcovers and turf areas within the developed landscape area;
b. [ ] Plant botanical name(s), common name(s), container size(s),spacing and quantities;
c. [ ] Property lines, streets and street names;
d. [ ] Driveway(s), sidewalk(s) and other hardscape features as necessary;
e. [ ] Pool(s), fountain(s), fence(s) and retaining wall(s);
f. [ ] Existing and proposed buildings;
g. [ ] Square footages for the various landscape hydrozones.

3. [ ] The combined area of turf and swimming pools does not exceed 25% of the total developed landscape area.
Note: This requirement applies only to services using potable water for irrigation.

4. [ ] The combined area of turf and swimming pools does not exceed 40% of the total developed landscape area.
Note: This requirement applies only to services using reclaimed water for irrigation.

5. [ ] This landscape is in an area designated as a **future reclaimed water service area** and will have reclaimed water available within one year of the service agreement date.

   A reclaimed water service connection date has been confirmed by the District's Reclaimed Water Section. The planting plan meets the requirements for services using reclaimed water for irrigation. Refer to Planting requirements, Item 4.

6. [ ] High-water use plants, decorative pools, fountains and water features do not exceed 10% of the total developed landscape area.

7. [ ] All other plantings are composed of low-water use plant material.

8. Planting areas with overhead irrigation with slope ratios greater than 3:1 conform to one of the following:

   a. [ ] The recommendations of a soils laboratory report and the report submitted to District for review.
   b. [ ] The recommendations of the landscape architect. Also, these recommendations can be found in either the written specifications or on the planting plan.

9. Planting areas with overhead irrigation with slope ratios less than 3:1 conform to one of the following:

   a. [ ] The recommendations of a soils laboratory report and the report submitted to District for review.
   b. [ ] Planter soils will be ripped or rotary cultivated to a depth of 6 inches and have an organic amendment incorporated into the soil at a rate of 5 cubic yards per 1000 square feet.

10. [ ] All exposed soil surfaces of non-turf areas within the developed landscape are mulched with a minimum 2 inch layer of organic material.

CERTIFICATION STATEMENT:

I hereby certify that the planting, irrigation and grading plans are accurate and follow the Marin Municipal Water District's Water Conservation Ordinance No.326.

LANDSCAPE ARCHITECT: _____

(Print Name)

ADDRESS: _____

PHONE: _____ FAX: _____

_____

State license stamp with signature

(Effective 10/91)

MARIN MUNICIPAL
WATER DISTRICT

220 Nellen Avenue
Corte Madera, CA 94925-1169
415.924.4600
FAX 415.927.4953

LANDSCAPE ARCHITECT'S CERTIFICATION STATEMENT

ORDINANCE NO. 326

FIRST SITE INSPECTION

Please complete the following information:

DISTRICT PLAN REVIEW NUMBER: _____

PROJECT NAME: _____

PROJECT ADDRESS: _____

_____

ACCESSORS'S PARCEL NUMBER: _____

LANDSCAPE SITE INSPECTION INSTRUCTIONS

It is the responsibility of the owner or the owner's agent to schedule a site inspection with a landscape architect prior to installation of the irrigation system. This checklist is for the landscape architect's first site inspection.

Please check all the boxes and fill in the appropriate blanks below. Unchecked boxes and blanks require the landscape architect to submit a written explanation why the District should consider a variance and why that requirement cannot be met.

The District will consider and may allow the substitution of well-designed conservation alternatives or innovations which may equally reduce water consumption for any of the Ordinance 326 requirements. However, all written explanations, variances, substitutions, alternatives or innovations must be reviewed and approved by the District before making changes in the field.

An Equal Opportunity/Affirmative Action Employer

The landscape architect must complete and return this certification statement form to the District's Environmental Resources Division within 10 days of inspection.

FIRST SITE INSPECTION:

1. [ ] The installing contractor has District approved planting and irrigation plans on site.

2. [ ] Soil preparation requirements have been satisfied.

CERTIFICATION STATEMENT:

I hereby certify that the above information is accurate and that this project follows the Marin Municipal Water District's Water Conservation Ordinance No.326:

INSPECTION DATE: _____

LANDSCAPE ARCHITECT: _____
(Print Name)

ADDRESS: _____

_____

PHONE:_____ FAX:_____

_____
State license stamp with signature

(Effective 10/91)

MARIN MUNICIPAL
WATER DISTRICT

220 Nellen Avenue
Corte Madera, CA 94925-1169
415.924.4600
FAX 415.927.4953

LANDSCAPE ARCHITECT'S CERTIFICATION STATEMENT FOR ORDINANCE NO. 326

SECOND SITE INSPECTION

GENERAL PROJECT INFORMATION

Please complete the following information:

DISTRICT PLAN
REVIEW NUMBER: _____

PROJECT NAME: _____

PROJECT ADDRESS: _____

_____

ACCESSORS'S PARCEL NUMBER: _____

LANDSCAPE SITE INSPECTION INSTRUCTIONS

It is the responsibility of the owner or the owner's agent to schedule a site inspection with a landscape architect within ten days of completion of work to verify compliance with the approved landscape plans. This checklist is for the landscape architect's second site inspection.

Please check all the boxes and fill in the appropriate blanks below. Unchecked boxes and blanks require the landscape architect to submit a written explanation why the District should consider a variance and why that requirement cannot be met.

The District will consider and may allow the substitution of well-designed conservation alternatives or innovations which may equally reduce water consumption for any of the Ordinance 326 requirements. However, all written explanations, variances, substitutions, alternatives or innovations must be reviewed and approved by the District before making changes in the field.

An Equal Opportunity/Affirmative Action Employer

The landscape architect must complete and submit this certification statement form to the Districts Environmental Resources Division within 10 days of inspection.

SECOND SITE INSPECTION

1. [ ] The installed landscape meets all District planting requirements. (Refer to project's Landscape Plan Review form pages 4 and 5.)

2. [ ] The installed landscape meets all District irrigation requirements. (Refer to project's Landscape Plan Review form pages 2 and 3.)

CERTIFICATION STATEMENT:

I hereby certify that the above information is accurate and that this project follows the Marin Municipal Water District's Water Conservation Ordinance No.326:

INSPECTION DATE: _____

LANDSCAPE ARCHITECT: _____
(Print name)

ADDRESS: _____

_____

PHONE:_____ FAX:_____

_____
State license stamp with signature

(Effective 10/91)

LANDSCAPE WATER EFFICIENCY STANDARDS for the CITY OF PALO ALTO

in compliance with the
STATE OF CALIFORNIA
WATER CONSERVATION
IN LANDSCAPING ACT
AB 325

Developed by the City of Palo Alto
Department of Utilities, Energy Services Section,
in cooperation with the
Department of Planning and Community Environment

March 15, l993

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CITY OF PALO ALTO
LANDSCAPE STANDARDS

I. Purpose

The purpose of these standards is to promote efficient water use through landscape design and irrigation management appropriate to Palo Alto's climate zone.

II. Applicability

A. The standards apply to new and rehabilitated industrial, commercial and institutional landscaping and all new or rehabilitated multi-family common areas.

B. Single-family residences and multi-family private areas are exempt from these standards. However, all residents are encouraged to follow them.

C. The standards do not apply to cemeteries or registered historical sites. However, landscape managers at these sites are encouraged to follow efficient irrigation system management practices as indicated in Section V.C.2.

D. The standards do not apply to any landscaping which is irrigated solely by reclaimed water and to which there is no pipeline installed to deliver potable City water.

E. School yards, parks, playgrounds, sports fields, and golf courses are exempt from a maximum water allowance. Every other requirement of these standards is applicable, including estimation of irrigation water requirements. In addition, turf areas of these sites shall have a landscape irrigation audit performed after the installation or renovation of the irrigation system.

III. Definitions

The terms used in this document have the meaning set forth below:

Common areas:
Those areas in a residential development maintained by either the developer or a homeowner's association.

Conversion factor (0.00083):
A number that converts the maximum water allowance from inches per square foot per year to units of one hundred cubic feet (CCF) per square foot per year. Water is metered and sold in Palo Alto in CCF units.

The conversion is calculated as follows:
(435.6 CCF/43,560 sq.ft.)/12 inches = 0.00083

Where 435.6 CCF = water per acre foot
43,560 sq. ft. = one acre
12 inches = one foot

Effective Precipitation:
The portion of total precipitation that is used by plants in the landscape. Precipitation is not a reliable source of water but can contribute in some degree toward the water needs of the landscape.

Estimated Applied Water
That portion of total water used in a landscape to be supplied by the City metered water supply. The estimated applied water may not exceed the maximum water allowance specified in Section IV. The Water Use Calculations form in Appendix 3 indicates one methodology acceptable for the purposes of conforming to these standards.

ET Adjustment Factor:
A factor of .8, that when applied to reference evapotranspiration, adjusts plant water requirements based on an average of plant water requirements and irrigation system efficiency.

ET_0: See, Reference Evapotranspiration

Hydrozone:
A portion of the landscaped area having plants with similar water needs in a similar microclimate. It may be served by one or more valves. A hydrozone may be irrigated or non-irrigated. For example, a naturalized area planted with native vegetation that will not need supplemental irrigation once established is a non-irrigated hydrozone.

Irrigation Efficiency:
A measurement of the amount of water beneficially used divided by the amount of water applied. Irrigation efficiency is derived from estimates of irrigation system design and management practices.

Irrigation Zone:
Same as irrigation circuit. An irrigation distribution line and associated application devices controlled by one valve.

Irrigation Zone Water Requirement:
The plant water requirement of an irrigation zone or circuit divided by the estimated design efficiency of the type and configuration of application devices in that zone. The result is expressed in CCF. Table 2 in Appendix 3 lists design efficiencies acceptable for conforming to the Landscape Standards.

Landscaped Area:
The parcel minus building pad(s), driveways, parking areas, impervious hardscapes such as decks and patios, and other non-porous surfaces. Examples of landscaped areas could include: plant areas, water bodies, porous walkways and natural areas. A natural area is one occupied by mature plants, native or acclimated plants growing on undisturbed grades, and which is not irrigated.

Landscape Coefficient:

A factor derived from analysis of plant species, planting density, and microclimate which, when compared to ET_O, results in an estimate of the amount of water required to maintain a planted area.

Table 1 in Appendix 3 lists numeric values developed through research done by Cooperative Extension, University of California, and others which are acceptable for the purposes of the Landscape Standards.

Local Annual Mean Precipitation:

The average amount of rain per year based on an average of annual rainfall over a 30-year period, in inches. The 30-year average for Palo Alto may be obtained from:

Department of Utilities, Resource Conservation
250 Hamilton Avenue
Palo Alto, CA 94301.

Maximum water allowance:

For design purposes, the upper limit of annual water use for the established landscaped area which may be supplied through City water meters as specified by the formula in Section IV.

Plant Water Requirement:

An estimate of the amount of water required to maintain an acceptable degree of health and vigor in the planting or group of plants irrigated by one valve.

Reference Evapotranspiration (ET_O):

A standard measurement of environmental parameters which affect the water use of plants. ET_O is measured in inches per day, month, or year and is derived from measurements of evapotranspiration from a test plot of four to seven-inch tall turf in an open field that is well watered.

Total Water Use:

The sum of water from the City metered water supply and also from effective precipitation estimated to be used for a landscape.

IV. Calculation of Maximum Water Allowance

A. Maximum Water Allowance

A Maximum Water Allowance (MWA) will be established for each site submitted for review:

$$MWA = (ET_O) \times .8 \times (LA) \times 0.00083$$

Where:

MWA = Maximum Water Allowance in CCF
ET_O = Annual Reference Evapotranspiration in inches for Palo Alto
0.8= Local ET adjustment factor
LA = Landscaped area in square feet
0.00083 = Conversion factor into CCF per square foot

Example for a one acre site:

$$MWA = 43.1 \times .8 \times 43560 \times 0.00083$$

$$MWA = 1246.6 \text{ CCF annual water allowance}$$

The MWA will be itemized on a Landscape Water Use Statement form provided by the City. See Appendix 1 for a sample form.

Note: For the purposes of these standards, the annual ET_o for Palo Alto may be considered to be 43.1 inches/square foot/year. Using real-time ET_o data for irrigation management after plant installation, e.g.,from the California Irrigation Management Information System (CIMIS), or other site-specific, electronically monitored, ET_o calculation system is encouraged.

B. Effective Precipitation

It is understood that rainfall may provide some or all of a landscape's water requirements during some winter months in Palo Alto's climate zone. At the option of the landscape architect or irrigation designer, landscape water use calculations may include up to 25% of the local annual mean precipitation. This percentage shall be referred to as "effective precipitation."

All provisions of Section VII, Water Use Monitoring, shall apply to the metered water use of landscape water accounts whether effective precipitation is included in the landscape water use calculations or not.

V. Requirements for Landscape Plans

A. Planting Design Plan

1. Landscape Design Requirements

a. Plant Selection and Grouping

i. Any plants may be used in the landscape, provided the total metered water use does not exceed the maximum landscape water allowance plus allowable effective precipitation and that the plants meet the specifications set forth in Sections ii. and iii. below.

Table 1 in Appendix 3 provides values which may be used to derive estimated water use for various types of landscaped areas.

ii. Plants having similar water use shall be grouped together in distinct hydrozones.

iii. Plants shall be selected appropriately based upon their adaptability to the climatic, geologic, and topographical conditions of the site. Protection and preservation of native species and natural areas is encouraged.

iv. The plant establishment period is considered to be 18 months for the purposes of these standards. Landscapes may require more irrigation than the maximum water allowance during the first 18 months after planting.

b. Water Features

i. Water needed to fill and maintain levels in water features shall be calculated in CCF and included as part of the maximum landscape water allowance.

ii. Fountains or other types of decorative water bodies where water is sprayed into the air are discouraged. "Misting" will not be allowed. Any water feature submitted for review shall be designed to minimize evaporation.

iii. Recirculating water shall be used for any water feature.

iv. Use of reclaimed water for fountains and water features is encouraged. **Reclaimed water used in this way need not be included in calculation of the maximum landscape water allowance.**

v. Refilling of all fountains and/or other types of decorative water bodies with potable water may be prohibited during a City-Council-declared water emergency.

c. Horticultural Soils Analysis

i. For projects with a landscaped area greater than 44,000 square feet, a basic soil chemistry analysis or horticultural suitability analysis from a laboratory specializing in landscape soils is required. The soil analysis shall be made for approved projects after rough grading is completed. If soil is imported for use in the landscaped area, an analysis shall be submitted from each different source of origin of that fill material. Samples will be selected for analysis from each different soil type area of the project.

Final inspections of the project will not be completed without receipt of the soils test report.

ii. Soil will be amended according to the soils test report recommendations.

2. Documents to be submitted for Planting Plan review

a. Statement of Design Intent

Each landscape plan submitted for review shall be accompanied by a Statement of Design Intent. This statement shall consist of 1) a brief statement of the design concept and description of the project at maturity, 2) a description of the irrigation of the proposed project describing how the system conforms to Palo Alto's irrigation design requirements, and 3) a summary of the projected long range maintenance of the project until maturity.

A sample Statement of Design Intent appears in Appendix 2.

b. Landscape Planting Plan

The planting plan shall be drawn on project base sheets at a scale that accurately and clearly identifies:

i. All hydrozones.

ii. Landscape materials, trees, shrubs, groundcover, turf, and other vegetation. Planting symbols shall be clearly drawn and plants labeled by botanical name, common name, container size, spacing, and quantities of each group of plants indicated.

iii. Property lines and street names.

iv. Streets, driveways, walkways, and other paved areas.

v. Pools, ponds, water features, fences and retaining walls.

vi. Existing and proposed buildings and structures including elevation, if applicable.

vii. Natural features including, but not limited to, rock outcroppings, existing trees, and shrubs that will remain.

viii. Location, size, and species of existing street trees.

ix. Spot elevations used in making the grading plan.

x. A calculation of the total landscaped area in square feet.

c. Planting Specifications and details

Planting specifications shall include details of tree staking and plant installation, soil preparation details, and any other applicable planting and installation details. These specifications must include the following:

A minimum of 2 inches of mulch shall be added in non-turf areas to soil surface after planting except for areas planted with a non-turf groundcover which shall have a minimum of 1 inch of mulch added to the soil surface. Visqueen, sheet plastic, and other non-porous material shall not be placed under the mulch. Porous weed-barrier fabrics are acceptable.

B. Grading Design Plan

Grading design plans satisfying the following conditions shall be submitted with the documents for landscape review:

1. A grading design plan shall be drawn on project base sheets on the same scale as the landscape planting plan. It should be separate from, but use the same format as, the landscape planting plan.

2. The grading design plan shall indicate finished configurations and elevations of the landscaped area, including the height of graded slopes, drainage patterns, pad elevations, and finish grade.

C. Irrigation Design Plan

1. Irrigation Design Plan Requirements

a. Maximum Water Allowance

A maximum water allowance shall be established for new projects.

See the Landscape Water Use Statement in Appendix 1.

b. Unified Plumbing Code

Specifications for irrigation systems shall ensure that all requirements of the adopted unified plumbing code are met.

c. Water Meters

A separate water meter shall be installed to irrigate each approved landscape. This meter shall be designated as an irrigation account and no other utilities will be billed on such accounts.

d. Backflow Prevention

The irrigation system shall be separated from the City of Palo Alto water supply by a backflow prevention device or devices approved by the City Utilities Department. For a list of approved devices contact:

Cross Connection Officer
Department of Utilities
Field Operations (415)496-6972

Written requests may be made to:

Cross Connection Officer
Department of Utilities/Field Operations
City of Palo Alto
P.O. Box 10250
Palo Alto, CA 94303.

e. Soil-Water Relationships

Soil types and infiltration rates shall be considered when designing irrigation systems. All irrigation systems shall be designed to avoid runoff, low head drainage, overspray, or other similar conditions where water flows onto adjacent property, non-irrigated areas, walks, roadways, or structures. Proper irrigation equipment shall be used to closely match application rates to infiltration rates thereby minimizing runoff and overspray.

f. Irrigation Zones

Irrigation zones shall have the following characteristics:

i. All plants shall have approximately similar water requirements.

ii. Irrigation zones shall encompass only one microclimate.

iii. All application devices shall have matched precipitation and distribution uniformity.

g. Irrigation Equipment

Irrigation system components shall be selected on the basis that they are appropriate for the task. Criteria shall include performance, ease of maintenance, and public safety.

h. Sprinklers

All sprinklers for turf (microsprays, sprayheads, rotors,etc.) shall have spring retracted pop-up operation with flexible connections to piping. Sprinklers shall be selected and spaced for maximum distribution uniformity. No overhead sprinkler irrigation systems shall be installed in areas less than eight (8) feet wide.

i. Bubblers

All bubblers shall be pressure compensating. Bubblers exceeding .33 gpm shall be used only in planting basins with permanent basin walls to prevent runoff (i.e., tree wells in hardscape areas, planters, containers, etc.)

j. Drip Systems

Drip systems shall be designed to provide water uniformly to the area of a mature rootzone. Drip systems shall use PVC lateral piping below grade for primary distribution of water to emitters or groups of emitters. Secondary distribution lines may be of other materials.

k. Electric Control Valves (ECVs)

At each ECV, there shall be a pressure gauge valve (Schrader Valve) for measuring zone pressure during operation. This valve may be an integral part of the ECV or it may be "tapped" into a PVC fitting downstream of the ECV outlet.

l. Irrigation Controllers

Electronic controllers shall be required for all projects. They shall be capable of managing all aspects of the irrigation system design. Minimum controller requirements are as follows:

i. Precise individual station timing.

ii. Runtime capabilities for extremes in precipitation rates.

iii. At least one program for each hydrozone and microclimate.

iv. Sufficient multiple cycles to avoid runoff.

v. Extended day calendar for deep-rooted plants.

vi. Power failure backup for all programs.

m. Anti-Drain Valves

The irrigation system shall be designed to prevent gravity drainage of water through application devices. Two anti-drain valves which are available are in-line check valves for lateral piping, or in-head check valves to prevent low head drainage.

n. Rain Sensing Devices

Irrigation systems shall be equipped with rain sensing devices to prevent irrigation during rainy weather. Soil moisture sensors shall not be used as rain sensing devices.

o. Tree Irrigation

Trees in mixed planting areas of shrubs and/or ground covers shall have an additional means of irrigation for deep watering (i.e. drip or bubblers) which shall be separate from all other circuits and served by separate valves.

Trees may not be planted in turf unless surrounded by a mulched area of a diameter equal to the diameter of the projected median-life crown drip line.

2. Irrigation System Management

Irrigation management practices shall consist of efficient scheduling, system inspections, and maintenance.

a. Irrigation Operation

Irrigation shall be scheduled according to any emergency water use ordinance in effect.

b. Establishment Period

The plant establishment period shall be considered to be **18 months.**

c. Real-Time ET_o Data

Whenever possible, irrigation management shall incorporate the use of real-time ET_o data from the California Irrigation Management Information System (CIMIS), or other site-specific, electronically monitored, ET_o calculating system.

d. Irrigation System Inspections

The irrigation system should be inspected after each mowing for turf areas and bi-monthly in other areas for the life of the system. This 'wet-check' inspection consists of operating the valves and observing the performance of each irrigation zone.

f. Irrigation System Maintenance

The irrigation system should be kept clean and properly adjusted. Damaged equipment should be repaired promptly with identical equipment to maintain the original design integrity.

3. Irrigation Efficiency

Irrigation systems shall be designed, constructed, managed, and maintained to achieve as high an overall efficiency as possible. Irrigation efficiency (IE) is calculated as follows:

IE = Design Efficiency (DE) x Management Efficiency (ME)

a. Design Efficiency

DE is based on equipment performance and design factors. Table 2 in Appendix 3 lists efficiencies which are acceptable for the purpose of conforming with these standards.

b. Management Efficiency

ME is based on scheduling procedures and maintenance practices. The management efficiency shall be assumed to be 70% with the use of monthly irrigation schedules, inspection of turf areas after mowing, bi-monthly non-turf irrigation system inspections, controllors turned off during rainy periods, and appropriate system maintenance. The management efficiency may be increased by adding automated scheduling equipment and flow sensing control systems as described below to the above requirements.

The City will not consider a lower management efficiency percentage in the calculation of maximum water requirements. If inspection and maintenance are neglected, the overall efficiency of the system will decrease over time. The result is likely to be increased costs, either in replacing plant materials or in excess water use, or both.

c. Automated Scheduling Equipment

With the additional installation of automatic scheduling equipment, management efficiency shall be assumed to be increased by 10%. Automated scheduling equipment includes Central Computer Control utilizing an ET_0 weather station (CIMIS) or soil moisture sensors. Use of soil moisture sensors must meet the following conditions:

i. The irrigation base schedule shall be used as a reference for moisture sensor settings.

ii. There shall be a minimum of one sensor for each hydrozone and/or microclimate. One sensor per irrigation zone is encouraged.

iii. The soil moisture sensing system shall be designed so that adjustments can be made from a central control unit at the controller. Field adjustments shall not be required.

iv. Sensors shall be monitored on a weekly basis.

d. Flow Sensing Control System

With the installation of a flow sensing control system **in addition to the basic practices itemized in Section b. above,** management efficiency shall be assumed to be increased by 10% when the following conditions are met:

i. A master electric control valve shall be installed just downstream of the backflow device.

ii. The flow sensing control system shall include a flow sensor and an integral irrigation controller that can monitor station GPM for overflows, underflows and main line breaks.

iii. The controller shall be capable of shutting off 1) malfunctioning individual stations without disrupting the remaining program and 2) the master valve in the event of a mainline or valve failure downstream.

4. Documents to be submitted for Irrigation Plan Review

a. Water Use Statement

A landscape water use statement in the form which appears in Appendix 1 shall be submitted with the plans for every project. **This landscape water use statement defines the maximum landscape water allowance for each site. Therefore it should be completed before final planting or irrigation designs are developed.**

Copies of this form are available from the City:
Dept. of Planning and Community Environment
250 Hamilton Ave.
Palo Alto, CA 94301

b. Irrigation Drawings and Details

Drawings shall be the same scale as the landscape planting plan and shall accurately and clearly identify:

i. Location and size of the landscape water meter.

ii. Minimum static pressure at the point of connection. The nominal system static pressure for each of the Palo Alto water service areas is available from the Palo Alto Water Transmission Supervisor at:

Department of Utilities
Water-Gas-Wastewater/Municipal Services Center
3201 E. Bayshore Blvd.
Palo Alto, CA 94303

iii. Location, type, and size of all components of the irrigation system, including electronic controllers, main and lateral lines, valves, application devices, rain shutoff sensors, flow sensors, soil moisture sensors, booster pumps and backflow prevention devices.

iv. Station/Zone number, valve size, flow rate (GPM), and operating pressure for each irrigation zone.

v. Spot elevations used in making the grading plan.

vi. Details of assembly and installation.

c. Irrigation Specifications and Details

Specifications shall prescribe quality of materials, standards of workmanship, expected results, and guarantees and include details as required.

d. Calculation Worksheets

A summary of the information used to determine landscape water requirements and irrigation efficiency shall be submitted in a form similar to the Water Use Calculations sheet in Appendix 3. The City requires documentation of the values used to determine the total estimated irrigation requirement. Documentation in other formats which provide substantially the same information and which are clearly itemized and concise may be submitted for review.

VI. Alternative Equipment or Design

The City realizes that more and more research is being conducted on plant water needs, in mixed plantings as well as for individual species. As this data becomes available and is accepted by landscape professionals, more detailed data may be available than that itemized in Table 1, Appendix 3. The City will accept alternative methodologies for calculat ing plant water needs as long as the methodology has been endorsed and accepted by appropriate academic and professional organizations.

Also, new and increasingly efficient irrigation equipment is being designed and manufactured. Irrigation designers may submit test data to support different efficiencies for irrigation application devices other than those listed in Table 2, Appendix 3. Acceptable test data will include, at a minimum, results based on field testing, not bench testing, endorsed and accepted by appropriate professionals.

VII. Water Use Monitoring

A. Landscape water use will be monitored on an annual basis for comparison to the MWA. All irrigation accounts which have been established as a result of an approved landscape plan will be subject to annual review by the Department of Utilities.

1. Water use will be based on utility records of the water meter installed as the irrigation meter for each landscape.

2. The first 18 months after planting will be considered as the establishment period for the landscape plant materials.

3. Irrigation water use will not be compared to the MWA for that landscape until 12 months after the 18-month establishment period.

B. The Department of Utilities will determine whether the irrigation account water usage is lower than or equal to the MWA, or greater than the MWA established for that landscape.

1. If the irrigation account water use is lower than or equal to the MWA, the landscape shall be designated as a water-efficient landscape.

a. The property owner, or party responsible for utilities payment, as appropriate, will be presented with a Water-Efficient Landscape award. The landscape will then be eligible for display of a notice or sign from the Department of Utilities regarding its status.

b. A copy of the Water-Efficient Landscape award will also be sent or presented to the Landscape Architect and/or Irrigation Designer responsible for the plant selection and irrigation design.

c. TheWater-Efficient Landscape status will remain in effect as long as the irrigation water use remains lower than or equal to the MWA.

2. If the irrigation account water use is greater than the MWA, the landscape shall have a landscape irrigation audit.

a. At a minimum, the audit shall be in accordance with the California Landscape Water Management Program as described in the Landscape Irrigation Auditor Handbook, the entire document which is hereby incorporated by reference. See: Landscape Irrigation Auditor Handbook, Dept. of Water Resources, Water Conservation Office, June 1990, version 5.5.

b. The audit report shall be delivered to the Department of Utilities within 90 days of notification of excess water use.

❖

Appendix B

Procedure for the Quantification of Evaporative Cooling Water Requirements

Procedure for the Quantification of Evaporative Cooling Water Requirements

Prepared by
Brian C. Wilson, P.E.
New Mexico State Engineer Office

November 1995

OPERATING CHARACTERISTICS OF DRIP EVAPORATIVE COOLERS

Drip-type direct evaporative coolers, also known as "desert coolers," "swamp coolers," and "water coolers," are only satisfactory in arid climates, and for applications having a high sensible heat gain and a low latent heat gain. Thus, crowded areas, such as department stores and theaters, are better served by other types of air conditioning equipment.

A typical evaporative cooler is a cubical metal or plastic box with large flat vertical air filters, called pads, that are fitted into separate pad-holders in the cooler frame for easy removal and replacement. The pads consist of very wettable porous material such as spun glass fibers, aspen excelsior pads, or a tinsel made of copper or aluminum. A pump lifts water from the sump in the bottom of the unit and delivers it to perforated troughs at the top of the unit. The pads are kept moist by water dripped continuously into their upper edges. Unevaporated water trickles down through the pads and collects in the bottom pan for discharge or recirculation. A fan, which is generally a centrifugal or "squirrel cage" type of blower, draws outside air through the pads, and this cools and humidifies the air. Most coolers discharge the washed air through side outlets, but there are also coolers that deliver air directly downward. Down-flow type coolers generally have more pad area and gain greater output capacity or better economy and pad life than side-outlet coolers. Evaporative coolers are designed for 100% outside air intake, and therefore provision must be made for exhausting this same quantity of air from the conditioned spaces (Trane Company, 1974, p. 222). Many coolers have two or three fan speeds, so users can modulate outputs as needed. Thermostats are seldom cooler components; most serve only ducted and engineered systems (Watt, 1986, p. 125).

Every gallon of water evaporated from a cooler leaves behind its entire content of dissolved minerals. The accumulation of scale on the pads reduces the quantity of air flowing through them and the performance of the cooler decreases. In areas where water is very hard (high calcium and magnesium), and/or where dusty conditions prevail, pads may become clogged very quickly and must be replaced frequently. Water used to flush the pads is called "bleed-off" or "blowdown" water. Bleed-off water reduces the build-up of lime scale and dirt on the pads; dilutes the mineral concentration of the pan water; and prevents pump malfunctions due to blockages (Watt, 1986, p. 108-109). There are two types of bleed-off systems. The once-through or pumpless type, and the recirculating or pump type. The pumpless type is simpler and cheaper but consumes more water and

needs constant drainage. The recirculating pump type cools better, saves water, and can operate with intermittent draining but, for pad life, should be flushed periodically or have a small constant drain flow. The necessary bleed-off rate varies with the entering water mineral content and its scaling tendency. Logic suggests that bleed-off should equal the amount evaporated, however, where entering water is only moderately hard, bleed-offs 25-50% less may be adequate; and one authority suggests bleeding off 1gallon per hour for each 1,000 cubic feet per minute (cfm) of air flow (Watt, 1986, p. 105, 110).

PROCEDURE FOR QUANTIFYING EVAPORATIVE COOLING WATER REQUIREMENTS

The following procedure may be used to compute the water requirements for evaporative cooling units installed in single and multi-family dwelling units.

Step 1: Compute the volume of interior space which will be cooled in each dwelling unit. The total volume (V), in cubic feet, is computed using Equation (1) for buildings with flat, nonvaulted ceilings.

$$V=(A_f)(H) \qquad \text{(Eq. 1)}$$

where A_f is the total floor area and H is the average ceiling height, which is typically 8 ft. For dwelling units which have some rooms with vaulted ceilings, or other buildings with very high ceilings (not necessarily vaulted), the calculation of interior space must be modified accordingly.

Step 2: Compute the required capacity of the cooling unit for each dwelling unit. This is the rate at which air must be moved through the building. Manufacturers generally recommend that there should be a complete change of air in the building every 4 minutes. The volumetric rate of air flow, in cubic feet per minute (CFM), is computed using Equation (2).

$$CFM=V/T_1 \qquad \text{(Eq. 2)}$$

where T_1 is the time in minutes required for a 100% air change.

Step 3: Determine the design dry bulb (DB) and mean coincident wet bulb (WB) temperatures which are appropriate for the climate and locale by reviewing data published by the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE, 1989) or Ecodyne (1980). Data for selected locations in New Mexico are shown in the table included in this paper.

Step 4: Compute the maximum hourly make-up water requirement for each dwelling unit. Approximately 1 gallon per hour (gph) is evaporated by a cooling unit operating at 80% efficiency for each 1,000 cfm of unit capacity, for each 10 degrees Fahrenheit of wet bulb depression (Arvin, 19??). The maximum make-up water requirement, or consumptive use (CU_1), in gallons per hour, is computed using Equation (3).

$$CU_1=(CFM/1{,}000)(DB-WB/10) \qquad \text{(Eq. 3)}$$

where DB is the design dry bulb temperature, and WB is the mean coincident wet bulb temperature, for the area under study.

Step 5: Compute the annual make-up water requirement for each dwelling unit. Except under extreme temperature conditions, evaporative coolers will only operate at maximum capacity for a limited number of hours in each 24-hour period. Cooling units typically have two fan speeds--high and low. At low fan speeds, the air flow rate is usually 67% of the high rate. The number of hours a cooling unit operates at maximum capacity will be dependent upon the climatic conditions and the design and construction of the buildings, and will generally be some fraction of the total number of cooling season hours. As a matter of practicality, the average annual make-up water requirement may be estimated to be 80% of the maximum requirement. The annual make-up water requirement (CU_2) for each building, in gallons per year, is computed using Equation (4).

$$CU_2=(K)(CU_1)(T_2) \qquad \text{(Eq. 4)}$$

where K is the coefficient applied to reflect average operating conditions, and T_2 is the total number of design cooling hours in a calendar year, for the area under study. Note that K will be higher in areas where the evaporative cooling unit operates at maximum capacity for a greater number of hours each day than in areas where cooling requirements are more moderate, and the unit operates at maximum capacity for fewer hours each day.

Step 6: Compute the total annual evaporative cooling water requirement for each dwelling unit. The annual water requirement (W) for each building, in gallons per year, is computed using Equation (5).

$$W=(F)(CU_2) \qquad \text{(Eq. 5)}$$

where F is the bleed-off water multiplier. As a general rule of thumb, it may be assumed that F is 1.15 for residential cooling units with recirculating bleed-off systems, and 1.67 for coolers without bleed-off recirculation (See Watt, 1986, p. 105 and 110 for discussion on this subject).

Step 7: Compute the total annual evaporative cooling water requirement in gallons per capita per day (GPCD) using Equation (6).

$$GPCD=W/[(CPU)(365\ \text{days/yr})] \qquad \text{(Eq. 6)}$$

where CPU is the number of capita per dwelling unit.

EXAMPLE CALCULATION NO. 1

Evaporative cooling water requirements for a 1,700 square foot home with 8 foot high ceilings and 3 occupants, in **Santa Fe**, New Mexico. Assume that a cooling unit with a recirculating bleed-off system will be installed to conserve water.

(1) V=(1,700 ft^2)(8 ft)=13,600 ft^3

(2) CFM=(13,600 ft^3)/(4 min)=3,400

(3) DB=90.0 and WB=61.0 (from table)

(4) CU_1=(3,400 cfm/1,000)(90.0-61.0/10)=9.86 gallons per hour (gph)

(5) CU_2=(0.80)(9.86 gph)(686 hours)=5,411 gallons per year (gpy)

(6) W=(1.15)(5,411 gpy)=6,223 gpy

(7) GPCD=6,223/[(3 capita)(365 days/yr)]=5.68

EXAMPLE CALCULATION NO. 2

Evaporative cooling water requirements for a 1,700 square foot home with 8 foot high ceilings and 3 occupants, in **Albuquerque**, New Mexico. Assume that a cooling unit with a recirculating bleed-off system will be installed to conserve water.

(1) V=(1,700 ft^2)(8 ft)=13,600 ft^3

(2) CFM=(13,600 ft^3)/(4 min)=3,400

(3) DB=96.0 and WB=61.0 (from table)

(4) CU_1=(3,400 cfm/1,000)(96.0-61.0/10)=11.90 gallons per hour (gph)

(5) CU_2=(0.80)(11.90 gph)(1130 hours)=10,758 gallons per year

(6) W=(1.15)(10,758 gpy)=12,372 gpy

(7) GPCD=12,372/[(3 capita)(365 days/yr)]=11.30

EXAMPLE CALCULATION NO. 3

Evaporative cooling water requirements for a 1,700 square foot home with 8 foot high ceilings and 3 occupants, in **Carlsbad**, New Mexico. Assume that a cooling unit with a recirculating bleed-off system will be installed to conserve water.

(1) V=(1,700 ft^2)(8 ft)=13,600 ft^3

(2) CFM=(13,600 ft^3)/(4 min)=3,400

(3) DB=103.0 and WB=67.0 (from table)

(4) CU_1=(3,400 cfm/1,000)(103.0-67.0/10)=12.24 gallons per hour (gph)

(5) CU_2=(0.80)(12.24 gph)(1779 hours)=17,420 gallons per year

(6) W=(1.15)(17,420 gpy)=20,033 gpy

(7) GPCD=20,033/[(3 capita)(365 days/yr)]=18.29

EXAMPLE CALCULATION NO. 4

Evaporative cooling water requirements for a 1,700 square foot home with 8 foot high ceilings and 3 occupants, in **Las Cruces**, New Mexico. Assume that a cooling unit with a recirculating bleed-off system will be installed to conserve water.

(1) V=(1,700 ft^2)(8 ft)=13,600 ft^3

(2) CFM=(13,600 ft^3)/(4 min)=3,400

(3) DB=99.0 and WB=64.0 (from table)

(4) CU_1=(3,400 cfm/1,000)(99.0-64.0/10)=11.90 gallons per hour (gph)

(5) CU_2=(0.80)(11.90 gph)(1718 hours)=16,355 gallons per year

(6) W=(1.15)(16,355 gpy)=18,808 gpy

(7) GPCD=18,808[(3 capita)(365 days/yr)]=17.18

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Karpiscak, Martin M., et al. (1994). Evaporative cooler water use within the city of Phoenix: final report for 1993 cooling season. Arizona Department of Water Resources, Phoenix, AZ.

Trane Company. (1974). Trane air conditioning manual. Trance Company, La Crosse, WI.

Watt, John R. (1986). Evaporative air conditioning handbook. Chapman and Hall, New York, NY.

Recommended design dry bulb and mean coincident wet bulb temperatures for selected locations in New Mexico. (Source: Ecodyne, 1980; Watt, 1986).

		Design Temperatures in Degrees Fahrenheit for 99% Confidence Level	
Locale	Cooling Hours	Dry Bulb	Wet Bulb
Alamogordo	1718	98.0	64.0
Albuquerque	1130	96.0	61.0
Artesia	1779	103.0	67.0
Carlsbad	1779	103.0	67.0
Clayton	See Distrib.	91.0	61.0
Clovis	1199	95.0	65.0
Deming	1718	99.0	64.0
Farmington	See Distrib.	95.0	63.0
Gallup	See Distrib.	90.0	59.0
Grants	See Distrib.	89.0	59.0
Hobbs	See Distrib.	101.0	66.0
Las Cruces	1718	99.0	64.0
Las Vegas	See Distrib.	91.0	64.0
Los Alamos	See Distrib.	89.0	60.0
Raton	See Distrib.	91.0	60.0
Roswell	1617	100.0	66.0
Santa Fe	686	90.0	61.0
Silver City	See Distrib.	95.0	61.0
Socorro	See Distrib.	97.0	62. 0
Truth or Consequences	1718	99.0	64.0
Tucumcari	See Distrib.	99.0	66.0

Appendix C

Landscape Irrigation Requirements in New Mexico

Landscape irrigation water requirements in a normal weather year (1951-80), in gallons per square foot per year, for flood and sprinkler irrigation assuming an application efficiency of 50%, and drip irrigation assuming an efficiency of 85%, in selected locations in New Mexico. (Prepared by Brian C. Wilson, P.E., and Anthony Lucero, 1995)

		Flood or Sprinkler Irrigation					Drip Irrigation	
County	Locale	KYBL	BERM	BUFF	TREE	HORT	TREE	HORT
Bernalillo	Albuquerque	50.13	37.45	26.42	28.17	26.59	16.57	15.64
Bernalillo	Corrales and Rio Rancho	45.42	34.53	24.30	25.68	22.30	15.11	13.12
Bernalillo	Los Ranchos	44.21	33.56	23.79	25.16	22.40	14.80	13.18
Catron	Reserve	45.63	36.05	24.47	26.39	16.92	15.52	9.95
Chaves	Roswell	54.17	40.79	28.36	29.94	25.74	17.61	15.14
Cibola	Grants and Milan	32.38	24.46	16.43	17.00	13.86	10.00	8.15
Colfax	Cimarron	29.10	20.11	11.76	12.95	11.99	7.62	7.05
Colfax	Raton	28.82	19.60	11.24	12.55	11.94	7.38	7.03
Colfax	Springer	30.59	21.51	12.83	13.98	12.63	8.22	7.43
Curry	Clovis	40.63	28.32	17.32	19.00	17.30	11.18	10.18
De Baca	Fort Sumner	45.38	33.04	21.74	23.20	20.63	13.65	12.14
Dona Ana	Hatch	51.44	38.88	27.14	28.54	24.56	16.79	14.45
Dona Ana	Las Cruces and Mesilla Park	55.98	42.52	30.12	31.63	27.88	18.60	16.40
Eddy	Artesia	52.19	38.81	26.60	28.31	25.00	16.65	14.70
Eddy	Carlsbad	55.74	41.05	27.70	29.55	26.18	17.38	15.40

Key: KYBL=Kentucky bluegrass; BERM=Bermuda grass; BUFF=Buffalo grass; TREE=Trees and shrubs; HORT=Horticultural plants, e.g., herb and vegetable gardens.

Landscape irrigation water requirements in a normal weather year (1951-80), in gallons per square foot per year, for flood and sprinkler irrigation assuming an application efficiency of 50%, and drip irrigation assuming an efficiency of 85%, in selected locations in New Mexico. (Prepared by Brian C. Wilson, P.E., and Anthony Lucero, 1995)

		Flood or Sprinkler Irrigation					Drip Irrigation	
County	Locale	KYBL	BERM	BUFF	TREE	HORT	TREE	HORT
Eddy	Loving	56.39	42.10	29.01	30.24	26.95	17.79	15.85
Grant	Bayard and Central	37.95	27.39	17.64	18.84	16.16	11.08	9.50
Grant	Silver City	38.42	27.70	17.84	19.49	17.07	11.46	10.04
Guadalupe	Santa Rosa	44.61	32.51	21.26	22.65	19.77	13.32	11.63
Harding	Mosquero	33.45	22.86	13.38	14.86	13.64	8.74	8.02
Hidalgo	Lordsburg	53.68	40.53	28.31	29.93	26.27	17.61	15.45
Lea	Hobbs	48.93	34.92	22.48	24.06	22.10	14.15	13.00
Lincoln	Carrizozo	41.45	30.46	20.22	21.68	18.86	12.75	11.10
Lincoln	Ruidoso	17.95	12.27	5.65	5.82	3.94	3.42	2.32
Los Alamos	Los Alamos	28.76	19.37	11.12	12.44	12.06	7.32	7.09
Luna	Deming	53.42	40.59	28.60	30.06	26.22	17.68	15.42
McKinley	Gallup	33.40	25.47	17.59	18.23	15.72	10.72	9.25
Mora	Wagon Mound	26.62	17.80	9.72	11.06	10.66	6.50	6.27
Otero	Alamogordo	55.07	40.93	28.14	29.96	27.14	17.62	15.96

Key: KYBL=Kentucky bluegrass; BERM=Bermuda grass; BUFF=Buffalo grass; TREE=Trees and shrubs; HORT=Horticultural plants, e.g., herb and vegetable gardens.

Landscape irrigation water requirements in a normal weather year (1951-80), in gallons per square foot per year, for flood and sprinkler irrigation assuming an application efficiency of 50%, and drip irrigation assuming an efficiency of 85%, in selected locations in New Mexico. (Prepared by Brian C. Wilson, P.E., and Anthony Lucero, 1995)

		Flood or Sprinkler Irrigation					Drip Irrigation	
County	Locale	KYBL	BERM	BUFF	TREE	HORT	TREE	HORT
Otero	Cloudcroft	16.71	9.84	4.19	4.08	3.55	2.40	2.09
Otero	Tularosa	56.03	42.14	29.46	31.05	28.09	18.27	16.52
Quay	Tucumcari	45.72	32.92	21.27	22.89	20.53	13.46	12.08
Rio Arriba	Chama	20.50	14.70	8.81	9.37	8.35	5.51	4.91
Rio Arriba	Espanola	37.99	28.60	19.70	20.74	18.28	12.20	10.75
Roosevelt	Portales	42.29	30.31	19.12	20.56	17.64	12.09	10.38
Sandoval	Bernalillo	43.32	32.71	22.81	24.17	21.38	14.22	12.58
San Juan	Aztec	39.00	29.93	21.16	22.14	19.68	13.02	11.58
San Juan	Bloomfield	44.48	33.49	23.69	25.11	23.65	14.77	13.91
San Juan	Farmington	39.92	30.68	21.82	22.75	20.13	13.38	11.84
San Miguel	Las Vegas	28.12	19.30	11.17	12.22	11.23	7.19	6.61
Santa Fe	Santa Fe	32.70	23.36	14.91	16.13	15.11	9.49	8.89
Sierra	Truth or Consequences	55.48	41.38	29.01	30.58	28.44	17.99	16.73
Socorro	Socorro	48.36	36.39	25.48	26.80	24.05	15.77	14.15

Key: KYBL=Kentucky bluegrass; BERM=Bermuda grass; BUFF=Buffalo grass; TREE=Trees and shrubs; HORT=Horticultural plants, e.g., herb and vegetable gardens.

Landscape irrigation water requirements in a normal weather year (1951-80), in gallons per square foot per year, for flood and sprinkler irrigation assuming an application efficiency of 50%, and drip irrigation assuming an efficiency of 85%, in selected locations in New Mexico. (Prepared by Brian C. Wilson, P.E., and Anthony Lucero, 1995)

		Flood or Sprinkler Irrigation					Drip Irrigation	
County	Locale	KYBL	BERM	BUFF	TREE	HORT	TREE	HORT
Taos	Questa	27.02	19.86	12.95	13.66	12.27	8.04	7.22
Taos	Red River	11.57	8.07	3.73	4.24	3.18	2.49	1.87
Taos	Taos	30.09	22.22	14.64	15.58	14.03	9.17	8.25
Torrance	Estancia	32.46	24.24	16.01	16.68	14.12	9.81	8.31
Union	Clayton	32.85	23.49	14.45	15.78	13.76	9.28	8.10
Union	Des Moines	27.34	18.49	10.21	11.51	10.71	6.77	6.30
Valencia	Belen	48.17	36.50	25.84	27.30	24.46	16.06	14.39
Valencia	Los Lunas	44.63	33.87	23.84	25.02	22.07	14.72	12.98

Key: KYBL=Kentucky bluegrass; BERM=Bermuda grass; BUFF=Buffalo grass; TREE=Trees and shrubs; HORT=Horticultural plants, e.g., herb and vegetable gardens.

Appendix D

Insurance Services Office Procedure for Calculating Needed Fire Flow

FIRE SUPPRESSION RATING SCHEDULE

INSURANCE SERVICES OFFICE

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Edition 5-80

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ISO COMMERCIAL RISK SERVICES, INC.

TWO SYLVAN WAY PARSIPPANY, N.J. 07054 (201) 267-0359

August 1, 1990

TO: ALL HOLDERS OF THE FIRE SUPPRESSION RATING SCHEDULE (FSRS)

The FSRS produces ten different public protection classifications defining differing levels of public fire suppression capabilities. These classifications are reflected in many individual property insurance cost relativities. The FSRS objectively reviews those features of available public fire protection that have a significant influence on minimizing damage once a fire has occurred (Fire Alarm, Water Supply System and Fire Department).

The Fire Suppression Rating Schedule (FSRS) does not include a review of prevention features that would require a subjective evaluation of enforcement on an overall community basis. Rather, the Specific Commercial Property Evaluation Schedule used by CRS recognizes those fire prevention and building code activities that impact on those conditions evaluated in individual properties.

It is recognized that most communities have adopted one of the available model codes; and, that most have implemented some program for enforcing codes, educating the public regarding fire safety matters and investigating fires to seek prosecution where arson is the cause. It is important that such programs be continued where they exist, and be implemented where they do not exist, so as to impact positively on identified fire problems within a community. These programs are an important component of a community's total fire defense system.

An Addendum to the FSRS is effective August 1, 1990, in the state of LOUISIANA. If you are operating in the state of LOUISIANA, you may wish to contact the Property Insurance Association of Louisiana for a copy of that addendum at 433 Metairie Road - Suite 400, Metairie, LA 70005.

NEEDED FIRE FLOW

300. GENERAL:

This item develops Needed Fire Flows for selected locations throughout the city which are used in the review of subsequent items of this Schedule. The calculation of a Needed Fire Flow (NFF_i) for a subject building in gallons per minute (gpm) considers the Construction (C_i), Occupancy (O_i), Exposure (X_i) and Communication (P_i) of each selected building, or fire division, as outlined below.

310. CONSTRUCTION FACTOR (C_i):

That portion of the Needed Fire Flow attributed to the construction and area of the selected building is determined by the following formula:

$$C_i = 18F\,(A_i)^{0.5}$$

F = Coefficient related to the class of construction:

F = 1.5 for Construction Class 1* (Frame)
= 1.0 for Construction Class 2* (Joisted Masonry)
= 0.8 for Construction Class 3* (Non-Combustible) and Construction Class 4* (Masonry Non-Combustible)
= 0.6 for Construction Class 5* (Modified Fire Resistive) and Construction Class 6* (Fire Resistive)

A_i = Effective* area

In buildings with mixed construction a value, C_{im}, shall be calculated for each class of construction using the effective area of the building. These C_{im} values are multiplied by their individual percentage of the total area. The C_i applicable to the entire building is the sum of these values. However, the value of the C_i shall not be less than the value for any part of the building based upon its own construction and area.

The maximum value of C_i is limited by the following:

8,000 gpm for Construction Classes 1 and 2
6,000 gpm for Construction Classes 3, 4, 5 and 6
6,000 gpm for a 1-story building of any class of construction.

The minimum value of C_i is 500 gpm. The calculated value of C_i shall be rounded to the nearest 250 gpm.

320. OCCUPANCY FACTOR (O_i):

The factors below reflect the influence of the occupancy in the selected building on the Needed Fire Flow.

Occupancy Combustibility Class*	Occupancy Factor (O_i)
C-1*(Non-Combustible)	0.75
C-2*(Limited Combustible)	0.85
C-3*(Combustible)	1.00
C-4*(Free Burning)	1.15
C-5*(Rapid Burning)	1.25

330. EXPOSURES (X_i) AND COMMUNICATION (P_i) FACTORS:

The factors developed in this item reflect the influence of exposed and communicating buildings on the Needed Fire Flow. A value for ($X_i + P_i$) shall be developed for each side of the subject building:

$$(X+P)_i = 1.0 + \sum_{i=1}^{n} (X_i + P_i), \text{ maximum } 1.75, \text{ where } n = \text{number of sides of subject building.}$$

A. Factor for Exposure (X_i):

The factor for X_i depends upon the construction and length-height value* (length of wall in feet, times height in stories) of the exposed building and the distance between facing walls of the subject building and the exposed building, and shall be selected from Table 330.A.

*When an asterisk is shown next to a term in this item, the term is defined in greater detail in the Commercial Fire Rating Schedule.

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TABLE 330.A
FACTOR FOR EXPOSURE (X_i)

Construction of Facing Wall of Subject Bldg.	Distance Feet to the Exposed Building	Length - Height of Facing Wall of Exposed Building	Construction of Facing Wall of Exposed Building Classes: 1,3	2, 4, 5, & 6: Unprotected Openings	2, 4, 5, & 6: Semi-Protected Openings (wired glass or outside open sprinklers)	2, 4, 5, & 6: Blank Wall
Frame, Metal or Masonry with Openings	0-10	1-100	0.22	0.21	0.16	0
		101-200	0.23	0.22	0.17	0
		201-300	0.24	0.23	0.18	0
		301-400	0.25	0.24	0.19	0
		Over 400	0.25	0.25	0.20	0
	11-30	1-100	0.17	0.15	0.11	0
		101-200	0.18	0.16	0.12	0
		201-300	0.19	0.18	0.14	0
		301-400	0.20	0.19	0.15	0
		Over 400	0.20	0.19	0.15	0
	31-60	1-100	0.12	0.10	0.07	0
		101-200	0.13	0.11	0.08	0
		201-300	0.14	0.13	0.10	0
		301-400	0.15	0.14	0.11	0
		Over 400	0.15	0.15	0.12	0
	61-100	1-100	0.08	0.06	0.04	0
		101-200	0.08	0.07	0.05	0
		201-300	0.09	0.08	0.06	0
		301-400	0.10	0.09	0.07	0
		Over 400	0.10	0.10	0.08	0
Blank Masonry Wall	Facing Wall of the Exposed Building is Higher Than Subject Building: Use the above table EXCEPT use only the Length-Height of Facing Wall of the Exposed Building ABOVE the height of the Facing Wall of the Subject Building. Buildings five stories or over in height, consider as five stories.					
	When the Height of the Facing Wall of the Exposed Building is the Same or Lower than the Height of the Facing Wall of the Subject Building, $X_i = 0$.					

330. EXPOSURE (X_i) AND COMMUNICATION (P_i) FACTORS: (Continued)

B. **Factor for Communications (P_i):**

The factor for P_i depends upon the protection for communicating party wall* openings and the length and construction of communications between fire divisions* and shall be selected from Table 330.B. When more than one communication type exists in any one side wall, apply only the largest factor P_i for that side. When there is no communication on a side, $P_i = 0$

*When an asterisk is shown next to a term in this item, the term is defined in greater detail in the Commercial Fire Rating Schedule.

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TABLE 330.B
FACTOR FOR COMMUNICATIONS (P_I)

Description of Protection of Passageway Openings	Fire Resistive, Non-Combustible or Slow-Burning Communications				Communications With Combustible Construction					
	Open	Enclosed			Open			Enclosed		
	Any Length	10 Ft. or Less	11 Ft. to 20 Ft.	21 Ft. to 50 Ft. +	10 Ft. or Less	11 Ft. to 20 Ft.	21 Ft. to 50 Ft. +	10 Ft. or Less	11 Ft. to 20 Ft.	21 Ft. to 50 Ft. +
Unprotected	0	+ +	0.30	0.20	0.30	0.20	0.10	+ +	+ +	0.30
Single Class A Fire Door at One End of Passageway	0	0.20	0.10	0	0.20	0.15	0	0.30	0.20	0.10
Single Class B Fire Door at One End of Passageway	0	0.30	0.20	0.10	0.25	0.20	0.10	0.35	0.25	0.15
Single Class A Fire Door at Each End or Double Class A Fire Doors at One End of Passageway	0	0	0	0	0	0	0	0	0	0
Single Class B Fire Door at Each End or Double Class B Fire Doors at One End of Passageway	0	0.10	0.05	0	0	0	0	0.15	0.10	0

\+ For over 50 feet, $P_I = 0$.

\+ + For unprotected passageways of this length, consider the 2 buildings as a single Fire Division.

Note: When a party wall has communicating openings protected by a single automatic or self-closing Class B fire door, it qualifies as a division wall* for reduction of area.

Note: Where communications are protected by a recognized water curtain, the value of P_I is O.

*When an asterisk is shown next to a term in this item, the term is defined in greater detail in the Commercial Fire Rating Schedule.

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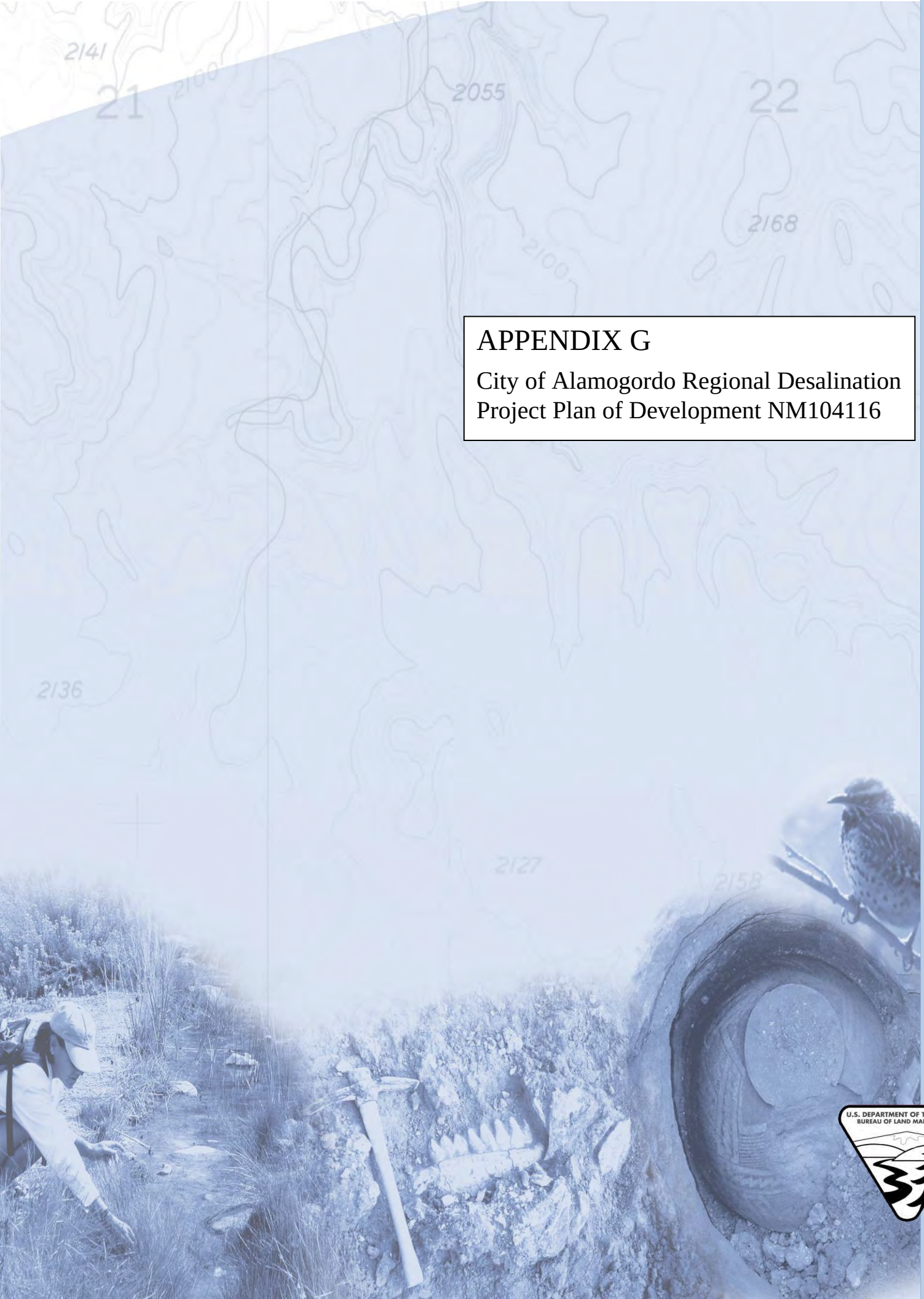
APPENDIX G

City of Alamogordo Regional Desalination Project Plan of Development NM104116



U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

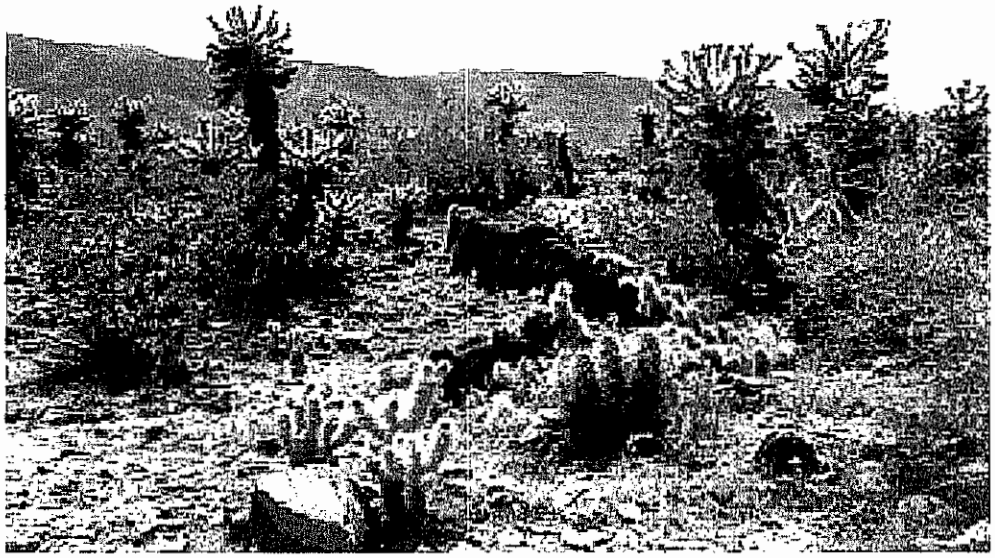
R.U./Desert - Appl/Permits - (1-A) BLM

CITY OF ALAMOGORDO

REGIONAL DESALINATION PROJECT

PLAN OF DEVELOPMENT
NM104116

July 15, 2003



Talked To Jim (434-2509) 8/6/03 provided information/comments

Prepared For:
Bureau of Land Management
Las Cruces Field Office

1.0 PURPOSE AND NEED

The City of Alamogordo (City) is requesting a right-of-way grant from the Bureau of Land Management (BLM) in order to drill 10 water production wells, including access roads and water pipelines, as part of a regional water desalination project (project). The project would help meet current and future demands for a sustainable water supply for Alamogordo, La Luz, Tularosa, and Holloman AFB and the surrounding area, including

The current water demand for the City averages about 6 million gallons per day, but peak demands in the summer months can be as high as 13 million gallons per day. Future demand for water is projected to be more than 9 million gallons per day by the year 2040, with summer peaks approaching 20 million gallons per day.

Seventy seven percent of the City water supply is from surface water that is susceptible to drought. The majority of fresh water in the region is from surface water that originates in the Sacramento Mountains and from a small pocket of ground water south of Alamogordo. Additional surface water is not available to meet increasing demand. The pumping of additional fresh ground water is limited by the Office of State Engineer special administrative rules, physical quantity, and land ownership (more than half of the fresh water south of Alamogordo is beneath military lands). It is highly unlikely the City could obtain water rights for this fresh ground water.

Alamogordo has implemented conservation measures and reclaimed water to reduce potable water demands by more than 4 million gallons per day. The City is conserving about everything it can at this point in time. To meet peak summer demands, water is drawn from storage reservoirs at La Luz Water Treatment Plant, but without stored water there is not enough supply to meet these current peak demands.

The most feasible alternative to a long-term stable water supply for the region is desalination. There is a large volume of brackish ground water available for a sustainable supply without impacting the regional agricultural economy. Desalination of this brackish water is the most feasible alternative for meeting City future water demands, reducing the reliance on drought-sensitive surface water, and developing a long-term sustainable supply.

An Environmental Assessment (EA) would be completed for the project. The EA would address environmental impacts to resources and construction practices after applying standard management procedures for compliance with health, safety, and environmental requirements. For NEPA compliance, the U.S. Environmental Protection Agency will be the lead agency with BLM as a cooperator.

1.1 Authorizations, Permits, Reviews and Approvals

The project conforms to the current BLM Resource Management Plan for the Las Cruces Field Office and conforms with all other related federal, state, and local statutes, regulations, and plans. The project will include rights-of-way from the state and approval of water rights from the State Engineer's Office. See attached map for location of all facilities on BLM administered land.

2.0 Project Description

The City plans to drill 10 water wells, construct access roads to each well, and bury water pipelines to transport water from each well. The area of the right-of-way is known as the Snake Tank Well Field. A separate powerline right-of-way from the local power company will also be needed to supply electrical power to each well. The linear right-of-way will be 50 feet wide and will include the roads, pipelines and powerlines. The project on BLM lands is located about 10 miles north of Tularosa on the east side of U.S. 54. The proposed right-of-way consists of the following new facilities on BLM lands:

- Drill 10 water wells on 295.16 x 295.16 (2 acre) pads.
- Construct a total of 28,655 feet ± (Approximately 5.43 miles) of access road.
- Construct a total of 28,800 ± feet of water pipeline.
- All above facilities will be within T. 12 S., R. 9 E. and 10 E., and T. 13 S., R. 9 E. and 10 E., NMPM.
- Replacement Water To Existing user

2.1 Pipelines

The water pipelines will be installed in a trench 4-feet deep and 3-4 feet wide. The pipe will vary in size from 8" to 24". Since all disturbance will be within the 50 foot grant, no temporary construction space is required. After construction, steel stakes 2-inches by 4 feet will be used about every 500 feet along the route to delineate the location of the water line to prevent accidentally compromising the line. All construction will conform to BLM standard pipeline requirements.

2.1.1 Trenching Operation

The trench would be dug with a one-pass trencher to a depth of 4-feet. At the bottom of the trench, 9-12 inches of type II aggregate would be used to bed the pipe. The trencher is 10 feet wide and is capable of digging 4 feet deep at each pass. The soil from the trench would be stored adjacent to the trench for a period of no more than 5 days. As the digging progresses, the piping would be installed at predetermined lengths and the soil would be replaced in the trench in the opposite order it was stored, thus preserving any seed bank existing in the soil.

2.1.2 Thrust Blocks

At each angle required for directional change, a thrust block would be poured in place to restrain the movement of the pipeline. Standard concrete would be used and poured in place, with any spillage or washout of the chute constrained within the trench.

2.2 Roads

The access roads would be used for access to the work areas, future maintenance requirements and will provide permanent access to the well sites. The roads would be 14 feet wide, crowned and ditched to BLM resource road standards. These roads are intended to carry little volume and will be constructed and maintained by the City in accordance with the City's requirements and with stipulations developed by BLM. Construction and maintenance will be done to ensure that the City's traffic remains within the right-of-way and erosional damage is mitigated. Culvert pipes will be used for cross drains on grades in excess of 10 percent. Drainage crossings will be designed for a 25-year frequency or greater storm.

2.3 Distribution Power

Distribution power will be required at each well site to run the water pumps. The power lines will be constructed within the 50 foot grant area and will be authorized under a separate grant.

3.0 Facility Construction

All construction activities are expected to be completed within the right-of-way area. No temporary construction areas are anticipated. Once construction begins, it will take about 2 years to complete the project.

3.1 Project Compliance Plan

Once the right-of-way grant is approved, the City shall contact the BLM Authorized Office at least 5 days prior to commencing construction and/or any surface disturbing activities. The City shall conduct all activities associated with the construction, operation, and termination of the right-of-way within the authorized limits of the right-of-way. A copy of the complete right-of-way grant, including all stipulations, shall be made available on the right-of-way area during construction, operation and termination.

3.2 Surveying Activities

Construction survey work for the project consists of determining specified right-of-way boundaries and marking at 100 to 200 foot intervals with painted laths or flags. These

would be maintained until final cleanup and/or reclamation is completed, after which they would be removed.

3.3 Dust Control

Water trucks would be the primary means of dust abatement during all phases of construction. Any application other than water must first be approved by BLM. All trenching areas, roads, and well pads would be watered prior to and during all construction activities.

3.4 Access Roads

All construction crews and workers associated with this project would be required to stay on designated roads only. Roads would be flagged by the construction contractor.

3.5 Trench Installation

The pipeline would be installed using backhoes, then the pipeline would be bedded with type II material and covered with material removed in the trenching operation. The pipe would be delivered to the temporary lay down area, adjacent to the pipeline routing. Standard accepted construction practices would be used in the pipeline installation process.

3.6 Construction Yards

Temporary construction yards would not be necessary since the water line piping would be stored within the right-of-way boundary. Concrete used for corner foundations on the water line would be available from commercial sources in the Alamogordo area; therefore, no remote batch plant would be anticipated.

3.7 Site Reclamation

"as nearly as practical"

All temporary construction areas would be restored to its pre-construction condition. Construction sites, material storage areas, and access roads would be kept in an orderly condition and free of trash throughout the construction period. Refuse and trash would be collected in a closed container until removed from the site and disposed of in an approved manner. Oils and fuels would not be dumped alone the line. Waste oils or chemicals would be hauled to an approved site for disposal.

3.8 Fire Protection Plan

All federal, state and county laws, ordinances, rules and regulations, which pertain to prevention, presuppression, and suppression of fires, shall be strictly adhered to. All personnel would be advised of their responsibilities under the applicable fire laws and

regulations. It shall be the responsibility of the construction contractor to notify the BLM when a project related fire occurs within or adjacent to the construction area.

4.0 Environmental Concerns

4.1 Air Quality

Emissions produced during grading and construction are of short-term duration and would cease upon completion of construction. Dust would be minimized by application of water to disturbed areas. Construction activities would comply with all Otero County air quality standards.

4.2 Wastes, Hazardous or Solid

The contractor would comply with applicable laws pertaining to proper usage and disposal of potentially hazardous materials. No hazardous materials would be used on the right-of-way. Trash and solid waste generated from construction activities would be stored in closed containers and disposed of in accordance with regulatory requirements. Any spills would be immediately reported so that cleanup can be implemented immediately. All spill materials would be labeled and stored per BLM instructions for accumulation and disposal.

4.3 Cultural and Paleontological Resources

Cultural resources are defined as buildings, structures, or objects, each of which have historical, architectural, archeological, cultural, and/or scientific importance. Numerous laws, regulations, and statutes, on both federal and state levels, seek to protect and target the management of cultural resources. The extent of the archeological investigation would be determined by the BLM archeologist.

4.4 Biological Resources

4.4.1 Noxious Weeds

If noxious weeds are encountered during construction, mitigation measures would be instituted in consultation with the BLM Botanist and/or Authorized Officer. Construction equipment, materials, and vehicles would enter the site clean and would be stored within the right-of-way and designated construction yards.

4.4.2 Threatened or Endangered Species/State Sensitive Species

Surveys for federally listed threatened or endangered plants and animals or state sensitive species will be conducted as directed by the BLM. If any listed species are located on site, a mitigation plan will be developed including flagging for flora species to avoid

disturbance. Roadways would be flagged to indicate where construction traffic may travel.

4.4.3 Vegetation and Erosion Protection Plan

as overall as practical

Areas of temporary disturbance would be restored to its pre-construction condition in accordance with BLM requirements. All soils removed will be returned to the disturbed areas in the reverse order in which they were removed thereby preserving the top soil. Any slopes over 10 percent will be water barred to prevent erosion. The access roads and well pads will remain as permanent disturbed areas.

4.4.4 Additional Project Measures

1. Construction vehicle movement would be restricted to designated access, or public roads.

2. No paint or permanent discoloring agents would be applied to rocks or vegetation to indicate limits of survey or construction activity.

3. The water line and well sites would be regularly patrolled and properly maintained in compliance with applicable safety codes.

4. New roads would be built at right angles to washes to the extent practicable. Construction and maintenance activities would be conducted to minimize disturbance to vegetation and drainage channels. Existing roads would be left in or restored to a condition equal to or better than their condition prior to construction

5.0 Maintenance and Operation

5.1 Overview

The City would maintain the right-of-way as required by BLM stipulations. When the water line is no longer needed, the City would submit an abandonment plan and implement a reclamation plan subject to BLM approval.

Land uses that are compatible with safety regulations would be permitted in and adjacent to the right-of-way. Existing land uses, such as grazing and recreation, are generally permitted within the right-of-way. Incompatible land uses within the right-of-way include construction and maintenance of inhabited dwellings, and any use requiring changes in surface elevation that would affect existing or planned facilities. Land uses that comply with local regulations would be permitted adjacent to the right-of-way. Compatible uses of the right-of-way on public lands would have to be approved by the BLM.

5.2 Public and Environmental Protection

The water line and water wells would be inspected on a regular basis. Maintenance would be performed as needed. When access is required for non-emergency maintenance and repairs, the City would adhere to the same precautions that were taken during the original construction.

Emergency maintenance would involve prompt movement of repair crews to repair or replace any damage. Crews would be instructed to protect plants, wildlife, and other resources of significance. Limiting noise, dust, and the danger caused by maintenance vehicle traffic would provide for the comfort and safety of local residents.

Dust control during maintenance would be managed the same as during construction.

APPENDIX H

Water Resources Technical Report

WATER RESOURCES TECHNICAL REPORT FOR THE ALAMOGORDO REGIONAL WATER SUPPLY PROJECT ENVIRONMENTAL IMPACT STATEMENT (TASK 1)

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1.0 INTRODUCTION

The purpose of this Water Resources Technical Report (the Report) is to supplement the general information presented for water resources in the Alamogordo Regional Water Supply Environmental Impact Statement (EIS). This technical report serves as the basis for evaluating the long-term viability of water resources available for municipal uses in the project area. Information presented in the Report will also be used to examine alternatives to the proposed well field near Snake Tank Road. This report provides a technical overview of:

- The quantity and quality of surface water resources in the Alamogordo region
- The distribution and quality of ground-water resources within the Hueco-Tularosa aquifer
- Existing ground-water development and pumping
- Simulations of future ground-water development and pumping

In addition, a review of existing technical reports and documents and a limited number of ground-water modeling simulations from the City of Alamogordo (John Shomaker & Associates, Inc. [JSAI] 2003a), the New Mexico Office of the State Engineer (OSE) (Morrisson 1989), and Hydroscience Associates, Inc. (HAI) (2003a and 2003b) are discussed for the Snake Tank Well Field Alternative.

2.0 HYDROGEOLOGIC SETTING AND WATER RESOURCES OF THE TULAROSA BASIN

Agriculture, industry, municipalities, and residents in the Tularosa Basin rely on a combination of surface water and ground water to meet potable and other water needs. The population centers of Alamogordo and Tularosa were founded and have grown due to their access to reliable sources of fresh water. However, demands have grown, in some cases outstripping readily available supply, and understanding the occurrence and availability of water resources in the Basin has become increasingly important. This section describes the physical setting of the Tularosa Basin and the conditions that influence the occurrence, quality, reliability, and availability of water. New Mexico water law as it applies to surface water and ground-water resources in the project area is briefly summarized in Section 2.5.

2.1 PHYSIOGRAPHY AND GEOLOGY

The Tularosa Basin is a broad, north-trending intermountain depression that occupies approximately 6,500 square miles in south-central New Mexico (Figure 2.1). It extends approximately 170 miles north from the New Mexico–Texas border, where a slight topographical divide separates the Tularosa Basin from the Hueco Bolson to the south. To the north and west lies Chupadera Mesa. The Tularosa Basin varies in width from about 25 miles to 60 miles. Bounding the basin are the Sacramento Mountains on the east, Sierra Blanca Peak to the north, and a series of mountain ranges that defines the western extent of the basin from the Franklin Mountains in the south to the Organ and San Andres Mountains in the central and northern portions of the basin, respectively. Elevations range from less than 4,000 feet in the south-central portion of the basin to nearly 12,000 feet at Sierra Blanca Peak.

The basin formed as a graben or structural trough as a result of extensional forces. Nearly vertical north-trending faults separate the down-thrown basin floor from the mountain blocks to the east and west. This faulting has exposed Precambrian through Tertiary igneous and sedimentary rocks in the mountains bordering the basin. Generally, the same geologic units are present in the center of the basin beneath up to 8,000 feet of basin-fill sediments of Tertiary and Quaternary age (Orr and Myers 1986).

In the south-east portion of the basin, beginning with the Jarilla Mountains near Orogrande and extending northward to Round Mountain west of Tularosa, a smaller uplifted block of Paleozoic rocks interrupts the basin-fill sediments, dividing much of the Tularosa Basin into two north-trending sub-basins (Figure 2.1). The western extent of this smaller uplifted block is defined by the steeply dipping Jarilla Fault. The thickest accumulation of basin-fill deposits occurs just west of the Jarilla fault along the north-south axis of the larger Tularosa Basin and underlying the White Sands Missile Range. The eastern sub-basin is smaller and is asymmetrical in cross section (Figure 2.2), with the greatest thickness of sediments (up to 2,500 feet) closest to the Sacramento Mountain–front fault (McLean 1970). Communities within the smaller eastern sub-basin include, from south to north, Valmont, Alamogordo, Tularosa, and Three Rivers.

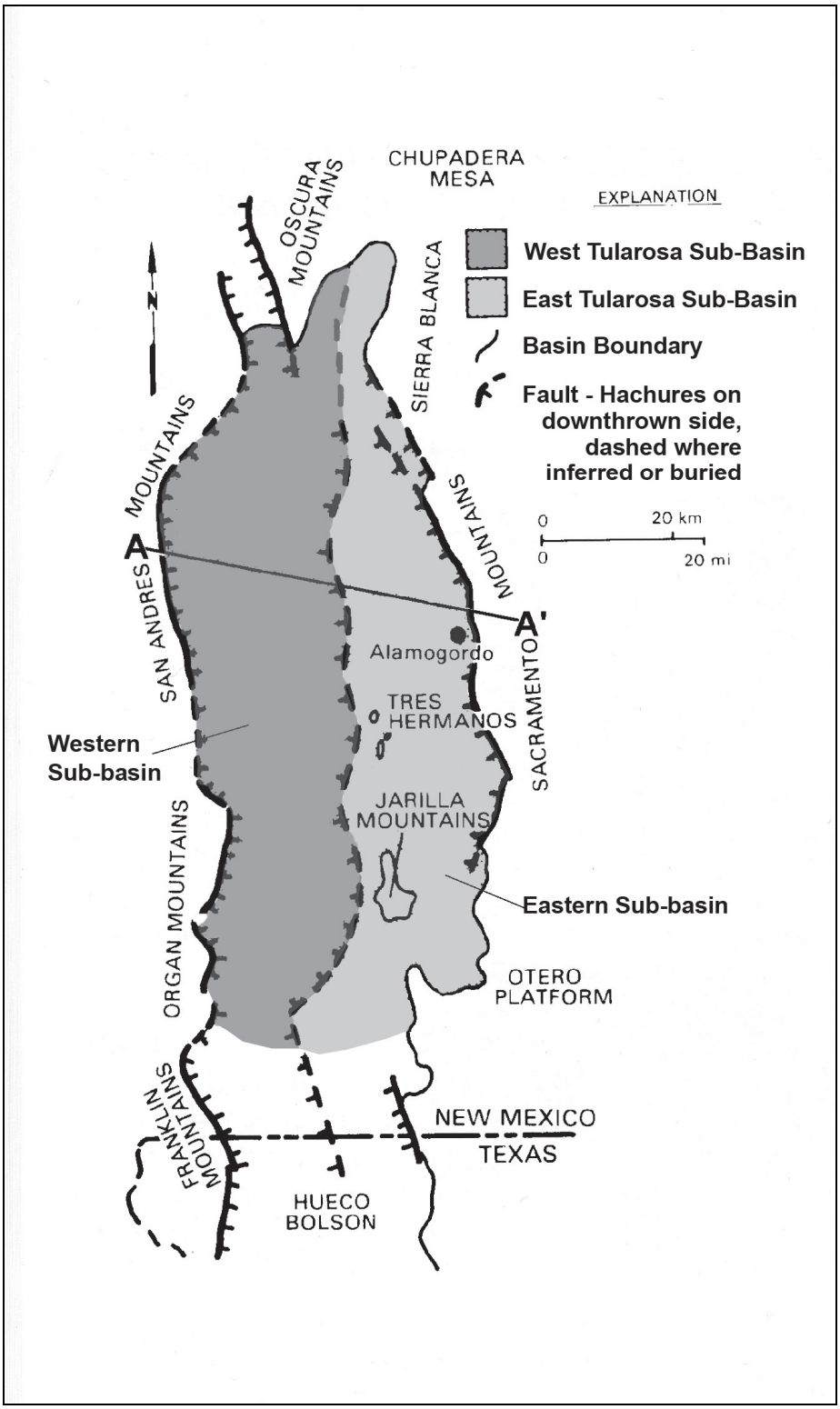

Figure 2.1 Map of the Tularosa Basin showing the western and eastern sub-basins (after Lueth et al. 2002).

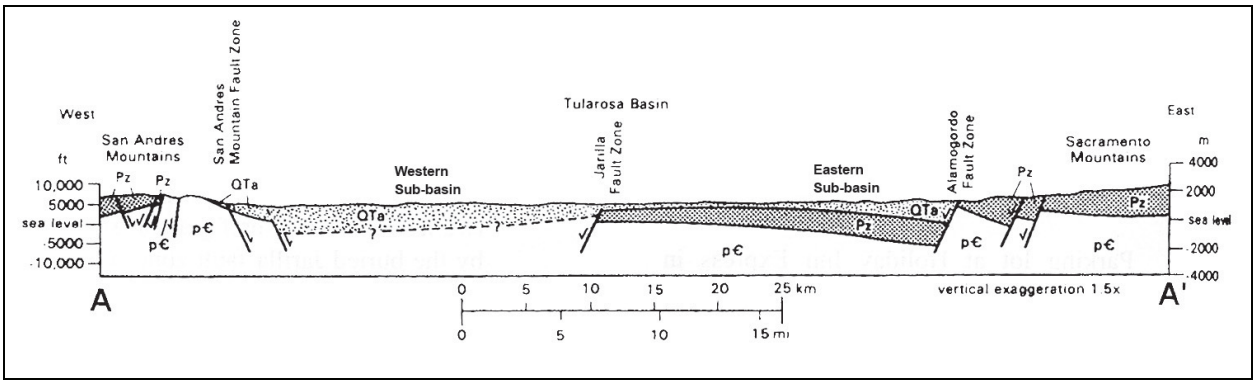

Figure 2.2 Cross-section of the Tularosa Basin, illustrating the western and eastern sub-basins (after Lueth et al. 2002).

2.1.1 PRE-CENOZOIC ROCKS

Consolidated bedrock of Precambrian to Tertiary age is present predominantly at the margins of and beneath the basin floor. Figure 2.3 shows a stratigraphic column that describes the lithology and thickness of rock units in the Tularosa Basin. Precambrian rocks occur mostly at depth within the mountain blocks but are also exposed along the eastern flanks of the Organ and San Andres Mountains. These exposures consist primarily of granitic intrusive rocks with some metamorphic units. Paleozoic rocks older than Permian in age are present in thicknesses ranging from 2,000 to 5,000 feet and are widely exposed in the San Andres, southern Organ, and Franklin Mountains to the west (McLean 1970). These older Paleozoic units also make up much of the western flank of the Sacramento Mountains between Valmont and Tularosa. Predominant lithologies include dolomite and limestone, with lesser amounts of sandstone, siltstone, and shale.

Permian formations with combined thicknesses up to 3,500 feet comprise much of the remaining consolidated rock exposed in the area (McLean 1970). These units, including the Bursum, Abo, and Yeso Formations, the Glorieta Sandstone, and the San Andres Limestone, consist of arkosic sandstone, siltstone, shale, limestone, dolomite, and evaporates. These rocks make up much of the exposures in the northern and southern Sacramento Mountains, those at higher elevations within the central Sacramento Mountains, and nearly all of Chupadera Mesa. The relative importance of the Paleozoic rocks for water supply and their impacts on surface water and ground-water quality are discussed later in this section.

Mesozoic rocks are exposed in the Tularosa Basin from the Three Rivers area north and east to north of Carrizozo. These units include the Dockum Group of Late Triassic age and the Cretaceous Mesaverde Group, Mancos Shale, and Dakota Sandstone. Exposed in the Carrizozo area, the Dockum Group sandstones, siltstones, shale, and limestone are up to 500 feet in thickness. The sandstone, shale, and local coal beds of the Mesaverde Group are from 500 to 1,000 feet thick in this area and are underlain by approximately 1,200 feet of the low-permeability Mancos Shale and about 100 feet of Dakota Sandstone (McLean 1970).

	Stratigraphic units		Lithology	Thickness (feet)	Description
CENEZOIC	Quaternary			0-2000	Alluvial conglomerate and gravel in Tularosa basin and along flanks of Hueco and Sacramento Mountains. Well-sorted aeolian sands in northern and southeastern part of McGregor Range.
CENEZOIC	Tertiary				Monzonite, diorite, syenite. Occurs as sills, dikes, and stocks intruding Paleozoic strata.
PALEOZOIC	Permian	San Andres Fm.		0-750	Brown to olive gray limestone with minor olive gray dolostone; fine-to medium-grained white sandstone in lower part.
PALEOZOIC	Permian	Yeso Fm.		0-1800	Tan to brown finely crystalline dolostone and limestone with subsidiary red to gray, fine-grained sandstone.
PALEOZOIC	Permian	Abo Fm.		0-300	Red shale; minor fine-to very fine-grained sandstone and dolomitic siltstone.
PALEOZOIC	Permian	Hueco Fm.		400-1500	Light-to dark gray limestone with minor interbedded gray shale and white fine-to coarse-grained sandstone.
PALEOZOIC	Permian	lower Abo or Pow Wow Cg1.		0-600	Red shale, dolomitic fine-to coarse-grained sandstone, arkosic conglomerate. Minor dolostone and limestone.
PALEOZOIC	Pennsylvanian	Panther Seep Fm.: Holder Fm.; Beeman Fm. / Lead Camp Fm.: Gobbler Fm.		0-3300	Holder, Beeman and Gobbler Formations in Sacramento Mountains; Panther Seep Fm. and Lead Camp Fm. elsewhere. Panther Seep Fm. comprised of black lime mudstones and wackestones. Holder, Beeman, and Gobbler Fms. consist of light-to dark gray limestone interbedded with light-to dark gray shale and minor quartzose sandstone.
PALEOZOIC	Mississippian	undivided (Helms, Rancherio Lake Valley, and Caballero Fms.)		0-500	Gray to dark gray limestone interbedded with dark gray to black shale. Divided into Helms Rancheria, Las Cruces, Lake Valley, and Caballero Formations in the Sacramento Mountains; undivided in subsurface.
PALEOZOIC	Devonian	upper Shale		10-100	Black shale
PALEOZOIC	Devonian	Canutillo Fm.			Black chert, bedded to brecciated
PALEOZOIC	Devonian	lower Shale			Black shale
PALEOZOIC	Silurian	Fusselman Formation (including Valmont Dolomite)		130-500	Dolostone, dark gray, cherty
PALEOZOIC	Ordovician	Montoya Group		150-500	Dolostone, light gray, cherty in places
PALEOZOIC	Ordovician	El Paso Group		400-700	Thin bedded dark gray dolostone with minor quartzose sandstone.
PALEOZOIC	Ordovician	Bliss Sandstone		100-250	Quartzose sandstone, minor thin-bedded dolostone.
PRECAMBRIAN	Proterozoic				Granitic rock, rhyolite porphyry, diabase to gabbro, metasedimentary rocks.

Figure 2.3. Stratigraphic column indicating lithology and thickness of rock units in the Tularosa Basin (taken from Broadhead 2002).

2.1.2 CENOZOIC DEPOSITS

Igneous Tertiary rocks, both intrusive and extrusive, are exposed primarily in the northeastern portions of the Tularosa Basin. Here they make up the Godfrey Hills northeast of Three Rivers, as well as most of Sierra Blanca. Lesser exposures are also present in the Jarilla Mountains and the Organ Mountains in the southern portions of the basin.

The majority of Cenozoic deposits, and the units most important in terms of water resources and supply in the Tularosa Basin, are the unconsolidated Tertiary and Quaternary basin-fill sediments of the Santa Fe Group. This thick sequence of clay, silt, sand, and evaporite deposits began to accumulate in the middle Tertiary (Miocene) time as the mountains bordering the basin formed (McLean 1970). Alluvium derived from the adjacent uplands was carried into the basin by streams and deposited in alluvial fans, floodplains, lakes, and playas throughout much of the late Tertiary and Quaternary periods. Late Quaternary fill consists largely of playa, eolian, and alluvial plain deposits, which are commonly gypsiferous, especially nearer the center of the basin. A sheet of basaltic lava over 100 feet thick, probably of late Holocene age, caps the basin-fill deposits in the northern portion of the Tularosa Basin (Bedinger et al. 1989).

Much of the basin-fill deposits consist of clay and silt that intertongue with wedges of coarser sand, silt, and gravel alluvial fan deposits along the basin margins (Bedinger et al. 1989). Geophysical surveys and a number of test and water-supply wells drilled throughout the basin have documented the thickness and nature of basin-fill sediments (McLean 1970; Meinzer and Hare 1915; Orr and Myers 1986). The coalescing alluvial fans along the basin margin are variable in size and thickness. The poorly sorted sediments that make up these units range from thin veneers over shallow bedrock to thick sequences of hundreds of feet that are important as local water supply aquifers. Coarser-grained units, including sands, silts, and gravels, are more common not only along the basin margins, but in the upper portion (upper several hundred feet) of the basin-fill deposits. Beneath these coarser, shallow subsurface units, clay dominates the lithology, with interbedded sand units typically comprising 25 percent or less of the profile. One deep stratigraphic test well, T-14, drilled on White Sands Missile Range penetrated mostly sand between depths of 3,600 and 6,000 feet; lateral extent of this coarser unit cannot be determined due to the lack of other deep test wells.

2.2 SURFACE WATER

The Tularosa Basin is a closed basin with respect to surface water flow. Precipitation varies significantly within the basin, with the lower elevations receiving about 40 percent less than the surrounding mountain regions (Garza and McLean 1977). Differences in average annual precipitation are illustrated by the records for Holloman Air Force Base, with approximately 8.5 inches per year, and Cloudcroft, with about 26 inches per year. Much of the surface water in the basin originates as runoff from the mountains in the form of winter and spring snowmelt and summer runoff from intense thundershowers. The amount of runoff from the Sacramento Mountains to the east is approximately twice the runoff received from the San Andres and Organ Mountains to the west, owing to differences in altitude and resulting precipitation patterns (Waltemeyer 2001).

Surface water enters the basin from the surrounding mountain ranges by way of intermittent and perennial streams that drain toward the center of the basin. These streams typically originate at springs that issue from bedrock in the mountains. As the perennial streams exit the canyons and flow onto the alluvial fans and basin fill, much of the water is diverted for agricultural or municipal uses or infiltrates the bottom of stream channels to recharge shallow ground water. Some surface water collects near the center of the basin in a series of playas or shallow, short-lived salt lakes where it evaporates, leaving behind an accumulation of minerals including gypsum, halite, and potassium salts.

2.2.1 SURFACE WATER QUANTITY

The largest drainages entering the Tularosa Basin originate in the Sacramento Mountains and include, from north to south, the Three Rivers drainage, Rinconada Canyon, the Tularosa Creek, the Fresnal/La Luz Creek system, and Alamo Canyon (Figure 2.4). These streams are characteristically perennial in their upper reaches, where they flow across the bedrock, with some discharge to and recharge from shallow ground water. Much of the remaining streamflow typically infiltrates into the basin fill to recharge shallow ground water within a relatively short distance after passing the Alamogordo Fault Zone. Each of these streams has been developed as a water supply for municipal purposes, irrigation, or both.

Waltemeyer (2001) estimates the mountain-front mean annual streamflow available for potential recharge to the Tularosa Basin using two regional regression models. The Basin-Climatic Characteristics Method estimates mean annual streamflow based on stream drainage area and mean annual precipitation using the formula

$$Q_a = 1.70 \times 10^{-4} A^{1.35} P^{1.65}$$

where Q_a = mean annual streamflow, in cubic feet per second
A = drainage area, in square miles
P = mean annual precipitation, in inches

The second method, the Channel-Geometry Characteristics Method, estimates streamflow based on channel width. Waltemeyer (1993) previously demonstrated a statistically significant relationship between these variables at six streamflow-gauging stations in southern New Mexico. Streamflow was estimated by this method using the formula

$$Q_a = 0.04 W^{1.59}$$

where Q_a = mean annual streamflow, in cubic feet per second
W = active-channel width, in feet

The estimated streamflow for each of the major Sacramento Mountains drainages listed above derived from these two methods is:

- Three Rivers 11.5 ft^3/s* to 18.8 ft^3/s†
- Rinconada Canyon 12.7 ft^3/s* to 24.1 ft^3/s†
- Tularosa Creek 24.2 ft^3/s* to 8.93 ft^3/s†
- La Luz Creek 7.3 ft^3/s* to 16.4 ft^3/s†
- Alamo Canyon 1.98 ft^3/s* to 17.0 ft^3/s†

*Derived from *Basin-Climatic Characteristics Method* †Derived from *Channel-Geometry Characteristics Method*.

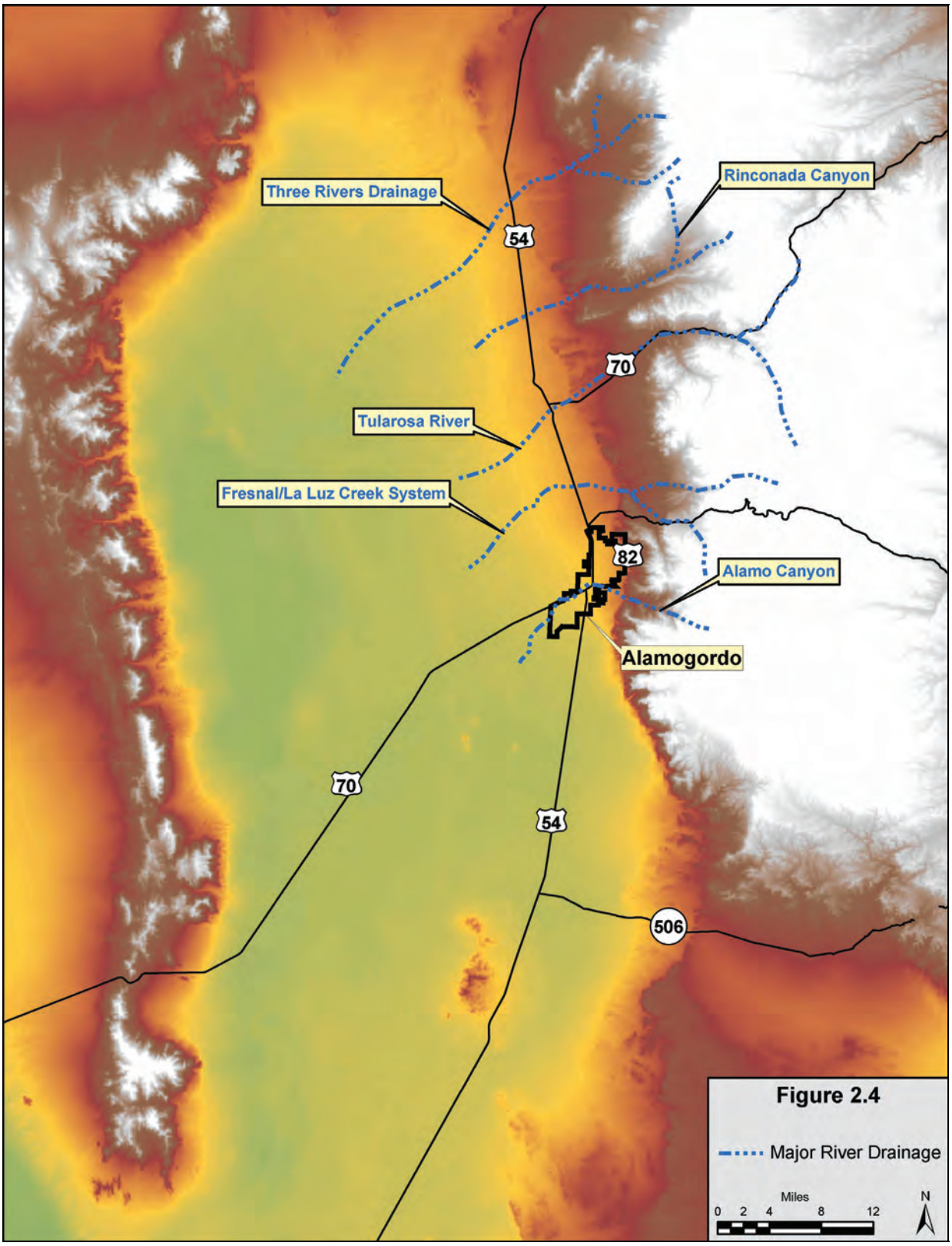

Figure 2.4. Map showing major river drainages from the Sacramento Mountains to the Tularosa Basin.

Waltemeyer (2001) also estimated the total annual streamflow available for recharge to the Tularosa Basin as 68,800 acre-feet for a year of average precipitation. An estimated 47,800 acre-feet, or nearly 70 percent, enters the eastern portion of the basin from the Sacramento Mountains, with the remainder from the San Andres and Organ Mountains to the west. Waltemeyer's estimates appear not to consider diversions for municipal supply or irrigation from the Sacramento Mountain drainages (Waltemeyer 2001).

The Regional Water Plan for the Tularosa and Salt Basins utilizes the data reported by Waltemeyer (2001) for streamflow as part of an estimate of watershed yield that considers both streamflow and infiltration to bedrock upstream of the mountain-front (South Central Mountain RC&D Council, Inc., [RC&D] 2002). From watershed yield, the direct recharge of basin-fill deposits and recharge due to flow from the bedrock formations of the northern and eastern portions of the basin are estimated. Including this bedrock recharge, the Regional Water Plan estimates a basin recharge rate of 30,000 acre-feet for the Northern Tularosa Basin, 9,291 acre-feet for the Western Tularosa Basin, and 47,099 acre-feet for the Eastern Tularosa Basin, for a total of 86,390 acre-feet for the basin as a whole.

2.2.2 SURFACE WATER QUALITY

Water quality in the streams draining the Sacramento and San Andres Mountains generally exceeds that found in ground water of the Tularosa Basin. The quality of surface waters is influenced by the geologic formations in the headsprings areas and by the lithology of the other formations exposed downstream along these drainages. Water quality also can be expected to vary with the seasons and with the volume of flow in these channels, deteriorating to some degree at lower flows.

Surface water quality in the upper Three Rivers drainage is among the best in the eastern Tularosa Basin. This is likely due to the low solubility of the igneous rocks in most of this drainage basin. RC&D (2002) reports a dissolved solids concentration of 678 milligrams/liter (mg/L) and sulfate at 299 mg/L in a single sample collected in May 1985. In the lower reaches of this stream water quality degrades, with dissolved solids rising to more than 1,000 mg/L and sulfate up to 651 mg/L (Hood and Herrick 1965).

Further south along the Sacramento Mountain front, Tularosa Creek water quality patterns are similar to those found in the Three Rivers drainage. Dissolved solids of 585 mg/L near the headsprings increases downstream to 1,230 mg/l at Bent, approximately 12 miles upstream of the Village of Tularosa. Sulfate concentrations range between 128 and 220 mg/L over this stretch of the river (Garza and McLean 1977).

2.3 SPRINGS

There are reports of at least 50 springs in the Tularosa Basin, most of them identified during a 1911 survey. Table 2.1 lists the name, location, geologic source unit, flow, and total dissolved solids (TDS) for each spring; Figure 2.5 shows their locations. Springs found in the canyons of the western Sacramento Mountains serve as an important source of water for communities along

Table 2.1. Springs in the Tularosa Basin

Location	Name	Geologic Unit	Flow (Gpm)	Total Dissolved Solids (Mg/L)	Reference(S)
T6S R6E S20	Deer Spring	Madera Limestone	1-2	390	McLean 1970
T6S R6E S20	Rabbit Spring	Quaternary alluvium	Not reported	331	McLean 1970
T6S R6E S31	Council Spring	Madera Limestone	1–15	393	McLean 1970
T7S R6E S9	Yates Spring	Madera Limestone	Not reported	434	McLean 1970
T7S R6E S29	Dripping Spring North Gallery	Madera Limestone	1–2	450	McLean 1970
T7S R6E S29	Dripping Spring South Gallery	Madera Limestone	Not reported	584	McLean 1970
T7S R7E S 6	Seep Spring	Abo Sandstone	10	724–919	McLean 1970
T7S R7E S15	Red Canyon Spring	Abo Sandstone	1–2	3,130	McLean 1970
T7S R10E S26	Carrizozo Spring	Quaternary alluvium, Cretaceous rocks	50	1,603–2,040	McLean 1970
T8S R6E S27	unnamed spring	Not reported	Not reported	2.244	McLean 1970
T8S R9E S29	Lower Willow Spring	Mancos Shale, Quaternary alluvium	5	2,280–2,560	McLean 1970
T8S R10E S22	Upper Coyote Spring	Quaternary alluvium, Cretaceous rocks, undivided	6	1,258	McLean 1970
T9S R8E S23	Bull Gap Spring	Dockum Group	2	5,220	McLean 1970
T9S R8E S34	Phillips Spring	Dakota Sandstone	3	1.760–1,938	McLean 1970
T9S R9E S9	Root Spring	Mesaverde Group	5	1,840	McLean 1970
T9S R9E S10	Jakes Tunnel	Mesaverde Group	3	1,722	McLean 1970
T9S R9E S10	Jakes Spring	Mesaverde Group	30	1,480–1,625	McLean 1970
T9S R9E S32	Milagro Spring	Mesaverde Group	20	1,254–1,430	McLean 1970
T10S R6E S23	Mound Spring #7	Quaternary alluvium	5	4,682	McLean 1970
T10S R6E S23	Mound Springs	Quaternary alluvium	3	4,170	McLean 1970
T10S R6E S26	Mound Spring #25	Quaternary alluvium	2	4,133	McLean 1970
T11S R4E S35	Brady Spring	Not reported	Not reported	Not reported	McLean 1970
T11S R9E S35	Falls Ranch Spring	Cretaceous rocks, undivided	Not reported	1,897	McLean 1970
T12S R4E S2	Grapevine Spring	Not reported	1	Not reported	McLean 1970
T12S R7E S8	Malpais Spring	Quaternary basalt	220–1	1,500	McLean 1970; Bedinger et al. 1989
T13S R2E S12	Rhodes Spring	Abo Sandstone	0.25	Not reported	McLean 1970
T13S R9E S5	Chosa Spring	Quaternary alluvium	5	3,272	McLean 1970; Garza and McLean 1977

Table 2.1. Springs in the Tularosa Basin, continued

Location	Name	Geologic Unit	Flow (Gpm)	Total Dissolved Solids (Mg/L)	Reference(S)
T13S R12E S27	Sulphur Spring (North Spring)	Not reported	Not reported	Not reported	McLean 1970; Garza and McLean 1977
T14S R8E S35	Tularosa Spring (Tula Spring) (Barrel Spring)	Quaternary alluvium	25	1,250–1,838	McLean 1970; Garza and McLean 1977
T14S R9E S3	Lomitas Spring	Quaternary alluvium	5	2,602	McLean 1970; Garza and McLean 1977
T14S R12E S12	Head Springs	Yeso Formation	Not reported	Not reported	Garza and McLean 1977
T15S R9E S10	unnamed spring	Quaternary alluvium	Not reported	8,056	McLean 1970
T15S R9E S9	Mesquite Springs	Quaternary alluvium	Not reported	7,846	McLean 1970; Garza and McLean 1977
T15S R11E S11	unnamed spring	Not reported	Not reported	Not reported	Garza and McLean 1977
T15S R11E S24	Maruchi Springs	Not reported	Not reported	Not reported	Garza and McLean 1977
T15S R11E S25	La Luz Springs	Not reported	Not reported	Not reported	Garza and McLean 1977
T16S R9E S7	unnamed spring	Quaternary alluvium	Not reported	4,576	McLean 1970
T16S R9E S14	unnamed spring	Quaternary alluvium	Not reported	9,413	McLean 1970
T16S R10E S1	Fresnal Canyon Springs	Not reported	Not reported	Not reported	McLean 1970
T16S R11E S2	Wooten Spring	Madera Limestone	Not reported	1,324	McLean 1970
T16S R11E S28	Caballero Canyon Springs	Not reported	Not reported	Not reported	Garza and McLean 1977
T17S R8E S6	Salt Spring	Not reported	Not reported	7,504	McLean 1970; Garza and McLean 1977
T17S R8E S28	Black Spring	Pennsylvanian rocks, undivided (?)	Not reported	8,970	McLean 1970
T17S R11E S7	Alamo Canyon Springs	Quaternary alluvium	Not reported	Not reported	Garza and McLean 1977
T18S R8E S17	Harrington Spring	Not reported	Not reported	Not reported	McLean 1970; Garza and McLean 1977
T18S R8E S17	Salt Spring	Not reported	Not reported	Not reported	McLean 1970; Garza and McLean 1977
T19S R5E S4	unnamed spring	Quaternary alluvium	Not reported	94,980	McLean 1970
T20S R4E S17	Burke Spring	Not reported	2	480	McLean 1970
T21S R4E S12	Bonney Spring	Quaternary alluvium	1	496	McLean 1970
T21S R4E S34	Aguirre Springs	Not reported	Not reported	Not reported	BLM, undated
T23S R4E S24	Globe Spring	Not reported	Not reported	302	McLean 1970

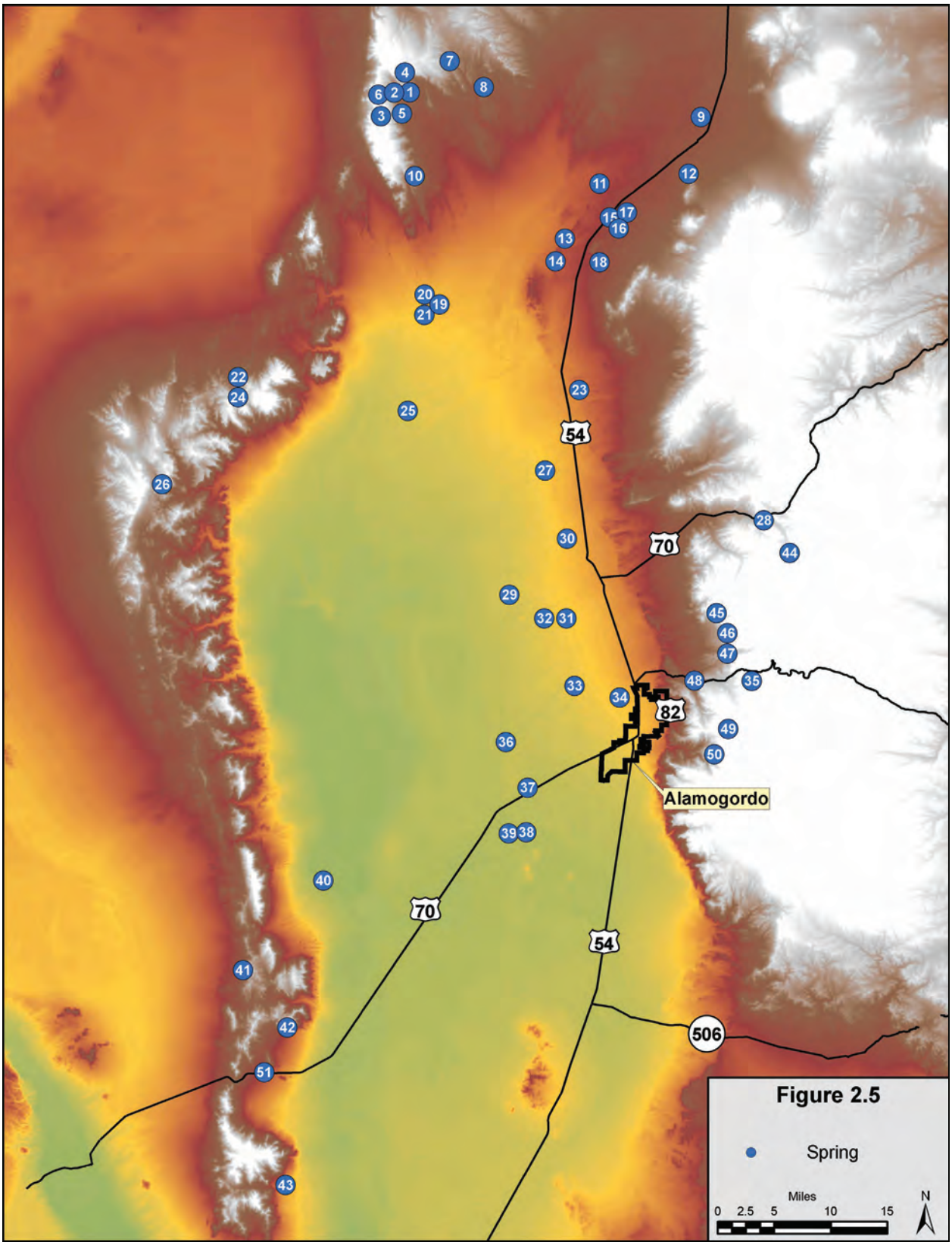

Figure 2.5. Map showing the locations of springs in the Tularosa Basin.

the eastern margin of the Tularosa Basin. Examples include the La Luz, Fresnal, and Alamo Canyon Springs (and springs tributary to these drainages), which are an important source of water for Alamogordo. The Tularosa Creek, on which the community of Tularosa and some irrigators depend for water, also originates at several springs in the western Sacramento Mountains. Similar bedrock springs are found in the mountains on the western side of the Tularosa Basin, including Rhodes Canyon in the northern San Andres Mountains and Aguirre Springs in the Organ Mountains. However, there are fewer large springs on the western side of the basin.

A number of smaller springs are located on or near the floor of the Tularosa Basin, some of which issue from bedrock (limestone, shale, and sandstone) near the contact with basin-fill materials. The majority of these springs are located in the northern portion of the Tularosa Basin. Examples of bedrock springs in the northern portion of the basin include Carrizozo Spring near Carrizozo and Jakes and Milagro Springs near Oscura. Malpais Spring is at the southern edge of a Quaternary basalt flow in the northern basin, at the contact with underlying basin-fill deposits. A few springs originate in the unconsolidated basin-fill deposits. Examples include Mound Springs, west of the Quaternary basalt, and Salt Springs on White Sands National Monument.

Few data are available regarding the discharge of ground water from springs outside of those that feed the important mountain drainages. McLean (1970) reported estimates of the flow from Carrizozo, Jakes, and Milagro Springs as 50, 30 and 20 gallons/minute (gpm), respectively. Measurements of flow from Malpais Spring from several investigators ranged from 220 gpm to 1,500 gpm (Bedinger et al. 1989). Discharges from Mound Springs in the northern basin are estimated to be in the range of 2 to 5 gpm (McLean 1970).

Perennial springs in La Luz and Fresnal Canyons provide water of good quality to La Luz Creek. Water quality declines downstream from a dissolved solids concentration of 672 mg/L at the Fresnal Canyon springs to 1,700 mg/L at La Luz, with sulfate concentrations rising from 112 to 799 mg/L over this same distance. The springs in Alamo Canyon provide water of good quality to Alamo Creek. Dissolved solids are commonly around 500 mg/L, and sulfate is present at 130 mg/L (RC&D 2002).

Few water quality data are available for the smaller tributaries and springs of the eastern or western Tularosa Basin, but similar patterns can be expected based on the bedrock types found within the drainage basins.

Springs located near or on the basin floor are typically higher in total dissolved solids than those found in the mountains. Dissolved solids measured in water from the bedrock springs in the northern basin (e.g., Carrizozo, Jakes, Milagro) range from about 1,250 to 2,500 mg/L. Springs that issue from Quaternary deposits typically range from 4,000 to 10,000 mg/L of dissolved solids, with one sample from Salt Spring reportedly containing 94,980 mg/L (McLean 1970).

2.4 GROUND WATER

Ground water has been developed from both bedrock and basin-fill aquifers in the Tularosa Basin. The basin-fill deposits represent the most important aquifers in the area in terms of the quantity of water available, achievable production rates, and the degree of historic development of these resources. Ground water in the basin-fill deposits generally originates as precipitation in the mountains that moves into coarse material at the proximal ends of alluvial fans.

2.4.1 WATER OCCURRENCE AND QUALITY

2.4.1.1 PRE-CENOZOIC ROCKS

The Precambrian rocks of the Tularosa Basin are mostly crystalline, with low primary permeability and some limited secondary fracture permeability. Because of the low solubility of the minerals that comprise these rocks, water quality is typically good, with dissolved solids concentrations of less than 1,000 mg/L. However, owing to their low permeability and limited distribution, Precambrian rocks are not an important source of ground water within the basin.

The pre-Permian Paleozoic rocks commonly exposed in the San Andres, Organ, and Franklin Mountains are largely crystalline sedimentary formations composed of dolomite and limestone and are also fairly low in permeability. Ground water yields are low in these units, with wells typically producing less than 100 gpm and with a drawdown on the order of 500 feet. Supplies produced from shallow outcrop areas tend to be calcium bicarbonate water of good quality with dissolved solids of less than 1,000 mg/L (Figure 2.6), but quality probably declines with depth, especially where water enters from overlying Permian rocks (McLean 1970).

Permian formations represent marginal water sources within portions of the Tularosa Basin. The Yeso Formation supplies water to stock and domestic wells in the northern portion of the basin. Water in the upper portion of the saturated zone may have a TDS of 1,000 to 3,000 mg/L and a calcium sulfate ionic composition, but the salinity increases quickly with depth due to the gypsum that is dominant in the formation. Further, the well yields in the Yeso are typically low (less than 5 gpm), though they may be higher where solution cavities exist (McLean 1970). The Glorieta Sandstone and San Andres Limestone are both important water-producing units outside of the basin, but they are either thinner or less permeable within the basin. Thus, though water quality within these units is typically good, yields are low.

In the area southwest of Carrizozo, the Late Triassic Dockum Group yields water of usable quality (TDS of 1,000 to 3,000 mg/L) in springs and irrigation wells. These wells are characterized by low yields, except where fractures are intercepted and wells producing up to 150 gpm have been reported (McLean 1970).

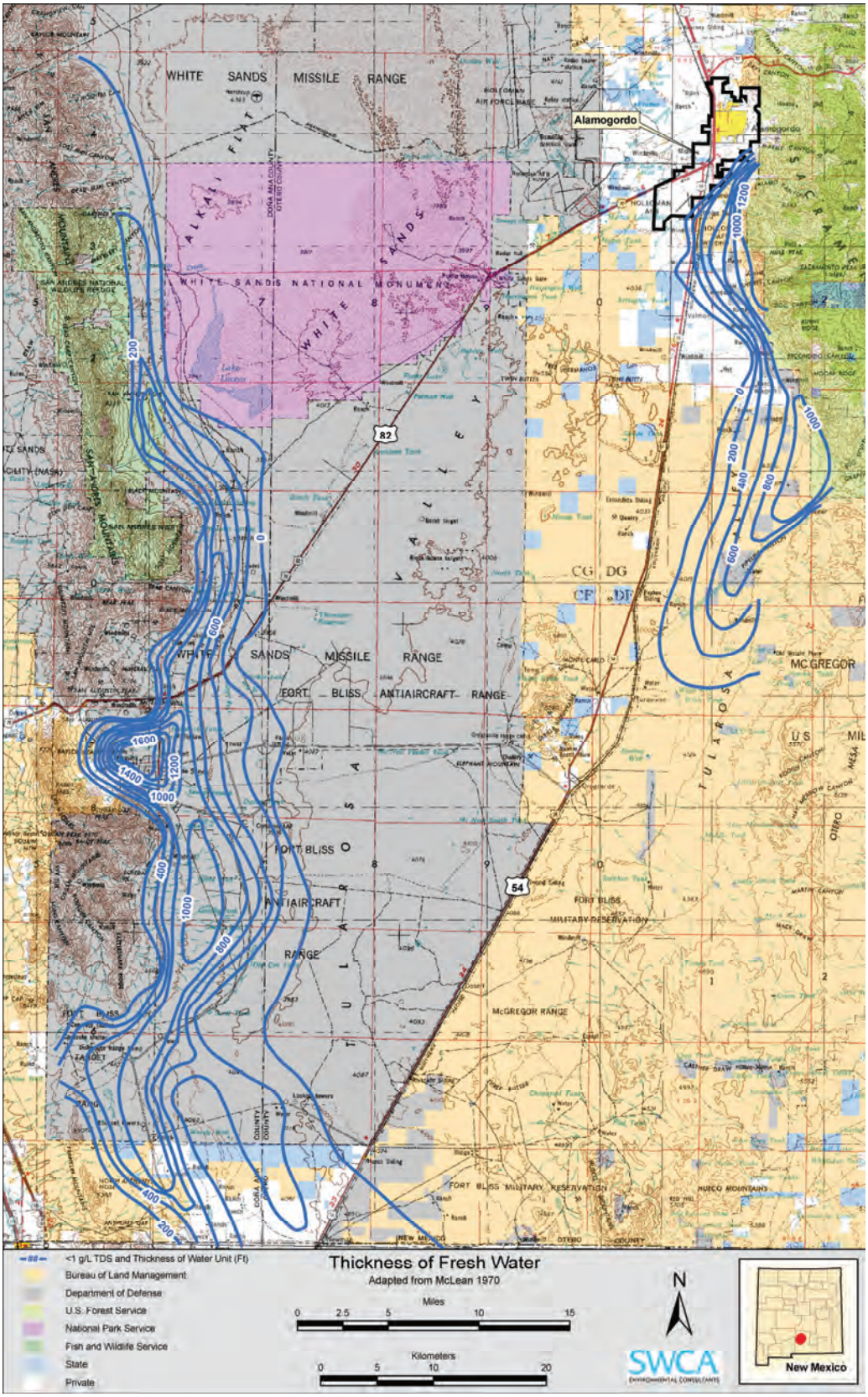

Figure 2.6. Thickness of fresh water unit (from McLean 1970).

Cretaceous rocks are also locally important as aquifers in the Carrizozo area, where wells completed in the sandstones of the Mesaverde Group can produce up to 850 gpm. The underlying Mancos Shale produces little water, but at greater depth the Dakota Sandstone also yields sufficient water (5–125 gpm) for development of wells. Water from both of these formations has a typical TDS of 1,000–3,000 mg/L (McLean 1970).

2.4.1.2 CENOZOIC DEPOSITS

The most important aquifers in the Tularosa Basin are within the unconsolidated basin-fill deposits. As described in Section 2.1.2, these deposits are variable in nature, both by location and by depth. Water in these aquifers is probably Holocene in age (1,000–10,000 years old), based on dating in the southeastern part of the basin (Huff 2002). The ground water gets older as it moves deeper and farther away from the mountain-fronts.

Wells in Cenozoic deposits generally have yields in the range of 700–1,400 gpm. The highest yields generally correspond with the water of best quality, which comes from within the coarse deposits high on the alluvial fans on the east and west sides of the basin. However, the spatial extent and continuity of these coarse-grained deposits within the alluvial fans may be limited, which would constrain the water available for water supply. A geophysical study conducted in Grapevine Canyon suggests that structural features within the alluvial fans are filled with finer-grained sediments and that the permeable coarse-grained materials may be limited to thin layers (Belzer et al. 2002). Another study in alluvial fan deposits in the vicinity of Soledad Canyon found the hydraulic properties to be highly variable because of both the heterogeneity of the sediments and tectonic activity (Naus 2002).

With distance from the mountain-front, these alluvial sediments typically become finer grained and interfinger with lacustrine clays and evaporate deposits present in the center of the basin. On the lower fans, well yields of 300–700 gpm can be expected (McLean 1970). Little information is available regarding well yields in the center of the basin because high salinities have led to limited water development in this area. Within the main portion of the basin, sands and silts that can produce greater quantities of water are mostly present within a few hundred feet of the surface. Sands encountered between 3,600 and 6,000 feet from at least one test well may or may not be laterally continuous in a large portion of the basin. The Jarilla Fault, running north-south through the basin, divides a smaller sub-basin along the Sacramento Mountain–front from the main part of the basin. The flow conditions across this fault are not known, although it probably represents a zone of at least reduced permeability.

Water quality declines with distance from the mountain-fronts. Close to sources of recharge (from surface water infiltration and an unknown volume of bedrock flow), fresh water (less than 1,000 mg/L TDS) is often available to wells. The chemistry of these waters is dependent on the geologic units, present at depth, that are exposed in the drainage basins and on the composition of the alluvial materials that make up these basin-fill aquifers. Generally speaking, salinity also increases with depth within basin-fill deposits. However, recent sampling at the Tularosa Basin National Desalination Research Facility and at a Snake Tank test well (B. McGuire, personal communication) have documented the opposite trend, with ground-water samples collected at depth showing lower concentrations of dissolved solids.

2.4.2 FRESH GROUND WATER SOURCES

Significant volumes of fresh water (TDS of less than 1,000 mg/L) exist in basin-fill sediments in two main areas along the margin boundaries, one in the fan deposits along the southern Sacramento Mountains and a second area in the fan deposits adjacent to the southern San Andres and Organ Mountains (Figure 2.7). As mapped by McLean (1970), the area of fresh ground water along the southern Sacramento Mountains is about 20 to 25 miles long, extending from Alamo Canyon south of Alamogordo to about 10 miles beyond Grapevine Canyon. The width of this zone varies from 2 miles to a maximum of about 4 miles opposite Grapevine Canyon. Near the mountain-front the fresh-water zone is up to 1,200 feet thick, thinning to an irregular edge westward where it is underlain by more saline water. This fresh-water zone has been extensively developed by Holloman Air Force Base and by private irrigation and domestic users. McLean (1970) estimated that approximately 3 to 4 million acre-feet of fresh water is present in this zone.

The other significant area of fresh-water resources in the basin is adjacent to the south San Andres and Organ Mountains. This area extends over 50 miles, from Ash Canyon in the north to south of the Texas border. A reentrant in the mountain-front at White Sands Missile Range Headquarters contains over 1,800 feet of basin-fill sediments saturated with fresh water. This area serves as the water supply for the range. Despite the ground-water withdrawal from the Post Headquarters well field, ground-water storage in the Soledad Canyon area has not been affected (Naus 2002). The remainder of this zone is elongated north-south along the mountain-front, is 200 to 1,000 feet thick, and ranges in width from 2 miles in the north to nearly 10 miles in the south near the Franklin Mountains. An estimated 7 million acre-feet of fresh water is present in this area (McLean 1970).

2.4.3 SLIGHTLY SALINE GROUND WATER SOURCES

Water containing dissolved solids concentrations between 1,000 and 3,000 mg/L is found generally around the margins of the Tularosa Basin and also exists as a transition zone between the fresh water areas described above and the saline water that characterizes most of the basin (Figure 2.7). McLean (1970) represents this water quality unit as a band around the basin margin, ranging from about 2 to 5 miles in width and having a thickness of up to a few hundred feet with the notable exception of two areas, in the northeastern and southeastern portions of the basin. The slightly saline zone in the northeastern basin extends about 30 miles from Alamogordo in the south to Three Rivers in the north, with its widest expression (10 miles) in the south and the narrowest (4 miles)in the north. The lack of a significant volume of fresh ground water in this area is likely due to the presence of soluble minerals in the alluvial materials and to recharge from ground water flowing through sedimentary rocks rich in sulfate materials (Hood and Herrick 1965).

John Shomaker & Associates, Inc., (JSAI) (2003a) and the South Central Mountain RC&D Council, Inc., (RC&D) (2002) have a more conservative interpretation of the extent of this slightly saline unit, recognizing the presence of more saline water closer to the Jarilla Fault. JSAI estimates that about one-third of the water in the eastern sub-basin, or approximately 13 million acre-feet, is in the slightly saline range.

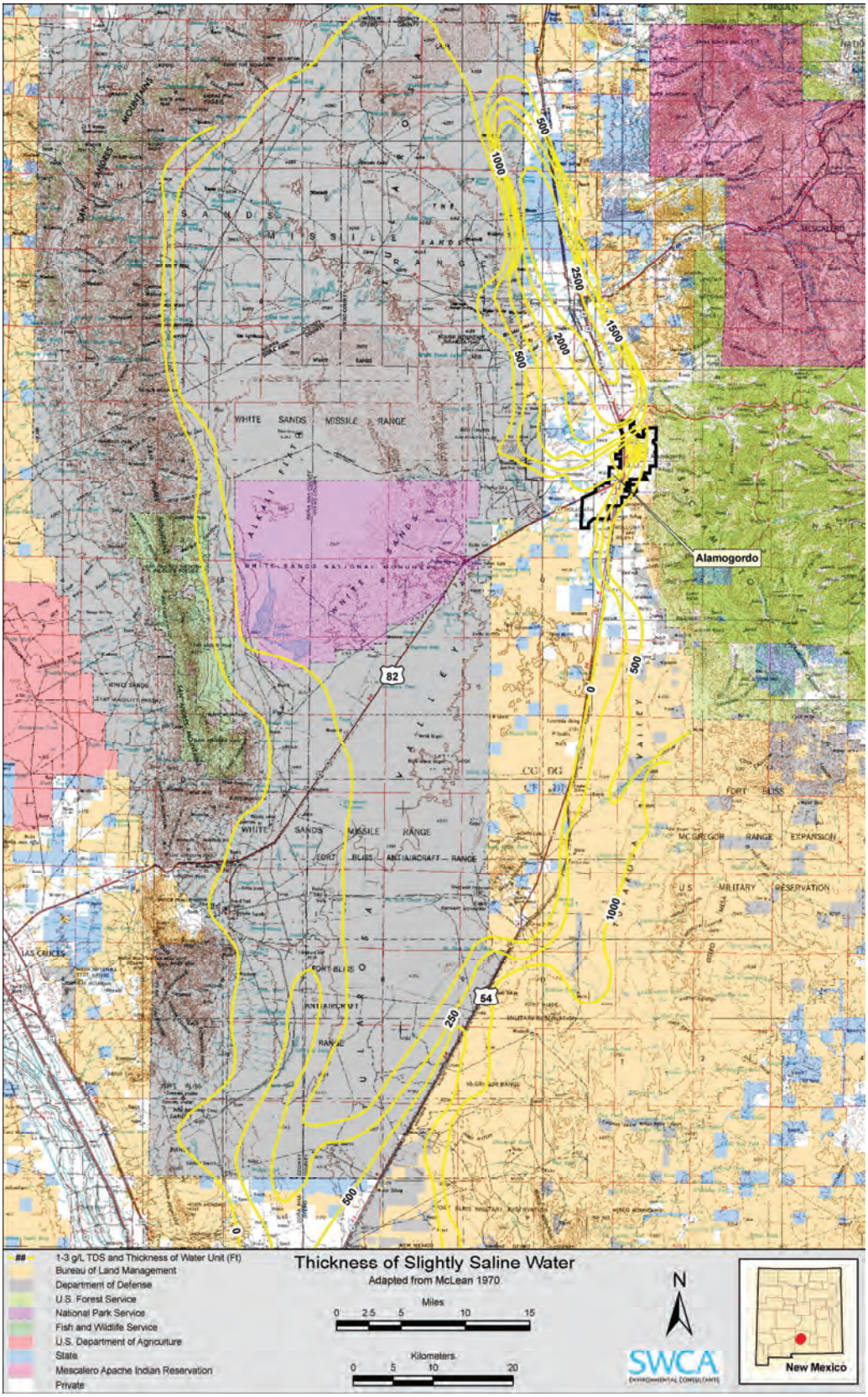

Figure 2.7. Thickness of slightly saline water unit (from McLean 1970).

2.4.4 SALINE GROUND WATER SOURCES

The central portion of the basin is saturated with water that ranges from moderately saline to brine (Figure 2.8). In places, ground water of the central basin contains dissolved solids in excess of 100,000 mg/L. Limited water quality analyses are available for these waters, but most data indicate sodium and chloride as the primary ions. McLean (1970) estimates that 98 percent of the alluvial deposits in the Tularosa Basin are saturated with sodium chloride brine, with a dissolved solids content of over 35,000 mg/L. In some areas, shallower wells have produced water with a TDS range of 13,900–57,600 mg/L, in which the predominant ions were either sodium and sulfate or sodium, chloride, and sulfate (Orr and Myers 1986).

2.5 NEW MEXICO WATER LAW

The New Mexico Constitution declares that all natural waters in New Mexico, both surface water and ground water, belong to the public and are subject to appropriation for beneficial use. An appropriator does not own the water, only the right to use the water. The state's water law and framework for water rights are defined in New Mexico Statutes Chapter 72 and administered by the Office of the State Engineer (OSE). Under the statutes, beneficial use is the basis, measure, and limit of the right to use water. The OSE has the authority to determine what constitutes beneficial use. All beneficial uses are considered equal; however, under the state's doctrine of prior appropriation, "senior" water rights are given priority over more "junior" water rights. This policy takes effect in consideration of new applications for water rights and when water supply is limited and cannot meet all water demands.

2.5.1 APPLICATION PROCESS

A permit is required for the appropriation of any surface water within the state and for appropriation of ground water in any basin declared by the OSE to have reasonably ascertainable boundaries. The underground waters of the State of New Mexico comprise 33 declared basins (New Mexico Office of the State Engineer [OSE] 2005). Exceptions to the permitting requirement include domestic uses and small-scale stock watering. Small livestock and domestic ground water users must submit a permit application but are exempt from other permitting requirements.

Upon filing an application for a water use permit with the OSE, the applicant must publish a public notice of the proposed appropriation. Any person, firm, or corporation who believes that the granting of the application will impair their existing water right may file an objection or protest with the OSE within an established protest period. Protests may also be filed on the basis that granting the application will adversely affect public welfare or would be contrary to the conservation of water within the state. The applicant and protestants may reach a settlement, or if a settlement is not reached, the applicant may request a hearing before the OSE. In these hearings, the burden of proof is on the applicant.

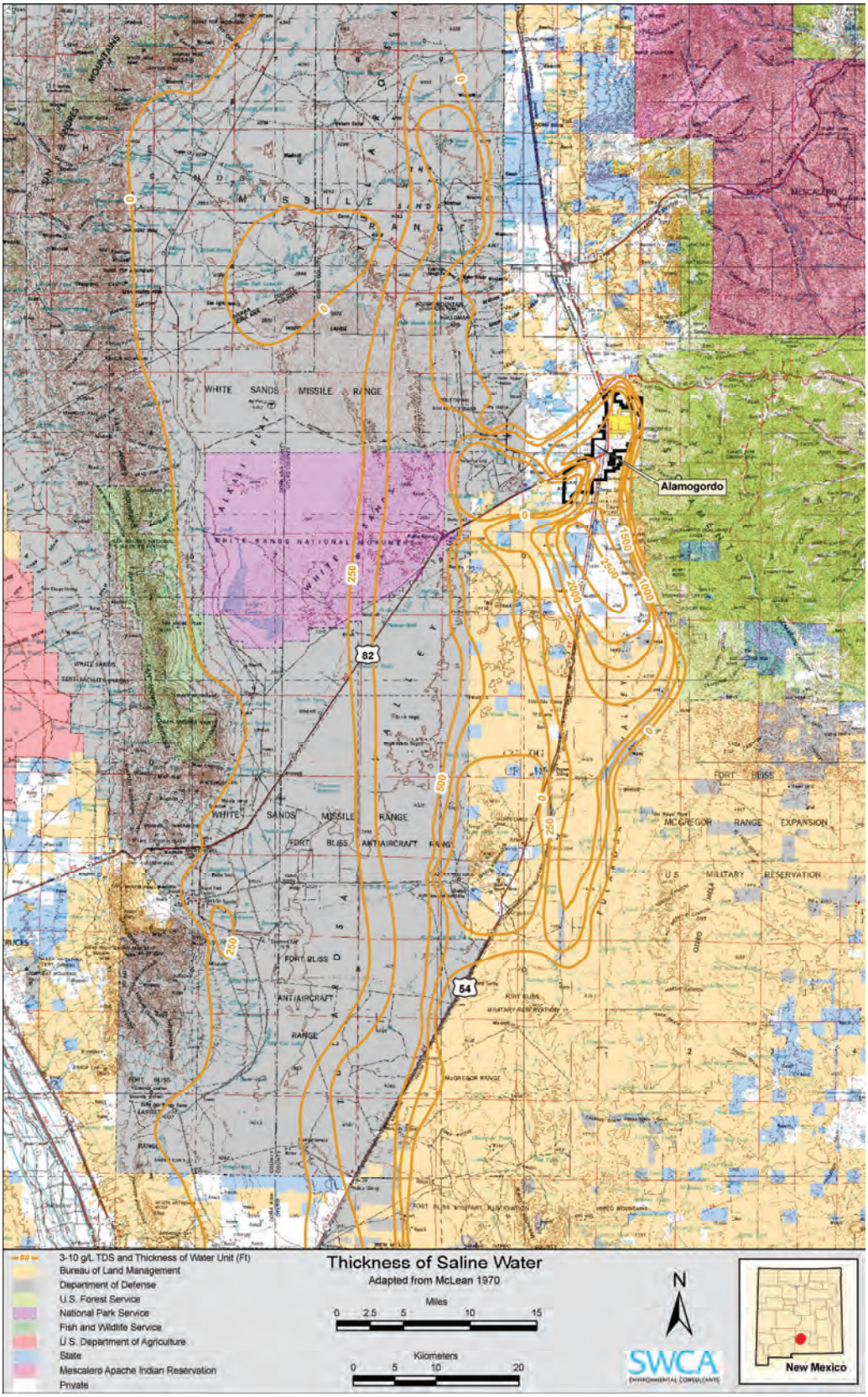

Figure 2.8. Thickness of 3,000 to 10,000 TDS saline water unit (from McLean 1970).

In evaluation of a permit application, the OSE must consider the following: whether the application will impair any existing water right; whether granting the application would be contrary to the conservation of water within the state; and whether the application will be detrimental to public welfare. The OSE may approve the application as submitted, for a lesser amount of water or different period of use than requested, or under other conditional approval, or may reject the application. If approved, the application becomes a permit to appropriate water and must state the time within which construction will be completed and water will be appropriated for beneficial use. Any appeals to the OSE decision go to the District Court.

A water right, once granted by the OSE, becomes a private property right and can be bought or sold. The right can also be forfeited in part or in whole for failure to put the water to beneficial use. Any change in the point of diversion requires a new permit application. Water rights approved for the purpose of irrigation become appurtenant (attached) to the land upon which the right is used. Transfer of an irrigation water right to another property or for another use also requires a new permit application.

2.5.2 WATER RIGHTS ISSUES SPECIFIC TO THE TULAROSA BASIN

The Tularosa Underground Water Basin, an area of 6,070 square miles, was declared by the OSE on July 7, 1982, and was subsequently extended by 586 square miles on September 27, 2005, by OSE Special Order 162 (19.27.64.7 NMAC). The current Tularosa Basin Underground Water Basin is 6,656 square miles (Figure 2.9). To assure the orderly development of ground-water resources in the more populous Alamogordo-Tularosa corridor, the Alamogordo-Tularosa Administrative Area (Administrative Area) was adopted by the OSE in May 1997. The Water Rights Division developed criteria for water rights administration and the processing of water rights applications within the new sub-basin. A ground-water model developed by Thomas M. Morrison of the OSE (Morrison 1989) serves as a tool to assist in the administration of water rights in the Administrative Area. The administrative criteria for new applications establish a maximum allowable drawdown of 100 feet over a 40-year planning period, or dewatering of approximately one-quarter of the available fresh-water thickness. Because of the high level of total dissolved solids in much of the ground water in the Tularosa Basin, ground-water applications in the Administrative Area are also evaluated for their potential impact on distribution of dissolved solids in the aquifer.

2.5.3 SUMMARY OF PERMITTED WATER RIGHTS IN THE TULAROSA BASIN

Information regarding existing permitted water rights within the Tularosa Basin is available to the public through the WATERS Database on the OSE internet website (OSE 2005b). Data listed in WATERS for each water right includes the owner, the location of the point of diversion, the permitted maximum diversion, and the intended use. Analysis of these data illustrates the geographical distribution of water rights within the Basin and provides an indication of the relative consumption by each type of water use (e.g., agricultural, municipal, military, residential). Data are provided for both surface water rights and ground-water rights; however, the analysis provided below focuses solely on ground-water rights.

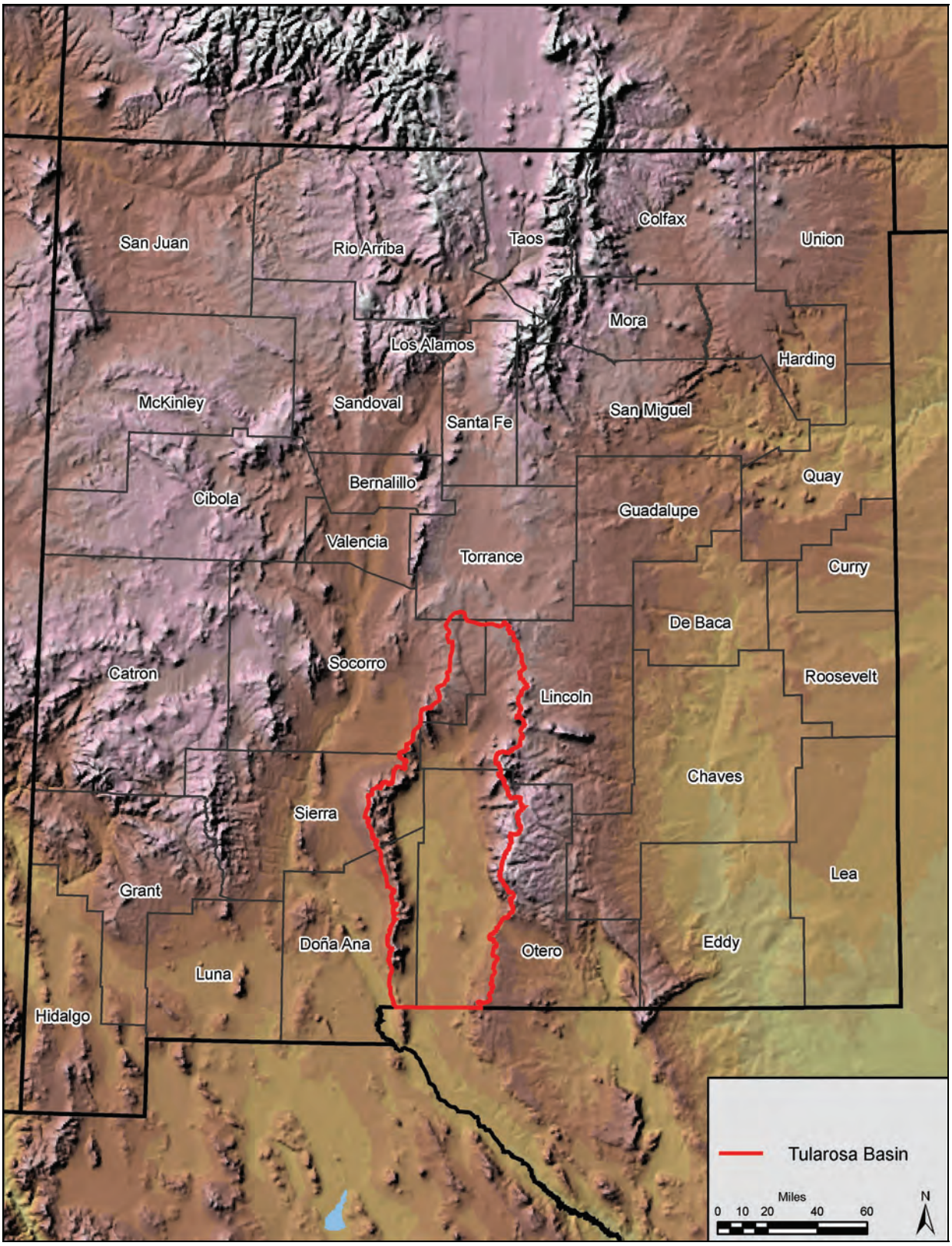

Figure 2.9. Map of the Tularosa Underground Water Basin defined by the New Mexico Office of the State Engineer.

A summary by use type of 4,911 permitted ground-water rights within the Tularosa Basin is provided in Table 2.2. For comparison, the table also includes a separate analysis of the water rights data for the smaller Alamogordo-Tularosa Administrative Area. The number of water rights by use type is listed for the Tularosa Basin and for the Administrative Area, as is the total permitted diversion by acre-foot per year (ac-ft/yr). As illustrated in Figure 2.10, the majority (62%) of individual water rights in the Tularosa Basin are owned by residential users. Agricultural users (25%) make up the second largest number of water rights permitted within the Basin. The balance of water rights is divided between commercial (3%), municipal (1%), "other" uses (9%) including exploration, monitoring, highway construction and unspecified use, and lastly, military use (<1%). Total permitted ground-water diversions within the Basin by ac-ft/yr are represented in Figure 2.11. In terms of permitted diversions, agricultural users dominate with 58% of the total water use, even though agriculture makes up only 25% of the permitted diversions in the Basin. Military water use (16%) ranks second, followed by municipal (12%), residential (9%), commercial (4%), and the combined category of other water uses (<1%). As shown in Figure 2.12, the majority of these 4,911 water rights are concentrated within the Alamogordo-Tularosa Administrative Area.

In general, the ranking of the number of ground-water rights by usage type is the same in the Administrative Area (Figure 2.13) as for the Basin as a whole (residential, agricultural, other uses, commercial and municipal). However, the top three use types for ground-water diversions (Figure 2.14) are agricultural (67%), municipal (19%) and residential (12%) as there are no military ground-water diversions from within the Administrative Area. These figures show that agriculture accounts for 67% of the total water used in the Administrative Area, even though it makes up only 24% of the permitted diversions. Figure 2.15 provides an illustration of the current density and distribution of consumptive ground-water uses in and around the Administrative Area.

Table 2.2. Existing Water Rights within the Tularosa Basin and the Alamogordo-Tularosa Administrative Area

	Tularosa Basin Water Rights		**Administrative Area Water Rights**	
Use Type	**Number of Water Rights**	**Diversion Total (ac-ft/yr)**	**Number of Water Rights**	**Diversion Total (ac-ft/yr)**
Agricultural	*1,216*	*92,562*	*775*	*64,202*
Commercial	*128*	*6,149*	*88*	*2,317*
Municipal	*41*	*19,278*	*16*	*18,305*
Residential	*3,083*	*14,570*	*2,209*	*12,048*
Military	*6*	*26,046*	*0*	*0*
Other	*437*	*248*	*192*	*144*
Total	**4,911**	**158,853**	**3,280**	**97,016**

Source: New Mexico Office of the State Engineer WATERS Database, November 16,2005, (OSE 2005b)

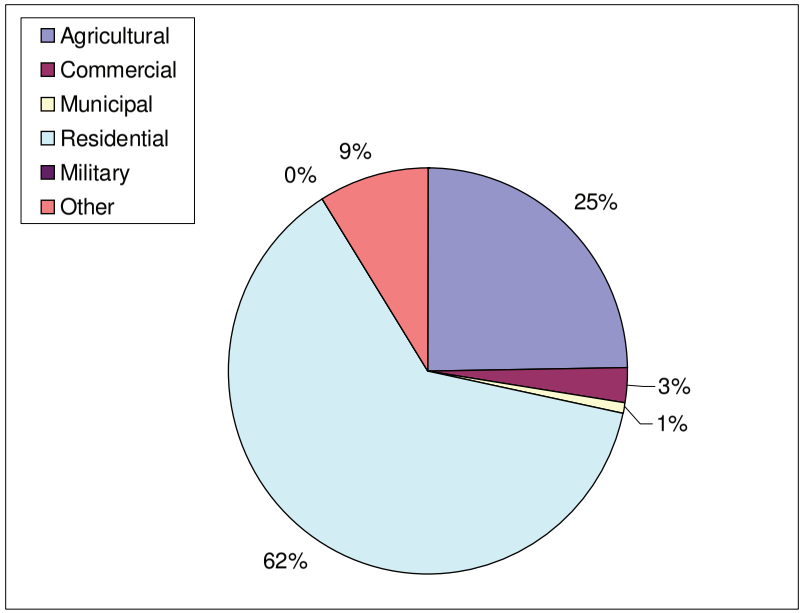

Figure 2.10. Distribution of individual permitted ground-water diversions (water rights) for the Tularosa Basin by type of use.

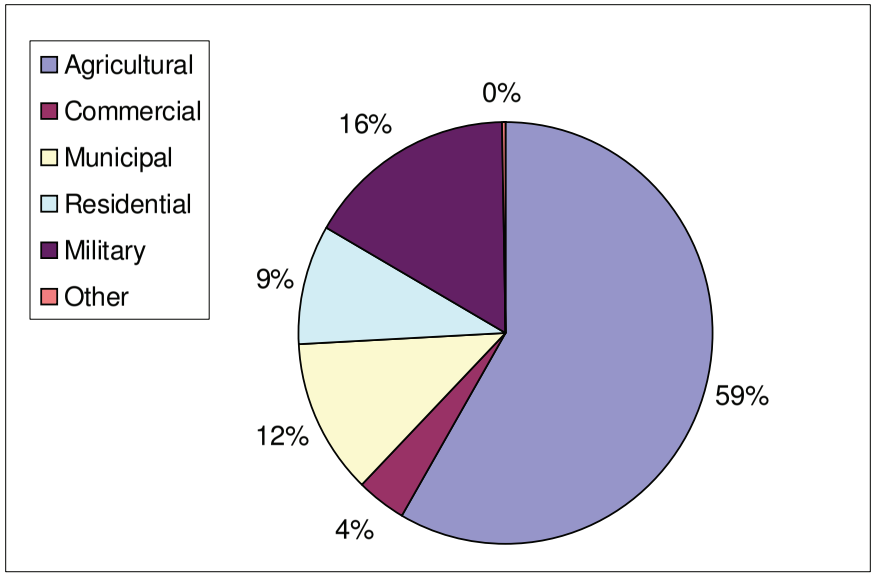

Figure 2.11. Permitted ground-water diversions (ac-ft/yr) in the Tularosa Basin by type of use, shown as percent of total permitted diversions.

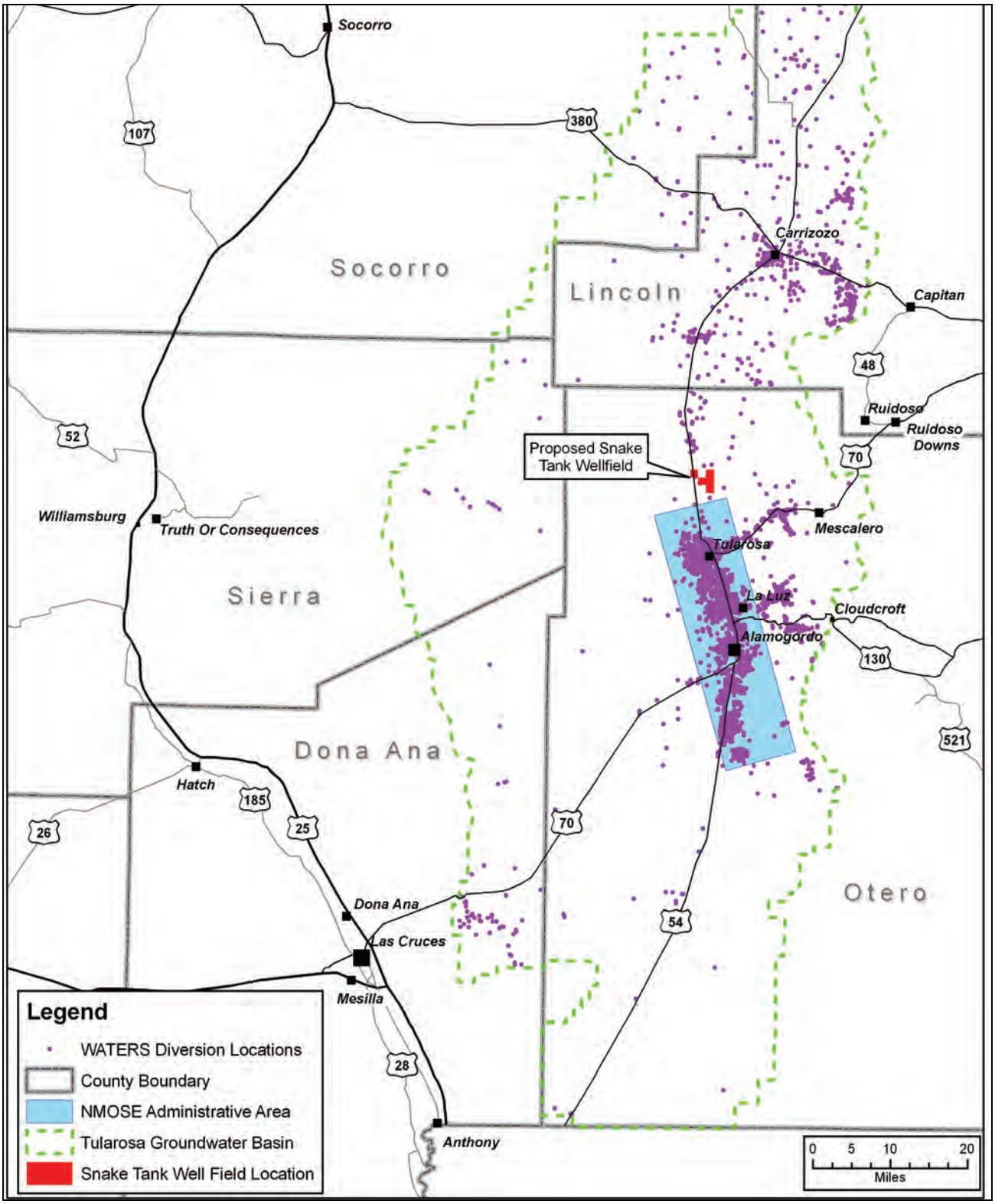

Figure 2.12. Well locations from W.A.T.E.R.S. database (Tularosa Groundwater Basin).

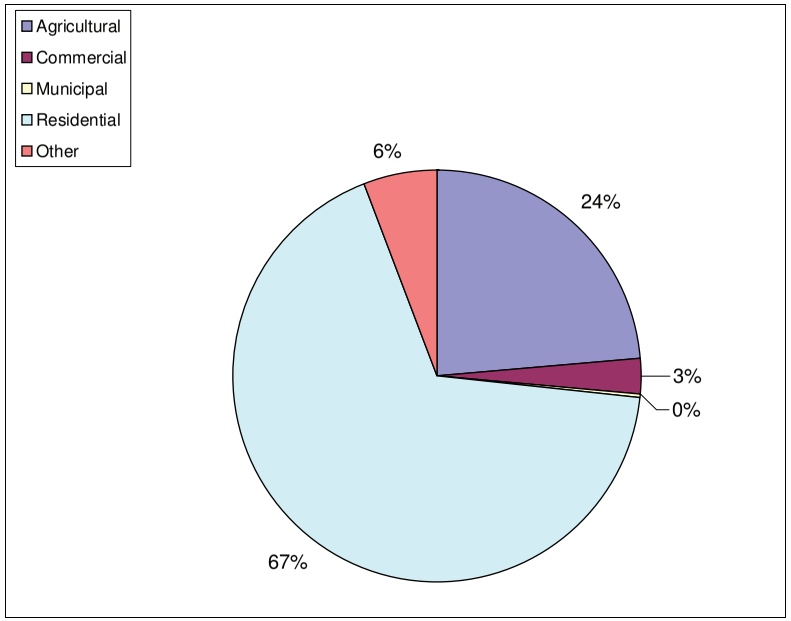

Figure 2.13. Distribution of individual permitted ground-water diversions (water rights) for the Alamogordo-Tularosa Administrative Area by type of use.

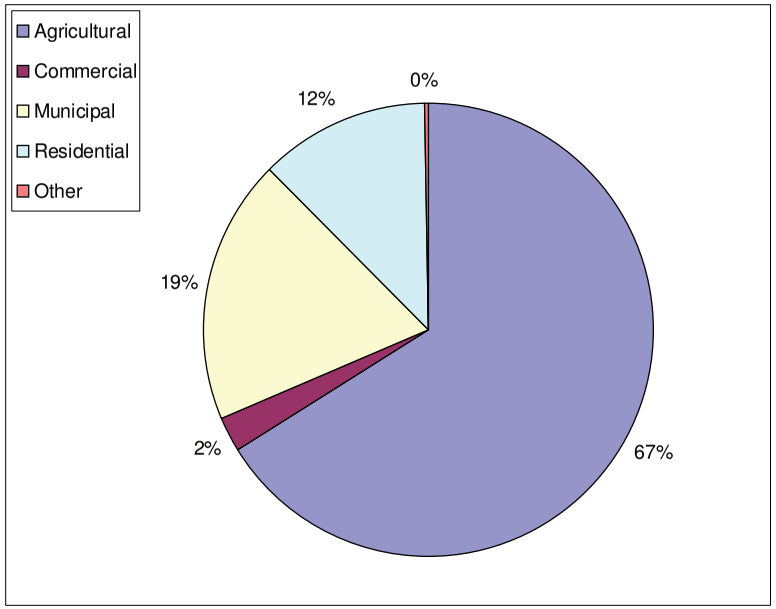

Figure 2.14. Permitted ground-water diversions (ac-ft/yr) in the Alamogordo-Tularosa Administrative Area by type of use, shown as a percent of total permitted diversions.

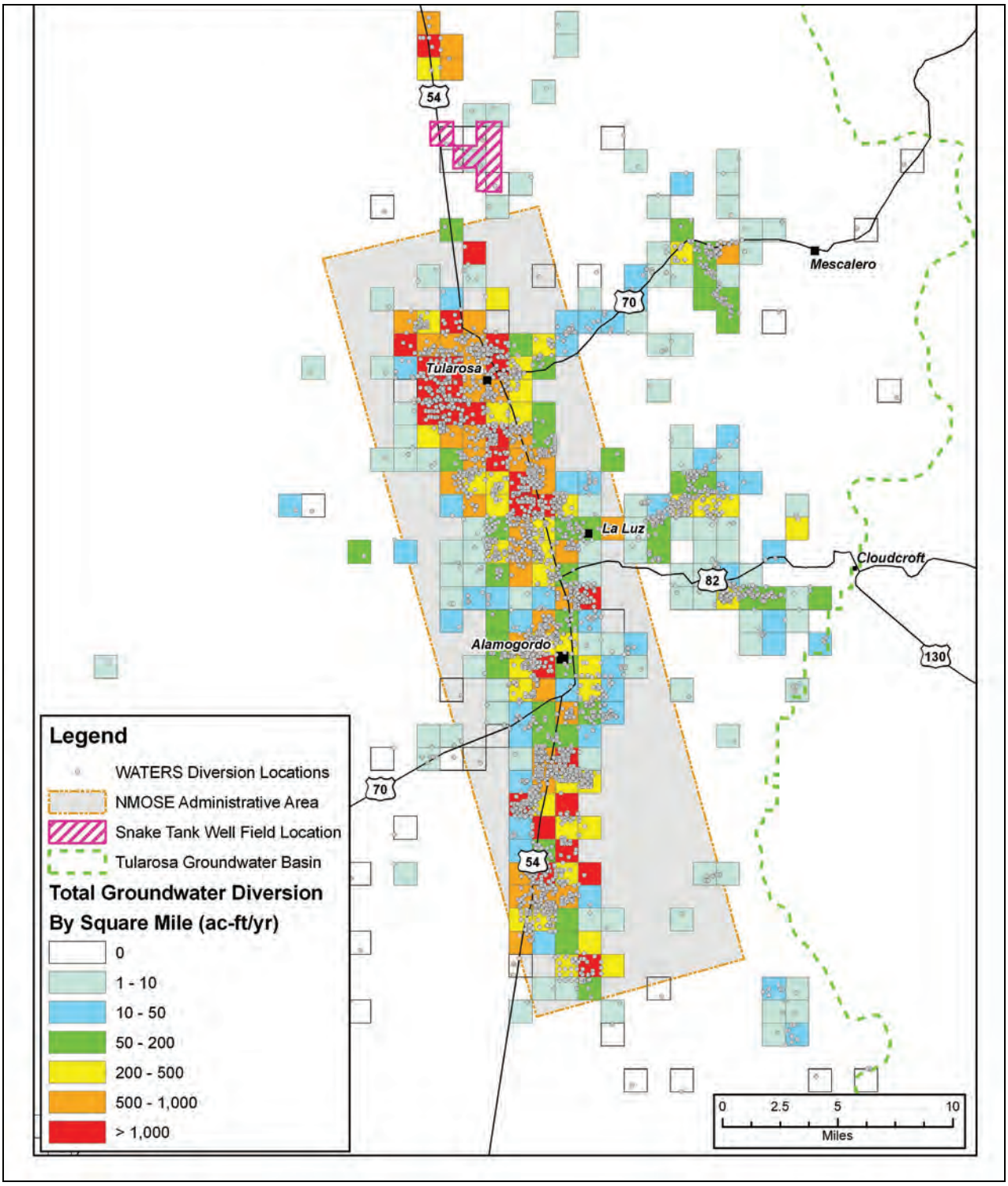

Figure 2.15. Distribution and locations of existing water diversions within the NMOSE Administrative Area near Alamogordo, New Mexico. The total amount of ground water presently diverted within 1 square mile is represented by colored cells.

2.6 ESTIMATED WATER RESOURCES VERSUS FIRM YIELD

Water rights have been established in the Tularosa Basin based on estimates of the available supply and the demonstrated need or proposed beneficial use. In practice, the amount of water that can be *diverted* under a water right varies and may be significantly less than the amount *permitted* under the water right. These variations in yield may be based on hydrologic, collection, and distribution system limitations and may impact the reliability of a water resource. In planning for future water needs, the City of Alamogordo has used the concept of "firm yield" of existing water resources in comparing their existing water supply to current and projected future demands. Alamogordo consultant JSAI defines "firm yield" as "the minimum yield during the life of the reservoir [supply] (JSAI, 2003b:pg. 2)." In applying this concept to analysis of the City's supply sources, JSAI states that "firm yield is based on the lowest surface- and ground-water diversions for the period of record (JSAI 2003b:pg. 2)."

In calculating the firm yield for surface water sources, JSAI took into account reductions in annual yield due to recent drought conditions, pipeline conditions, periods of poor water quality, and minimum lake level requirements (Bonito Lake) for fish, wildlife, and recreation. It was assumed that the amount of water diverted from each source was the maximum amount that could be taken. The fifth percentile was chosen as a conservative flow value that would be available on demand, "since 95 percent of historical flows exceed the fifth percentile (JSAI 2003b:pg. 2)."

Variability in the annual yield from ground-water sources results from aquifer capacity, number of wells, well performance, and equipment downtime for maintenance and replacement. JSAI calculated the firm yield of the City of Alamogordo's La Luz Well Field by summing the minimum annual production from each well for the period 1999 to 2002, adding a factor of 20 percent to correct for year-round pumping (currently, the wells are used 8–10 months of the year), then subtracting the minimum annual production from the single best-producing well as a reliability factor.

These firm-yield calculations provide a conservative estimate of reliable water resources availability for planning purposes. The estimates are conservative because they assume historical minimum (or near minimum) production from each of the City's water sources at the same time (data from multiple surface water sources for a 35-year period and from the La Luz Well Field for 4 years). Table 2.3 compares the permitted water right for each of the City's sources and the calculated firm yield used for planning purposes.

Table 2.3. Comparison of Permitted Water Rights and Calculated Firm Yield (modified from JSAI 2003b)

Water Resource	Permitted Water Right (ac-ft/yr)	Calculated Firm Yield (ac-ft/yr)	Firm Yield as a Percent of Permitted Water Right
La Luz–Fresnal Canyon	12,395	2,557	20
Alamo Canyon	3,078	750	24
Bonito Lake	1,719	0*	0
La Luz Well Field	4,573	1,093	24
TOTAL	**21,765**	**4,400**	**20**

*Assumed for planning and contingency

3.0 WATER RESOURCES ALTERNATIVES DEVELOPMENT

In the development and analysis of alternatives to the proposed action, the Environmental Impact Statement (EIS) project team conducted an independent evaluation of water resource availability in the general project area. The intent of this evaluation was to develop a set of feasible options for a reliable source of water to meet the identified need for a minimum period of 40 years. As stated in the EIS purpose and need, existing regional water users (especially municipal, agricultural, and military users) are heavily dependent on surface water. As demonstrated by conditions over the past decade, surface water is particularly vulnerable to drought, impacting the reliability of regional water systems. To meet the purpose of providing a sustainable water supply, the team limited the evaluation to ground-water resources of the Hueco-Tularosa aquifer.

The team was aided by a significant body of existing published literature on the occurrence and quality of ground water within the basin. Chief among the references consulted were:

- *Saline Ground-Water Resources of the Tularosa Basin, New Mexico*, 1970, McLean, J. S., US Geological Survey, Research and Development Progress Report No. 561.

- *Water Resources in Basin-Fill Deposits in the Tularosa Basin, New Mexico*, 1986, Orr, Brennon R., and Myers, Robert G., US Geological Survey, Water-Resources Investigations Report No. 85-4219.

- Alamogordo Municipal and Industrial Water Supply Study, New Mexico (Working Document), 1986, US Bureau of Reclamation.

- *Tularosa Basin and Salt Basin Regional Water Plan, 2000–2040*, 2002, Livingston Associates and John Shomaker and Associates, Inc., for South Central Mountain Resource Conservation and Development Council, Inc.

The development of alternatives for water resources focused on aquifers within the basin-fill deposits of the Tularosa Basin. These deposits, including the alluvial fans flanking the mountain fronts on the east and west sides of the basin and the lacustrine and eolian deposits of the central basin, contain substantial quantities of saline and, to a lesser extent, fresh ground-water resources. The area considered in the development of water resources alternatives extends from the New Mexico/Texas border north to Oscura and from near the crest of the Sacramento Mountains in the east to near the crest of the San Andres and Organ Mountains in the west (Figure 3.1). Much of the region outside of this area is characterized by bedrock, present at or near the ground surface, with limited water production potential. Alluvial or basin-fill deposits outside of the Tularosa Basin were not considered in the development of alternatives, due largely to the administrative difficulties posed by trans-basin water diversion.

To screen potential water resources locations within the area of evaluation, the EIS team applied a number of criteria related to the quality, quantity, accessibility and availability of ground water.

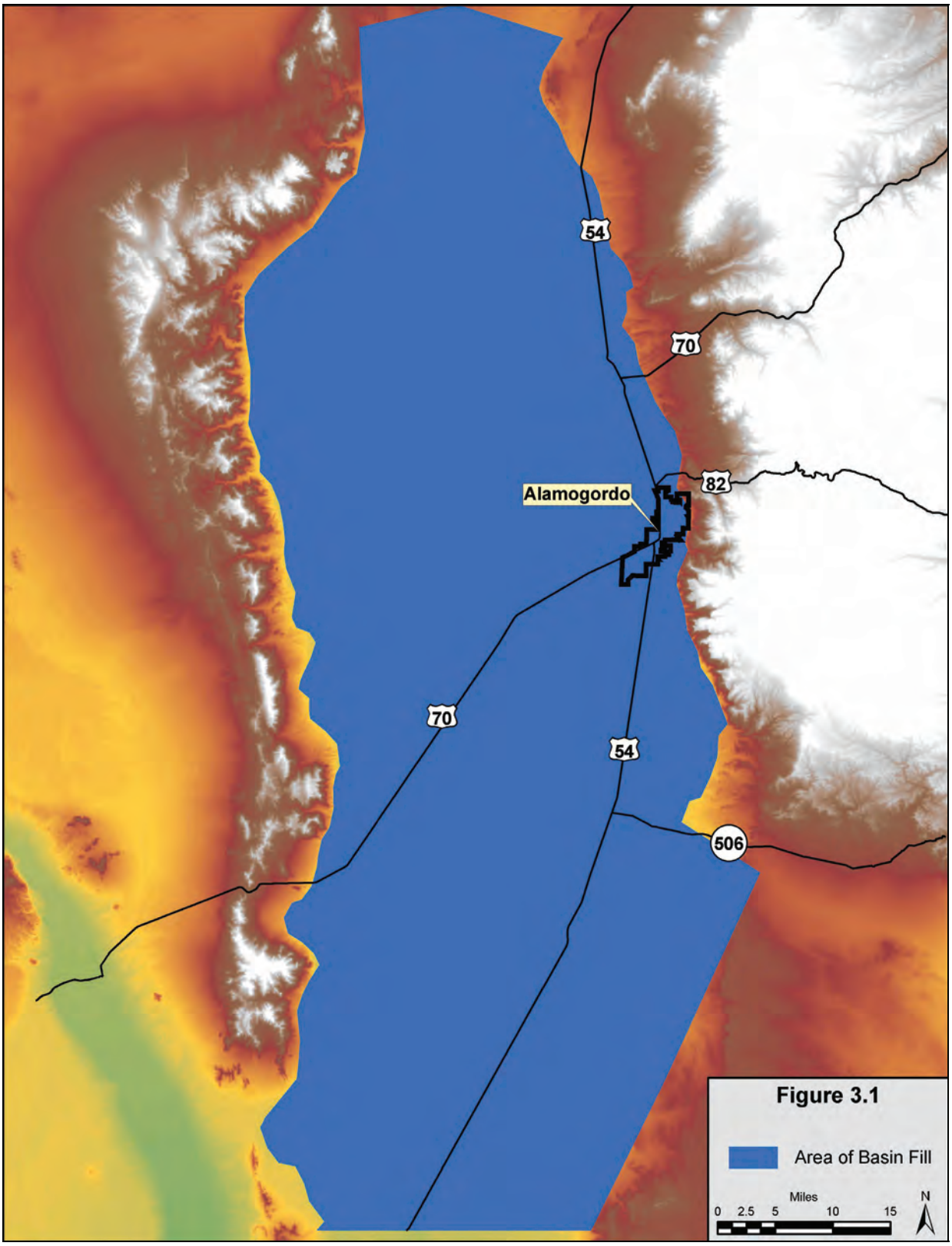

Figure 3.1. Area of basin-fill deposits considered in the development of water resources alternatives.

The criteria used were both scientific (e.g., ground water quality, quantity, and recoverability) and administrative (e.g., permitability and current land ownership). The selection and definition of these criteria were influenced by the availability of data in published literature. Utilizing a Geographic Information System (GIS) approach, available data for each criterion were overlain on a map of the area to identify the most favorable alternatives for further analysis. The following sections outline the criteria that were used in this analysis and the resulting preliminary water resources alternatives developed.

3.1 PERMITABILITY

Permitability is an important consideration for alternatives identification and screening, given that water users in New Mexico must obtain their water rights under state law, and that these rights are administered by the OSE. The application process for new water rights is described above in Section 2.5.1 under New Mexico Water Law. By declaring the 6,665-square-mile Tularosa Underground Water Basin (see Section 2.5.2), the OSE established the requirement for water rights by permit. Therefore, any new ground water development by the City of Alamogordo within the Tularosa Basin will require an approved permit application prior to construction.

Additional considerations are imposed by the OSE for any new ground-water development within the Alamogordo-Tularosa Administrative Area. The OSE established in 1997 that these considerations were necessary because the Tularosa is a "mined water basin," or one in which the water withdrawal from wells exceeds natural or induced recharge. Further, the majority of existing and pending well applications in the Tularosa Basin were found to be within this Administrative Area. Under the Administrative Area requirements, applications for new water rights are considered with respect to their potential to cause significant drawdown within ground-water model "blocks" or to impact fresh (<1,000 mg/L TDS) ground-water quality by influencing migration of saline water. A number of model blocks within the Administrative Area are already considered "critical" under the defined criteria, and no further ground-water development is permitted in those areas.

Because of the degree of existing ground-water development in the Alamogordo-Tularosa Administrative Area, the more stringent criteria for permit application approval, and the large areas already considered critical where further ground-water development is not permitted, new water rights of the magnitude required by the City of Alamogordo are unlikely to be granted. Ground water within the boundaries of the Administrative Area has therefore been eliminated from further consideration as a water resources alternative for this project (Figure 3.2).

Outside of the Administrative Area but within the Tularosa Basin, permitability of ground-water resources is affected by the proximity to other, senior water rights. Application for a new water right can be challenged if it is believed that the ground-water development will cause unacceptable impairment of an existing water right. Additionally, the City of Alamogordo has stated that it is their intention to minimize impacts to the existing agricultural lifestyle that characterizes much of the Tularosa Basin (Livingston and Shomaker. 2002). For this reason, the permitability criteria used for water resources alternatives development also consider

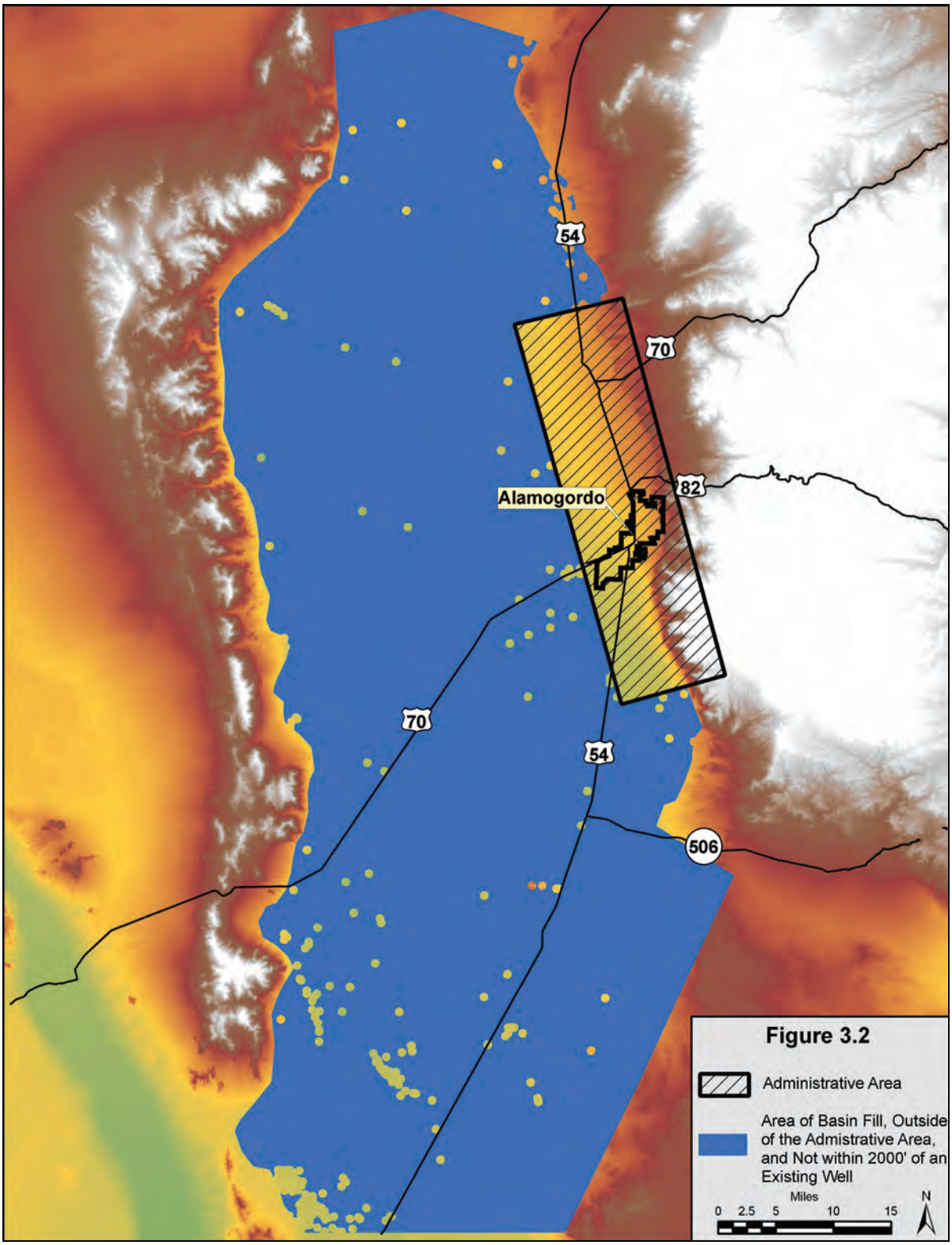

Figure 3.2. Area of basin-bill deposits showing the Alamogordo-Tularosa Administrative Area and the location of existing senior water rights (each water-rights location shown with a 2000-foot radius).

proximity to existing senior water rights. Figure 3.2 shows the location of existing permitted ground-water wells (OSE 2003) outside of the Administrative Area. Each well is shown with a 2000-foot radius to approximate the area of greatest hydraulic influence. The GIS analysis of water resources alternatives considered only those areas outside of the Administrative Area, where a new well field (assumed to occupy 10 square miles) could not be within 2,000 feet of the nearest existing permitted well.

3.2 RECOVERABILITY

Two aquifer characteristics, depth to ground water and potential yield to wells, were used to provide a preliminary measure of ground-water recoverability in potential water resource areas. Other attributes considered but discussed later in this section include water quality and estimated thickness of the production zone.

Data on depth to ground water were obtained from McLean (1970). Depth to water was included as a criterion in the comparison of ground-water resources alternatives because of the progressively increasing technical difficulty of drilling and maintaining deeper wells. A depth to water of 400 feet or less was selected as a preferred condition for development within the evaluation area (Figure 3.3). McLean (1970) used this depth in his analysis of water resources availability. As can be seen in Figure 3.3, nearly all ground water within the evaluation area occurs within 400 feet of the surface. Therefore, this criterion excluded very little of the basin from further evaluation as a water resources alternative.

McLean (1970) summarized data on potential yields of wells developed within the upper 500 feet of the saturated zone in alluvial and lacustrine deposits within the Tularosa Basin. These data were contoured in several ranges: 0–300 gpm, 300–700 gpm, and more than 700 gpm. In general, the highest yields (in some cases, over 1,000 gpm) are in wells drilled in the coarse sands and gravels of alluvial fans bordering the eastern and western mountain fronts. Lower on these alluvial fans, toward the center of the basin, wells are typically completed in finer sands and silts and yield from 300 to 700 gpm. The distal alluvial deposits and lacustrine sediments of the central portion of the basin are typically higher in clay and evaporate minerals, and well yields are frequently very low. As discussed earlier, bedrock aquifers at the margins of the basin have limited water production potential. Although locally important for municipal, stock, or agricultural uses, well yields in these bedrock aquifers are commonly less than 100–200 gpm and are frequently much less.

Based on the available data, the EIS team adopted a well yield of 300 gpm as a recoverability criterion for water resources alternatives. To meet the City of Alamogordo's projected need of 10,000 afy, a well field of 10 wells would need to achieve an average pumping rate of over 600 gpm per well. To meet this same target at a well yield of less than 300 gpm would require more than 20 wells, representing a significant increase in the well field area, project complexity, and capital, operational, and maintenance costs. Figure 3.4 shows portions of the basin-fill deposits where well yields of more than 300 gpm can be expected, based on the information reported by McLean (1970). This criterion eliminates from further consideration the center of the Tularosa Basin, as well as portions of the northwest and southeast areas of the basin.

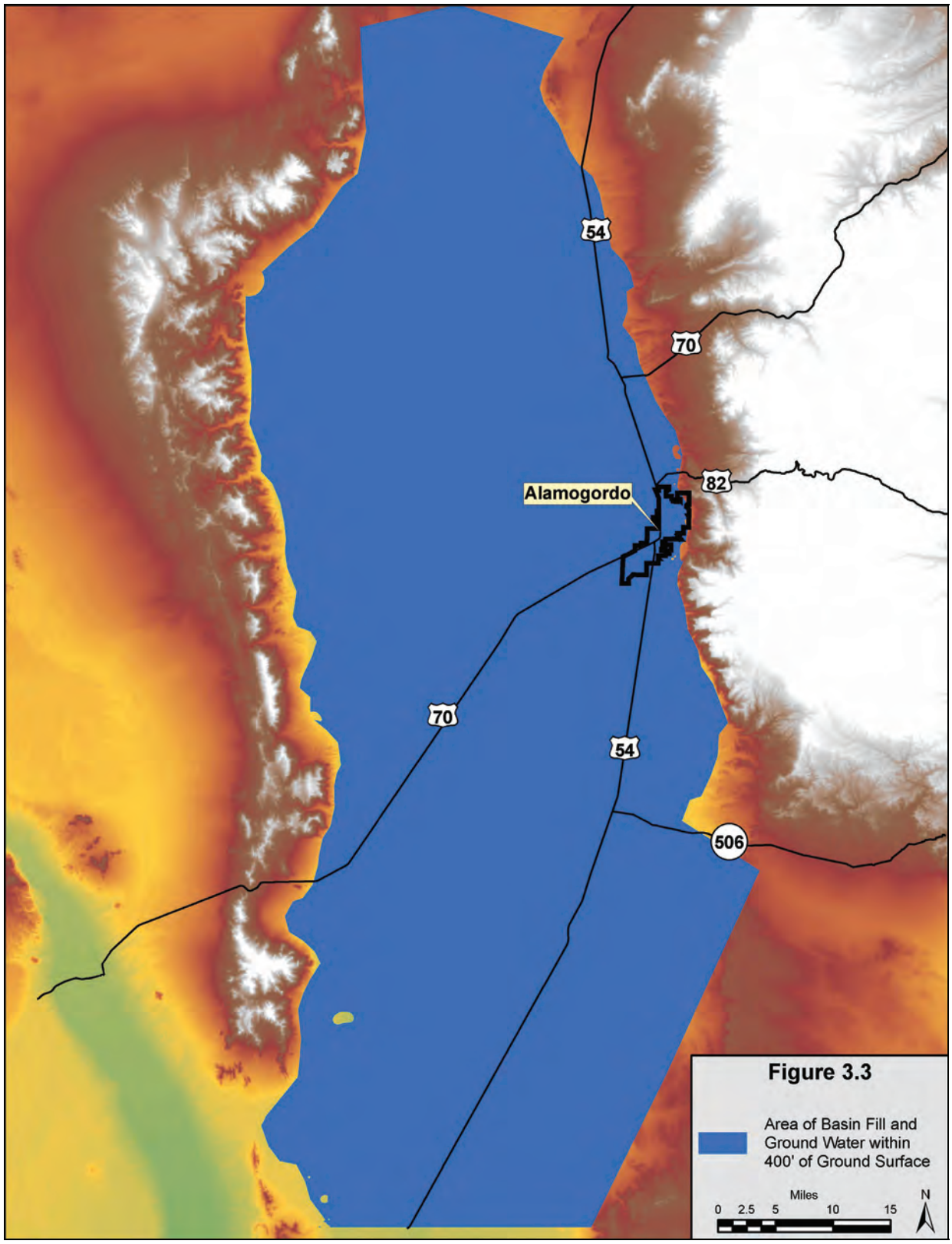

Figure 3.3. Area of basin-fill deposits where ground water is present within 400 feet of the surface.

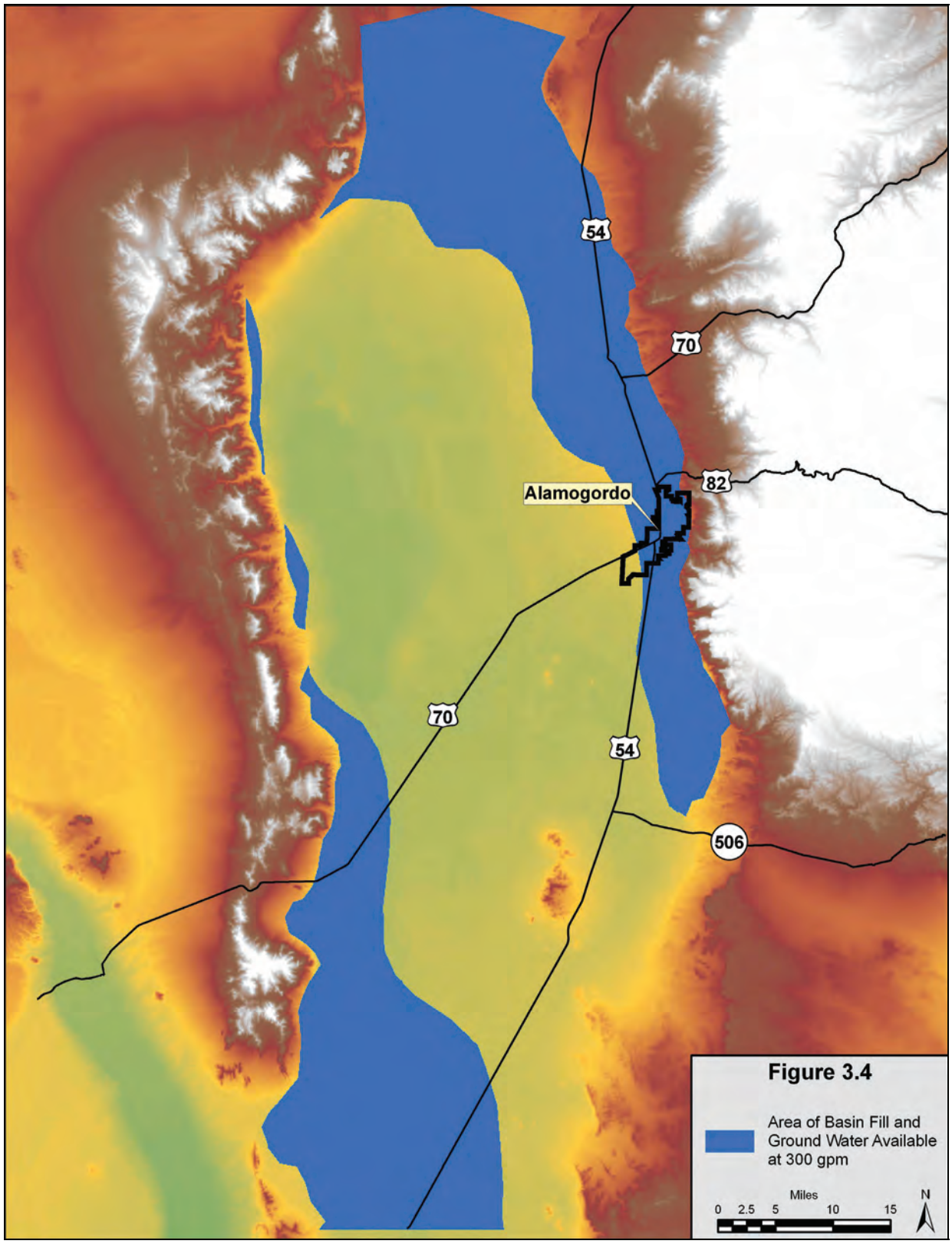

Figure 3.4. Areas of basin-fill deposits where well yields of more than 300 gpm can be expected.

3.3 LAND OWNERSHIP

For the purposes of this preliminary alternatives screening, privately owned lands and Native American and Tribal lands have been excluded from consideration. Public lands considered accessible for the development of water resources alternatives include those managed by the Department of Defense (including White Sands Missile Range, Holloman Air Force Base, and Fort Bliss), the National Park Service (White Sands National Monument), the BLM (except those currently identified as BLM Wildlife Management Areas), the Forest Service, and the State of New Mexico (State Lands, State Parks, and the New Mexico Department of Game and Fish). Each of these public land management agencies has different requirements for development of water-resources projects. It is quite possible that further investigation will demonstrate that some of these public lands are not available to the City of Alamogordo for the proposed water resources development project. However, all listed federal and state lands were considered accessible for this preliminary alternatives screening. Figure 3.5 shows the areas of public land considered accessible for development of water resources alternatives.

Table 3.1 summarizes the preliminary screening criteria used in the development of water resources alternatives. Water quality is considered in Section 3.4, and a more detailed analysis of the remaining water resources alternatives is presented in Section 4.0.

Table 3.1. Preliminary Water Resources Alternatives Screening Criteria

Water Resource Consideration	Criteria used for Preliminary Screening
Permitability	outside of the Administrative Area more than 2,000 feet from existing senior water rights
Recoverability	ground water present within 400 feet of the surface expected well yields of 300 gpm or more
Land Ownership	publicly owned land (federal and state), excluding BLM Wildlife Management Areas

3.4 PRELIMINARY WATER RESOURCES ALTERNATIVES

GIS overlay maps showing areas that meet the permitability, recoverability, and land-ownership criteria defined above can identify areas for further investigation of water resources alternatives. Figure 3.6 shows the areas that survived this preliminary screening. A large area north and west of the Alamogordo-Tularosa Administrative Area remains for further analysis. This area contains the City of Alamogordo's proposed Snake Tank Well Field site and extends northwest to include the southern portion of the Quaternary basalt flows in the northern Tularosa Basin. Another large area remains in the southwest portion of the basin, east of the southern San Andres and Organ Mountains and extending south to the New Mexico–Texas border. Smaller areas that meet all the screening criteria are also present south of Alamogordo in the vicinity of the Grapevine Canyon alluvial fan and to the northwest in narrow strips along the front of the central San Andres Mountains.

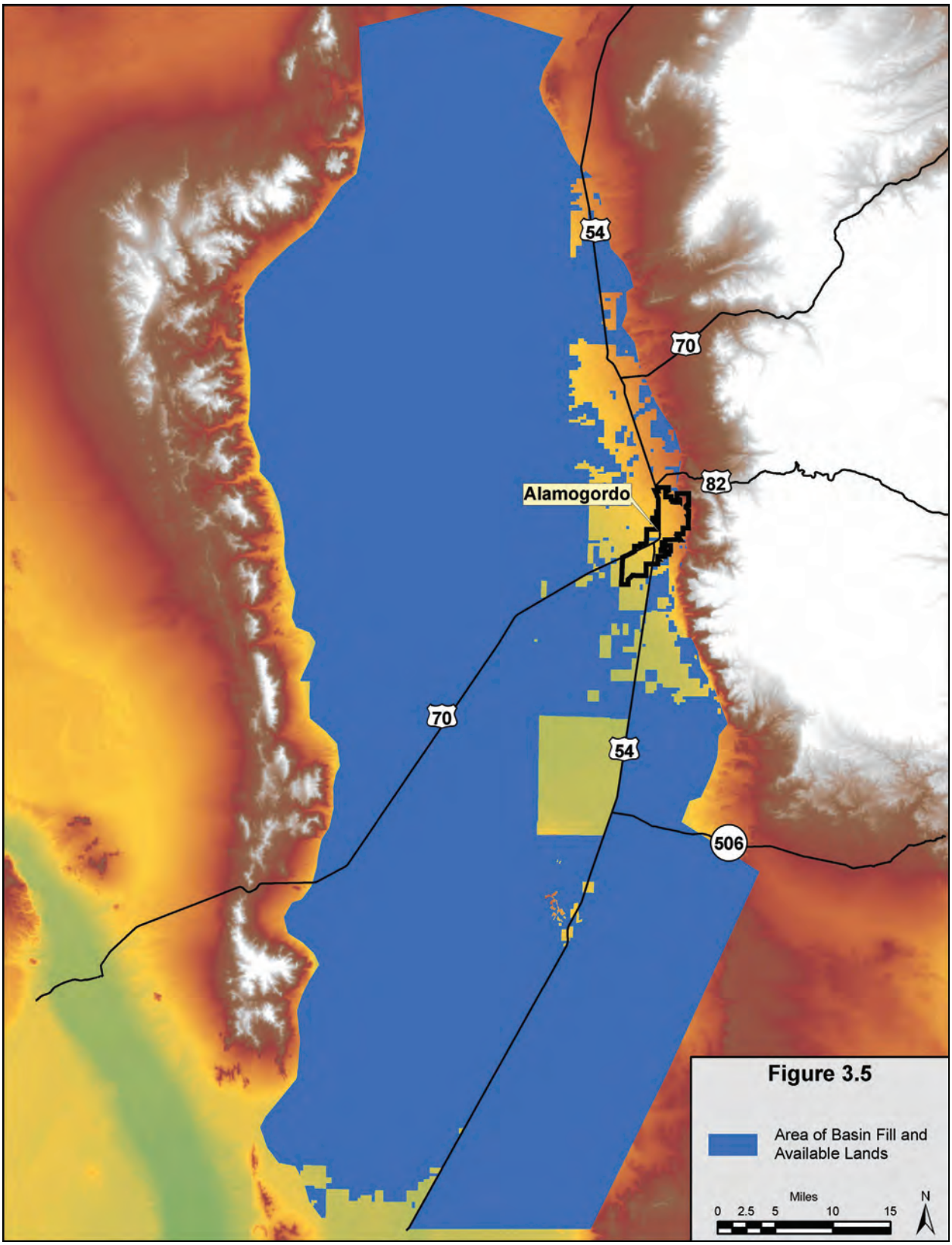

Figure 3.5. Area of basin-fill deposits with public land ownership.

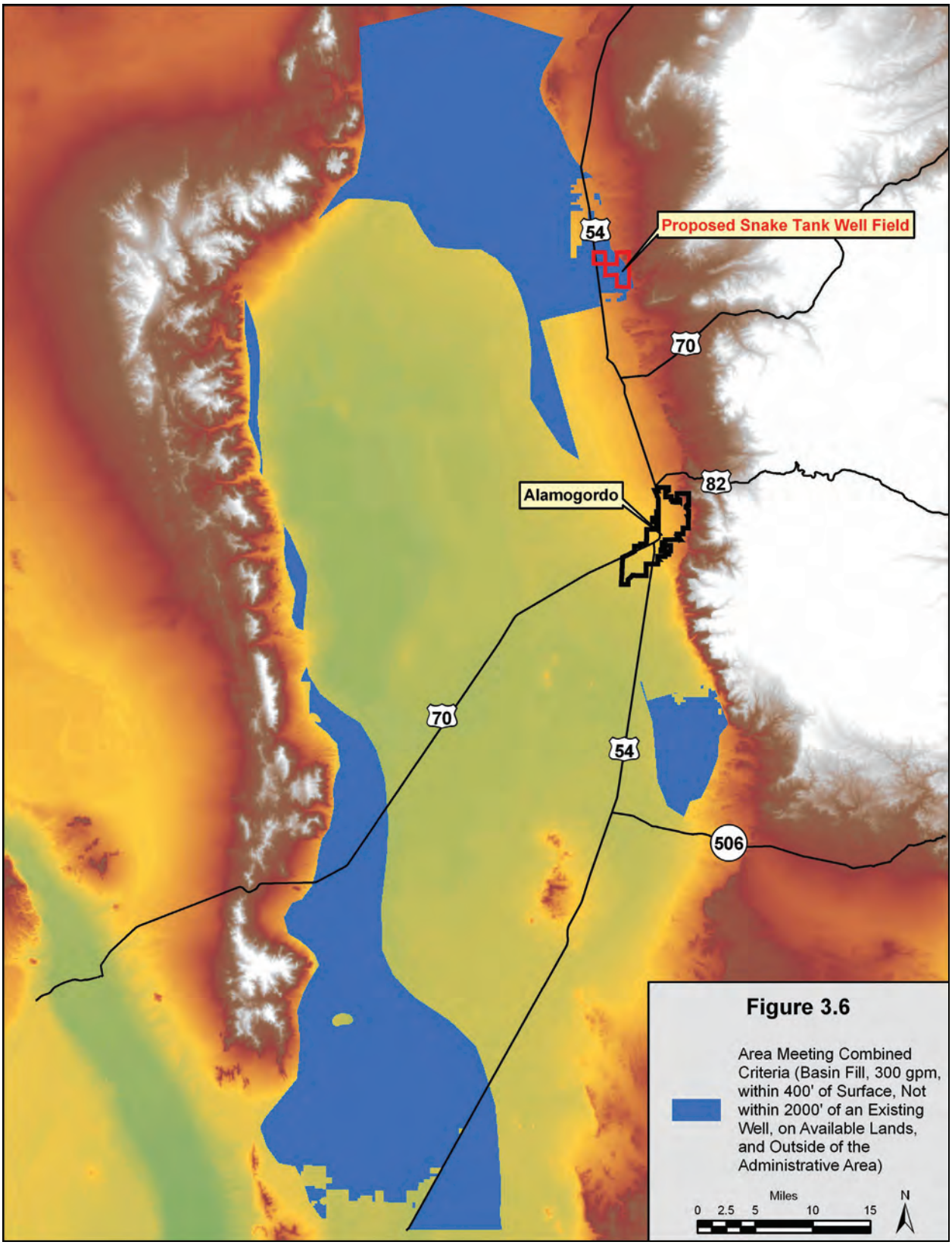

Figure 3.6. Areas of basin-fill deposits that meet all preliminary screening criteria.

Ground-water quality is an important consideration in water resources alternatives development for the proposed project that has not been factored into the preliminary screening process described above. McLean (1970) has provided data on the distribution of salinity in Tularosa Basin ground water, in terms of both area and depth. When these data are overlaid on Figure 3.6, the resulting maps (Figure 3.7, Figure 3.8, Figure 3.9) show potential water resources alternatives for fresh (0–1000 mg/L TDS), slightly saline (1000–3000 mg/L TDS), and moderately saline (3000–10,000 mg/L) ground water. As discussed in the more detailed analysis of alternatives that follows (Section 4.0), use of fresh-water resources means that desalination is not required prior to distribution. Slightly and moderately saline water sources require increasinglevels of treatment to remove TDS, with obvious impacts for project complexity and cost.

In applying McLean's (1970) water-quality data for water resources alternatives development, only aquifer zones with thicknesses of 250 feet or more were considered viable for development. For screening purposes, if the saturated thickness for a specific salinity range was less than 250 feet, it was considered insufficient to support the defined water needs. Each of the areas surviving this preliminary screening process is further evaluated through the EIS process.

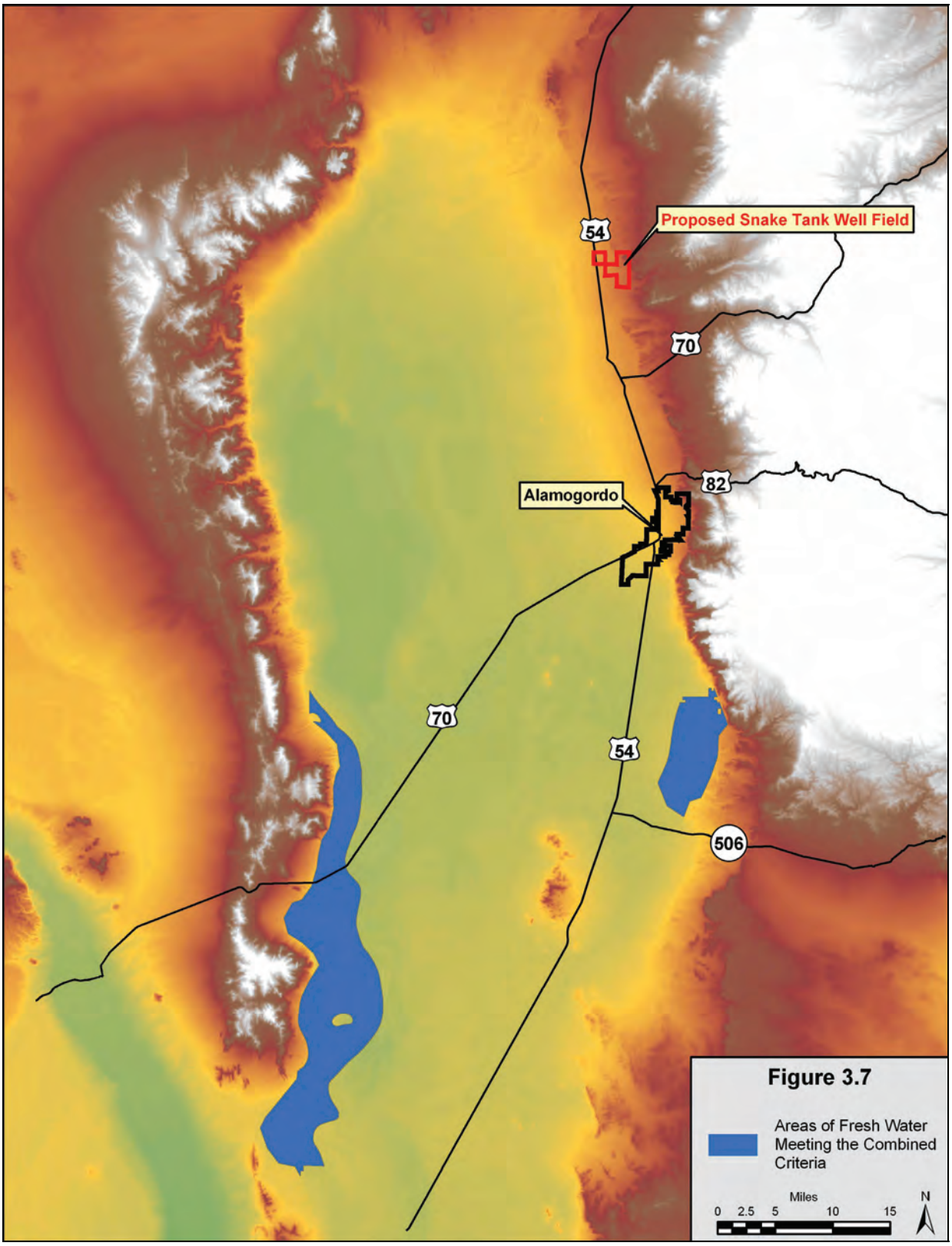

Figure 3.7. Areas of basin-fill deposits meeting screening criteria with fresh (0–1000 mg/L TDS) ground-water resources.

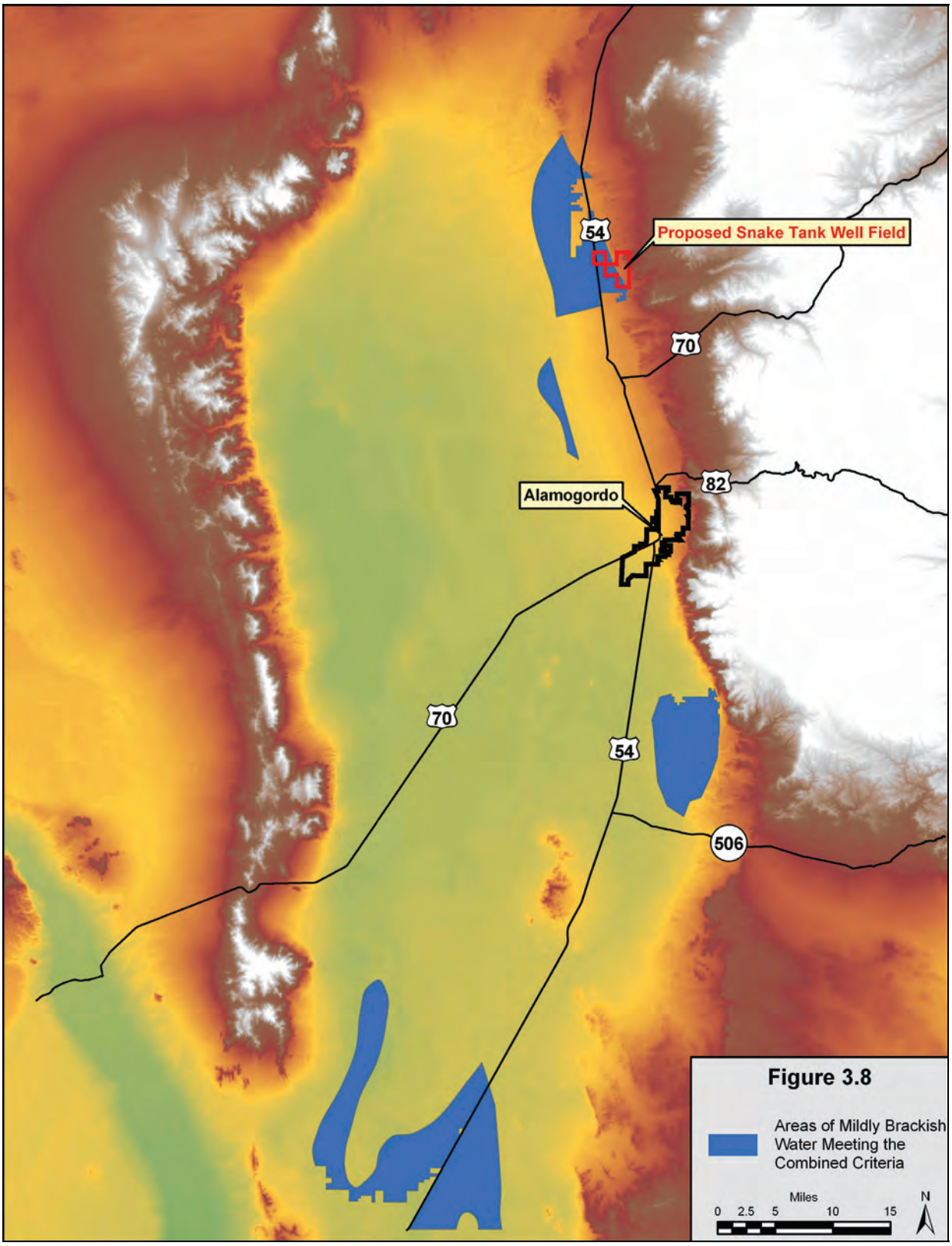

Figure 3.8. Areas of basin-fill deposits meeting screening criteria with slightly saline (1000–3000 mg/L TDS) ground-water resources.

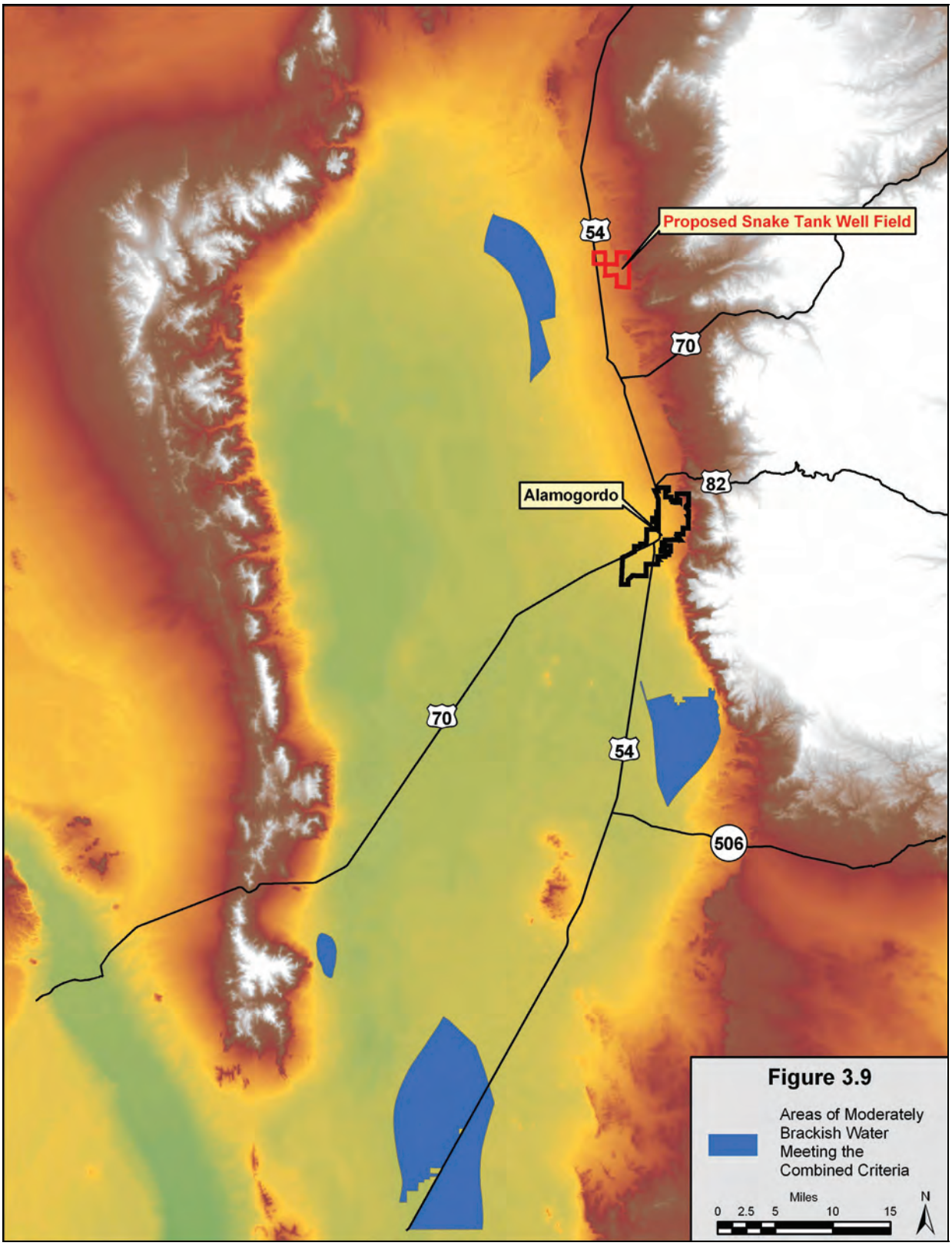

Figure 3.9. Areas of basin-fill deposits meeting screening criteria with moderately saline (3000–10,000 mg/L TDS) ground-water resources.

4.0 ALTERNATIVES EVALUATION

The development and screening of water resources alternatives in Section 3 identified four potential water supplies in the Tularosa Basin area that may represent viable alternatives to meet the purpose and need of the project. These alternatives are listed in Section 4.1 and further explored in Section 4.2. For each alternative, available information is summarized regarding hydrogeologic conditions, existing water development, and potential impacts to existing water rights and environmental receptors. The volume and depth of previous studies for each alternative vary considerably. The extent of the discussion of each alternative is a reflection of the available literature. Section 4.3 presents a matrix comparison of the four remaining resources alternatives.

4.1 RESULTS OF WATER SUPPLY ALTERNATIVES SCREENING

Four water resource options remained after the preliminary screening of alternatives. All four involve the development of ground water from basin-fill or alluvial-fan deposits near the margins of the Tularosa Basin. These alternatives are listed below and shown on Figure 4.1.

1. **Snake Tank Well Field Site** – Development of a slightly saline ground water, approximately 3 miles north of the Alamogordo-Tularosa Administrative Area.
2. **Alvarado Area** – Development of a slightly saline ground water, in the southwest portion of the Tularosa Basin, south of White Sands Missile Range Headquarters between US 54 and the Franklin Mountains.
3. **White Sands Missile Range Headquarters Area** – Development of a fresh ground water resource, coincident with the mountain-front embayment east of San Augustin Pass.
4. **Grapevine Canyon** – Development of a fresh ground water resource, in alluvial fan deposits west of Grapevine Canyon and approximately 3 miles south of the Alamogordo-Tularosa Administrative Area.

These four alternatives met all preliminary screening criteria for physical, hydrogeologic, and administrative conditions defined in Section 3.

4.2 EVALUATION OF WATER SUPPLY ALTERNATIVES

Additional information on each of the four water resources alternatives is summarized in the following subsections, beginning with the Snake Tank Well Field.

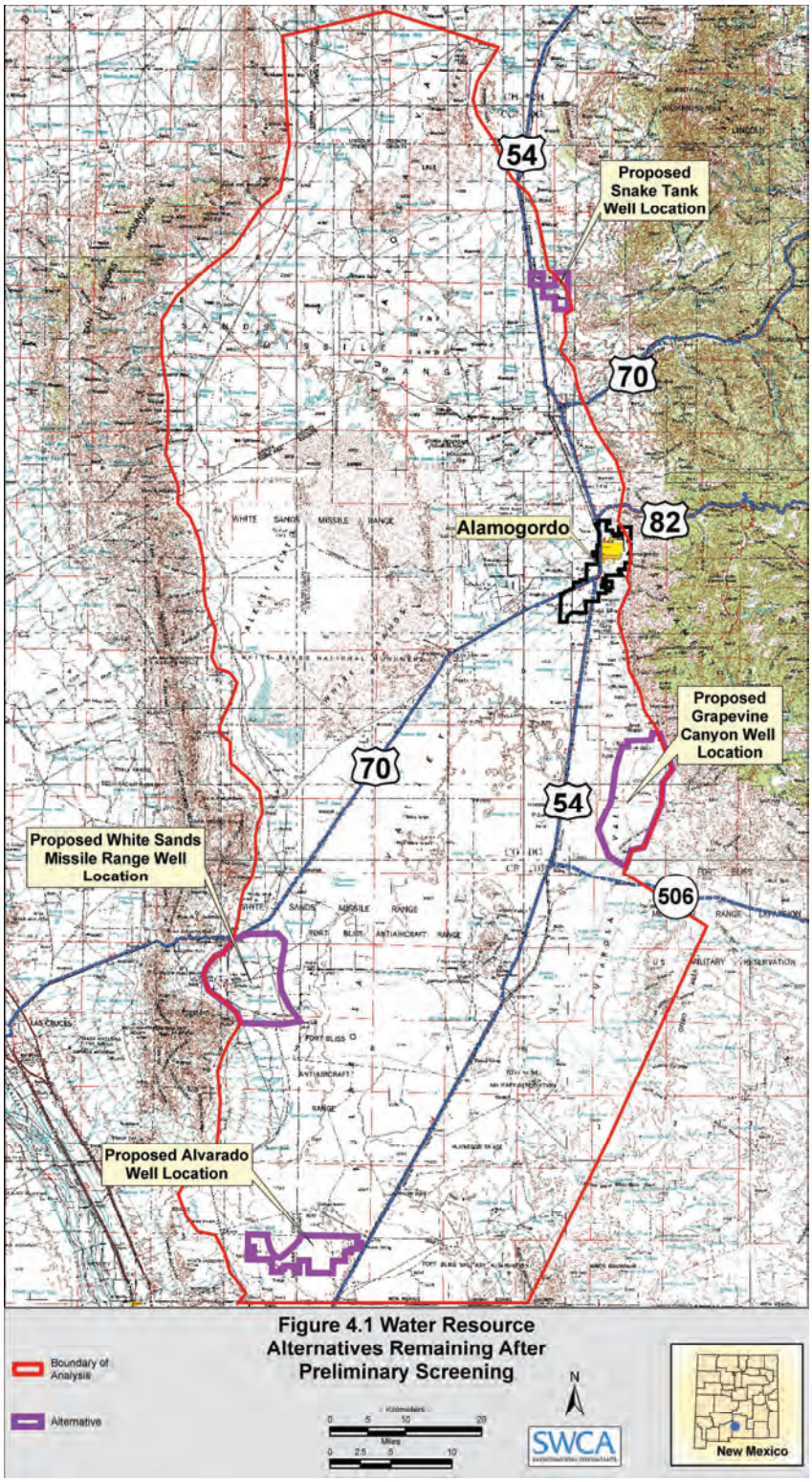

Figure 4.1. Water-resource alternatives remaining after preliminary screening.

4.2.1 SNAKE TANK ROAD

4.2.1.1 HYDROGEOLOGIC CHARACTERISTICS

The Snake Tank Well Field site (Snake Tank site) is located east of US Route 54 and occupies approximately 5 square miles along the northeast margin of the Tularosa Basin in an area of alluvial fan basin-fill deposits extending west from the Sacramento Mountains (Figure 4.1). The proposed well field is a few miles northwest of the mouth of Rinconada Canyon, and much of the alluvial material in this area is likely carried from the mountains by this drainage. McLean's (1970:Figure 5) map showing the elevation of bedrock and the basin-fill water table suggests that there is a trough of saturated alluvial deposits in this area, ranging in thickness from about 1,500 to 2,500 feet. Little information is available regarding the underlying bedrock, but it is likely characterized by the sedimentary Permian units exposed in the Sacramento Mountains to the east. In general, Quaternary alluvial fan materials in this area can be expected to be more coarse grained near the mountain-front, consisting largely of sand and gravel. With distance from the mountain-front, fan deposits become increasingly fine grained, with a greater fraction of silt and clay.

The Snake Tank site lies in the area of the main north-south range-bounding fault separating the Sacramento Mountain block from the Tularosa Basin (Figure 4.2). The location of the fault can be approximated from drilling logs and geophysical survey data. Offset of bedrock units across this fault, with a downdrop to the west, likely leads to significant differences in the thickness of the alluvial fan deposits beneath the eastern and western portions of the Snake Tank site.

The City of Alamogordo has drilled several test wells at the Snake Tank site, but as of this writing, lithologic logs are available from only one well. The well log filed with the OSE (T-03837, drilled October–December 2001) reported a total depth of 710 feet, with alluvium/basin-fill sediments encountered to total depth. The alluvium was described as predominantly gravel with lesser seams of sand, silt, and clayey gravel. The depth to water in this well is reported to be 177 feet. At least one of the City's test wells at the Snake Tank site penetrated 900 feet of alluvial deposits before encountering bedrock (B. McGuire, personal communication). The depth of alluvial sediments on the western portion of the Snake Tank site is likely in excess of 1,500 feet.

McLean (1970) estimated a well yield of at least 300–700 gpm over an area of alluvial basin-fill deposits that includes the Snake Tank site and extending to the west. Well yields are probably more than 700 gpm closer to the mountain front, but only where thickness of basin-fill deposits is adequate. The City estimated a specific capacity of 10 gpm per foot (gpm/ft) of screened well for the basin-fill deposits at the Snake Tank site, based on aquifer tests performed at well T-03837 (JSAI 2003a). The Permian-age strata beneath the basin-fill deposits may also yield water to wells; however, no wells are known to have penetrated these units in the area of the Snake Tank site.

Ground water quality at the Snake Tank site is in the slightly saline range of 1,000–3,000 mg/L TDS. McLean (1970:Figure 8) shows a slightly saline unit with a saturated thickness of 500–2,000 feet in this area. Ground water salinity at the Snake Tank site was predicted to be 2,000–3,000 mg/L TDS in estimates developed by the City of Alamogordo (JSAI 2003a) and confirmed by analysis of a water sample from City well T-03837, which contained 2,220 mg/L TDS.

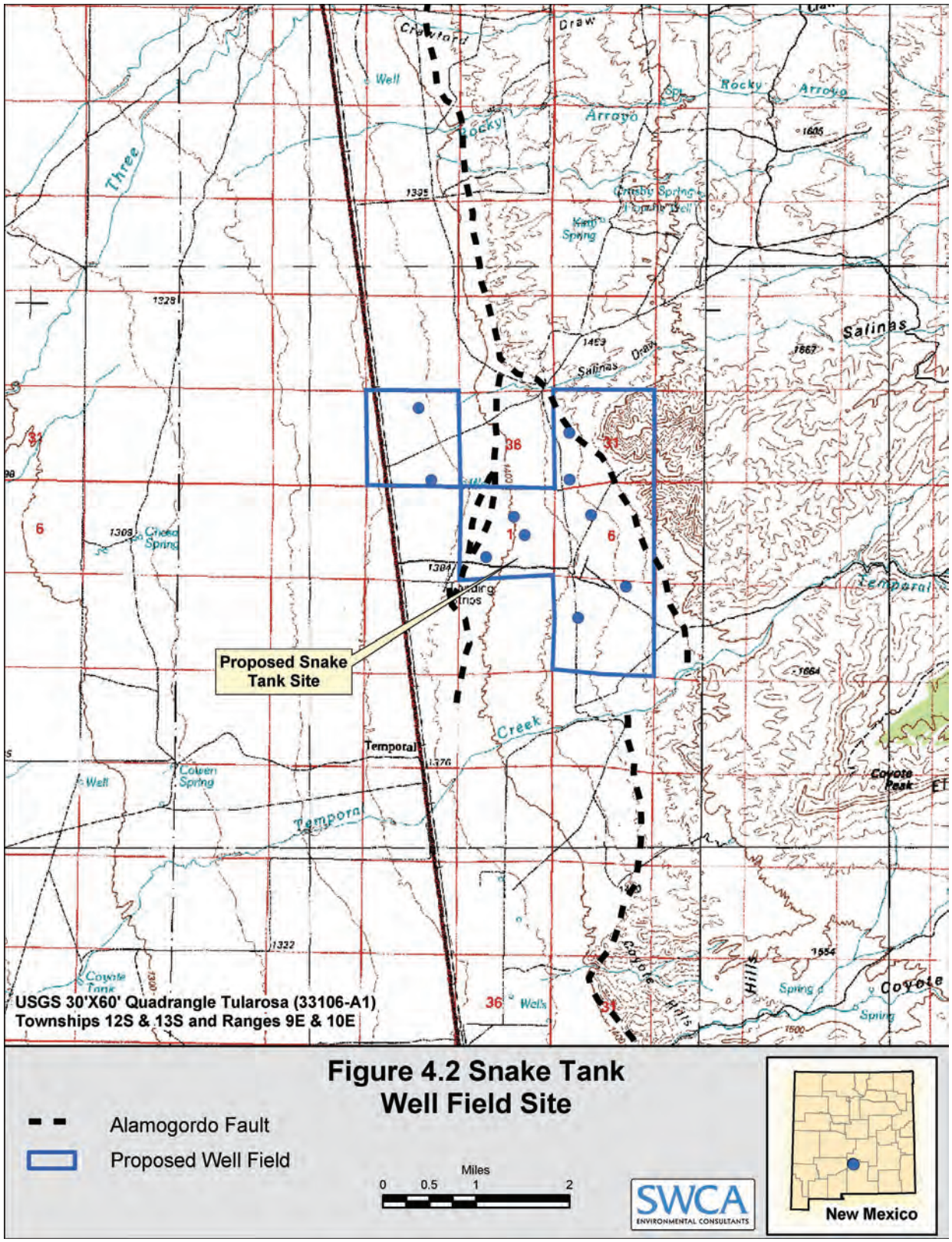

Figure 4.2. Snake tank well field site.

Surface water features within 10 miles of the Snake Tank site include the Tularosa Creek, numerous intermittent streams, and a number of springs. The Tularosa, located approximately 8 miles south-southeast of the site, is the only perennial stream. Temporal Creek, an intermittent stream, drains west-southwest from the Sacramento Mountains and across the basin-fill deposits approximately 2 miles south of the Snake Tank site. The intermittent Three Rivers drainage runs west from Sierra Blanca, then turns to the southwest and passes about 3 miles northwest of the site.

At least 27 springs are within 10 miles of the Snake Tank site (see JSAI 2003a:Appendix A). Three of these springs—the Falls Ranch Spring, Chosa Spring, and Lomitas Spring—are described in the published literature and are included in the description of Tularosa Basin springs in Section 2.3. Several of the springs listed by JSAI (2003a), including Chosa Spring, Cowen Spring, and Lomitas Spring, issue from Quaternary alluvial basin-fill deposits. Many other springs flow from Cretaceous or Permian bedrock exposed in the foothills of the Sacramento Mountains. A protestant to the City of Alamogordo's Permit Application with the OSE has filed permit applications for 10 springs on the High Nogal Ranch, all within 8 miles of the Snake Tank site.

4.2.1.2 POTENTIAL IMPACTS OF NEW WATER DEVELOPMENT

JSAI (2003a:Appendix E) listed over 600 wells located between Three Rivers and Tularosa. Ground-water well uses include municipal (Village of Tularosa), irrigation, stock, commercial, and domestic. Additionally, there are a number of permitted surface-water diversions from the Tularosa Creek for irrigation and stock-watering. The potential impacts of the proposed water development to ground-water users nearest the Snake Tank site has been estimated by others using the ground-water models discussed in Section 5.0. Using different modeling methods, HAI (2003a) and JSAI (2003a) each determined that drawdown from pumping would reduce the water column in four existing wells to less than 70 percent of initial levels over a 40-year period. Keyes (2003) predicted that up to nine wills would experience a reduction in water column to less than 70 percent of initial levels. Each model also found that one existing well, the Christopher well at High Nogal Ranch, would go dry due to the proposed water development. All of the other wells found to have a final water column of less than 70 percent of initial levels are owned by protestant HFR Corporation. Well users at greater distances from the site may experience drawdown effects of less than 70 percent of the initial water levels, potentially leading to reduced well yield or needed well maintenance (e.g., lowering pumps).

Existing ground-water users could also be affected by changes in ground-water salinity resulting from the proposed development, though the authors of the modeling efforts summarized in Section 5.0 found less agreement on the potential changes. HAI (2003a) concluded that insufficient data exist to model potential changes in water quality, but predicted that "it seems highly likely that within the area of the proposed wellfield and at some of the closer wells, water quality would likely decline over time." However, JSAI (2003a) completed solute-transport modeling and determined that there would be no changes in salinity at existing wells, as the capture zone of the pumping wells would not extend far enough to the west to induce the flow of more saline water. Finally, Keyes (2003), using the same model employed by HAI for analysis of drawdown effects, found that induced salinity changes in existing wells would be "very small," with the greatest increase in salinity in any single well being 24 mg/L TDS over a 40-year simulation period.

Potential impacts of the proposed project on the surface-water features are unknown. Section 5.0 describes the use of ground-water models by the City of Alamogordo and others to assess the potential hydrogeologic impacts of the proposed ground-water development. Consideration of surface water/ground water interactions in these models is limited to the simulation of ground-water recharge via stream leakage. The models predict the pumping-induced drawdown in the regional basin-fill aquifer and impacts on existing water wells in the area. The predicted drawdown impacts extend as much as 12 miles north and south of the Snake Tank site and 5 miles or more to the east and west (see JSAI 2003a:Figure 18). This area of potential impacts encompasses most of the springs identified by JSAI (2003a) and includes the Tularosa Creek from its exit from the mountain-front, west through the Village of Tularosa and beyond. It is possible that these surface-water features will be affected by the proposed pumping, if they are hydraulically connected to the regional aquifer from which water would be produced. Possible effects could include increased induced recharge from the Tularosa, resulting in reduced stream flows and reduction or cessation of flows at springs if they are hydraulically linked to the regional aquifer. Springs that issue from the Quaternary alluvium, especially those closer to the site, may also be affected by pumping-induced drawdown.

The information on surface water/ground water interactions in the existing literature is not adequate to make reliable predictions regarding potential impacts of the proposed ground-water development to surface-water users. Users who rely on springs, especially springs that issue from the Quaternary alluvial deposits that are nearest the Snake Tank site, are the most likely to be affected as a result of the proposed development.

The same data limitations that preclude the evaluation of potential impacts of the proposed pumping to surface-water users also limit the assessment of potential environmental impacts. If induced drawdown due to proposed pumping would cause a decline in shallow water table elevations and reduces spring discharge, the possibility of impacts to riparian habitats would exist. In the semi-arid climate of the Tularosa Basin, small changes in water table elevations could result in significant changes in these riparian habitats that rely on a shallow depth to groundwater, and could influence the flora and fauna located in these settings. Collection and analysis of additional data to characterize the hydraulic connection between shallow ground water and the regional basin-fill aquifer would reduce the uncertainty of potential environmental effects of the proposed project.

4.2.2 WHITE SANDS HQ AREA

The White Sands Missile Range (WSMR) Headquarters area (Figure 4.3) was considered for locating ground-water wells, but eliminated from further analysis because of restricted land access. The mission of WSMR is to provide the Army, Navy, Air Force, Department of Defense, and other customers with high quality services for experimentation, test, research, assessment, development, and training in support of the Nation at war. Developing ground-water wells to serve a municipal drinking water system for the City of Alamogordo does not fit the mission of WSMR (Appendix A – letter from WSMR). As a result, the WSMR well field alternative was eliminated from detailed analysis. Please see Chapter 2 of the EIS for further information.

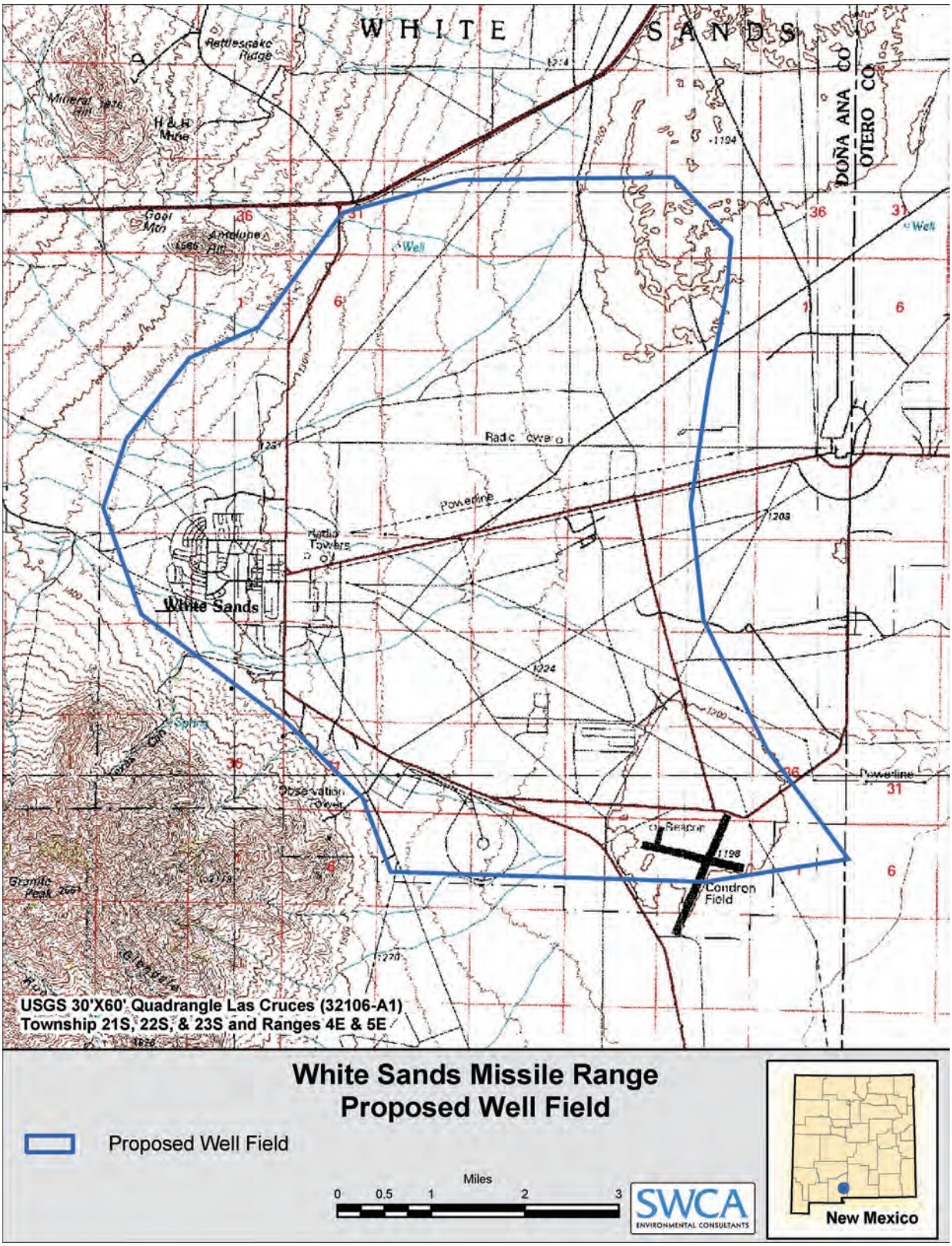

Figure 4.3. White Sands Missile Range Headquarters site.

4.2.3 GRAPEVINE CANYON

The area west of Grapevine Canyon (Figure 4.4) was considered for locating ground-water wells, but was eliminated from further analysis because of restricted land access. Fresh water resources at this site are located within the McGregor Range, a large tract of land that has been withdrawn from public domain for use by the U.S. Army (Fort Bliss). This land was withdrawn under the Military Lands Withdrawal Act (PL 106-65) for military purposes. The McGregor Range is the principal training facility for air defense systems, a critical part of military operational readiness for national defense (BLM 2005). As a result, this alternative has been eliminated from detailed analysis because developing ground-water production wells on this land would compromise the U.S. Army's mission for the McGregor Range at Fort Bliss (Appendix B – letter from Ft. Bliss). Please see Chapter 2 of the EIS for further information.

4.2.4 ALVARADO AREA

4.2.4.1 HYDROGEOLOGIC CHARACTERISTICS

The Alvarado Well Field Site (Alvarado area) is located between Route 54 and the Franklin Mountains, about 20 miles south of the White Sands Missile Range Headquarters Area. The region of interest occupies an irregular area of approximately 18 square miles along the southwest margin of the Tularosa Basin in an area of alluvial fan and basin-fill deposits extending east from the Franklin Mountains (Figure 4.1). The unusual shape of the Alvarado area is an artifact of the overlapping GIS layers used to screen potential water resource alternatives (Figure 4.5).

The prospective well site is several miles southeast of Fillmore Pass, the former path followed by the Rio Grande into the Tularosa Basin (Seager 1981). The Alvarado area is east of the range-bounding Organ Mountains Fault in an area of thick basin-fill deposits. Repeated movement along the Organ Mountains Fault, the Artillery Range Fault Zone, and related faults paralleling the mountain front have created a deep trough where a thick sequence of alluvial fan, debris flow, and fluvial deposits of the Camp Rice Formation accumulated during the Pliocene and Early Pleistocene (Seager et al. 1987). Contours of the altitude of the top of consolidated bedrock, as presented in McLean (1970), suggest that the thickness of the basin-fill deposits in the Alvarado area ranges from a few hundred to several thousand feet. An east-west cross-section drawn a mile south of the Alvarado area (Seager et al. 1987) shows a basin-fill thickness of up to 5000 feet. Well data on file with the OSE indicate that the majority of water wells drilled in this general area are between 500 and 600 feet deep, although several have penetrated 1000 feet or more of basin-fill deposits.

In general, the piedmont-slope and fluvial sediments of the Camp Rice Formation are composed of sand, gravel, and conglomerate, grading to finer-grained deposits with distance from the mountain-front. The deposits closest to the mountain front contain poorly sorted debris flow units; fluvial units are characteristically well sorted. Toward the eastern portion of the Alvarado area these ancestral Rio Grande–related units likely interfinger increasingly with finer-grained lacustrine deposits, including clays and evaporates. Calcium carbonate cement, frequently well developed, is irregularly distributed throughout the basin-fill deposits (Naus 2002). Several north-south faults that occur within the Alvarado area have experienced late Pleistocene movement, resulting in offset within the Camp Rice sediments (Seager et al. 1987).

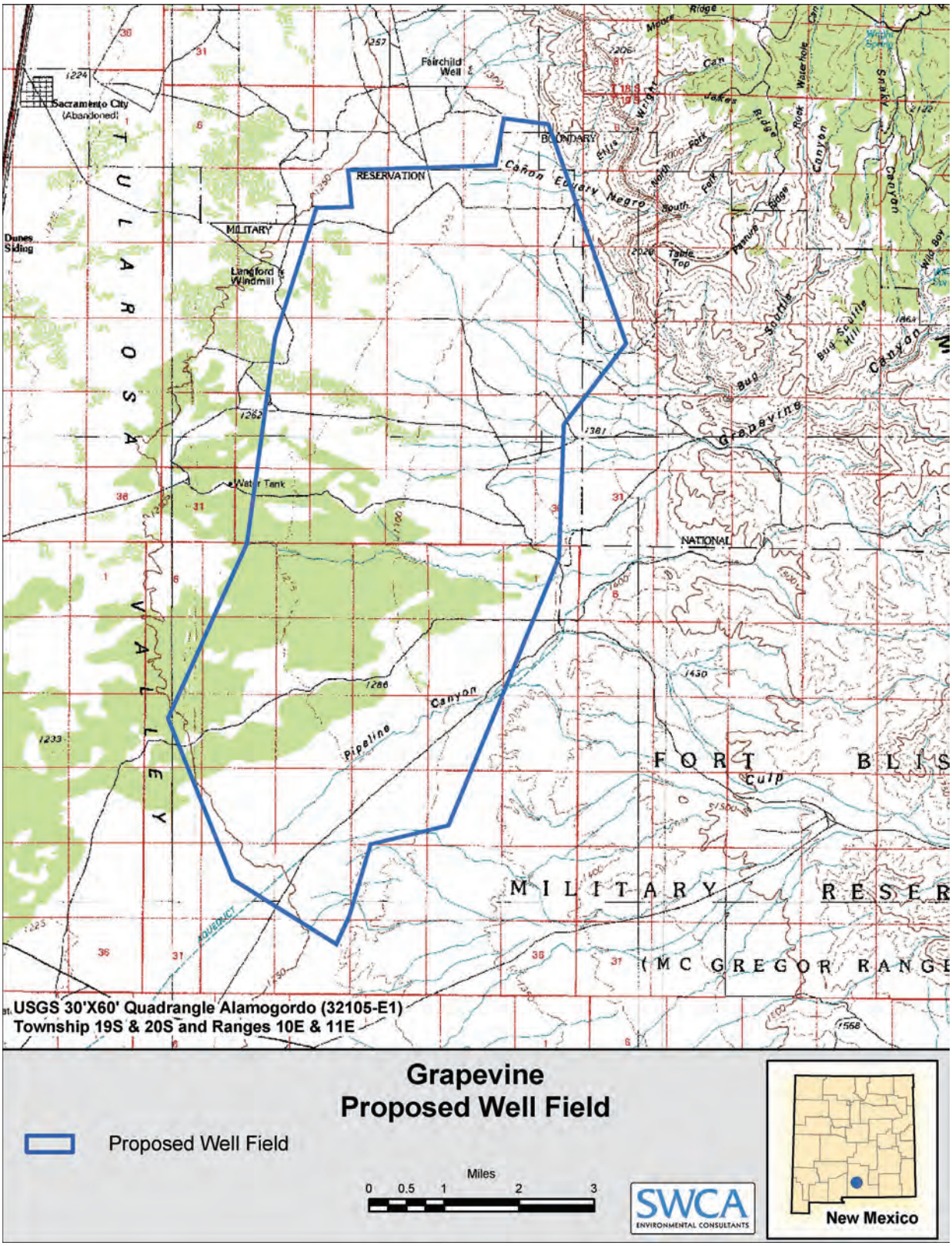

Figure 4.4. Proposed location of well field west of Grapevine Canyon.

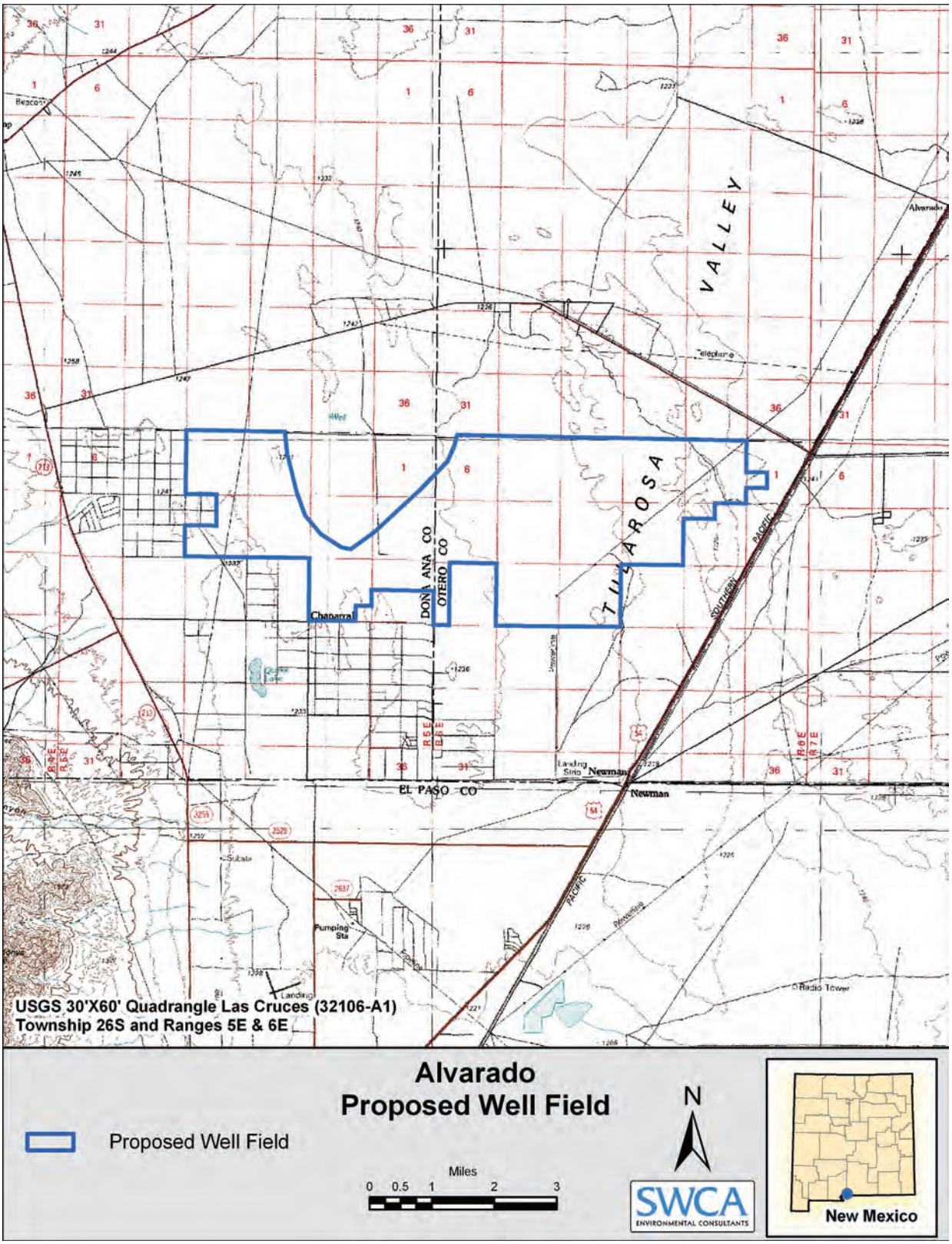

Figure 4.5. Proposed location of Alvarado well field.

McLean (1970) estimated well yields of 300–700 gpm in the eastern half of the Alvarado area and over 700 gpm in the western half. Review of well records on file with the OSE confirms production rates in these ranges, with several wells reportedly producing 2000 gpm or more. Production rates for specific wells can be expected to vary significantly due to differences in lithology of basin-fill deposits and the presence and degree of cementation present. Additionally, the presence of several faults within the Alvarado area is likely to influence hydraulic properties in a manner that is difficult to predict. Based on well data from the White Sands Missile Range Headquarters Area, Kelly and Hearne (1976) concluded that fault zones in this portion of the basin represent zones of increased hydraulic conductivity. However, in analyzing data from a well closer to the Alvarado area, Lyford (1970) determined that a fault zone acted as a barrier to ground-water flow.

Data on ground water quality specific to the Alvarado area are limited. McLean (1970:Figure 7) shows a fresh water unit with a thickness of 200 to 400 feet overlying a slightly saline unit about 250 feet thick. Presumably, the water below this depth is even more saline. Water produced from the eastern portion of the Alvarado area is likely more saline than the water derived from wells farther west. Analytical data reported by McLean (1970) for 20 wells located near the Alvarado area indicated dissolved solids concentrations in the majority of these wells of less than 1000 mg/l. In the Soledad Canyon area about 12 miles north of Alvarado, the freshwater unit is estimated to be about 10 miles wide and almost 2000 feet thick. Naus (2002) reports that salinity increases with depth in this portion of the basin.

Few surface water features of any significance exist within 10 miles of the Alvarado area. Several small, intermittent streams drain the east flanks of the Franklin Mountains a few miles west of the site. The direction of flow in these channels is generally to the east-northeast. A mile south of the western portion of the Alvarado area is Quirke Lake, an intermittent playa. Several springs are located in and around Soledad Canyon 12 to 15 miles north of the site.

4.2.4.2 POTENTIAL IMPACTS OF NEW WATER DEVELOPMENT

The OSE WATERS Online Database lists approximately 200 wells within about 6 miles of the Alvarado area. Ground-water well uses include irrigation, stock, commercial, and domestic. The potential impacts of the proposed water development to ground-water users in the Alvarado area and to surface-water features are unknown. Collection and analysis of additional data to characterize the hydraulic connection between shallow ground water and the regional basin-fill aquifer would reduce the uncertainty of potential environmental effects of the proposed project.

5.0 PROPOSED GROUND WATER DEVELOPMENT

Water planning efforts by the City of Alamogordo have led to the preliminary selection of an alternative for future water resource development. This alternative involves the development of a well field at the Snake Tank Road Site, approximately 25 miles north of Tularosa, and extraction of brackish water, water treatment to potable standards, and water distribution. This section describes the City's application to the New Mexico Office of the State Engineer (OSE) for water rights for this alternative, ground-water models that have been used to assess the potential impacts of this development, and how the results yielded by these models contribute to the evaluation of alternatives for this EIS.

5.1 OFFICE OF THE STATE ENGINEER PERMIT APPLICATION

On September 6, 2000, and in January 2002, the City of Alamogordo filed 10 applications (numbered T-3825 through T-3825-S-9) with the OSE to appropriate ground water from the Tularosa Underground Water Basin. The original application was to divert 1,500 acre-feet per year (afy) per well, with a total not to exceed 13,450 afy. Under the permit application, 10 wells would be drilled approximately 10 miles north of the Village of Tularosa on property owned by the Bureau of Land Management in Township 12 South, Range 9 East, Sections 35 and 36; Township 12 South, Range 10 East, Section 31; Township 13 South, Range 9 East, Section 1; and Township 13 South, Range 10 East, Sections 6 and 7. The applications contemplate pumping brackish water on a graduated schedule, treating it, and transporting it via pipeline for beneficial use within Otero County.

Notice of the applications was issued on February 1, 2002. The applications were protested by several parties, including the Three Rivers Cattle Company, Ltd., HFR Corporation, High Nogal Ranch (David Christopher), and the Tularosa Community Ditch Company. Some of the protests were dismissed in August 2002 and April 2003. The City amended its application on April 22, 2003, to reduce the total amount of water applied to 10,000 afy. This amount is consistent with population projections contained in the City's 40-Year Water Development Plan (the Plan) and a per capita per day usage of 165 gallons (Livingston and Shomaker 2002). The Plan proposes City pumping at a rate of 5,000 afy for the first 10 years, 6,500 afy for the next 10 years, 8,000 afy for the next 10 years, and 10,000 afy thereafter.

The OSE held a hearing on this amended application 2003. A key issue discussed during the hearing was the issue of the City's unmet water demand. The average water supply the City has historically had available to divert from both surface and ground-water sources has been 7,774 afy. The OSE determined that the City's unmet water demand would be 2,601 afy. The City expects an 84 percent recovery of potable water from desalination of the brackish water and thus would need to divert 3,096 afy (2,601 afy divided by 0.84) to produce the unmet potable water demand. The hearing also included much testimony on and discussion of the possible effects of

the proposed wells on existing senior water rights and on water levels in the Tularosa Basin Administrative Area. The Morrison (1989), regridded Morrison (HAI 2003), and modified regridded Morrison (Keyes 2003) and JSAI (2003a) ground-water models were applied in analyzing possible outcomes.

The OSE approved the permit application on December 29, 2004, with the conditions that the City could divert up to 3,000 afy from its proposed wells on an average annual basis but could divert up to 4,500 afy for any calendar year provided that the sum of annual diversions for any consecutive 5-year period not exceed 15,000 afy. The OSE further conditioned its approval to allow the City's existing wells to divert no more than 2,088 afy, to require that the City meter the new wells and submit quarterly records of water pumped, and to require semi-annual reports of water level and total dissolved solids monitoring from surface and ground waters. The OSE further requires the City to drill and operate the new wells and submit a proof of completion prior to May 2009. Several entities filed appeals to the OSE decision within the allotted 30-day protest period. These appellants include the City of Alamogordo, High Nogal Ranch (David Christopher), and the Tularosa Community Ditch Corporation. As of this writing, the appeals are still pending.

5.2 EXISTING GROUND WATER MODELS

To date there have been two significant modeling efforts on ground water in the Tularosa Basin. The models were developed for different purposes and thus are conceptually different. This section provides an overview of the existing models, including conceptual bases, numerical inputs, and calibration. Section 5.3 is a comparison and discussion of the modeling results for the proposed ground-water development project.

The first major model for the region, developed in 1989 by the OSE (Morrison 1989), is referred to herein as the Morrison model. This model was developed and has been used to help administer water rights in portions of the Tularosa Underground Water Basin, a 6,656-square-mile region within Doña Ana, Lincoln, Otero, Sierra, and Socorro Counties. Specific objectives for this model included evaluating the effects of proposed wells on water rights and estimating future water level declines due to existing water development. The Morrison model consists of a two-dimensional ground-water flow model and a separate two-dimensional mixing-cell water-quality model. The Morrison model grid was refined and rerun in March 2003 (HAI 2003a) on behalf of HFR Corporation and High Nogal Ranch, entities protesting the City of Alamogordo's OSE permit application. This refined Morrison model was further modified and rerun by the OSE as part of the well protest hearings (Keyes 2003).

The second major model for the region was developed in March 2003 by John Shomaker and Associates, Inc. (JSAI 2003a) and is referred to herein as the JSAI model. This model was developed for the City of Alamogordo to support its application for supply wells under OSE Permit numbers T-3825 through T-3825-S-9. The JSAI model is an integrated and fully three dimensional ground-water flow and solute transport model. The respective model domains for the Morrison and JSAI models are illustrated in Figure 5.1.

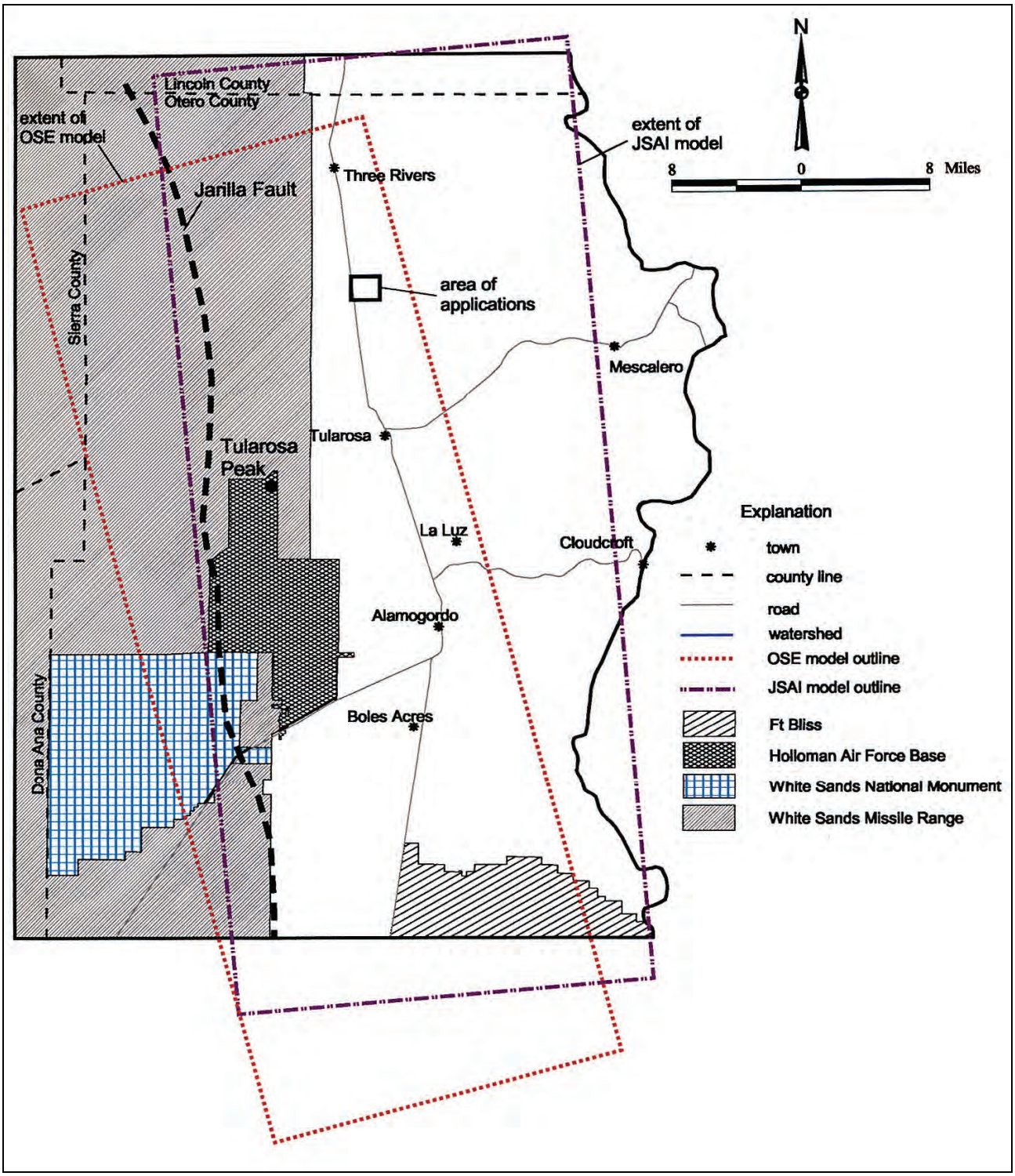

Figure 5.1. Map showing area of applications, outlines of the OSE and JSAI model grids, major watersheds in the Sacramento Mountains, military lands, the Jarilla Fault, and other geographic features of the Eastern Tularosa Basin (from JSAI 2003a).

5.2.1 MORRISON MODEL

5.2.1.1 DOMAIN AND GRID

The OSE's Morrison ground-water model was developed using the USGS finite-difference numerical ground-water flow model called MODFLOW (MacDonald and Harbaugh 1988). In the project area, the Morrison (OSE) model covers an area of approximately 1,600 square miles, discretized into a model domain oriented northwest parallel to the estimated pre-development ground-water contours and parallel to the mountain-front (Figure 5.1). The model domain extends beyond the Alamogordo-Tularosa Administrative Area. The proposed City of Alamogordo supply wells are located within but relatively close to the eastern and northern boundaries of this model domain, approximately 10 miles from the northern boundary and approximately 0.75–3.0 miles from the eastern boundary.

The model is subdivided into cells, in 82 rows by 24 columns, that range in area from a half-square-mile on the east near the Sacramento Mountains to 5 square miles on the northwest and southeast corners. In the vicinity of the proposed Alamogordo well field, the model cells are 1.5 to 2 miles long north-south and 0.5 mile wide east-west. The model consists of one layer that is coded as an unconfined aquifer with constant transmissivity in a given model cell.

5.2.1.2 MATERIAL PROPERTIES

The Morrison model uses aquifer transmissivity based on 29 data points compiled from three sources. These values were adjusted during model calibration. The report includes a table comparing the reported values and the final calibrated values in the corresponding model cell (Morrison 1989). Observed transmissivity values range from 60 to 20,000 square feet per day (ft^2/day), with most values in the 1,000–2,000 ft^2/day range. Transmissivity values in the calibrated model range from 100 to 6,000 ft^2/day, with the higher values in the alluvial fans at the mouths of the canyons issuing from the Sacramento Mountains. For the transient simulations, the storage coefficient is used. Observed values range from 0.0004 to 0.04. The model uses values representative of an unconfined aquifer, with values in the calibrated model ranging from 0.01 to 0.12. The calibrated storage coefficient values generally are higher than the observed values but appear reasonable for the types of unconsolidated sediments described for the basin-fill alluvium and for an unconfined aquifer. The Morrison report presents the transmissivity and storage coefficient values used in the model as contour maps.

5.2.1.3 BOUNDARY CONDITIONS

The Morrison model was developed to represent a subset of the basin-fill unconsolidated deposits of the Tularosa Basin so that the boundary conditions depict flow conditions at its edges. The north and south ends of the model (top and bottom rows) consist of no-flow boundaries to represent lines of ground-water flow. The eastern edge (rightmost row) of the model represents the escarpment of the Sacramento Mountains and is also simulated as a no-flow boundary. The western edge (first row) was simulated as a constant head boundary to represent underflow for the steady-state model. This was replaced with a no-flow boundary during the transient simulations so that the entire model was surrounded by no-flow boundaries.

5.2.1.4 AQUIFER STRESSES

Aquifer stresses consist of the inflows and outflows simulated in the ground-water model other than the model boundary conditions. The steady-state model simulates ground-water recharge from the Sacramento Mountains to the east and ground-water discharge through both evapotranspiration and deeper underflow on the west. For the transient model the stresses consist of recharge on the east and evapotranspiration on the west.

Ground-water recharge is primarily a function of precipitation in the Sacramento Mountains. Given the short duration and high flows of summer thunderstorms, little recharge is thought to occur during the summer, so almost all recharge occurs in the winter and spring periods. Direct runoff occurring as sheet flow, runoff infiltrating into streambeds that drain the mountains, and infiltration from springs are represented as part of the overall mountain-front recharge. The model defines recharge from the mountains by specified-flux using the Well package in MODFLOW.

The Morrison model uses a combination of approaches to estimate ground-water recharge, all of them based on the assumption that precipitation can be used to approximate recharge. A drainage area from the Sacramento Mountains of approximately 600 square miles is used to estimate ground-water recharge, with 35 individual drainage basins used to calculate precipitation using a regression equation developed by the OSE that is based on a land surface elevation. Other parties have estimated recharge in specific drainage basins of the Sacramento Mountains using Darcy's Law. The current modeling effort translated these data into the percent of precipitation estimated as recharge, with values ranging from 1 to 4 percent for the major drainages to 8 percent in smaller drainages. The result was an overall estimate of 14,847 afy, about 3 percent of total precipitation on the mountainous drainage area for the steady-state model. For the transient version of the model, the mountain-front recharge was reduced in several drainages (the Tularosa Creek and La Luz, Fresnal, and Alamo Canyons) in proportion to diversion of surface water as a source of water supply. Declines in ground-water levels at the mouth of Alamo Canyon of several hundred feet compared to pre-development conditions was used as the evidence for a decrease in recharge associated with surface-water diversions.

Evapotranspiration was estimated to occur to a depth of approximately 15 feet below land surface, with the highest values at land surface. The maximum value is not specified in the Morrison model report. Estimates were made by comparing average land surface elevation to the average pre-development water level for each model cell. For the steady-state model, the locations and values assigned for this parameter were determined through model calibration, with a total evapotranspiration loss in the model area estimated at 5,300 afy. This parameter was simulated in the model as a specified flux using the Well package of MODFLOW. For the transient version of the model, evapotranspiration was reduced in proportion to the decline in water table surface compared to the steady-state water surface.

Pumping was simulated in the transient version of the Morrison model. Irrigation well pumping was calculated based on estimates of irrigated acreage using air photos and notes from field surveys. Ground-water pumping was then estimated to be 2.2 afy per irrigated acre. Municipal and other non-agricultural pumping, such as from Holloman Air Force Base, was estimated from

water rights declarations records on file with the OSE and from records compiled by the USGS and Reclamation, or was assumed for years when no other sources of information were available.

5.2.1.5 MODEL CALIBRATION

The Morrison model calibration involved both steady-state and transient simulations. The steady-state model targeted pre-development conditions based on water levels measured during the 1950s. The transient calibration period used extends from 1910 to 1984 and comprises 15 periods of 5 years' duration each. The calibration process involved an iterative approach between the steady state and transient models, modifying transmissivity, storage coefficient, mountain-front recharge, evapotranspiration, and irrigation pumping to obtain a match between observed and simulated water table surfaces. The transient model used water level measurements from 44 wells to compare against simulated conditions, with hydrographs of observed and simulated water levels presented for 14 wells. Adjustments were made in the transient model to better reflect observed drawdown near wells, and the steady-state model was then rerun using the revised properties. This iterative process continued until an acceptable match was obtained in both the steady-state and transient versions of the model. The resulting calibrated steady-state model has an absolute mean of the difference between observed and simulated water levels of 14.81 feet and a standard deviation of 9.23 feet.

The transient model represents a superposition of the historical stresses on the pre-development water table by simulating that pre-development water table as a flat surface of uniform elevation. This approach allows ready comparison of relative effects of pumping, recharge, and other stresses but does not provide information on absolute water level elevations that can be compared to observed values. For the calibrated transient model, the absolute mean of the difference between observed and simulated drawdown is 5.39 feet for all model cells and 10.6 feet with a standard deviation of 7.5 feet for the 44 model cells corresponding to locations where water level measurements are available.

A sensitivity analysis was conducted on four parameters: mountain-front recharge, transmissivity, evapotranspiration, and storage coefficient.

5.2.2 JSAI MODEL

5.2.2.1 DOMAIN AND GRID

The JSAI model (JSAI 2003a) uses the Morrison model as a foundation but expands the model grid area and layering. The MODFLOW model is also used, applying the software package Visual Modflow to perform pre and post processing and graphical output of model results. The model domain is oriented more to the north than the in Morrison model and is expanded to the east by approximately 10 miles and to the north by approximately 4 miles near the proposed Alamogordo supply wells (Figure 5.1). This expansion of the model area allows this model to take into account more of the Sacramento Mountains. The JSAI model uses a uniform half-square-mile grid of 120 rows and 52 columns.

The model domain is partitioned into three layers of varying thickness. The upper two layers are coded as unconfined/confined with variable transmissivity. The lower layer is coded as a confined aquifer. The upper layer extends from land surface and includes the upper 200 feet of

the basin-fill aquifer. The middle layer is approximately 500 feet thick in the basin-fill aquifer and ranges from 500 to 900 feet thick in the bedrock aquifer along the eastern portion of the model. The lower layer is 1,400 feet thick. All three model layers consist of model cells representative of either bedrock or alluvial basin-fill materials, with the distinction defined by the material properties assigned to individual model cells.

5.2.2.2 MATERIAL PROPERTIES

A key feature of the JSAI model is its incorporation of bedrock aquifers. Conceptually these aquifers define the Sacramento Mountains and are present under the eastern portion of the basin-fill aquifer. The bedrock aquifers are thought by JSAI to provide significant subsurface flow into the basin-fill aquifer by capturing high-elevation infiltrating water and routing it through fracture networks present in the bedrock formations. Some of the evidence for this additional flow is the reportedly high yields of some wells drilled in the upland areas, but verification was not possible due to lack of data. A hydraulic conductivity value of 0.1 ft/day was assigned to the bedrock aquifer in the Rinconada, Tularosa, and La Luz watersheds (the watersheds adjacent to the proposed Alamogordo well field) in layer 1. This value is reportedly similar to the one determined by Wasiolek (1991) for the corresponding Permian-age formations that occupy these drainages. Deeper bedrock formations were assigned hydraulic conductivity values ranging from 0.01 to 0.05 ft/day. The transmissivity corresponding to these values ranges from 20 to 600 ft^2/day. The ratio of vertical to horizontal hydraulic conductivity is 1:1 for the bedrock aquifers to simulate regional flow in fractured rock.

The hydraulic conductivity of the basin-fill deposits decreases from east to west and with depth, and ranges from 15 to 0.5 ft/day. The highest value is found in a zone at the foot of the Sacramento Mountains that extends throughout the model domain except beneath the city of Alamogordo. The northern portion of these zones of high hydraulic conductivity extends from Alamogordo to north of the town of Three Rivers and includes the vicinity of the proposed Alamogordo well field. The hydraulic conductivity used in the model is based on 29 aquifer tests, similar to those in the Morrison model report, but with the addition of an 8-hour test and a 5-day test run on an exploratory well drilled at the site of the proposed Alamogordo well field. The results from this aquifer test provided a hydraulic conductivity value of 30 ft/day. The JSAI model report provides a table comparing the reported value, the value used in the corresponding cell in the Morrison model, and the value used in the corresponding cell in the JSAI model (Table 5.1). As shown in the table, the values used in the JSAI model are in most cases much higher than those used in the Morrison model. This difference is explained in the JSAI model report as being due to the higher recharge value used in that model. For the region north of Tularosa, the estimated ranges of hydraulic conductivity from pumping test data and from the JSAI model input compare favorably.

The ratio of vertical to horizontal hydraulic conductivity is 1:100 for the basin-fill deposits. The transmissivity corresponding to these values ranges from 2,000 to 15,000 ft^2/day for the basin-fill aquifer. The JSAI report presents the hydraulic conductivity graphically for each model layer. A storage coefficient of 0.08 was assigned to the basin-fill aquifer, with values 0.008 and smaller assigned to the bedrock aquifer.

Table 5.1. Comparison of Morrison and JSAI Models, Alamogordo Application T-3825 et al.

Model Parameter	Morrison Model	JSAI Model	Notes
Model Software	Modflow88	Modflow96 via Visual Modflow, version3.0	
Domain and Gridding			
Model domain	Approx 1,368 square miles; extends to eastern edge of basin fill; proposed well field located within 3–5 miles of eastern model edge and within 10 miles of northern model edge.	1,560 square miles; extends 3-5 miles into eastern mountains	see JSAI (2003a:Figure 3) for domains & grid orientation
Model orientation	Approx 10 degrees to the NW	Approx 30 degrees to the NW	
Model grid	82 rows and 24 columns	120 rows and 52 columns	
Grid spacing	Half-square-mile on the east to 5 square miles on the NW and SW corners	Uniform half-square mile cells	
Grid spacing near proposed well field	1.5–2 miles by 0.5 miles; regridded model (by HAI 2003a) has half-mile cell size in northern portion of model	Uniform half-square mile cells	
Model layering	One layer; represents alluvial basin-fill	3 layers; represents alluvial basin-fill and bedrock of adjacent mountains to the east	
Layer definitions	Coded as confined aquifer with constant T	Upper 2 layers coded as variably unconfined/confined, with variable T; bottom layer coded as confined with constant T	
Layer thicknesses	Not applicable when using constant T	Upper layer variable, from land surface to 200 ft below pre-development water table surface; layer 2 is 500 ft thick in the basin fill and 500–900 ft thick when representing bedrock units to the east; lower layer is 1,400 ft thick.	

5.2.2.3 BOUNDARY CONDITIONS

The JSAI model uses a combination of boundary conditions to represent conditions at the edges of the model domain. In the initial steady-state model, a constant head boundary condition was used to define evapotranspiration from the basin-fill aquifer. These cells were converted to head-dependent flux cells to more closely represent evapotranspiration in the final steady-state and transient versions of the model. The eastern boundary uses the Modflow Recharge package to simulate direct recharge associated with precipitation. Most of the western boundary is simulated using the Modflow Evapotranspiration package. The northern and southern boundaries are defined as no-flow.

5.2.2.4 AQUIFER STRESSES

Aquifer stresses include bedrock recharge from direct precipitation, basin-fill recharge along the mountain-front, evapotranspiration, and well pumping. Bedrock recharge from direct precipitation was based on land surface elevation and modified during model calibration. Recharge values used in the model range from 1 inch per year above 9,000 feet to 0.25 inch per year for elevations between 6,000 and 7,000 feet. Approximately 15,500 afy were applied as bedrock recharge in the steady-state version of the JSAI model, a value reported to be similar to the one provided in the Tularosa Basin 40-year Water Plan. The Modflow Recharge package was used to simulate direct infiltration.

Recharge occurring at the mountain front was based on a 2001 USGS study (Waltemeyer 2001) for the Tularosa Basin, in which the estimated streamflow in 12 canyons totaled approximately 39,000 afy. The JSAI model applied approximately 25,000 afy in its calibrated steady-state model to basin-fill recharge along the mountain front. It is unclear from the JSAI model report how the mountain-front recharge was determined and assigned spatially in the model. Mountain-front recharge was varied in the transient version of the model beginning in 1950 to reflect municipal water diversion from La Luz and Alamo Creeks, and to reflect high streamflow that occurred between 1975 and 1995. The mountain-front recharge into the basin-fill aquifer was simulated using the Modflow Well package. A table showing mountain-front recharge assigned to selected creeks and other areas for each of the 5-year historic periods is provided in the report.

Evapotranspiration was simulated to occur over the western quarter of the JSAI model domain. Evapotranspiration rates were based on an assumed extinction depth of 25 feet and a maximum rate of 50 inches per year. A total discharge from the steady-state model by evapotranspiration is approximately 45,000 afy. In comparison, the discharge estimated by evapotranspiration in the Morrison steady-state model is approximately 5,300 afy.

Pumping was input to the transient model to simulate irrigation, municipal, and private domestic use. The JSAI report includes an appendix with the detailed pumping schedule used as model input for each 5-year model stress period. However, other than a listing of irrigated acres, little information is provided in the report on how the numbers were developed. The total pumping depletions in the JSAI model are consistently higher than those used in the Morrison model, with pumping in the 1975–1984 periods approximately 50 percent higher in the JSAI model.

The JSAI model extends pumping and other stresses through the year 2000 based on reported values, whereas the Morrison model ends its historic period in 1984.

5.2.2.5 MODEL CALIBRATION

In the steady-state model, constant heads defined the boundary condition for evapotranspiration from the basin-fill aquifer. The calibration was undertaken in two stages. In the first state the model transmissivity and recharge were varied to obtain an acceptable match to ground-water levels representing pre-development conditions. In the second stage, the flux values from the constant head cells were converted to equivalent values using the Modflow Evapotranspiration package. The model was then rerun in transient mode for 1,000 years to produce the final steady-state equivalent results. The root mean square (RMS) error between observed and simulated heads for 33 wells was 36.9 feet with a standard error of 6.3 feet. The report notes that an RMS error divided by the range in heads should be less than 10 percent, and that for this model a value of 1.8 percent was obtained. The simulated water level elevation contours of 4,300 and 4,400 feet, representing the pre-development head values beneath the proposed Alamogordo well field area, are low by 30–100 feet compared to observed values, although hydraulic gradients in the area generally match observed values.

The historic transient calibration period in the JSAI model is from 1910 to 2000. The transient version of the model was calibrated to historic conditions using over 30 wells and plotting hydrographs of observed and simulated water levels. Pumping reduced water levels in the basin-fill aquifer, thereby reducing evapotranspiration by approximately 12 percent compared to the steady-state rate. Mountain-front recharge was reduced by 5 percent during the transient calibration period to provide a better match to observed water levels. A total flux rate for the end of the transient calibration period of approximately 54,750 afy was obtained. No calibration statistics were provided for the transient calibration.

A sensitivity analysis was conducted during modeling using as parameters hydraulic conductivity, mountain-front recharge, and specific yield. The result of this analysis helped lead to the final calibrated values.

5.2.3 HAI MODEL

As part of the well permit protests, the Morrison model was revised by Hydroscience Associates, Inc. (HAI 2003b). The key model revisions consisted of refining the grid in the portion of the model corresponding to the proposed Alamogordo well field. The model cells up to 4 miles north of the proposed well field were regridded to one-half-mile square, resulting in conversion of model rows 1 to 6 in the Morrison model to model rows 1 to 20. All other inputs were adjusted to reflect this regridding, but no input values were changed in the Morrison model.

5.2.4 MODIFIED OSE MODEL

As part of well permit protests, the OSE revised the Morrison model in the vicinity of Alamogordo's proposed wells (Keyes 2003). The aquifer transmissivity was revised in the northeastern corner of the model domain in an area extending from north of Tularosa to the northern edge of the model and from the model's eastern edge to between 2 and 8 miles to the west. The revisions were based on the aquifer pumping test conducted at the site of the proposed well field and on further analysis of specific capacity data in this region. Aquifer transmissivity values are 500 or 1,000 ft^2/day in the Morrison model cells where the proposed wells would be located. These values were increased to 1,600 and 5,880 ft^2/day, respectively, in the Modified

OSE model (Keyes 2003). An additional change was made in a zone southwest of the proposed wells, where transmissivity values of 1,000 ft^2/day were increased to 2,450 ft^2/day.

HAI further revised the Modified OSE model as part of the well permit protests, incorporating the transmissivity modifications into their regridded Morrison model to create a regridded Modified OSE model (HAI 2003b). The Modified OSE and regridded Modified OSE models were run to evaluate pumping effects of the proposed well field.

5.3 SUMMARY OF RESULTS FROM EXISTING MODELS

The Morrison, JSAI, and HAI models were used to simulate impacts due to future pumping. A summary comparing the modeling parameters and results is provided in Table 5.2. The model results are discussed in more detail below.

5.3.1 MORRISON MODEL

The Morrison model was used to predict future ground-water withdrawals for the 40-year period 1982–2022. Three predictive scenarios were simulated, representing a range of ground-water depletions from 10,200 to 436,400 afy. Since the model was constructed to examine incremental effects only, the difference in drawdown over the 40-year period was computed for each scenario. The maximum drawdown was simulated to be approximately 65, 100, and 500 feet for the low, medium, and high pumping scenarios, respectively. The mixing cell solute transport model was used to estimate changes in water quality under each scenario. Some improvement in water quality was observed when relatively fresh water near the canyon mouths of the Sacramento Mountains was drawn into the central part of the basin-fill material. Generally, water quality declined for the Tularosa area, with increases in TDS of up to 350 mg/l and increases in the La Luz well field of 96 to 227 mg/l for the low and high pumping scenarios, respectively.

An external solute transport model developed by Rao and Hathaway (1989) was used in combination with the Morrison model to estimate changes in total dissolved solids within the model area. The one-layer transport model computes concentration changes that occur as solutes travel along a ground-water flow path, assuming the solute mixes completely within each cell and using a conservation-of-mass approach. The solute transport model did not simulate the decrease in water quality with depth reported by Morrison, but it was able to estimate changes in total dissolved solids concentration as ground water flowed west. Because of data limitations, no attempt was made to calibrate the water quality model.

5.3.2 JSAI MODEL

The JSAI model simulated future pumping at the proposed Alamogordo well field in four 10-year intervals: 5,000 afy from 2000 to 2009, 6,500 afy from 2010 to 2019, 8,000 afy from 2020 to 2019, and 10,000 afy from 2030 to 2039. The maximum rate simulated by any one well in this well field was 1,001 afy. The pumping was assigned to each model layer and appeared to be proportional to the initial aquifer transmissivity. Four of the wells (T-3825-S, -S-2, -S-5 and –S-

Table 5.2. Comparison of Morrison and JSAI Models, Alamogordo Application T-3825 et al.

Model Parameter	Morrison Model	Jsai Model	Notes
Model Software	Modflow88	Modflow96 via Visual Modflow, version3.0	
Domain and Gridding			
Model domain	Approx 1,368 square miles; extends to eastern edge of basin fill; proposed well field located within 3–5 miles of eastern model edge and within 10 miles of northern model edge.	1,560 square miles; extends 3-5 miles into eastern mountains	see JSAI (2003:Figure 3) for domains & grid orientation
Model orientation	Approx 10 degrees to the NW	Approx 30 degrees to the NW	
Model grid	82 rows and 24 columns	120 rows and 52 columns	
Grid spacing	Half-square-mile on the east to 5 square miles on the NW and SW corners	Uniform half-square mile cells	
Grid spacing near proposed well field	1.5–2 miles by 0.5 miles; regridded model (by HAI 2003a) has half-mile cell size in northern portion of model	Uniform half-square mile cells	
Model layering	One layer; represents alluvial basin-fill	3 layers; represents alluvial basin-fill and bedrock of adjacent mountains to the east	
Layer definitions	Coded as confined aquifer with constant T	Upper 2 layers coded as variably unconfined/confined, with variable T; bottom layer coded as confined with constant T	
Layer thicknesses	Not applicable when using constant T	Upper layer variable, from land surface to 200 ft below pre-development water table surface; layer 2 is 500 ft thick in the basin fill and 500–900 ft thick when representing bedrock units to the east; lower layer is 1,400 ft thick.	

6) have their middle and bottom layers defined as bedrock based on the hydraulic conductivity distributions contained in the model. This results in over 99 percent of the pumping from these wells coming from model layer 1. For predictive purposes, mountain-front recharge was maintained at steady-state rates less depletions from surface water diversions.

The JSAI model examined both the total drawdown due to all pumping wells and the incremental drawdown due to pumping from the proposed wells. The incremental effects were obtained by running two simulations, one with depletions from existing users and one with cumulative depletions from existing users plus the proposed well field, then subtracting the results. The JSAI report includes maps of total and incremental drawdown. At the end of the 40-year period, predicted drawdown based on existing users is approximately 10 to 20 feet in the vicinity of the proposed well field, , and 60 to 80 feet in the Tularosa area. Contours of simulated drawdown are elongated along the mountain front, corresponding to the zones of higher transmissivity (Figure 5.2). Cumulative drawdown exceeds 100 feet in the vicinity of the proposed well field and is 60 to 90 feet in the Tularosa area. The incremental drawdown due to pumping at the proposed well field exceeds 100 feet at the well field and is less than 5 feet at locations approximately 13 miles south, 8 miles west, and 12 miles north of the well field (Figure 5.3). It should be noted that predicted drawdown in cells where simulated pumping occurs underestimates actual drawdown in the pumping well itself, since the model produces a drawdown for each model cell that is the average value for the entire cell.

Model-predicted drawdown was computed for wells that are registered with the OSE and listed in the OSE's WATERS database of wells. Predicted drawdown for the registered wells located closest to the proposed well field, approximately 2 miles south, is approximately 50 feet after 40 years. The Tularosa Basin administrative area has criteria limiting drawdown to 100 feet in 40 years. In the Tularosa Basin Administrative Area, the administrative block nearest to the proposed well field is predicted to have an incremental additional drawdown of approximately 55 feet due to operation of the proposed well field. The current drawdown calculated for that same block is approximately 31 feet, resulting in a cumulative drawdown of approximately 86 feet. The JSAI report concludes that operation of the proposed well field will not prevent other appropriators from exercising their existing water rights, nor does the proposed well field violate other criteria for the Alamogordo-Tularosa Administrative Area.

Conceptually, water quality impairment is thought to occur due to a reversal of the hydraulic gradient, allowing the more saline ground water that exists closer to the center of the basin to migrate toward the pumping wells. The JSAI solute transport simulation results indicate that no degradation in water quality will occur within the 40-year planning period because the cone of depression from the proposed well field is not extensive enough to reverse the hydraulic gradient and capture more saline ground water. The JSAI report presents graphical results of TDS inputs to the model and predicted results showing ground-water flowlines.

5.3.3 HAI MODEL

The 40-year pumping schedule used in the JSAI model was input into the refined Morrison (HAI) model. Two criteria were used to evaluate impacts. For wells outside the Tularosa Basin Administrative Area, the OSE considers a well to be significantly impacted when its available water column is reduced to less than 70 percent of initial conditions or less than 10 feet of water

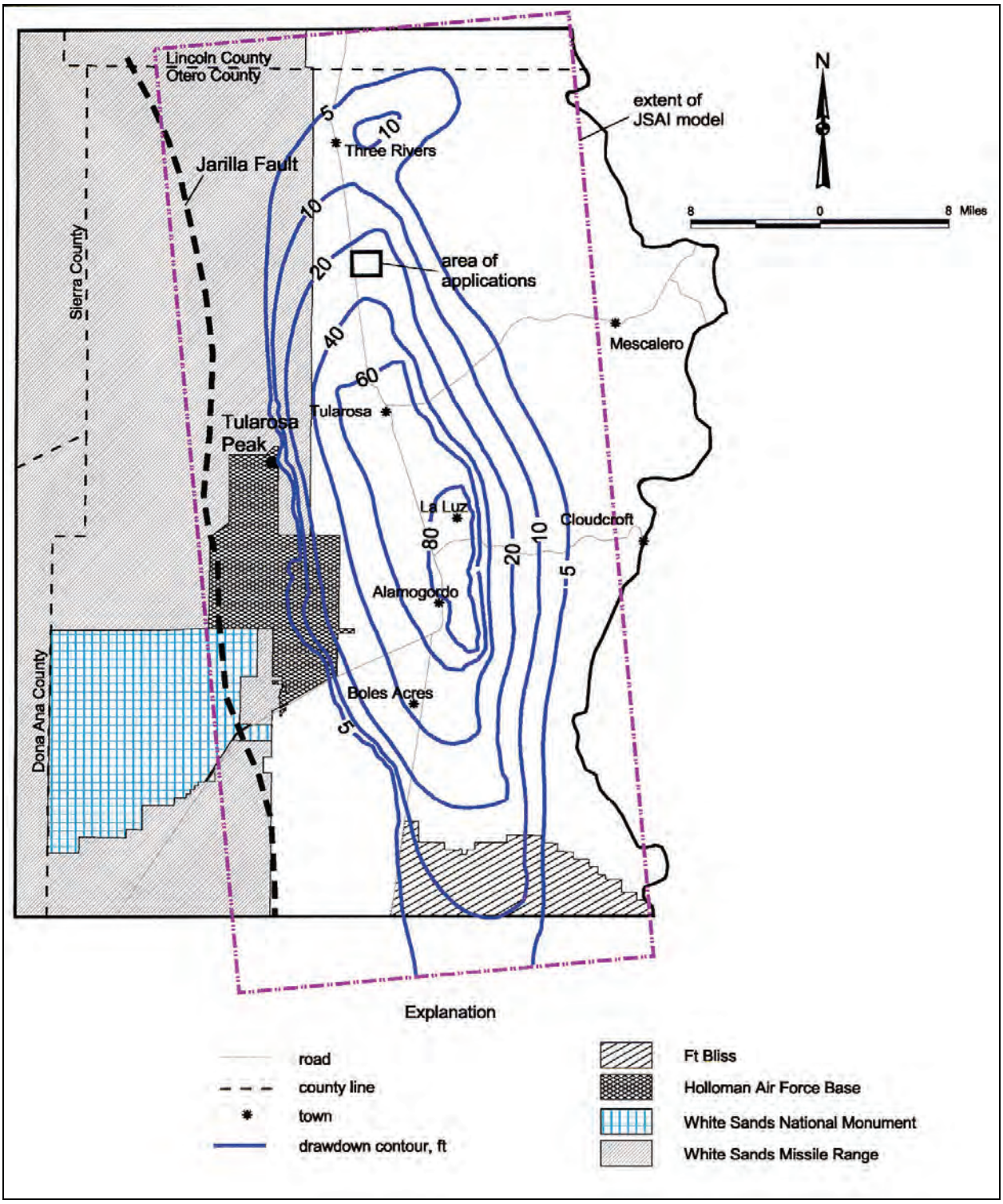

Figure 5.2. Map showing JSAI model–predicted drawdown due to historic and projected future pumping (1910 to 2040) without T-3825 et al. (from JSAI 2003a).

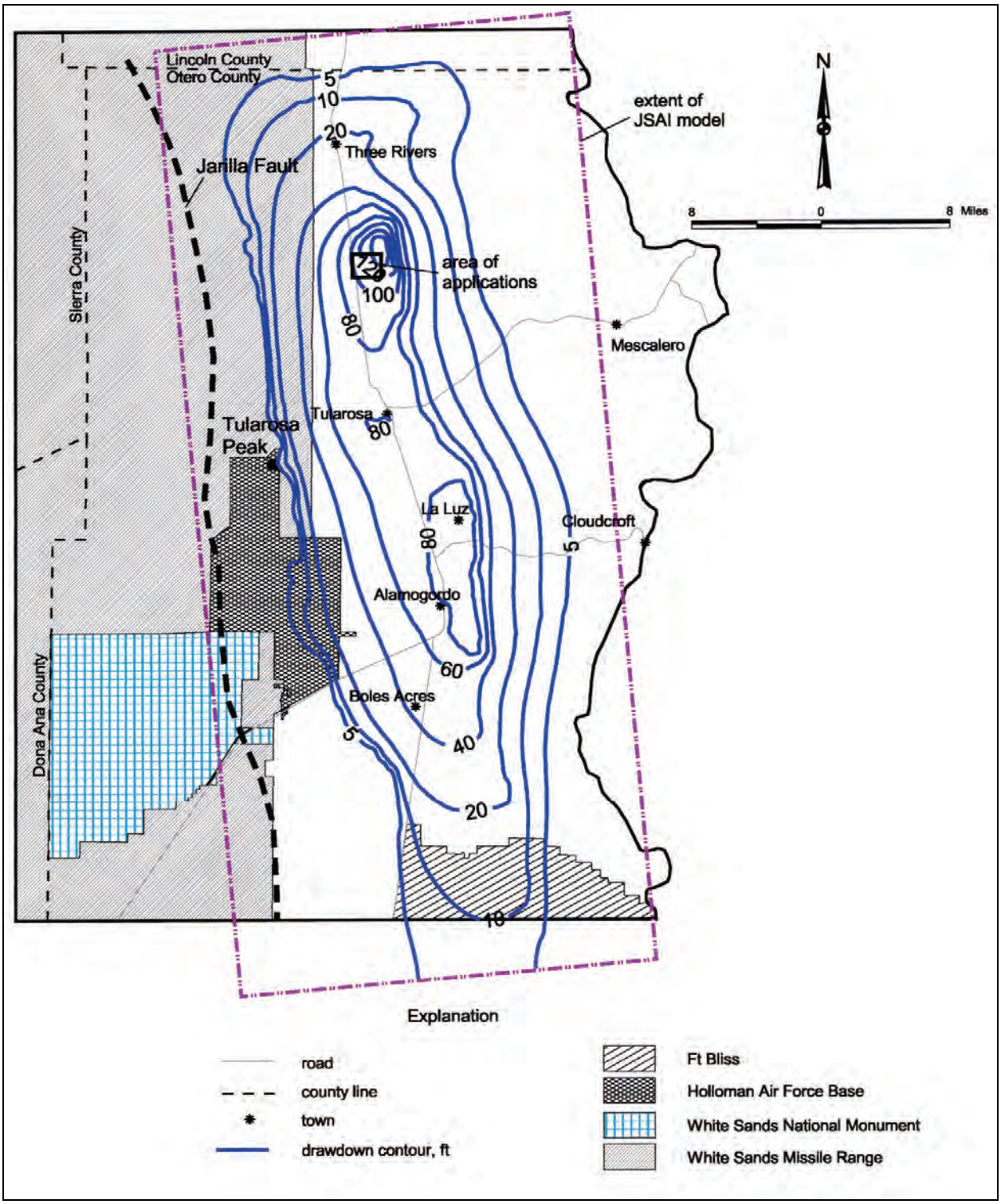

Figure 5.3. Map showing JSAI model–predicted drawdown due to historic and projected future pumping (1910 to 2040) with T-3825 et al. (from JSAI 2003a).

is in the well. Within this Administrative Area the Administrative Criteria allow for simulated declines of no more than 100 feet in 40 years. HAI's simulated results indicate that after 40 years the proposed pumping will cause the water columns in four wells to be reduced to less than 70 percent of the initial water column height and that another well would go dry. In addition, four model cells within the Tularosa Basin Administrative Area are simulated to have more than 100 feet of drawdown in 40 years. These cells are located approximately 3 miles south of the proposed well field and along the eastern edge of the model area (HAI 2003a). HAI concluded that water quality data available for the Tularosa Basin were insufficient to begin to calibrate a transport model and so did not undertake any water quality modeling. HAI surmised that water quality in the vicinity of the proposed well field would decline over time with ongoing pumping, since poorer-quality ground water would be induced into the well field area from the west.

5.3.4 MODIFIED OSE MODEL

The 40-year pumping schedule used in the JSAI model was input into both the Modified OSE and refined Modified OSE models. The higher transmissivity used in the Modified OSE model caused more drawdown to be simulated, resulting in nine wells having their water columns reduced to less than 70 percent and one well going dry (Keyes 2003). The regridded Modified OSE model projected that the water columns in six wells would be reduced to less than 70 percent of initial height and two wells would go dry (HAI 2003b).

5.4 CONCLUSIONS AND RECOMMENDATIONS

The larger drawdown predicted by the Morrison, HAI, Modified OSE, and regridded Modified OSE models in comparison to the JSAI model is due largely to differences in model domain, recharge, and transmissivity. The boundaries of the original Morrison model were not designed to address significant pumping 10 miles north of Tularosa, as is proposed by the City of Alamogordo. The eastern and northern boundaries of the Morrison and the regridded HAI models are too close to the proposed well field, causing simulated drawdown from the well field to be too large due to an effect comparable to a barrier boundary. As shown in the JSAI report, cumulative drawdown will extend beyond the boundaries of the Morrison and HAI model boundaries.

The JSAI model provides a more sophisticated representation of the hydrogeologic system in the eastern portion of the Tularosa Basin than the other models and, based on model calibration results, appears to be a better predictive tool for evaluating effects of the proposed well field. The JSAI model domain is appropriate for the purposes for which it was used. Its inclusion of bedrock materials and multiple layers better represents conditions present in the Tularosa Basin, and its ability to account for decreasing transmissivity with decreasing aquifer saturated thickness is conceptually and numerically superior to the constant transmissivity used by the Morrison and HAI models. The JSAI model also has a longer period of historical calibration by 15 years and, significantly, matches observed water levels much better than do the Morrison and HAI models.

In any numerical model the recharge and transmissivity can be varied in proportion to each other and yield a similar calibration. The higher values used in the JSAI model compared to the other

models discussed will tend to reduce the impact of pumping from the proposed well field. However, the combination of a relatively large value for direct recharge to the bedrock, the high hydraulic conductivity value, and the 1:1 horizontal to vertical conductivity ratio given for the bedrock strata adjacent to the well field are potential conceptual weaknesses in the JSAI model. This model has four of the proposed wells placed at least partially into bedrock strata, a factor that may have affected the simulation results and therefore may warrant further evaluation. Conducting additional aquifer pumping tests in the vicinity of the proposed well field would help to verify the high hydraulic conductivity value assigned by JSAI to that portion of the basin-fill aquifer and would provide insight into whether the JSAI model would need to be recalibrated.

The method by which ground water is allowed to discharge from the JSAI model, other than by pumping, is another aspect that may warrant more review and possible revision. The western (downgradient) model edge is a no-flow boundary, so water can discharge from the JSAI model only through ground water evapotranspiration. The depth below ground surface over which evapotranspiration is allowed to occur, 25 feet, far exceeds the value of 15 feet used in the Morrison, HAI, Modified OSE, and regridded Modified OSE models and is a relatively large part of the water balance of the JSAI model. As a result, a relatively large proportion of the water to be pumped from the proposed well field under the JSAI model is effectively offset by a predicted reduction in ground water evapotranspiration losses (salvaged ET). The JSAI model predicts that evapotranspiration will decline as the water table drops near the western edge of the modeled area. Under this model, pumped water is largely derived from salvaged ET rather than from aquifer storage. More water derived from storage would equate to a larger cone of depression around the proposed well field and greater impacts to existing wells than is predicted by the JSAI model.

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APPENDIX I

Tularosa Underground Water Basin Administrative Criteria for the Alamogordo-Tularosa Area

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

TULAROSA UNDERGROUND WATER BASIN ADMINISTRATIVE CRITERIA FOR THE ALAMOGORDO-TULAROSA AREA

PREPARED BY

NEW MEXICO STATE ENGINEER OFFICE

THOMAS C. TURNEY

STATE ENGINEER

MAY 1997

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NEW MEXICO STATE ENGINEER OFFICE

TULAROSA UNDERGROUND WATER BASIN ADMINISTRATIVE CRITERIA FOR THE ALAMOGORDO-TULAROSA AREA

May 19, 1997

INTRODUCTION

The Tularosa Basin was declared by State Engineer Special Order No. 131 on July 7, 1982 and encompasses an area of approximately 6,070 square miles (Figure 1). Due to the size of the basin and the geologic diversity of the region, criteria for water rights administration should be developed for specified sub-areas within the basin. This process will enable criteria to meet the specific conditions for unique areas. As of this date,the majority of pending well applications are located in the region near Alamogordo and Tularosa, within Townships 13 thru 18 South and Ranges 8 thru 10 East (Figure 1). The purpose of this document is to provide criteria for processing water rights applications for this sub-area.

Criteria for water rights administration for the Alamogordo-Tularosa administrative area will be used in decision making on pending and future applications (new appropriations, applications for supplemental wells, and applications to change point of diversion,or place or purpose of use). Applications for wells outside of this sub-area will be considered on a case-by-case basis. Criteria for these other areas will be developed as deemed necessary.

The state engineer has adopted the administrative criteria below in order to assure orderly development of groundwater resources within the Tularosa basin,while meeting statutory obligations regarding non-impairment to existing water rights, availability of unappropriated water, conservation of water within the state and public welfare of the state. This policy development process begins with the formulation of administrative objectives or water resource goals to be achieved. This is followed by the selection of administrative standards which quantify allowable levels of water level declines and water quality degradation. Criteria outlining the evaluation procedure are presented in the final section.

ADMINISTRATIVE OBJECTIVES

The state engineer has identified the following administrative objectives:

A. The Tularosa Basin is recognized as a mined basin and is administered to allow use of groundwater to a specified amount of de-watering during a forty-year planning period. A "mined basin" is defined as a groundwater basin in which well withdrawals are in excess of natural recharge or induced recharge from streams.

B. Water level decline rates should only occur at an acceptable rate.

C. The application of water shall not be contrary to the public welfare of the state. Water quality suitable for domestic, municipal, agricultural and industrial purposes shall be maintained.

D. Existing surface water and groundwater rights shall not be impaired by new appropriations.

E. A groundwater appropriation shall only be granted to the extent that unappropriated water is available to the well from the aquifer at the proposed point of diversion and other statutory requirements are met.

F. A major portion of the freshwater saturated thickness shall be reserved for uses beyond the 40-year planning period which extends from 1982 through 2022. The planning period is assumed to start at the beginning of 1982, the year the basin was declared.

G. The application of water shall not be contrary to conservation of water within the state.

ADMINISTRATIVE STANDARDS

To achieve the above objectives, quantitative standards as deemed reasonable by the state engineer must be selected which define allowable impacts from existing and proposed wells within the Alamogordo-Tularosa administrative area. These standards, and their basis, where applicable, are as follows:

A. The average annual water level decline rate of 2.50 feet per year or less due to the exercise of existing water rights will be considered acceptable. This level of mining has been selected for other mined basins in the state and was deemed reasonable for the Alamogordo-Tularosa administrative area. In areas where the freshwater thickness is less than 400 feet, acceptable average annual decline rates will be controlled by paragraph C below to extend the life of the freshwater zone.

B. Total dissolved solids (TDS) in groundwater is adopted as a measure of groundwater quality. Freshwater is defined as containing less than 1,000 mg/l TDS (Orr and Myers, 1986). Degradation of water quality from less than 1,000 mg/l TDS to 1,000 mg/l TDS or greater will be considered unacceptable. Two different methods will be used to provide protection to the freshwater zone. These are 1) a volumetric approach to allow a certain portion of the aquifer to be de-watered and 2) the use of a solute transport model to predict which areas will degrade to TDS concentrations of 1,000 mg/l or greater. Based on studies for the Hueco Basin (Papadopulos, 1987), it is assumed that water quality in the freshwater zone will remain fresh if drawdowns do not exceed one-half of the freshwater thickness estimated for the aquifer of the 1980s. The SEO has also developed a two-dimensional finite difference flow and solute transport model to simulate the effects of pumping on water levels and TDS concentration (Morrison, 1989). Future pumping by existing wells were simulated with a low, medium and high scenario. Unless the results of the solute transport simulations indicate that the water quality conditions will degrade to TDS levels of 1,000 mg/l or greater, it will be assumed that recoverable freshwater is one-half of the initial freshwater thickness estimated for the aquifer of the 1980s (Figure 2).

C. At least one-half of the recoverable freshwater will be reserved for use beyond the 40-year planning period for areas in which it is anticipated to remain fresh (Figure 2).

ADMINISTRATIVE CRITERIA

Criteria are developed to serve as agency guidelines on how to process and evaluate pending applications for groundwater appropriations. To quantify well impacts for this process, a two-dimensional finite difference groundwater flow model (Morrison, 1989) will be used to simulate the effects of pumping on water levels due to existing and proposed wells. A two-dimensional solute transport model has been developed to estimate changes in TDS due to existing wells and may be used if necessary to estimate impacts due to proposed wells. Administrative criteria are as follows:

1. The Alamogordo-Tularosa administrative area will be administered using blocks one-half mile square using the grid utilized by the groundwater model (Figure 3). If a proposed well field location is within more than one block, calculations should be performed with the well field located in the block which provides the most conservative analysis with respect to protecting existing water rights.

2. Water level declines and TDS changes due to existing wells will be considered along with water level declines due to a proposed well. TDS changes due to the use of proposed wells may also be considered if it is deemed necessary. Impacts will be computed to the beginning of 2022 for existing and proposed wells, and to provide a conservative analysis to protect existing water rights, the assumption will be that the proposed well would start pumping January of 1982.

3. It is assumed that a reasonable estimate of future water

use will be between the amounts estimated for the medium and high water use projections presented in Morrison ground water flow model. Impacts are assumed to be proportional to water use. Water level declines and changes in TDS will be computed by taking 20 percent of the absolute difference between the medium and high scenario results and adding the resultant to the medium scenario estimates. IMPACTS = Medium + 0.20(High - Medium)

4. The average annual water level decline rate due to existing uses will be calculated for each block by dividing the impacts computed in item 3 and dividing by 40 years. In an administrative block in which the average annual water level decline exceeds 2.50 feet, that block will be termed "critical." No new groundwater appropriation will be granted in a "critical" block, except as provided for in item 9.

5. In an administrative block where the 1980s freshwater thickness is less than 400 feet and the calculated average annual water level decline rate exceeds the value FW/4t

where, FW = estimated freshwater thickness (ft.) in the block in the 1980s

t = 40 years

that block will be termed "critical." No new groundwater appropriations will be granted in that block, except as provided for in item 9. This rate is the maximum decline which will allow for the reservation of one-half of the recoverable freshwater (Figure 2, Example 3). Freshwater thicknesses may be obtained from Figure 4, or from site specific data.

6. A groundwater appropriation will not be granted if it will cause the calculated average annual water level decline rate due to existing and proposed uses to exceed 2.50 feet, or the value determined in item 5 whichever is less, except to the extent as provided for in item 9.

7. For blocks containing freshwater in the 1980s, the estimated increase in TDS due to the use of existing water rights will be estimated using the procedure in item 3 and will be added to the estimated TDS for each block using data compiled in Appendix I of the groundwater flow model documentation (Morrison, 1989). Any freshwater block which has a resultant TDS of 1,000 mg/l or greater at the beginning of 2022 will be termed "critical." No new groundwater appropriations will be granted in a "critical" block, except as provided for in item 9.

8. For blocks which did not contain freshwater in the 1980s, increases in TDS due to existing and proposed wells will be considered on a case-by-case basis.

9. A groundwater appropriation may be granted provided that the proposed appropriation will not produce an average annual decline rate of greater than 0.05 feet on any "critical" block. Calculated water level declines for each new appropriation will be accounted to the nearest 0.01 foot. Applications to appropriate underground waters in accordance with Section 72-12-1 of the New Mexico Statutes will be granted within critical blocks with conditions of approval as deemed necessary to protect existing water rights.

10. Wells may not be completed to a depth of more than 50 percent of the freshwater thickness of the 1980s. Freshwater thickness may be obtained from Figure 4, or from site specific data.

11. Local effects due to a proposed appropriation will be evaluated on a case-by-case basis to ensure that impacts on the nearest wells of other ownership are not unreasonable. Available water columns, impacts from existing and proposed uses, and the ability to deepen wells to sustain a freshwater supply will be considered as deemed necessary. Calculations shall be performed in a manner to maximize the estimated impact to existing wells. For existing wells located 500 feet or less from a proposed well, drawdown calculations may be performed using the method presented by Prickett and Lonnquist, 1971 (page 61); or by using the Theis equation. Aquifer parameters used for local effect determinations may be obtained from the groundwater flow model or from site specific information as deemed reasonable. For existing wells located more than 500 feet from a proposed well, the groundwater flow model or any other method as deemed reasonable may be used to evaluate impacts to the nearest wells.

12. For the purpose of determining the annual water level decline due to existing rights, when a permit is granted for a new groundwater appropriation, the computed average annual water level declines from the approved permit over a 40-year period will be added to the declines computed in item 4. The well to be drilled under an approved permit becomes an existing well in considering

subsequent applications.

13. For modeling purposes only, a groundwater appropriation for irrigation purposes will be assumed to require a diversion requirement of 4.17 acre-feet per acre per annum. This is an estimated maximum diversion rate for irrigation in the basin based on an average consumptive irrigation requirement of 2.50 acre-feet per acre and an on farm irrigation efficiency of 0.60 (Wilson, 1993). Other diversion requirements, consumptive irrigation requirements, and irrigation efficiencies may be used as deemed reasonable (i.e. other information supplied by applicant may be considered). For the purpose of calculating conservative drawdown effects due to the use of new irrigation wells, it will be assumed that irrigation wells withdraw and deplete the total diversion requirement. For groundwater appropriations other than irrigation purposes groundwater depletions will be assumed to be equal to the diversion rate unless return flow credit has been approved by the State Engineer. Applications requesting return flow credit will not be granted unless the timing and quantification of flows back to the aquifer have been demonstrated.

14. As per item 13 above, a groundwater appropriation for irrigation purposes will be assumed to require a maximum diversion of 4.17 acre-feet per acre per annum. Requests to increase the diversion above this amount (stacking of water rights) will be prohibited unless the request has been deemed necessary by the state engineer. Stacking of water rights, if deemed necessary, will only be approved after proper application is made, advertising

has occurred, and the application has been deemed acceptable relative to the issues of impairment, conservation, and public welfare.

15. For applications to change point of diversion, or place or purpose of use; the maximum quantity of water continually consumptively used for beneficial use during the historical application shall be used as the amount which is available for consumptive use by the proposed transaction. For applications to transfer rights used for irrigation purposes, the average historical consumptive irrigation requirement will be maximum quantity available for transfer. If this transfer is to be applied for irrigation use, the diversion requirement will be established in accordance with criterion 13 above. If the transfer is from irrigation purposes to purposes other than irrigation, the diversion requirement for the move-to site will be the average historical consumptive irrigation requirement. Transfers within a critical block to the same block may be granted if other applicable criteria have been met.

16. Application for supplemental well(s) may be granted if applicable criteria have been met. Well(s) within a critical block may be supplemented by well(s) within the same block as allowed as follows: a) applications for supplemental well(s) for a declared water right may be approved, but only up to the amount historically beneficially used; b) application for supplemental well(s) for permitted water rights in good standing, may be approved for the total permitted water right.

17. The state engineer shall determine whether an application is contrary to the conservation of water in the state. Water conservation issues will be addressed on a case-by-case basis. Applications shall be reviewed to ensure the highest and best technology practically available will be utilized to ensure conservation of water to the maximum extent possible.

18. The state engineer shall determine whether an application is detrimental to the public welfare of the state. The state water planning process, statewide issues of concern, water quality issues, and information submitted by parties in a protested application, will be considered by the state engineer in making the public welfare determination.

19. Each application will be reviewed to determine whether the well may reasonably obtain the quantity of water sought. A determination of the availability of water from a particular point in the aquifer will be based on the transmissivity of the aquifer at that location, the proposed well casing diameter, the water column in the well and the freshwater thickness. In addition, it will be assumed that a well capacity of at least 6 gallons per minute will be required per irrigated acre and that an appropriation for other than irrigation purposes will be approved for a quantity not to exceed 60 percent of the well capacity, unless demonstrated by the applicant that a higher diversion percentage is appropriate.20. As new data become available, or as conditions warrant, the above criteria and model may be revised by the state engineer

to best achieve the administrative objectives.

APPROVED: Thomas C. Turney Date
State Engineer

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STANDARD CONDITIONS OF APPROVAL
FOR
APPLICATIONS FOR PERMIT TO APPROPRIATE
IN THE TULAROSA UNDERGROUND WATER BASIN

NOTE: These are minimum conditions of approval. Other conditions may be added as necessary to protect the impairment of existing rights, ensure that the permit is not contrary to conservation of waters within the State, nor is against the public welfare of the state.

1. **This permit shall not be exercised to the detriment of valid existing water rights, shall not be contrary to conservation of water within the state of New Mexico, and shall not be detrimental to the public welfare of the state of New Mexico.**

2. **The diversion of water from well no(s)._____shall not exceed_____acre-feet per annum for _____purposes. The consumptive use of the water diverted shall not exceed_____acre-feet per annum.**

3. **Well no(s)._____shall (each) be equipped with a totalizing meter(s) of a type and at a location approved by, and installed in a manner, acceptable to the State Engineer. The permittee shall provide in writing, the make, model, serial number, date of installation, initial reading, units, and dates of recalibration, of each meter, and any replacement meter, used to measure the diversion of water. No water shall be diverted from any well unless equipped with a functional totalizing meter.**

4. **Records of the amount of water diverted from well no(s)._____shall be submitted, in writing, to the State Engineer on or before the 10th day of the month for the preceding calendar month (or, on or before the 10th day of April, July, October, and January of each year for the three preceding calendar months; or, on or before the 10th day of January for the preceding calendar year).**

5. **A well record for well no(s). shall be filed with the State engineer within ten (10) days of drilling the well(s).**

6. **Proof of Completion of Well(s) shall be filed with the State Engineer on or before_____.**

7. **Proof of Application of Water to Beneficial Use shall be filed with the State Engineer on or before_____.**

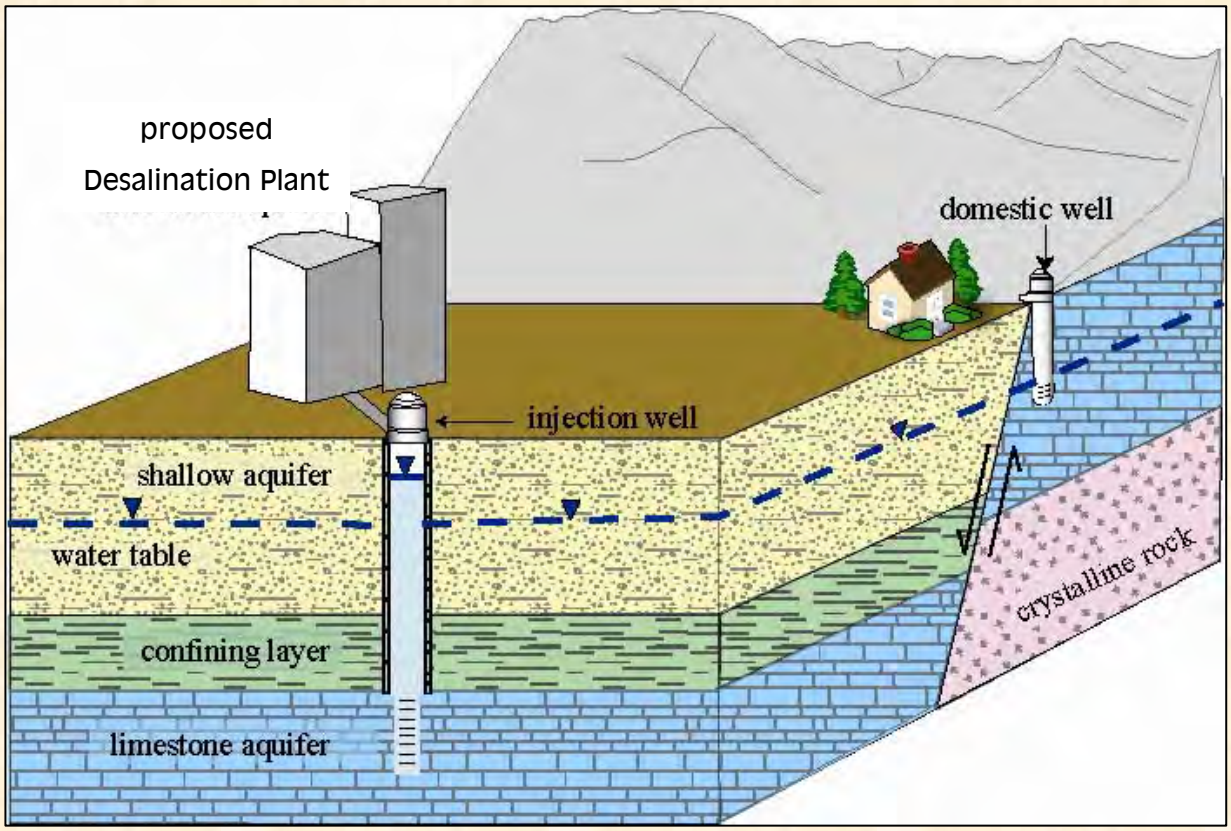
8. **Old well no(s)._____shall be plugged or capped in accordance with Article 4-14 of the Rules and Regulations Governing Drilling of Wells and Appropriation and Use of Ground Water in New Mexico. A written record of the plugging or capping shall be filed with the State Engineer within ten (10) days of the plugging or capping.**

9. **The water used under this permit shall utilize the highest and best technology practically available to ensure conservation of water to the maximum extent possible.**

APPENDIX J

Hydrogeology Technical Report

HYDROGEOLOGIC ASSESSMENT OF PROPOSED INJECTION WELLS FOR ALAMOGORDO REGIONAL WATER-SUPPLY PROJECT ALAMOGORDO, NEW MEXICO



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December 29, 2009

HYDROGEOLOGIC ASSESSMENT OF PROPOSED INJECTION WELLS FOR ALAMOGORDO REGIONAL WATER-SUPPLY PROJECT ALAMOGORDO, NEW MEXICO

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(follow text)

Figure 1. Regional map showing the study area.

Figure 2. Regional geologic map of the study area showing wells used on cross-section, Alamogordo Wastewater Treatment Plant, proposed Desalination Plant, and Alamogordo fault zone, Otero County, New Mexico.

Figure 3. West to east cross-section A-A' from Garton Well to the Sacramental Mountains, showing wells, geolologic features, and total dissolved solids (TDS) concentrations in groundwater in the vicinity of the proposed Desalination Plant.

Figure 4. Cross-section showing estimated injection well depths for Yeso Formation and Pennsylvanian-age units at the proposed Desalination Plant and the Wastewater Treatment Plant.

Figure 5. Proposed well completion for City of Alamogordo deep injection well.

HYDROGEOLOGIC ASSESSMENT OF PROPOSED INJECTION WELLS FOR THE ALAMOGORDO REGIONAL WATER SUPPLY PROJECT, ALAMOGORDO, NEW MEXICO

1.0 INTRODUCTION

The Alamogordo Regional Water Supply Project involves development of brackish groundwater for municipal supply. Brackish groundwater will be pumped from the Snake Tank Well Field, located north of Tularosa, and piped to the proposed Desalination Plant west of Alamogordo (Fig. 1). Deep-well injection is one of the logical alternatives for disposal of brine reject from the treatment plant. John Shomaker & Associates, Inc. (JSAI) was contracted by the City of Alamogordo (City) to assess the potential for deep-well injection of brine at the proposed Desalination Plant approximately 0.5 miles southwest of Alamogordo, New Mexico (Fig. 1). The City of Alamogordo Wastewater Treatment Plant (Alamogordo WTP) has been proposed as an alternative site for deep-well injection.

The New Mexico Office of the State Engineer (NMOSE) has agreed to issue a water rights permit to the City to divert an average of 4,000 acre-feet per year (ac-ft/yr) from the Snake Tank Well Field. Of this total diversion, approximately 80 percent with a target total dissolved solids (TDS) concentration of 800 milligrams per liter (mg/L) will be used for municipal supply, and 20 percent of the total diversion (800 ac-ft/yr) remaining as brine reject (Livingston and JSAI, 2006). Wells in the Snake Tank Well Field yield brackish groundwater with an average TDS concentration of 2,500 mg/L (Finch and Shomaker, 2006). Therefore, injected brine reject water will have an estimated TDS concentration of 9,300 mg/L.

Target injection zones should have TDS concentrations equal to or greater than that of the injected brine. Additionally, injection zones should be permeable enough to accommodate excess water and be separated from aquifers with fresher water by a confining layer. The purpose of this report is to evaluate the subsurface conditions at the City's proposed Desalination Plant and at the Alamogordo WTP to determine whether or not geologic conditions for deep-well injection exist.

2.0 DATA SOURCES

Much of the supporting data and analyses for this study were compiled during the Deep Well Study conducted for the City in November 2008 (Samuels and Finch, 2008). Data used in that study included geologic maps, oil- and gas-well logs, water-well logs, geologic reports, and academic literature. Reports on bedrock units in the study area by Pray (1961), McLean (1970), King and Harder (1985), Reynolds (1986), Finch (2005), and Finch and Shomaker (2006) were of particular importance.

3.0 HYDROGEOLOGIC SETTING

The study area is located in the Tularosa Basin, west of the Sacramento Mountains (Fig. 3). The Sacramento Mountains were uplifted during Tertiary-age Basin and Range extension. The same tectonic event formed the Tularosa Basin, which is separated from the mountains by the Alamogordo fault zone (Fig. 2). The Jarilla Fault parallels the Alamogordo fault zone in the center of the Tularosa Basin (Fig. 2). The Jarilla Fault lowered rocks along the western side and uplifted the same bedrock units along the eastern side, dividing the Tularosa Basin into two troughs (half grabens).

During mountain uplift, the eastern trough of the Basin (Alamogordo sub-basin) was filled with eroded sediments that can be more than 3,000 ft thick (Koning et al., 2006). Test well drilling at the Tularosa Basin National Desalination Research Facility (TBNDRF) (located adjacent to the proposed injection well site) has shown the basin-fill thickness to be 1,970 ft. The basin-fill thickness in the Alamogordo sub-basin, west of Alamogordo, is approximately 1,000 ft less than previous estimates by Reynolds (1986), but matches closely with McLean (1970). Also confirmed by drilling, older rocks that crop out on the east side of the Alamogordo fault zone and along the Jarilla Fault are present in the subsurface in the Alamogordo sub-basin.

Several geologic units, from Quaternary-age (less than 2.6 million years old) basin fill to Precambrian-age (more than 542 million years old) crystalline rocks, are present at depth in the study area. Table 1 summarizes bedrock units in the study area.

Table 1. Bedrock units in the northern and eastern Tularosa Basin and Sacramento Mountains, Otero County, New Mexico

age	symbol	stratigraphic unit	estimated thickness (ft)	description	water-bearing potential	water quality (TDS, mg/L)
Tertiary-Quaternary	TQal	basin fill	up to 4,000[1]			
Permian	Pg	Grayburg	1,148	fine-grained quartz sandstone and siltstone with minor gypsum	5± gpm[2]	
	Psg	San Andres and Glorieta	100-1,100	limestone and dolomite	8-2,000 gpm[2]; principal aquifer of Sacramento Mountains[4]	1,100-2,100[4]
	Py	Yeso	1,050-1,246	sandstone, siltstone, limestone, dolomite, shale, and gypsum	< 10 to 1,000 gpm in northern part of the Tularosa Basin; enhanced in fractured limestone and dolomite[3]	1,100[1]; 1,522-6,000[4]; 260,000[5]
Permian	Pa	Abo	300 to 400	reddish-brown mudstone and arkosic sandstone	potential confining unit6	
	Pbm	Bursum	< 3 to 350	carbonate shale with abrupt facies change to red beds	potential yield unknown3	

[1] Koning et al., 2006
[2] Mourant, 1963
[3] Livingston and JSAI, 2002
[4] Rawling et al., 2007
[5] Melis and Peery, 2008
[6] Becker et al., 1981
[7] Trauger, 1972
[8] Pray, 1961

TDS – total dissolved solids
mg/L – milligrams per liter
gpm – gallons per minute

Table 1. Bedrock units in the northern and eastern Tularosa Basin and Sacramento Mountains, Otero County, New Mexico (continued)

age	symbol	stratigraphic unit	estimated thickness (ft)	description	water-bearing potential	water quality (TDS, mg/L)
Pennsylvanian	ℙh	Holder	50-75	limestone conglomerate, limestone, sandstone, shale	good production in fractured areas; High Rolls wells average between 35 and 50 gpm[3]	
	ℙb	Beeman	350-500	thin-bedded argillaceous limestone interbedded with calcareous shale		
	ℙg	Gobbler	1,200-1,600	the lower 200-500 ft consists of well-sorted quartz sandstone and dark limestone with chert masses.	good production in fractured areas; High Rolls wells average between 35 and 50 gpm[3]	
Mississippian	Mr	Rancheria	0-300	succession of thin-bedded, silty limestone, siltstone, and thin-bedded shale between limestone beds	potential confining unit	
	Mlv	Lake Valley	0-400	limestone, minor calcareous siltstone, and calcareous shale	locally water-bearing in Grant County, NM with yields up to 150 gpm[7]	

[1] Koning et al., 2006
[2] Mourant, 1963
[3] Livingston and JSAI, 2002
[4] Rawling et al., 2007
[5] Melis and Peery, 2008
[6] Becker et al., 1981
[7] Trauger, 1972
[8] Pray, 1961

TDS – total dissolved solids
mg/L – milligrams per liter
gpm – gallons per minute

Table 1. Bedrock units in the northern and eastern Tularosa Basin and Sacramento Mountains, Otero County, New Mexico (concluded)

age	symbol	stratigraphic unit	estimated thickness (ft)	description	water-bearing potential	water quality (TDS, mg/L)
Devonian	D	Oñate		silty dolomitic sandstone to fine-grained quartz sandstone		
		Sly Gap	<100	gray calcareous shale interbedded with nodular limestone and minor black shale		
		Percha		fissile, non-calcareous shale	potential confining unit	
Silurian	S	Fusselman	70-100	dark-weathering cherty limestone	yields up to 5 gpm in Grant County wells[7]	
Ordovician	Ov	Valmont	150-190	finely-crystalline dolomite with minor chert along the base		
	Om	Montoya	190-225	crystalline and cherty dolomite; the base of this unit is marked by massive sandstone and sandy dolomite	yields up to 50 gpm in Grant County[7]	
	Oe	El Paso	430	dolomite, minor sandy dolomite, and dolomitic quartz sandstone	Grant County wells have yields up to 200 gpm locally[7]	
Cambro-Ordovician	Ꞓ-Ob	Bliss Sandstone	110	quartz sandstone with minor dolomitic sandstone and sandy dolomite	not water-bearing in Grant County[7]	
Precambrian	PꞒ	undivided		igneous and metamorphic rocks		

[1] Koning et al., 2006
[2] Mourant, 1963
[3] Livingston and JSAI, 2002
[4] Rawling et al., 2007
[5] Melis and Peery, 2008
[6] Becker et al., 1981
[7] Trauger, 1972
[8] Pray, 1961

TDS – total dissolved solids
mg/L – milligrams per liter
gpm – gallons per minute

3.1 Tertiary-Quaternary Basin Fill

Tertiary- to Quaternary-age basin fill is thickest west of the Alamogordo fault zone, where the half graben forming the Alamogordo sub-basin has been down-dropped the most (Fig. 3). The basin fill thins westward towards the Jarilla Fault, where bedrock has been uplifted. The thickness of basin fill is approximately 1,400 ft at the Wastewater Treatment Plant, and 1,970 ft at the proposed Desalination Plant. The basin fill typically is coarser grained at the mountain front, and decreases in grain size toward the basin center and with respect to depth (Finch and Shomaker, 2006).

The deep basin fill is not capped by a distinct continuous layer that separates it from the shallower aquifer, so basin fill should not be used as a target injection zone. Although the basin fill is not an attractive target for injecting brines, several intervals within the lower sections of the basin fill are predominantly clay, which would prevent brines injected into formations below the basin fill from mixing with relatively fresh, shallower groundwater in the basin fill.

Lithologic and geophysical logs, water-quality tests, and grain-size analysis from TBNDRF Test Well T-4428 provide excellent data for characterizing the basin fill beneath the proposed Desalination Plant on Lavelle Road. A summary of the data from Test Well T-4428 can be referenced from Table 2. Of particular importance is the contrast in TDS between the basin fill and underlying fractured limestone.

Table 2. Summary of borehole lithology and water quality from TBNDRF Test Well T-4428

interval	description	TDS (mg/L)
0 to 600	sand with alternating layers of silt and clay	3,800 to 6,700
600 to 1,060	silty clay	too clayey, not sampled
1,060 to 1,370	silty sand	1,100
1,370 to 1,685	silty clay	too clayey, not sampled
1,685 to 1,885	sand with alternating layers of silt and clay	1,600
1,885 to 1,970	clayey silt, very dense	1,600(?)
1,970 to 2,085	fractured limestone	9,400

TBNDRF – Tularosa Basin National Desalination Research Facility
TDS – total dissolved solids
mg/L – milligrams per liter

3.2 Permian-Age Rocks

The Permian-age San Andres and Yeso Formations are the thickest and most productive bedrock units in the Sacramento Mountains. These units are typically found in outcrop in the Sacramento Mountains. Only the Yeso Formation and older rocks are reported to be present in the subsurface west of the Alamogordo fault zone (Fig. 3). The contact between the Yeso and the underlying Abo Formation is gradational, but it is distinguished by a lithologic shift from the Yeso's gypsum, gray shale, and gray-to-yellowish limestone to the Abo's characteristic reddish-brown shales, mudstones, calcareous siltstone, and sandstone (Pray, 1961). In general, the lower section of the Yeso contains more shale and gypsum, and the upper section contains more limestone.

The thickness and stratigraphy (measured type sections) of the Yeso Formation has been described in detail by Pray (1961). The total thickness of the Yeso Formation near Alamogordo is approximately 1,250 ft. The Yeso Formation consists of alternating layers, with varying thickness, of limestone, shale, sandstone, and gypsum. Several of the shale layers are red in color ("red beds") and provide as markers in the stratigraphic column. There are three groups of shale packages in the Yeso Formation that could act as confining units:

1. Shale A: 50 ft of shale and siltstone located approximately 150 ft below the top of the formation.
2. Shale B: 100 ft of shale with "red beds" located approximately 450 ft below the top of the formation.
3. Shale C: 200 ft of shale, "red beds," and limestone located approximately 750 ft below the top of the formation.

West of Alamogordo, deep wells have been drilled though the basin fill and into the Permian-age rocks. The Garton Well (T18S, R8E, Section 5) was drilled through 686 ft of basin fill and 206 ft of shale and cavernous limestone to a total depth of 892 feet below ground level (ft bgl). The Garton Well was artesian, and flowed 1,100 gpm of saline groundwater (McLean, 1970). The test well drilled at the TBNDRF (Test Well T-4428) penetrated 1,970 ft of basin fill and 115 ft of fractured limestone. Both of these wells are believed to be drilled into the top of the Yeso Formation that is containing thick sequences of limestone, but the exact location in the stratigraphic column is unknown. Approximately 20 miles south of Alamogordo, the Plymouth No. 1 Federal oil and gas test well drilled through approximately 600 ft of Yeso Formation, suggesting more than one half of the formation had been eroded prior to deposition of basin fill.

The estimated depth to the top of the Yeso Formation at the Wastewater Treatment Plant is 1,400 ft (Fig. 3).

The Abo Formation underlies the Yeso Formation, and is 200 to 300 ft of shaley red beds. The Abo Formation is largely considered a confining layer for the underlying Pennsylvanian-age rocks.

3.3 Pennsylvanian-Age Rocks

Some Pennsylvanian-age rocks, found on the western side of the Sacramento Mountains and in the eastern Tularosa Basin (McLean, 1970; King and Harder, 1985), have been shown to be sufficiently permeable to transmit groundwater. Pennsylvanian-age Holder and Gobbler Formations are the water-bearing units for domestic wells in the High Rolls area. These wells yield 1 gpm (NMOSE WATERS database) to 50 gpm (Livingston Associates and JSAI, 2002). Water flow in these rocks is typically controlled by fractures.

Total thickness of Pennsylvanian-age rocks can exceed 1,000 ft (Table 1). During the Pennsylvanian period, tectonic instability led to highly localized depositional environments, which are preserved in the rock record as lateral and vertical facies changes (Pray, 1961). As a result, upper and lower contacts between each Pennsylvanian-age rock unit may be difficult to distinguish based on lithology. The contacts for overlying Permian-age rocks and underlying Mississippian-age rocks should be easy to distinguish from well logs.

Depth to Pennsylvanian-age rocks is estimated to be 3,300 ft at the proposed Desalination Plant on LaVelle Road, and 2,800 ft at the Wastewater Treatment Plant.

3.4 Older Rocks

Older Paleozoic-age rocks typically crop out along the Sacramento Mountains escarpment south of Alamogordo (Fig. 2), and are present in the subsurface south of Three Rivers and west of the Sacramento Mountains crest (King and Harder, 1985). The Mississippian-age Rancheria and Lake Valley Formations are made up of siltstone and shale layers, which are thought to be confining units. Devonian-age rocks in this area consist of three shales, which have a total thickness of less than 100 ft. The Silurian-age Fusselman Formation ranges from 70 to 100 ft thick (Table 1). This unit consists of cherty and may be permeable in fracture zones. South of the Sacramento Mountains (Otero Mesa and Diablo Plateau), oil and gas drilling into the Fusselman Formation has encountered brackish water in karst features. The Fusselman Formation is also the primary reservoir used by El Paso Water Utilities for deep-well injection of brine water from its Desalination Plant. The three Ordovician-age units consist of sandy dolomite to finely-crystalline dolomite. Although dolomite is not porous, it is brittle, and fractures may increase the permeability of these units. The Bliss Sandstone consists of quartz sandstone with minor amounts of dolomite.

4.0 GROUNDWATER QUALITY

Groundwater quality in deep formations can vary significantly, depending on the quality of recharge water, presence of soluble salts in the formation, and flow rates through the rocks. Analyses of spring and well water show that groundwater quality in the western Sacramento Mountains varies locally, and is likely influenced by geology. Therefore, some inference about water quality in deep geologic formations can be made based on near-surface samples from the same geologic units in areas of recharge (mountains) and areas of discharge (basin center).

4.1 Basin Fill

The lateral and vertical water-quality distribution has been extensively mapped by McLean (1970), and illustrated on Figure 3. In general, salinity increases from east to west and with respect to depth. Most wells located west and southwest of Alamogordo in Range 8 East yield saline groundwater with TDS greater than 10,000 mg/L (McLean, 1970).

Data from test wells drilled at TBNDRF can be used to characterize water quality in the basin fill near the proposed Desalination Plant. TDS concentrations in Test Well T-4428 do not increase systematically with depth. Instead, TDS concentrations in the basin fill are elevated between 3,800 and 6,700 mg/L near the water table, and lower (1,100 mg/L) in a sandy layer at 1,200 ft depth (Table 2; Fig. 3). Water with elevated TDS concentrations (9,400 mg/L) was identified in the Yeso Formation, near the basin fill - bedrock contact.

Shallow groundwater at the Wastewater Treatment Plant has a TDS range of 12,000 to 38,000 mg/L (Finch, 2000). Very little is known about the change in TDS with respect to depth at the Wastewater Treatment Plant. Although, according to McLean (1970), TDS concentrations in this area increase with depth, ranging from 3,000 to 10,000 mg/L from the water table to an approximate depth of 900 ft, and from 10,000 to 35,000 mg/L at depth below 900 ft.

4.2 Permian-Age Rocks

In the Yeso Formation, water quality varies between 1,000 mg/L TDS at the point of recharge in the Sacramento Mountains, to 10,000 mg/L TDS at the point of discharge in the Tularosa Basin along the Jarilla Fault (Fig. 2). In Test Well T-4428, the top portion of the Yeso Formation produced water with TDS concentrations of 9,400 mg/L (Fig. 3).

A deep well drilled near Cloudcroft (well PN-409-S-6) encountered a pocket of highly-saline groundwater (260,000 mg/L) in the lower section of the Yeso Formation (Street and Peery, 2007).

4.3 Older Paleozoic-age Rocks

No water samples are available for older Paleozoic-age rocks (Pennsylvanian to Precambrian) at depth in the Sacramento Mountains or Tularosa Basin. (McLean (1970) has inferred from geophysical logs from oil and gas test wells, which the TDS content in these older rocks may exceed 35,000 mg/L, where soluble salts are present in geologic units. The groundwater quality probably improves near outcrops and along the Alamogordo fault zone where deep percolation of recharge may occur.

5.0 DEEP GROUNDWATER FLOW PATHS

Groundwater in Paleozoic-age bedrock deep in the Alamogordo sub-basin is part of a large, deep, flow system rather than an isolated storage reservoir. In the case of the isolated storage reservoir, the groundwater storage volume is limited and salinity can be extreme. In the study area, groundwater follows a deep flow path through bedrock units from the Sacramento Mountains to the Jarilla Fault zone along the center of the Tularosa Basin. This was first identified by Meinzer and Hare (1915), and explained by Reynolds (1986) where he stated:

> "Examination of the records of the oil tests drilled along the Jarilla block shows that many of them had large flows of water during drillstem tests of pre-Tertiary rocks. …..There is also a considerable group of mound springs, both active and extinct, in T10S, R6E, New Mexico, in line with the north end of the Jarilla block. Meinzer and Hare (1915, p. 53) concluded that the spring water is under artesian pressure and comes from a comparatively deep source. …..there may be three separate hydrologic systems in the Tularosa basin: (1) normal groundwater conditions in the Upper Unit of the QT, (2) under-pressured formation water in the Lower Unit of the QT and (3) artesian water, probable moving through fracture systems, in the pre-Tertiary rocks. For these to be separate hydrologic systems, it would seem to be necessary that both the Middle Unit and the postulated basal unit of the QT be membranes or aquitards."

A fraction of the precipitation that falls on the Sacramento Mountains west of Cloudcroft becomes groundwater recharge and flows west across bedding planes and the Alamogordo fault zone, recharging Alamogordo-area groundwater resources (Finch and Shomaker, 2006; Rawling et al., 2008). Groundwater that originates in the Sacramento Mountains and recharges the basin fill, flows toward the basin center, and evaporates along the Jarilla Fault where basin fill thins and the water table intersects the land surface (Finch and Shomaker, 2006). The presence of artesian conditions in the Yeso Formation at the Garton Well suggests upward flow from a deep regional groundwater-flow path originating in the Sacramento Mountains. It is likely that this flow path discharges on the west side of the Jarilla Fault into the western half of the Tularosa Basin (Fig. 2). Shallow groundwater along the Jarilla Fault, and west of, is typically saline, with TDS content greater than 10,000 mg/L.

6.0 TARGET FORMATIONS

The suitability of target geologic formations for a deep injection well depends on four main factors:

1) water quality (TDS > 10,000 mg/L)
2) favorable hydraulic properties (transmissivity and storage capacity) of the target formation
3) the presence of a confining layer above the target formation
4) reasonable depth to target formation

The proposed wells will likely be classified by the New Mexico Environment Department (NMED) as Class I non-hazardous waste injection wells. The NMED may allow Class I non-hazardous waste injection wells to be completed in formations (injection zone) containing TDS concentration between 5,000 and 10,000 mg/L, provided that 1) it is not currently used as a domestic or agricultural water supply, and 2) there is no reasonable relationship between the economic and social costs of failure to designate its use as a domestic or agricultural water supply.

TDS concentrations in the target injection zone must be elevated so injected brine does not degrade the existing groundwater resource. Confining layers (e.g., shale) that separate the target injection zone from shallower aquifers also serve to protect relatively fresh groundwater resources. Existing data support the possibility of achieving the factors mentioned above at the proposed Desalination Plant on LaVelle Road or the Wastewater Treatment Plant.

As observed at the TBNDRF, the 85-ft-thick silty-clay layer at the bottom of the basin fill acts as a confining layer overlying the Yeso Formation. Drilling into the Yeso and using a sequence of shale layers as the primary confining zone, and the 85-ft-thick silty-clay layer as a secondary confining zone, would be the most protective of groundwater (Fig. 4). A borehole would need to be drilled through the entire Yeso Formation to determine if the Yeso Formation contains a confining unit with a viable underlying permeable zone for injection of brine reject water. Drilling to a depth of 3,000 ft would be required at the proposed Desalination Plant, and to a depth of 2,500 ft at the Wastewater Treatment Plant. Test borehole depths of approximately 4,000 ft or greater would be required to examine the Abo and Pennsylvanian-age Formations for confining layers and injection zones (Fig. 4).

6.1 Capacity Analysis

The capacity of proposed injection wells would depend on the hydraulic conductivity and thickness of the formation tapped by the well. Average hydraulic conductivity of the Yeso Formation in the Sacramento Mountains ranges from 0.007 to 7.0 ft/day (Finch and Shomaker, 2006), but hydraulic conductivity values could be an order of magnitude higher in fracture and karsts zones, such as observed at the Garton Well.

Required injection well capacity would be near 300 gpm, assuming two injection wells and a maximum average rate of 800 ac-ft/yr of brine reject. An average hydraulic conductivity greater than 1.0 ft/day would be required for a 300-gpm injection well with a 500-ft-thick target formation. This required average hydraulic conductivity is within the range of known values for the Yeso Formation.

6.2 Well Construction

The NMED regulations for a Class I non-hazardous injection well require the well to be constructed with annular seals and casing, similar to that shown on Figure 5. Considering the target injection rate of 300 to 600 gpm, the well will need to be large enough diameter to accommodate a 6-inch educator pipe.

7.0 FINDINGS

As confirmed by drilling in the region, suitable bedrock confining units and injection zones are found at depth at both the proposed Desalination Plant and the Wastewater Treatment Plant. At the proposed Desalination Plant, these units are found approximately 2,000 to 4,000 ft bgl and are overlain by approximately 1,970 ft of basin fill (Fig. 4). Logs from Test Well T-4428 document 75 ft of clay directly overlying the Yeso Formation at this site (Finch, 2005).

The basin fill is approximately 1,400 ft thick at the Wastewater Treatment Plant (Fig. 3), and the changes in lithology with respect to depth are largely unknown but expected to be fine grained. It is possible that deeper formations at the Wastewater Treatment Plant site may be slightly artesian, as observed at the Garton Well farther west.

There appears to be a deep groundwater-flow path in the Yeso Formation that originates at the Sacramento Mountains and discharges along the center of the basin near the Jarilla Fault. The results from the Garton Well suggest the deep groundwater system has a good permeability, and contains saline groundwater.

The City of El Paso has successfully drilled, constructed, and operated deep injection wells for brine disposal produced during the desalination process at its facility located on the southern end of the Tularosa Basin approximately 60 miles south of Alamogordo on the New Mexico-Texas state line (Kelsch et al., 2007). The subsurface geology near Alamogordo appears to be as favorable as that found at the El Paso site, making it likely that injecting brine west of the City could be as successful in southern New Mexico as it is on the Texas side of the state line.

In summary, the hydrogeologic assessment resulted in the following conclusions:

- The proposed Desalination Plant and the Wastewater Treatment Plant sites have hydrogeologic conditions suitable for construction of successful brine reject injection well(s).
- A test well is required to confirm the thickness and characteristics of the target formations at both sites.
- Injection wells at the Wastewater Treatment Plant site would likely be shallower than at the proposed Desalination Plant site.
- The potential for receptors of fugitive injected brine is greater at the proposed Desalination Plant than at the Wastewater Treatment Plant.

8.0 RECOMMENDATIONS

The hydrogeologic assessment presented above only confirms there are potential formations for deep well injection of brine reject, and the hydrogeologic conditions are favorable for deep well injection. Additional testing and analysis would be required to determine the actual feasibility of installing injection well(s). At a minimum, the recommended additional analyses would include the following:

- Drill a 4,000-ft test well at the Wastewater Treatment Plant site or a 4,000-ft test well at the proposed Desalination Plant to characterize lithology and salinity of basin fill and underlying bedrock formations. The information from the test well could be used to determine which of the two sites is most favorable for deep well injection of brine reject from the Desalination Plant.
- Existing information from the TBNDRF and new data from the proposed WTP test well could be used to make a final determination for permitting and construction of deep well injection wells.
- A detailed hydraulic analysis, such as groundwater-flow modeling of confining layers and injection zones, will likely be required for permitting injection wells with the NMED.

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ILLUSTRATIONS

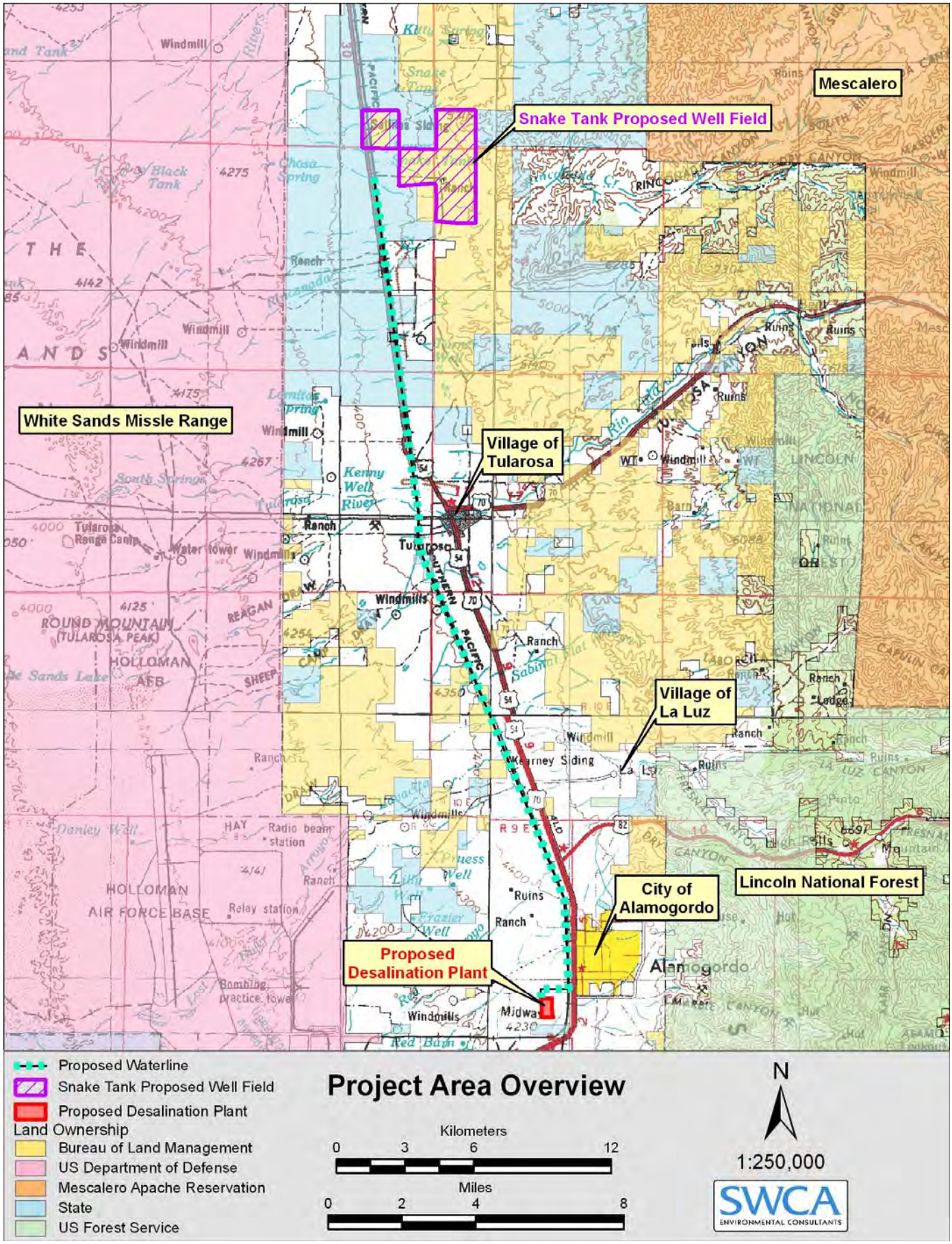
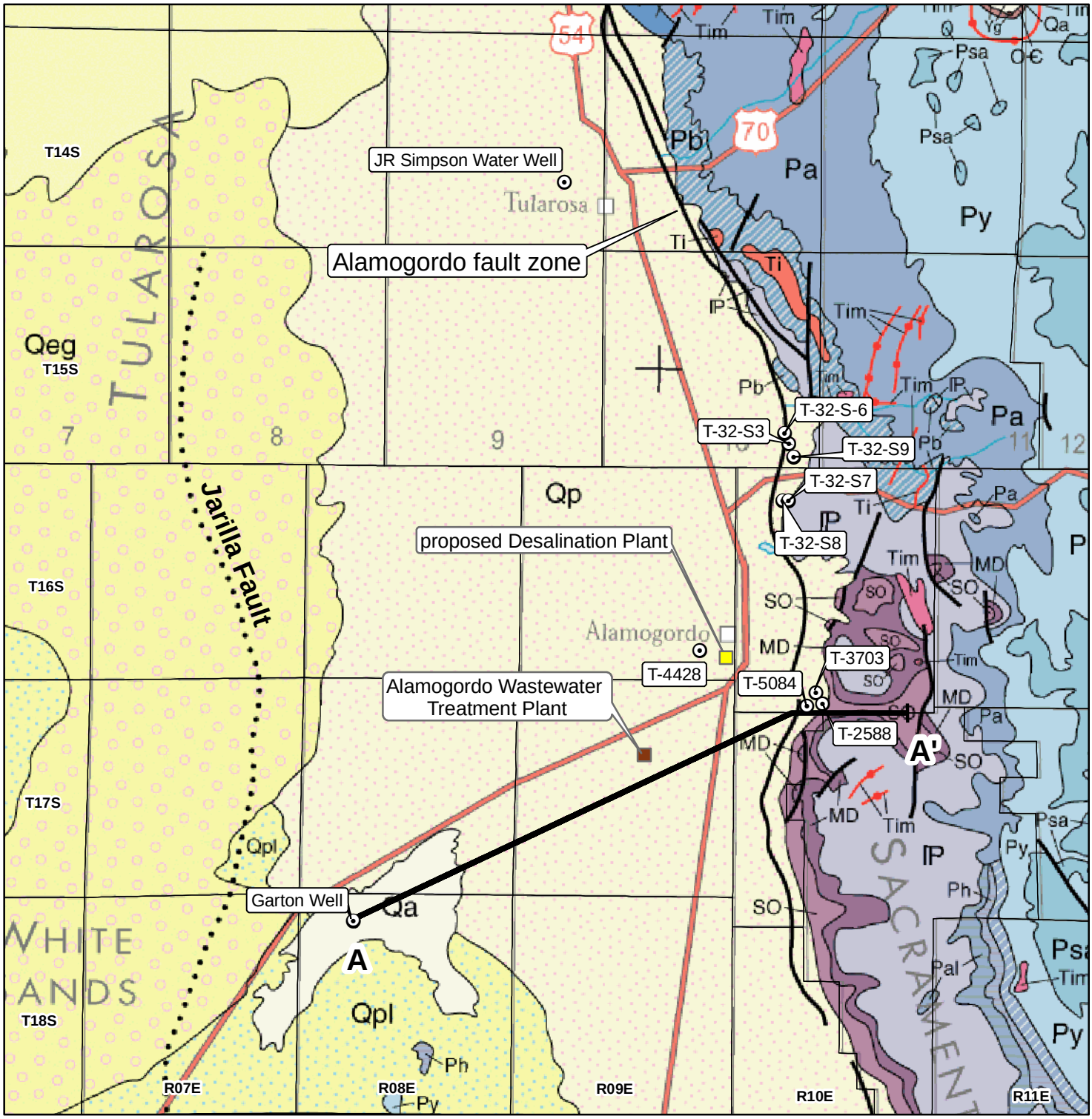


Figure 1. Regional map showing the study area.



Geologic map source: New Mexico Bureau of Geology and Mineral Resources, 2003, Geologic Map of New Mexico, 1:500,000.

Explanation

⊙ well

line of section

For explanation of map units, see Table 1.

Figure 2. Regional geologic map of the study area showing wells used on cross-section, Alamogordo Wastewater Treatment Plant, proposed Desalination Plant, and Alamogordo fault zone, Otero County, New Mexico.

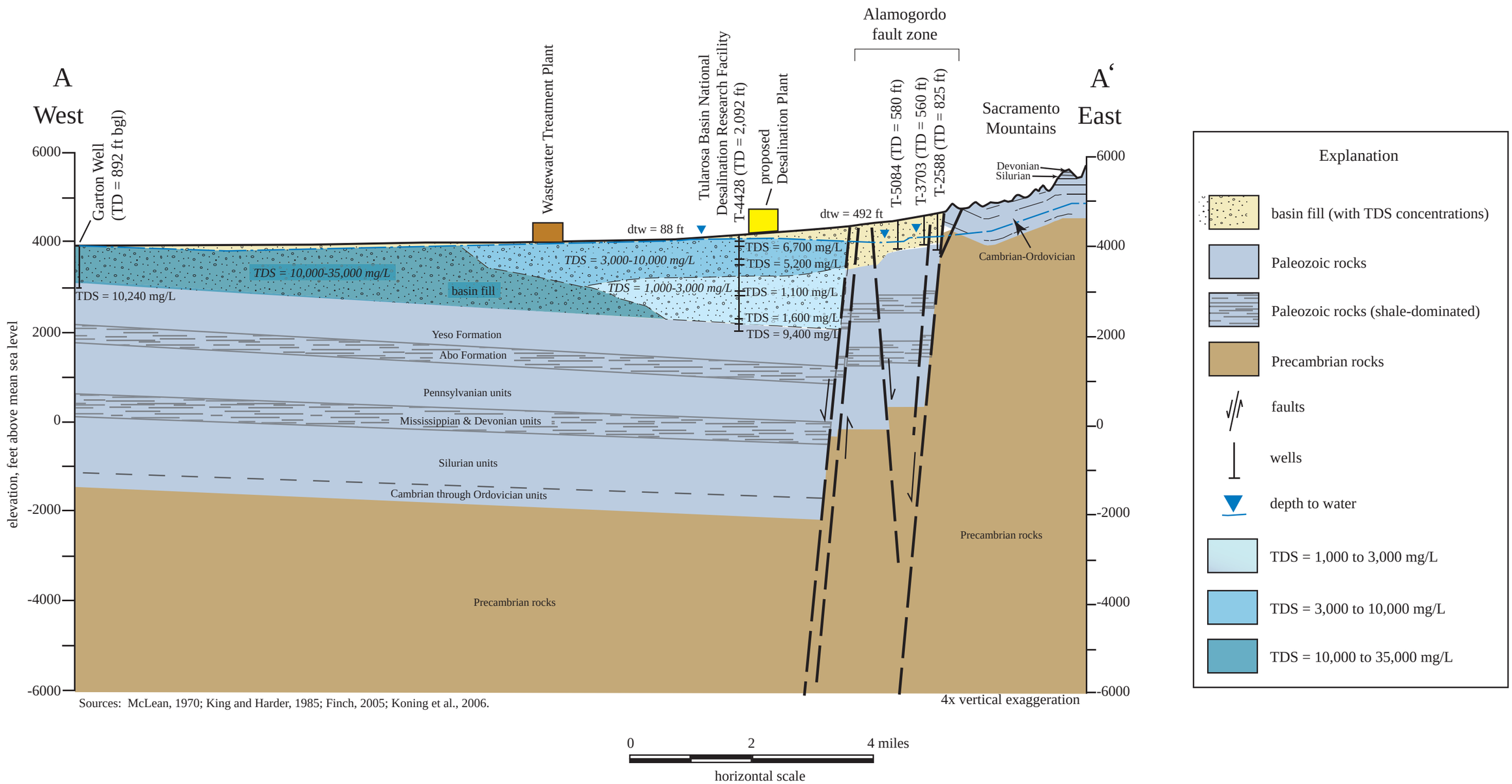


Figure 3. West-to-east cross-section A-A' from Garton Well to the Sacramento Mountains, showing wells, geolologic features, and total dissolved solids (TDS) concentrations in groundwater in the vicinity of the proposed Desalination Plant.

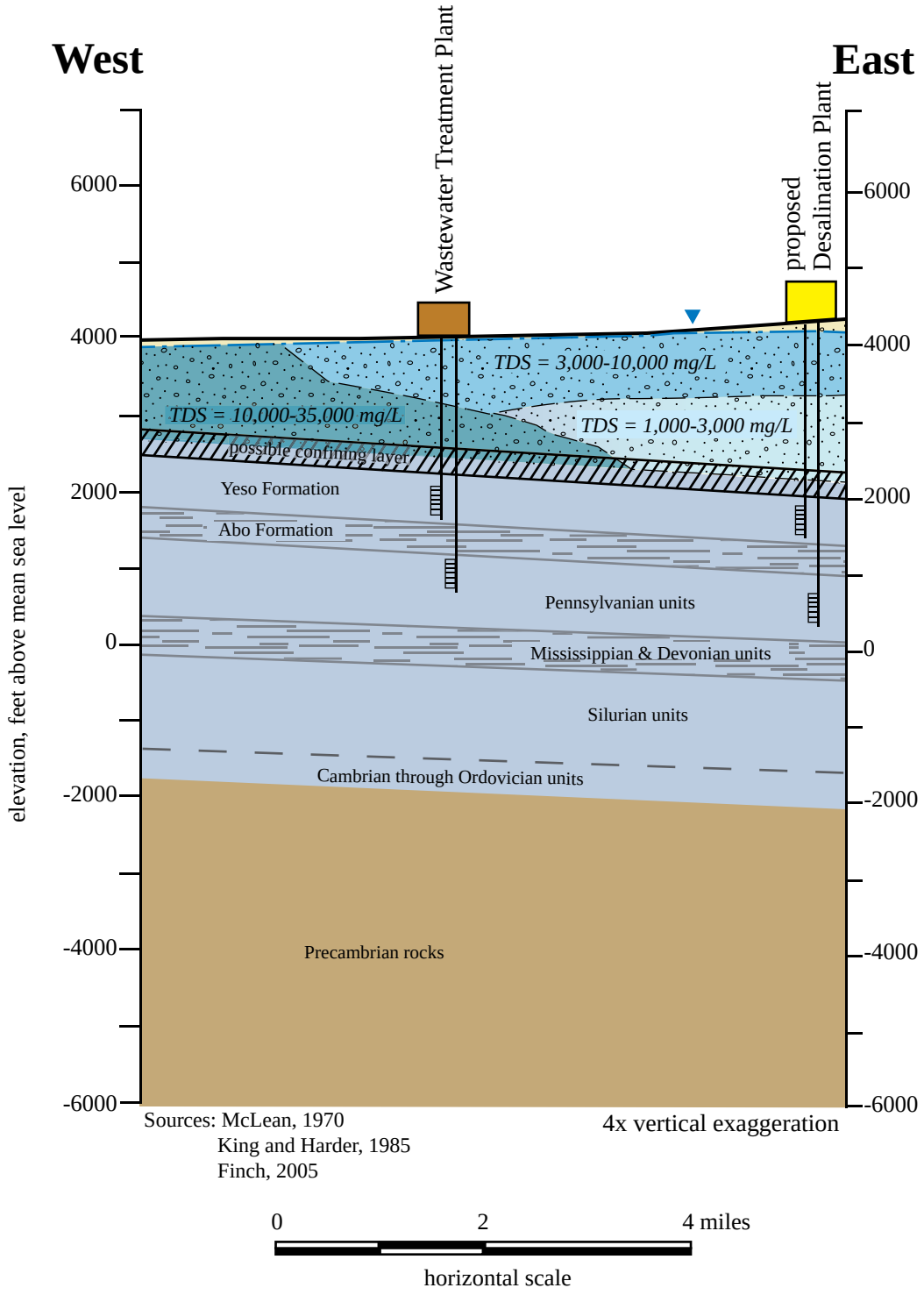


Figure 4. Cross-section showing estimated injection well depths for Yeso Formation and Pennsylvanian-age units at the proposed Desalination Plant and the Wastewater Treatment Plant.

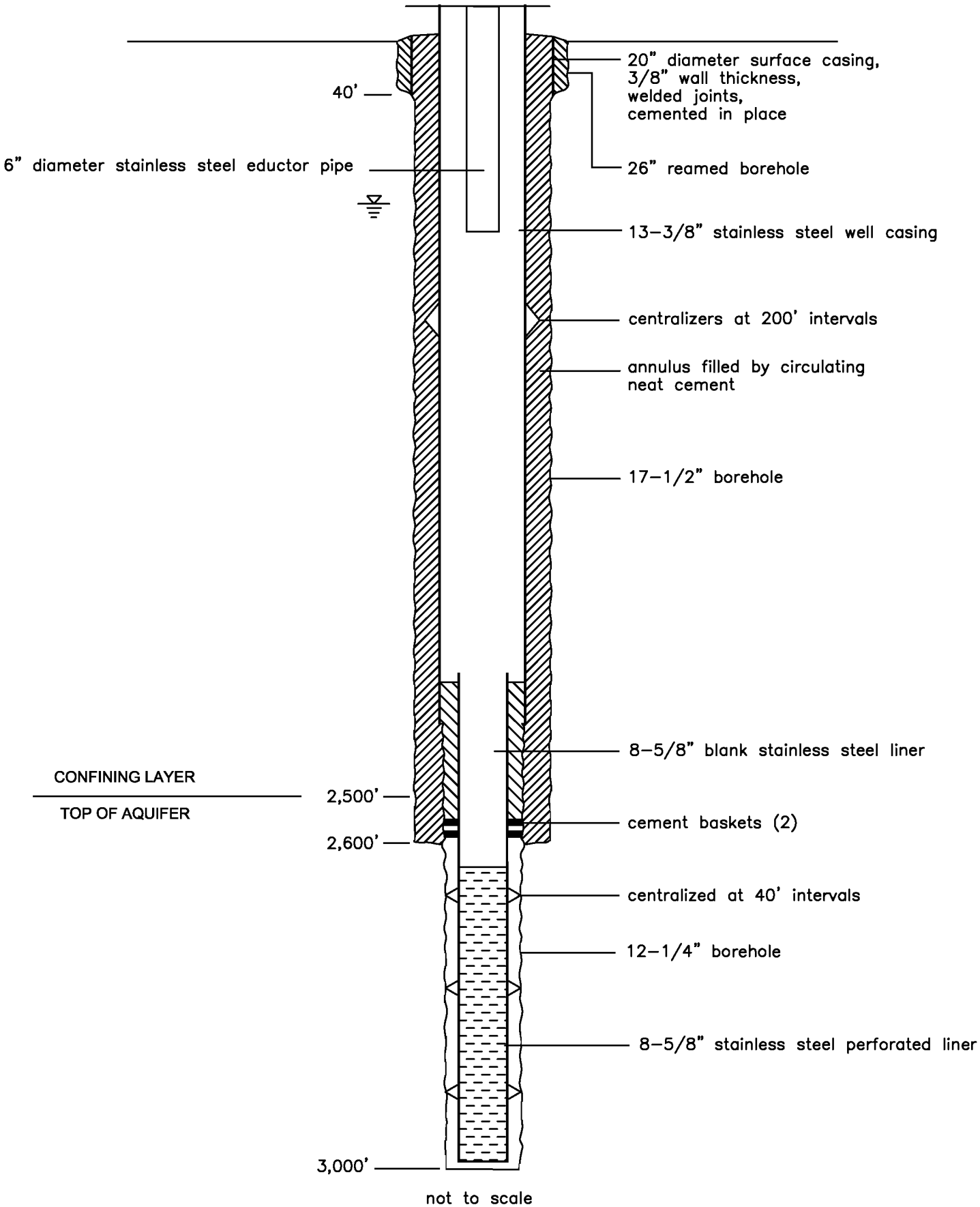


Figure 5. Possible well completion for City of Alamogordo deep injection well.

APPENDIX K

Affected Environment Information by Resource

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

Soil types located within the project area

Soil Type	NRCS Symbol	Location With Respect to Proposed Project	Length/Area of Project Intersect per Soil Type	
			Miles[1]	*Acres*[2]
Alamogordo-Aztec complex, 1 to 3 percent slopes	AdB[4]	Main waterline from well field to Alamogordo	1.68	10.18
		Desalination facility	—	33.0
Alamogordo-Gypsum land complex, 0 to 5 percent slopes	AEC[4]	Main waterline from well field to Alamogordo	2.64	16.0
		Well field waterlines[1]	7.32	44.36
		Well pads[1]	—	14.0
Alamogordo-McCullough sandy loams, hummocky, 0 to 3 percent	AhB[4]	Main waterline from well field to Alamogordo	0.11	0.66
Alamogordo variant, very fine sandy loam, 0-1 percent	AkA	Desalination facility	—	40.0
Aztec-Alamogordo complex, hummocky, 1 to 3 percent slopes	AoB[4]	Main waterline from well field to Alamogordo	0.89	5.39
Dumps	DUMP	Desalination facility	—	22.0
Gullied land	Gu	Main waterline from well field to Alamogordo	0.09	0.54
Largo silt loam, 0 to 1 percent slopes	LdA[4]	Main waterline from well field to Alamogordo	0.77	4.66
Largo silt loam, 0 to 3 percent slopes	LDB[4]	Main waterline from well field to Alamogordo	6.30	38.10
Largo silt loam, 1 to 3 percent slopes	LdB[4]	Main waterline from well field to Alamogordo	0.19	1.15
Largo very fine sandy loam, thick surface, 0 to 1 percent slopes	LcA[4]	Main waterline from well field to Alamogordo	0.95	5.75
McCullough sandy loam, 1 to 3 percent slopes	McB[4]	Main waterline from well field to Alamogordo	0.63	3.81
McCullough variant very fine sandy loam, 0 to 1 percent slop	MdA[4]	Main waterline from well field to Alamogordo	0.24	1.45
Prelo fine sandy loam, 0 to 1 percent slopes	PlA[4]	Main waterline from well field to Alamogordo	1.49	9.03
Prelo sandy loam, hummocky, 0 to 1 percent slopes	PkA[4]	Main waterline from well field to Alamogordo	0.93	5.63
Prelo silt loam, 0 to 1 percent slopes	PmA[3,4]	Main waterline from well field to Alamogordo	0.62	3.75
Prelo silt loam, 1 to 3 percent slopes	PmB[4]	Main waterline from well field to Alamogordo	0.83	5.03
		Desalination facility	—	4.0
Prelo silt loam, 1 to 3 percent slopes, eroded	PmB2[4]	Main waterline from well field to Alamogordo	0.23	1.39
Prelo silt loam, hummocky, 0 to 1 percent slopes	PnA[4]	Main waterline from well field to Alamogordo	2.29	13.87
Riverwash	Rw[4]	Main waterline from well field to Alamogordo	0.06	0.36
Tome silt loam, 0 to 5 percent slopes	TDB[4]	Main waterline from well field to Alamogordo	2.42	14.66
		Well field waterlines	1.37	8.30
		Well pads	—	6.0
Tome-Emot complex, 0 to 3 percent slopes	TfB[4]	Main waterline from well field to Alamogordo	0.16	0.96
Torrifluvents, hummocky	TvA[4]	Main waterline from well field to Alamogordo	0.26	1.57
Total	—	—	**32.47**	**315.60**

1 - Length includes all of the below ground waterlines, but does not include temporary disturbance associated trenching and installation activities.

2 - Acreage includes the area surveyed at the desalination plant and evaporation pond, well pad, and waterline sites. Total permanent ground disturbance would be significantly less.

3 - Prime farmland, if irrigated

4 - Highly erodible

All of the following soil descriptions were excerpted from *Soil Survey of the Otero Area, New Mexico, Parts of Otero, Eddy, and Chaves Counties* (U.S. Department of Agriculture 1976).

Alamogordo-Aztec complex (AdB)

Runoff class is very low. The depth to a restrictive feature is greater than 60 inches. This soil is well drained. The slowest soil permeability within a depth of 60 inches is moderately rapid. Available water capacity to a depth of 60 inches is low, and shrink swell potential is low. Annual flooding is none, and annual ponding is none. The minimum depth to a water table is greater than six feet. The maximum calcium carbonate equivalent within a depth of 40 inches is 40 percent. This component is not a hydric soil. The typical profile includes fine sandy loam and moderately alkaline soil in horizon 1 (zero to five inches); gravelly gypsiferous sandy loam and moderately alkaline soil in horizon 2 (five to 16 inches); and very gravelly gypsiferous fine sandy loam and moderately alkaline soil in horizon 3 (16 to 60 inches).

Alamogordo-Gypsum land complex (AEC)

Runoff class is very low. The depth to a restrictive feature is greater than 60 inches. This soil is well drained. The slowest soil permeability within a depth of 60 inches is moderately rapid. Available water capacity to a depth of 60 inches is moderate, and shrink swell potential is low. Annual flooding is none, and annual ponding is none. The minimum depth to a water table is greater than six feet. The maximum calcium carbonate equivalent within a depth of 40 inches is 30 percent. This component is not a hydric soil. The typical profile includes very fine sandy loam and moderately alkaline soil in horizon 1 (zero to seven inches); gypsiferous very fine sandy loam and moderately alkaline soil in horizon 2 (seven to 15 inches); and very fine sandy loam and moderately alkaline soil in horizon 3 (15 to 60 inches).

Alamogordo-McCullough sandy loams, hummocky (AhB)

Runoff class is very low. The depth to a restrictive feature is greater than 60 inches. This soil is well drained. The slowest soil permeability within a depth of 60 inches is moderately rapid. Available water capacity to a depth of 60 inches is moderate, and shrink swell potential is low. Annual flooding is none, and annual ponding is none. The minimum depth to a water table is greater than six feet. The maximum calcium carbonate equivalent within a depth of 40 inches is 15 percent. This component is not a hydric soil. The typical profile includes sandy loam and moderately alkaline soil in horizon 1 (zero to six inches); sandy loam and moderately alkaline soil in horizon 2 (six to 22 inches); and sandy loam and moderately alkaline soil in horizon 3 (22 to 60 inches).

Alamogordo variant (AkA)

Runoff class is low. The depth to a restrictive feature is greater than 60 inches. This soil is well drained. The slowest soil permeability within a depth of 60 inches is moderate. Available water capacity to a depth of 60 inches is low to moderate, depending on the amount of gypsum, and shrink swell potential is low. Annual flooding is none, and annual ponding is none. The minimum depth to a water table is greater than six feet. The maximum calcium carbonate equivalent within a depth of 40 inches is 10 percent. This component is not a hydric soil. The typical profile includes very fine sandy loam (zero to six inches) and loam with very fine sand with moderate alkalinity in horizons 2–4 (six to below 60 inches).

Aztec-Alamogordo complex, hummocky (AoB)

Runoff class is very low. The depth to a restrictive feature is greater than 60 inches. This soil is well drained. The slowest soil permeability within a depth of 60 inches is moderately rapid. Available water capacity to a depth of 60 inches is moderate, and shrink swell potential is low. Annual flooding is none, and annual ponding is none. The minimum depth to a water table is greater than six feet. The maximum calcium carbonate equivalent within a depth of 40 inches is 30 percent. This component is not a hydric soil. The typical profile includes fine sandy loam and moderately alkaline soil in horizon 1 (zero to seven inches); gypsiferous loam and moderately alkaline soil in horizon 2 (seven to 17 inches); and very fine sandy loam and moderately alkaline soil in horizon 3 (17 to 60 inches).

Gullied land (Gu)

No description available

Largo silt loam, 0 to 1 percent slopes (LdA)

Runoff class is low. The depth to a restrictive feature is greater than 60 inches. This soil is well drained. The slowest soil permeability within a depth of 60 inches is moderately slow. Available water capacity to a depth of 60 inches is high, and shrink swell potential is moderate. Annual flooding is none, and annual ponding is none. The minimum depth to a water table is greater than six feet. The maximum calcium carbonate equivalent within a depth of 40 inches is 15 percent. This component is not a hydric soil. The typical profile includes silt loam and moderately alkaline soil in horizon 1 (zero to four inches); silty clay loam and moderately alkaline soil in horizon 2 (four to 21 inches); and silty clay loam and moderately alkaline soil in horizon 3 (21 to 60 inches).

Largo silt loam, 0 to 3 percent slopes (LDB)

Runoff class is low. The depth to a restrictive feature is greater than 60 inches. This soil is well drained. The slowest soil permeability within a depth of 60 inches is moderately slow. Available water capacity to a depth of 60 inches is high, and shrink swell potential is moderate. Annual flooding is rare, and annual ponding is none. The minimum depth to a water table is greater than six feet. The maximum calcium carbonate equivalent within a depth of 40 inches is 15 percent. This component is not a hydric soil. The typical profile includes silt loam and moderately alkaline soil in horizon 1 (zero to four inches); silty clay loam and moderately alkaline soil in horizon 2 (four to 21 inches); and silty clay loam and moderately alkaline soil in horizon 3 (21 to 60 inches).

Largo silt loam, 1 to 3 percent slopes (LdB)

Runoff class is low. The depth to a restrictive feature is greater than 60 inches. This soil is well drained. The slowest soil permeability within a depth of 60 inches is moderately slow. Available water capacity to a depth of 60 inches is high, and shrink swell potential is moderate. Annual flooding is none, and annual ponding is none. The minimum depth to a water table is greater than six feet. The maximum calcium carbonate equivalent within a depth of 40 inches is 15 percent. This component is not a hydric soil. The typical profile includes silt loam and moderately alkaline soil in horizon 1 (zero to five inches); silty clay loam and moderately alkaline soil in horizon 2 (five to 25 inches); and silty clay loam and moderately alkaline soil in horizon 3 (25 to 60 inches).

Largo very fine sandy loam, thick surface (LcA)

Runoff class is medium. The depth to a restrictive feature is greater than 60 inches. This soil is well drained. The slowest soil permeability within a depth of 60 inches is moderately slow. Available water capacity to a depth of 60 inches is high, and shrink swell potential is moderate. Annual flooding is none, and annual ponding is none. The minimum depth to a water table is greater than six feet. The maximum calcium carbonate equivalent within a depth of 40 inches is 15 percent. This component is not a hydric soil. The typical profile includes very fine sandy loam and moderately alkaline soil in horizon 1 (zero to five inches); loam and moderately alkaline soil in horizon 2 (five to 13 inches); and silt loam and moderately alkaline soil in horizon 3 (13 to 60 inches).

McCullough sandy loam (McB)

Runoff class is very low. The depth to a restrictive feature is greater than 60 inches. This soil is well drained. The slowest soil permeability within a depth of 60 inches is moderately rapid. Available water capacity to a depth of 60 inches is moderate, and shrink swell potential is low. Annual flooding is none,

and annual ponding is none. The minimum depth to a water table is greater than six feet. The maximum calcium carbonate equivalent within a depth of 40 inches is 15 percent. This component is not a hydric soil. The typical profile includes sandy loam and moderately alkaline soil in horizon 1 (zero to five inches); fine sandy loam and moderately alkaline soil in horizon 2 (five to 22 inches); very gravelly coarse sand and moderately alkaline soil in horizon 3 (22 to 29 inches); and fine sandy loam and moderately alkaline soil in horizon 4 (29 to 60 inches).

McCullough variant very fine sandy loam (MdA)

Runoff class is low. The depth to a restrictive feature is greater than 60 inches. This soil is well drained. The slowest soil permeability within a depth of 60 inches is moderately slow. Available water capacity to a depth of 60 inches is high, and shrink swell potential is low. Annual flooding is none, and annual ponding is none. The minimum depth to a water table is greater than six feet. The maximum calcium carbonate equivalent within a depth of 40 inches is 15 percent. This component is not a hydric soil. The typical profile includes very fine sandy loam and moderately alkaline soil in horizon 1 (zero to seven inches); loam and moderately alkaline soil in horizon 2 (seven to 32 inches); and silt loam and moderately alkaline soil in horizon 3 (32 to 60 inches).

Prelo fine sandy loam (PIA)

Runoff class is medium. The depth to a restrictive feature is greater than 60 inches. This soil is well drained. The slowest soil permeability within a depth of 60 inches is moderately slow. Available water capacity to a depth of 60 inches is moderate, and shrink swell potential is moderate. Annual flooding is none, and annual ponding is none. The minimum depth to a water table is greater than six feet. The maximum calcium carbonate equivalent within a depth of 40 inches is 15 percent. This component is not a hydric soil. The typical profile includes fine sandy loam and moderately alkaline soil in horizon 1 (zero to four inches); silt loam and moderately alkaline soil in horizon 2 (four to 26 inches); and silt loam and moderately alkaline soil in horizon 3 (26 to 60 inches).

Prelo sandy loam, hummocky (PkA)

Runoff class is medium. The depth to a restrictive feature is greater than 60 inches. This soil is well drained. The slowest soil permeability within a depth of 60 inches is moderately slow. Available water capacity to a depth of 60 inches is high, and shrink swell potential is moderate. Annual flooding is none, and annual ponding is none. The minimum depth to a water table is greater than six feet. The maximum calcium carbonate equivalent within a depth of 40 inches is 15 percent. This component is not a hydric soil. The typical profile includes sandy loam and moderately alkaline soil in horizon 1 (zero to 10

inches); silty clay loam and moderately alkaline soil in horizon 2 (10 to 38 inches); and silty clay loam and moderately alkaline soil in horizon 3 (38 to 60 inches).

Prelo silt loam, 0 to 1 percent slopes (PmA)

Runoff class is medium. The depth to a restrictive feature is greater than 60 inches. This soil is well drained. The slowest soil permeability within a depth of 60 inches is moderately slow. Available water capacity to a depth of 60 inches is moderate, and shrink swell potential is moderate. Annual flooding is none, and annual ponding is none. The minimum depth to a water table is greater than six feet. The maximum calcium carbonate equivalent within a depth of 40 inches is 15 percent. This soil is prime farmland if irrigated. This component is not a hydric soil. The typical profile includes silt loam and moderately alkaline soil in horizon 1 (zero to eight inches); silty clay loam and moderately alkaline soil in horizon 2 (eight to 22 inches); and silt loam and moderately alkaline soil in horizon 3 (22 to 60 inches).

Prelo silt loam, 1 to 3 percent slopes (PmB)

Runoff class is medium. The depth to a restrictive feature is greater than 60 inches. This soil is well drained. The slowest soil permeability within a depth of 60 inches is moderately slow. Available water capacity to a depth of 60 inches is moderate, and shrink swell potential is moderate. Annual flooding is none, and annual ponding is none. The minimum depth to a water table is greater than six feet. The maximum calcium carbonate equivalent within a depth of 40 inches is 15 percent. This component is not a hydric soil. The typical profile includes silt loam and moderately alkaline soil in horizon 1 (zero to six inches); silty clay loam and moderately alkaline soil in horizon 2 (six to 20 inches); and silt loam and moderately alkaline soil in horizon 3 (20 to 60 inches).

Prelo silt loam, 1 to 3 percent slopes, eroded (PmB2)

Runoff class is medium. The depth to a restrictive feature is greater than 60 inches. This soil is well drained. The slowest soil permeability within a depth of 60 inches is moderately slow. Available water capacity to a depth of 60 inches is moderate, and shrink swell potential is moderate. Annual flooding is none, and annual ponding is none. The minimum depth to a water table is greater than six feet. The maximum calcium carbonate equivalent within a depth of 40 inches is 15 percent. This component is not a hydric soil. The typical profile includes silt loam and moderately alkaline soil in horizon 1 (zero to two inches); clay loam and moderately alkaline soil in horizon 2 (two to eight inches); and clay loam and moderately alkaline soil in horizon 3 (eight to 60 inches).

Prelo silt loam, hummocky (PnA)

Runoff class is medium. The depth to a restrictive feature is greater than 60 inches. This soil is well drained. The slowest soil permeability within a depth of 60 inches is moderately slow. Available water capacity to a depth of 60 inches is high, and shrink swell potential is moderate. Annual flooding is none, and annual ponding is none. The minimum depth to a water table is greater than six feet. The maximum calcium carbonate equivalent within a depth of 40 inches is 15 percent. This component is not a hydric soil. The typical profile includes silt loam and moderately alkaline soil in horizon 1 (zero to four inches); silty clay loam and moderately alkaline soil in horizon 2 (four to 28 inches); and silty clay loam and moderately alkaline soil in horizon 3 (28 to 60 inches).

Riverwash (Rw)

No description available

Tome silt loam (TDB)

Runoff class is medium. The depth to a restrictive feature is greater than 60 inches. This soil is well drained. The slowest soil permeability within a depth of 60 inches is moderately slow. Available water capacity to a depth of 60 inches is high, and shrink swell potential is moderate. Annual flooding is rare, and annual ponding is none. The minimum depth to a water table is greater than six feet. The maximum calcium carbonate equivalent within a depth of 40 inches is 15 percent. This component is not a hydric soil. The typical profile includes silt loam and moderately alkaline soil in horizon 1 (zero to five inches) and stratified very fine sandy loam to silt loam and moderately alkaline soil in horizon 2 (five to 60 inches).

Tome-Emot complex (TfB)

For this soil type, two descriptions are listed. ***Tome*** soil runoff class is medium. The depth to a restrictive feature is greater than 60 inches. This soil is well drained. The slowest soil permeability within a depth of 60 inches is moderately slow. Available water capacity to a depth of 60 inches is high, and shrink swell potential is moderate. Annual flooding is none, and annual ponding is none. The minimum depth to a water table is greater than six feet. The maximum calcium carbonate equivalent within a depth of 40 inches is 15 percent. This component is not a hydric soil. The typical profile includes loam and moderately alkaline soil in horizon 1 (zero to five inches) and stratified very fine sandy loam to silt loam and moderately alkaline soil in horizon 2 (five to 60 inches).

Emot soil runoff class is very low. The depth to a restrictive feature is greater than 60 inches. This soil is well drained. The slowest soil permeability within a depth of 60 inches is moderately rapid. Available water capacity to a depth of 60 inches is moderate, and shrink swell potential is low. Annual flooding is none, and annual ponding is none. The minimum depth to a water table is greater than six feet. The maximum calcium carbonate equivalent within a depth of 40 inches is 15 percent. This component is not a hydric soil. The typical profile includes fine sandy loam and moderately alkaline soil in horizon 1 (zero to four inches); gravelly very fine sandy loam and moderately alkaline soil in horizon 2 (four to 11 inches); and extremely gravelly silt loam and moderately alkaline soil in horizon 3 (11 to 60 inches).

Torrifluvents, hummocky (TvA)

Runoff class is very low. The depth to a restrictive feature is greater than 60 inches. This soil is well drained. The slowest soil permeability within a depth of 60 inches is moderately rapid. Available water capacity to a depth of 60 inches is low, and shrink swell potential is low. Annual flooding is frequent, and annual ponding is none. The minimum depth to a water table is greater than six feet. The maximum calcium carbonate equivalent within a depth of 40 inches is 10 percent. This component is not a hydric soil. The typical profile includes fine sandy loam and moderately alkaline soil in horizon 1 (zero to 10 inches) and very cobbly sandy loam and moderately alkaline soil in horizon 2 (10 to 60 inches).

4 ***Land cover types located within the project area***

SWReGAP Land Cover Type	SWReGAP Map ID	Project Segment	Length/Area of Project Intersect per Land Cover Type	
			Miles[1]	***Acres[2]***
Agriculture	N80	Main waterline (well field to Alamogordo)	0.84	5.09
Apacherian-Chihuahuan Mesquite Upland Scrub	S058	Main waterline (well field to Alamogordo)	0.30	1.81
Apacherian-Chihuahuan Piedmont Semi-Desert Grassland and Steppe	S077	Well field waterlines	1.02	6.18
		Main waterline (well field to Alamogordo)	0.59	3.57
		Desalination facility	---	2.00
		Well pads	—	3.53
Chihuahuan Creosotebush, Mixed Desert and Thorn Scrub	S062	Well field waterlines	5.71	34.60
		Main waterline (well field to Alamogordo)	14.54	88.12
		Desalination facility	---	2.00
		Well pads	---	9.62
Chihuahuan Gypsophilous Grassland and Steppe	S080	Well field waterlines	0.35	2.12
		Well pads	---	0.12
Chihuahuan Sandy Plains Semi-Desert Grassland	S113	Well field waterlines	0.01	0.06
		Well pads	---	1.32
Chihuahuan Stabilized Coppice Dune and Sand Flat Scrub	S068	Main waterline (well field to Alamogordo)	0.25	1.51
Developed, Medium - High Intensity	N22	Main waterline (well field to Alamogordo)	0.63	3.81
		Desalination facility	---	40.0
Developed, Open Space - Low Intensity	N21	Main waterline (well field to Alamogordo)	5.81	35.13
		Desalination facility	---	55.0
North American Warm Desert Playa	S022	Well field waterlines	1.60	9.69
		Main waterline (well field to Alamogordo)	0.35	2.12
		Well pads	---	5.39
North American Warm Desert Riparian Woodland and Shrubland	S097	Main waterline (well field to Alamogordo)	0.44	2.66
North American Warm Desert Wash	S020	Main waterline (well field to Alamogordo)	0.02	0.12
Total	---	---	**32.47**	**315.60**

5 1 - Length includes all of the below ground waterlines, but does not include temporary disturbance associated trenching
6 and installation activities.
7 2 - Acreage includes the area surveyed at the desalination plant and evaporation pond, well pad, and waterline sites.
8 Total permanent ground disturbance would be significantly less.
9

10

All of the following land cover descriptions were acquired from *Southwest Regional GAP Analysis Project – Land Cover Descriptions* (USGS National Gap Analysis Program 2004).

Agriculture (N80)

An aggregated land cover type that includes areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle, where pasture/hay vegetation accounts for greater than 20 percent of total vegetation; and areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards, where crop vegetation accounts for greater than 20 percent of total vegetation. This includes all land being actively tilled.

Apacherian-Chihuahuan Mesquite Upland Scrub (S058)

This ecological system occurs as upland shrublands that are concentrated in the extensive grassland-shrubland transition in foothills and piedmont in the Chihuahuan Desert. Substrates are typically derived from alluvium, often gravelly without a well-developed argillic or calcic soil horizon that would limit infiltration and storage of winter precipitation in deeper soil layers. *Prosopis spp.* and other deep-rooted shrubs exploit this deep soil moisture that is unavailable to grasses and cacti. Vegetation is typically dominated by *Prosopis glandulosa* or *Prosopis velutina* and succulents. Other desert scrub that may co-dominate or dominate includes *Acacia neovernicosa*, *Acacia constricta*, *Juniperus monosperma*, or *Juniperus coahuilensis*. Grass cover is typically low. During the last century, the area occupied by this system has increased through conversion of desert grasslands as a result of drought, overgrazing by livestock, and/or decreases in fire frequency. It is similar to Chihuahuan Mixed Desert and Thorn Scrub but is generally found at higher elevations where *Larrea tridentata* and other desert scrub are not co-dominant. It is also similar to Chihuahuan Stabilized Coppice Dune and Sand Flat Scrub but does not occur on eolian-deposited substrates.

Apacherian-Chihuahuan Semi-Desert Grassland and Steppe (S077)

This ecological system is a broadly defined desert grassland, mixed shrub-succulent or xeromorphic tree savanna that is typical of the Borderlands of Arizona, New Mexico and northern Mexico (Apacherian region) but extends west to the Sonoran Desert, north into the Mogollon Rim and throughout much of the Chihuahuan Desert. It is found on gently sloping bajadas that supported frequent fire and on mesas and steeper piedmont, and foothill slopes in the Chihuahuan Desert. It is characterized by typically diverse perennial grasses. Common grass species include *Bouteloua eriopoda*, *Bouteloua hirsuta*, *Bouteloua rothrockii*, *Bouteloua curtipendula*, *Bouteloua gracilis*, *Eragrostis intermedia*, *Muhlenbergia porteri*,

Muhlenbergia setifolia, *Pleuraphis jamesii*, *Pleuraphis mutica*, and *Sporobolus airoides*, succulent species of *Agave*, *Dasylirion*, and *Yucca*, and tall-shrub/short-tree species of *Prosopis* and various oaks (e.g., *Quercus grisea*, *Quercus emoryi*, *Quercus arizonica*). Many of the historical desert grassland and savanna areas have been converted, some to Chihuahuan Mesquite Upland Scrub (*Prosopis spp.*-dominated), through intensive grazing and other land uses.

Chihuahuan Mixed Desert and Thorn Scrub (S062)

This widespread Chihuahuan Desert land cover type is composed of two ecological systems the Chihuahuan Creosotebush Xeric Basin Desert Scrub and the Chihuahuan Mixed Desert and Thorn Scrub. This cover type includes xeric creosotebush basins and plains, and the mixed desert scrub in the foothill transition zone above, sometimes extending up to the lower montane woodlands. Vegetation is characterized by *Larrea tridentata* alone or mixed with thornscrub and other desert scrub such as *Agave lechuguilla*, *Aloysia wrightii*, *Fouquieria splendens*, *Dasylirion leiophyllum*, *Flourensia cernua*, *Leucophyllum minus*, *Mimosa aculeaticarpa* var. *biuncifera*, *Mortonia scabrella* (*Mortonia sempervirens* ssp. *scabrella*), *Opuntia engelmannii*, *Parthenium incanum*, *Prosopis glandulosa*, and *Tiquilia greggii*. Stands of *Acacia constricta*, *Acacia neovernicosa*, or *Acacia greggii* dominated thornscrub are included in this system, and limestone substrates appear important for at least these species. Grasses such as *Dasyochloa pulchella*, *Bouteloua curtipendula*, *Bouteloua eriopoda*, *Bouteloua ramosa*, *Muhlenbergia porteri*, and *Pleuraphis mutica* may be common, but generally have lower cover than shrubs.

Chihuahuan Gypsophilous Grassland and Steppe (S080)

This ecological system is restricted to gypsum outcrops or sandy gypsiferous and/or often alkaline soils that occur in basins and slopes in the Chihuahuan Desert. Elevation range is from 1100-2000 meters. These typically sparse grasslands, steppes, or dwarf-shrublands are dominated by a variety of gypsophilous plants, many of which are endemic to these habitats. Characteristic species include *Tiquilia hispidissima*, *Atriplex canescens*, *Calylophus hartwegii*, *Ephedra torreyana*, *Frankenia jamesii*, *Bouteloua breviseta*, *Mentzelia perennis*, *Nama carnosum*, *Calylophus hartwegii*, *Selinocarpus lanceolatus*, *Sporobolus nealleyi*, *Sporobolus airoides*, and *Sartwellia flaveriae*. This system does not include the sparsely vegetated gypsum dunes that are included in North American Warm Desert Active and Stabilized Dune.

Chihuahuan Sandy Plains Semi-Desert Grassland (S113)

This ecological system occurs across the Chihuahuan Desert and extends into the southern Great Plains where soils have a high sand content. These dry grasslands or steppes are found on sandy plains and

sandstone mesas. The graminoid layer is dominated or co-dominated by *Achnatherum hymenoides*, *Bouteloua eriopoda*, *Bouteloua hirsuta*, *Hesperostipa neomexicana*, *Pleuraphis jamesii*, *Sporobolus cryptandrus*, *Sporobolus airoides*, or *Sporobolus flexuosus*. Typically, there are found scattered desert shrubs and stem succulents such as *Ephedra torreyana*, *Ephedra trifurca*, *Fallugia paradoxa*, *Prosopis glandulosa*, *Yucca elata*, and *Yucca torreyi* that are characteristic of the Chihuahuan Desert.

Chihuahuan Stabilized Coppice Dune and Sand Flat Scrub (S068)

This ecological system includes the open shrublands of vegetated coppice dunes and sandsheets found in the Chihuahuan Desert. Usually dominated by *Prosopis glandulosa* but includes *Atriplex canescens*, *Ephedra torreyana*, *Ephedra trifurca*, *Poliomintha incana*, and *Rhus microphylla* coppice sand scrub with 10 to 30 percent total vegetation cover. *Yucca elata*, *Gutierrezia sarothrae*, and *Sporobolus flexuosus* are commonly present.

Developed, Medium - High Intensity (N22)

Developed, Medium Intensity: Includes areas with a mixture of constructed materials and vegetation. Impervious surface accounts for 50 to 79 percent of the total cover. These areas most commonly include single-family housing units. *Developed, High Intensity*: Includes highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses, and commercial/industrial. Impervious surfaces account for 80 to 100 percent of the total cover.

Developed, Open Space - Low Intensity (N21)

Open Space: Includes areas with a mixture of some construction materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20 percent of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes. *Developed, Low Intensity*: Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20 to 49 percent of total cover. These areas most commonly include single-family housing units.

North American Warm Desert Playa (S022)

This system is composed of barren and sparsely vegetated playas (generally less than 10 percent plant cover) found across the warm deserts of North America, extending into the extreme southern end of the San Joaquin Valley in California. Playas form with intermittent flooding, followed by evaporation, leaving behind a saline residue. Salt crusts are common throughout, with small saltgrass beds in depressions and sparse shrubs around the margins. Subsoils often include an impermeable layer of clay

or caliche. Large desert playas tend to be defined by vegetation rings formed in response to salinity. Given their common location in wind-swept desert basins, dune fields often form downwind of large playas. In turn, playas associated with dunes often have a deeper water supply. Species may include *Allenrolfea occidentalis*, *Suaeda* spp., *Distichlis spicata*, *Eleocharis palustris*, *Oryzopsis spp.*, *Sporobolus spp.*, *Tiquilia spp.*, or *Atriplex spp.* Ephemeral herbaceous species may have high cover periodically. Adjacent vegetation is typically Sonora-Mojave Desert Mixed Salt Desert Scrub, Chihuahuan Mixed Salt Desert Scrub, Gulf of California Coastal Mixed Salt Desert Scrub, Baja California del Norte Gulf Coast Ocotillo-Limberbush-Creosotebush Desert Scrub, or Chihuahuan Creosotebush Basin Desert Scrub.

North American Warm Desert Riparian Woodland and Shrubland (S097)

This ecological system consists of low elevation (less than 1,200 meters) riparian corridors along medium to large perennial streams throughout canyons and the desert valleys of the southwestern United States and adjacent Mexico. The vegetation is a mix of riparian woodlands and shrublands. Dominant trees include *Acer negundo*, *Fraxinus velutina*, *Populus fremontii*, *Salix gooddingii*, *Salix lasiolepis*, *Celtis laevigata* var. *reticulata*, and *Juglans major*. Shrub dominants include *Salix geyeriana*, *Shepherdia argentea*, and *Salix exigua*. Vegetation is dependent upon annual or periodic flooding and associated sediment scour and/or annual rise in the water table for growth and reproduction.

North American Warm Desert Wash (S020)

This ecological system is restricted to intermittently flooded washes or arroyos that dissect bajadas, mesas, plains, and basin floors throughout the warm deserts of North America. Although often dry, the intermittent fluvial processes define this system, which are often associated with rapid sheet and gully flow. This system occurs as linear or braided strips within desert scrub- or desert grassland-dominated landscapes. The vegetation of desert washes is quite variable ranging from sparse and patchy to moderately dense and typically occurs along the banks, but may occur within the channel. The woody layer is typically intermittent to open and may be dominated by shrubs and small trees such as *Acacia greggii*, *Brickellia laciniata*, *Baccharis sarothroides*, *Chilopsis linearis*, *Fallugia paradoxa*, *Hymenoclea salsola*, *Hymenoclea monogyra*, *Juglans microcarpa*, *Prosopis spp.*, *Psorothamnus spinosus*, *Prunus fasciculata*, *Rhus microphylla*, *Salazaria mexicana*, or *Sarcobatus vermiculatus*.

142 ***Plant species observed within the project area***

Species	Project Segment	Relative Abundance[1]
Woody Plants		
Broom snakeweed *Gutierrezia sarothrae*	Well field	Moderate
	Main waterline north of Tularosa	Moderate
	Main waterline south of Tularosa	Moderate
	Desalination facility	Moderate
Burrobrush *Hymenoclea salsola*	Well field	Rare
Cactus apple *Opuntia engelmannii*	Desalination plant site	Rare
	Well field	Moderate
Christmas cactus *Opuntia leptocaulis*	Well field	Moderate
Creosotebush *Larrea tridentata*	Well field	Abundant
	Main waterline north of Tularosa	Abundant
	Main waterline south of Tularosa	Moderate
Four-wing saltbush *Atriplex canescens*	Main waterline north of Tularosa	Moderate
	Main waterline south of Tularosa	Moderate
	Desalination facility	Moderate
Honey mesquite *Prosopis glandulosa*	Well field	Abundant
	Main waterline north of Tularosa	Abundant
	Main waterline south of Tularosa	Moderate
	Desalination facility	Moderate
Mormon tea *Ephedra viridis*	Main waterline north of Tularosa	Moderate
	Main waterline south of Tularosa	Moderate
Pale wolfberry Lycium pallidum	Main waterline north of Tularosa	Moderate
	Main waterline south of Tularosa	Moderate
Plains prickly pear *Opuntia polyacantha*	Main waterline south of Tularosa	Moderate
	Desalination facility	Rare
Purple pricklypear *Opuntia macrocentra*	Well field	Rare
Rubber rabbitbrush *Ericameria nauseosa*	Main waterline north of Tularosa	Moderate
Salt cedar[2] *Tamarix ramosissima*	Main waterline north of Tularosa	Rare
	Main waterline south of Tularosa	Rare
	Desalination facility	Rare
Sand sagebrush *Artemisia filifolia*	Main waterline north of Tularosa	Rare
Siberian elm[2] *Ulmus pumila*	Main waterline north of Tularosa	Rare
Soaptree yucca *Yucca elata*	Main waterline north of Tularosa	Moderate
	Main waterline south of Tularosa	Rare
Tarbush *Flourensia cernua*	Well field	Moderate
Texas pricklypear *Opuntia engelmannii* var. *lindheimeri*	Main waterline south of Tularosa	Rare

144 ***Plant species observed within the project area, continued***

Species	Project Segment	Relative Abundance[1]
Woody Plants (cont.)		
Tree cholla *Opuntia imbricata*	Main waterline north of Tularosa	Moderate
	Main waterline south of Tularosa	Moderate
	Desalination facility	Moderate
Tulip pricklypear *Opuntia phaeacantha*	Well field	Rare
Winterfat *Krascheninnikovia lanata*	Desalination facility	Rare
Grasses		
Alkali sacaton *Sporobolus airoides*	Well field	Abundant
	Main waterline north of Tularosa	Abundant
	Main waterline south of Tularosa	Abundant
	Desalination facility	Moderate
Bermudagrass *Cynodon dactylon*	Main waterline north of Tularosa	Rare
	Main waterline south of Tularosa	Rare
	Well field	Rare
Burrograss *Scleropogon brevifolius*	Well field	Moderate
	Main waterline north of Tularosa	Moderate
	Main waterline south of Tularosa	Rare
Bush muhly *Muhlenbergia porteri*	Main waterline north of Tularosa	Moderate
	Well field	Moderate
Crabgrass *Digitaria sp.*	Main waterline north of Tularosa	Rare
Feather fingergrass *Chloris virgata*	Desalination facility	Rare
James' galleta *Pleuraphis jamesii*	Main waterline north of Tularosa	Rare
Johnsongrass *Sorghum halepense*	Main waterline north of Tularosa	Rare
	Main waterline south of Tularosa	Rare
Low woollygrass *Dasyochloa pulchella*	Main waterline north of Tularosa	Rare
Orchardgrass *Dactylis glomerata*	Main waterline north of Tularosa	Rare
Purple threeawn *Aristida purpurea*	Well field[3]	Rare
Sand dropseed *Sporobolus cryptandrus*	Main waterline north of Tularosa	Moderate
	Main waterline south of Tularosa	Moderate
Sideoats grama *Bouteloua curtipendula*	Main waterline north of Tularosa	Rare
	Well field	Rare
Streambed bristlegrass *Setaria leucopila.*	Well field	Rare
Tabosagrass *Pleuraphis mutica*	Well field	Moderate

145

146 ***Plant species observed within the project area, continued***

Species	Project Segment	Relative Abundance1
Grasses (cont.)		
Threeawn *Aristida sp.*	Well field	Rare
Vine mesquite *Panicum obtusum*	Main waterline north of Tularosa	Rare
Wild oat Avena fatua	Main waterline south of Tularosa	Rare
Wild rye *Elymus sp.*	Main waterline north of Tularosa	Rare
Forbs		
African rue[2] *Peganum harmala*	Well field	Moderate
	Main waterline north of Tularosa	Moderate
	Main waterline south of Tularosa	Rare
Bicolor fanmustard *Nerisyrenia camporum*	Well field	Rare
Broadleaved pepperweed *Lepidium latifolium*	Main waterline south of Tularosa	Moderate
Camelthorn[2] *Alhagi pseudalhagi*	Main waterline north of Tularosa	Rare
	Main waterline south of Tularosa	Rare
Canadian Horseweed *Conyza canadensis*	Main waterline north of Tularosa	Rare
	Main waterline south of Tularosa	Moderate
Copper globemallow *Sphaeralcea angustifolia*	Well field	Rare
Curlycup gumweed *Grindelia squarrosa*	Main waterline south of Tularosa	Rare
Curly dock *Rumex crispus*	Main waterline south of Tularosa	Rare
Curlyhead goldenweed *Pyrrocoma crocea*	Well field	Rare
Desert marigold *Baileya multiradiata*	Main waterline south of Tularosa	Rare
Field bindweed[2] *Convolvulus arvensis*	Main waterline north of Tularosa	Rare
Globe mallow *Sphaeralcea sp.*	Main waterline north of Tularosa	Moderate
	Main waterline south of Tularosa	Moderate
	Desalination facility	Moderate
Goldeneye *Viguiera sp.*	Main waterline north of Tularosa	Rare
	Well field	Rare
Green prairie coneflower *Ratibida tagetes*	Desalination facility	Rare
Hairyseed bahia *Bahia absinthifolia*	Well field	Rare
Hog potato *Hoffmanseggia glauca*	Main waterline north of Tularosa	Moderate
	Main waterline south of Tularosa	Moderate
	Well field	Moderate

147

148 ***Plant species observed within the project area, continued***

Species	Project Segment	Relative Abundance1
Forbs (cont.)		
Horsenettle *Solanum fendleri*	Main waterline north of Tularosa	Rare
	Main waterline south of Tularosa	Moderate
Jimson Weed *Datura stramonium*	Desalination facility	Rare
	Main waterline south of Tularosa	Rare
Malta starthistle[2] *Centaurea melitensis*	Main waterline south of Tularosa	Rare
Mealy goosefoot *Chenopodium incanum*	Desalination plant site	Moderate
Mexican-fireweed *Kochia scoparia*	Main waterline north of Tularosa	Moderate
	Main waterline south of Tularosa	Moderate
Missouri gourd *Cucurbita foetidissima*	Main waterline north of Tularosa	Rare
	Main waterline south of Tularosa	Moderate
Mountain pepperweed *Lepidium montanum*	Well field	Rare
Oak-leaf thorn apple *Datura quercifolia*	Desalination facility	Rare
Perennial pepperweed[2] *Lepidium latifolium*	Main waterline	NA
Phacelia *Phacelia spp.*	Well field	Moderate
Pigweed *Amaranthus sp.*	Main waterline north of Tularosa	Rare
	Desalination facility	Rare
Puncturevine *Tribulus terrestris*	Main waterline south of Tularosa	Rare
Purple aster *Symphyotrichum patens*	Main waterline north of Tularosa	Moderate
Ragleaf bahia *Bahia dissecta*	Well field	Moderate
	Main waterline north of Tularosa	Moderate
	Main waterline south of Tularosa	Moderate
Ragweed *Ambrosia spp.*	Well field	Rare
	Main waterline north of Tularosa	Moderate
Russian knapweed[2] *Acroptilon repens*	Main waterline north of Tularosa	Rare
	Desalination facility	Rare
Russian thistle *Salsola kali*	Main waterline north of Tularosa	Moderate
	Main waterline south of Tularosa	Moderate
	Desalination facility	Moderate
Sand verbena *Abronia sp.*	Main waterline south of Tularosa	Rare
Seepwillow *Baccharis salicifolia*	Main waterline south of Tularosa	Rare
Spiny cocklebur *Xanthium spinosum*	Well field	Rare
	Main waterline south of Tularosa	Rare

149

150 ***Plant species observed within the project area, continued***

Species	Project Segment	Relative Abundance1
Forbs (cont.)		
Annual sunflower *Helianthus annuus*	Main waterline north of Tularosa	Moderate
	Main waterline south of Tularosa	Moderate
Wavyleaf thistle *Cirsium undulatum*	Well field	Rare
Western sunflower *Helianthus anomalus*	Main waterline north of Tularosa	Rare
	Main waterline south of Tularosa	Rare

151 1 - Abundant = occurs over most of the project area; Moderate = occurs on some segments of the project area and/or is patchily
152 distributed; Rere = isolated occurrences
153
154 2 - New Mexico State-listed noxious weed
155

156 ***Threatened and Endangered (TES) species with the potential to occur in Otero County***

Common and Scientific Name	Federal Status[1]	Known distribution and habitat needs	Likelihood of occurrence in project area
Kuenzler hedgehog cactus *Echinocereus fendleri* var. *kuenzleri*	E	Primarily gentle, gravelly to rocky slopes and benches on limestone or limy sandstone, in Great Plains grassland, oak woodland, or piñon-juniper woodland. Elevation 5,200-6,600 feet.	Occurrence unlikely; no suitable habitat and outside of species altitudinal range at the project location.
Sacramento prickly poppy *Argemone pleiacantha pinnatisecta*	E	Loose, gravelly soils of open disturbed sites; canyon bottoms and slopes, and sometimes along roadsides; 4,200-7,100 feet.	Occurrence possible
Todsen's pennyroyal *Hedeoma todsenii*	E	Loose, gypseous-limestone soils associated with or positioned immediately below the Permian Yeso Formation; usually on steep north or east-facing slopes in piñon-juniper woodland; 6,200-7,400 feet.	Occurrence unlikely; no suitable habitat and outside of species altitudinal range at the project location.
Sacramento Mountains thistle *Cirsium vinaceum*	T	Wet soils at springs, seeps, and along streams in meadows or forest margins; 7,500-9,500 feet	Occurrence unlikely; no suitable habitat and outside of species altitudinal range at the project location.

157 1 – E: listed by the U.S. Fish and Wildlife Service as an Endangered species.
158 T: listed by the U.S. Fish and Wildlife Service as a Threatened species.
159

Special status species with the potential to occur in Otero County

Common and Scientific Name	Status[1]	Known distribution and habitat needs	Likelihood of Occurrence in Project Area
Allium gooddingii Gooding's onion	USFWSs	Typically found in mature forests, along north-trending drainage bottoms associated with perennial, intermittent and ephemeral stream courses in mixed-conifer and spruce-fir zones at elevations ranging from 7,000-9,400 ft. elevation	Occurrence unlikely; no suitable habitat at project location
Anulocaulis leiosolenus var. howardii Howard's gyp ringstem	NMRPTCr	Open gypsum outcrop of the Yeso Formation, with limestone cobble, at about 1,350-1,450 m (4,425-4,750 ft).	Occurrence unlikely; no suitable habitat at project location
Aquilegia chrysantha var. chaplinei Chapline's columbine	NMRPTCr	Limestone seeps and springs in the montane scrub or riparian canyon bottoms at 1,400-1,700 m (4,700-5,500 ft).	Occurrence unlikely; no suitable habitat at project location
Astragalus altus Tall milkvetch	NMRPTCr	Limestone soils on steep slopes and road cuts in lower montane coniferous forest; 1,900-2,500 m (6,500-8,200 ft).	Occurrence unlikely; no suitable habitat at project location
Astragalus neomexicanus New Mexico milkvetch	NMRPTCr	Dry hillsides and valley bottoms, in piñon-juniper woodland or ponderosa pine forest; 2,090-2,580 m (6,850-8,450 ft).	Occurrence unlikely; no suitable habitat at project location
Besseya oblongifolia Sierra Blanca kittentails	NMRPTCr	Alpine meadows; 3,350-3,600 m (11,000-12,000 ft).	Occurrence unlikely; no suitable habitat at project location
Cereus greggii var. greggii Desert night-blooming cereus	USFWSs	Cereus (Peniocereus) greggii is found primarily in Sonoran desertscrub, in areas where Larrea tridentata is found in sandy or gravelly loams, along washes, on creosote bush flats or gentle slopes; 1,200–1,500 m (3,937–4,921 ft).	Occurrence possible
Chaetopappa elegans Sierra Blanca cliff daisy	USFWSs	Igneous rock faces in montane coniferous forest at 2,300–2,900 m (7,600-9,500 ft).	Occurrence unlikely; no suitable habitat at project location
Cirsium inornatum Plain thistle	NMRPTCr	Mountain meadows and roadsides over 2,288 m (7,500 ft).	Occurrence unlikely; no suitable habitat at project location
Cirsium wrightii Wright's marsh thistle	USFWSs	Wet, alkaline soils in spring seeps and marshy edges of streams and ponds; 1,130-2,600 m (3,450-8,500 ft).	Occurrence unlikely; no suitable habitat at project location
Delphinium novomexicanum New Mexico larkspur	NMRPTCr	Canyon bottoms, forest meadows and road banks in lower and upper montane coniferous forest; 2,200-3,400 m (7,200-11,200 ft).	Occurrence unlikely; no suitable habitat at project location

Special status species with the potential to occur in Otero County, continued

Common and Scientific Name	Status[1]	Known distribution and habitat needs	Likelihood of Occurrence in Project Area
Draba standleyi Standley's whitlowgrass	NMRPTCr	Igneous rock faces, bases of overhanging cliffs, clefts of porphyritic and andesitic rocks and soil; 1,675-1,980 m (5,500-6,500 ft).	Occurrence unlikely; no suitable habitat at project location
Ericameria nauseosa var. texensis Guadalupe rabbitbrush	NMRPTCr	In crevices on faces of limestone cliffs and huge boulders of canyon woodlands, less frequently in open gravel alluvium of stream beds in piñon-juniper woodland and Chihuahuan desert scrub; 1,500-2,150 m (4,900-7,000 ft).	Occurrence unlikely; but range and habitat are close to conditions at proposed project location. None were observed during field surveys at the site.
Erigeron rybius Sacramento Mountains fleabane	NMRPTCr	Meadows and forest openings in lower and upper montane coniferous forests; 2,100-2,800 m (7,000-9,200 ft).	Occurrence unlikely; no suitable habitat at project location
Eriogonum jamesii var. wootonii Wooton's wild buckwheat	NMRPTCr	Mountain slopes and small openings in lower and upper montane coniferous forest; 1,800-3,500 m (6,000-11,500 ft).	Occurrence unlikely; no suitable habitat at project location
Escobaria villardii Villard pincushion cactus	USFWSs, BLMs	Loamy soils of desert grassland with Chihuahuan desert scrub on broad limestone benches in mountainous terrain; 4,500-6,500 feet	Occurrence possible
Hedeoma pulcherrimum Mescalero pennyroyal, beautiful pennyroyal	NMRPTCr	Usually on steep hillsides, in rocky and/or disturbed habitats, including roadsides, in montane coniferous forest and piñon-juniper woodland; 1,500-2,350 m (5,000-9,000 ft).	Occurrence unlikely; no suitable habitat at project location
Heuchera wootonii Wooton's alumroot	NMRPTCr	Mountain slopes and protected, usually north-facing rock outcrops, or Gamble oak thickets in piñon-juniper woodland and lower and upper montane coniferous forest; 2,150-3,650 m (7,000-12,000 ft).	Occurrence unlikely; no suitable habitat at project location
Hexalectris nitida Shining coralroot, shining cock's comb	NMRPTCr	Deep canyons in leaf litter under oaks; 1,300 m (4,300 ft) at Eddy County location.	Occurrence unlikely; no suitable habitat at project location
Hexalectris spicata var. arizonica Arizona coralroot	NMRPTCr	In heavy leaf litter in oak, pine, or juniper woodlands over limestone.	Occurrence unlikely; no suitable habitat at project location
Lepidospartum burgessi Gypsum scalebroom	USFWSs, BLMs	Stabilized gypsum dunes with Chihuahuan desert scrub and arid grassland; 3,500-3,700 feet	Occurrence unlikely; no suitable habitat and outside of species altitudinal range at project location

Special status species with the potential to occur in Otero County, continued

Common and Scientific Name	Status[1]	Known distribution and habitat needs	Likelihood of Occurrence in Project Area
Lesquerella aurea Golden bladderpod	NMRPTCr	Open sites and bare areas of rocky limestone soil, road banks, open woods in montane coniferous forest; 2,000-2,750 m (6,500-9,000 ft).	Occurrence unlikely; no suitable habitat at project location
Lupinus sierrae-blancae Sierra Blanca lupine	NMRPTCr	Meadows and roadsides in pine and fir forest; 1,800-3,000 m (5,900-10,000 ft).	Occurrence unlikely; no suitable habitat at project location
Mentzelia humilis var. gaudalupensis Guadalupe stickleaf	NMRPTCr	Open gypsum outcrops of the Yeso Formation, with limestone cobble, at about 1,350-1,550 m (4,425-5,080 ft).	Occurrence unlikely; no suitable habitat at project location
Muhlenbergia villiflora var. villosa Hairy muhly	NMRPTCr	Open desert grassland and desert savanna, alkaline to calcareous soil; 1,400-1,600 m (4,800-5,200 ft).	Occurrence possible
Nama xylopodum Cliff nama	NMRPTCr	Partly shaded limestone cliffs and outcrops in montane scrub to piñon-juniper-oak woodland; 1,350-2,000 m (4,500-6,500 ft).	Occurrence unlikely; no suitable habitat at project location
Penstemon alamosensis Alamo beardtongue	USFWSs, BLMs	Sheltered rocky areas, canyon sides and bottoms, on limestone; 4,300-5,300 feet	Occurrence unlikely; no suitable habitat at project location
Penstemon cardinalis ssp. Cardinalis Scarlet penstemon	NMRPTCr	Canyon bottoms and rocky slopes in piñon-juniper woodland and lower montane coniferous forest; 2,100-2,700 m (7,000-9,000 ft).	Occurrence unlikely; no suitable habitat at project location
Penstemon cardinalis ssp. Regalis Guadalupe penstemon	NMRPTCr	Limestone slopes and canyon bottoms in montane scrub, piñon-juniper woodland, and lower montane coniferous forest; 1,400-1,800 m (4,500-6,000 ft).	Occurrence unlikely; no suitable habitat at project location
Penstemon neomexicanus New Mexico beardtongue	NMRPTCr	Wooded slopes or open glades in ponderosa pine or spruce/fir forests; 1,830-2,750 m (6,000-9,000 ft).	Occurrence unlikely; no suitable habitat at project location
Perityle staurophylla var. staurophylla New Mexico rock daisy	BLMs	Crevices in limestone cliffs and boulders, usually on protected north and east exposures; 4,900-7,000 feet	Occurrence unlikely; no suitable habitat at project location
Philadelphus microphyllus var. argyrocalyx Silvercup philadelphus	NMRPTCr	Mountain slopes of usually sedimentary rock in piñon-juniper woodland and lower montane coniferous forest; 2,100-2,600 m (6,900-8,500 ft).	Occurrence unlikely; no suitable habitat at project location
Philadelphus wootonii Wooton's philadelphus	NMRPTCr	Mountain slopes in piñon-juniper woodland and lower montane coniferous forest; 2,100-2,500 m (6,900-8,200 ft).	Occurrence unlikely; no suitable habitat at project location

166 ***Special status species with the potential to occur in Otero County, continued***

Common and Scientific Name	Status[1]	Known distribution and habitat needs	Likelihood of Occurrence in Project Area
Polygonatum cobrense Southwest Solomon's seal	NMRPTCr	Sandy humus soils on shaded slopes or shady places beneath trees in piñon-juniper-oak woodland to upper montane coniferous forest; 1,680-2,650 m (5,500-8,700 ft).	Occurrence unlikely; no suitable habitat at project location
Potentilla sierrae-blancae Sierra Blanca cinquefoil	NMRPTCr	Open windswept crests of ridges and mountain tops on igneous rock substrate with thin soil at 3,350-3,660 m (11,000-12,000 ft); occasionally found on igneous cliffs and outcrops in canyons as low as 2,440 m (8,000 ft).	Occurrence unlikely; no suitable habitat at project location
Ribes mescalerium Mescalero black currant	NMRPTCr	Dry slopes in open montane coniferous forests; 2,100-2,700 m (7,000-9,000 ft).	Occurrence unlikely; no suitable habitat at project location
Sedum integrifolium ssp. Neomexicanum New Mexico stonecrop	NMRPTCr	Igneous soils in alpine tundra, scree-slopes and rocky openings in subalpine forest; 3,000-3,600 m (9,900-11,800 ft).	Occurrence unlikely; no suitable habitat at project location
Senecio sacramentanus Sacramento groundsel	NMRPTCr	Meadows and aspen glades in lower and upper montane coniferous forest; 2,440-3,350 m (8,000-11,000 ft).	Occurrence unlikely; no suitable habitat at project location
Sibara grisea Gray sibara	BLMs	Crevices and at the base of limestone cliffs in interior chaparral and piñon-juniper woodland communities at 4,500-6,000 ft	Occurrence unlikely; no suitable habitat at project location
Sophora gypsophila var. guadalupensis Guadalupe mescal bean	NMRPTCr	Outcrops of pink, limy, fine-grained sandstone that is 1-2 percent gypsum (by analysis) in Chihuahuan desert scrub and juniper savanna; 1,720-2,180 m (5,260-6,650 ft).	Occurrence unlikely; no suitable habitat at project location and outside of species altitudinal range
Vaeriana texana Texas tobacco-root	NMRPTCr	Shaded, moist limestone or igneous cliffs, occasionally in canyon bottoms and boulders in creeks, within piñon-juniper woodland and montane coniferous forest; 1,600-2,500 m (5,200-8,000 ft).	Occurrence unlikely; no suitable habitat at project location

167 1 - USFWSs: listed by the U.S. Fish and Wildlife Service as a Sensitive species.
168 NMRPTCr: listed by the New Mexico Rare Plant Technical Council as a Rare species.
169 BLMs: listed by the Bureau of Land Management as a Sensitive species.
170

Wildlife species observed within the project area

Species	Type of Observation	Abundance[1]
Birds		
Loggerhead shrike (*Lanius ludovicianus)*	Visual	Few
Cactus wren (*Campylorhynchus brunneicapillus)*	Visual and Sound	Few
Great blue heron (*Ardea herodias)*	Visual	One
Black-throated sparrow (*Amphispiza bilineata)*	Visual and Sound	Many
Common nighthawk (*Chordeiles minor)*	Visual	Few
Killdeer (*Charadrius vociferus)*	Visual	One
Curve-billed thrasher (*Toxostoma curvirostre)*	Visual	Few
American kestrel (*Falco sparverius)*	Visual	Few
Common raven (*Corvus corax)*	Visual, Sound, and Stick Nest	Several
Mourning dove (*Zenaida macroura)*	Visual and Sound	Several
Horned lark (*Eremophila alpestris)*	Visual	Few
Western kingbird (*Tyrannus verticalis)*	Visual and Sound	Many
Western burrowing owl (*Athene cunicularia)*	Visual, Sound, Nest Burrow, Scat, and Pellets	Few
Swainson's hawk (*Buteo swainsoni)*	Visual and Stick Nest	Few
Northern mockingbird (*Mimus polyglottos)*	Visual and Sound	Many
Turkey vulture (*Cathartes aura)*	Visual	Few
Ash-throated flycatcher (*Myiarchus cinerascens)*	Visual and Sound	Many
Bullock's oriole (*Icterus galbula)*	Visual	Few
Barn swallow (*Hirundo rustica)*	Visual and Sound	Few
Western meadowlark (*Sturnella neglecta)*	Visual and Sound	Few
Pyrrhuloxia (*Cardinalis sinuatus)*	Visual and Sound	Few
Gambel's quail (*Callipepla gambelii)*	Visual and Sound	Few
Mammals		
Gopher (*Thomomys sp.)*	Mounds	Few
Coyote (*Canis latrans)*	Tracks	Few
American badger (*Taxidea taxus)*	Burrow, grubbing and tracks	Several
Mule deer (*Odocoileus hemionus)*	Scat	Few
Black-tailed jackrabbit (*Lepus californicus)*	Visual and Scat	Several
Cottontail (*Sylvilagus auduboni)*	Visual and Scat	Few
Rock Squirrel (*Spermophilus variegatus)*	Burrow	Few
Reptiles		
Fence lizard (*Sceloporus undulatus)*	Visual	One
Checkered whiptail (*Cnemidophorus tesselatus)*	Visual	Few
New Mexico whiptail (*Cnemidophorus neomexicanus)*	Visual	One
Side blotched lizard (*Uta stansburiana)*	Visual	Few
Texas horned lizard (*Phrynosoma cornutum)*	Visual	Few

Wildlife species observed within the project area, continued

Species	Type of Observation	Abundance[1]
Reptiles, continued		
Gopher snake (*Pituophis melanoleucus*)	Visual	One
Western Diamondback rattlesnake (*Crotalus atrox*)	Visual	One
Little striped whiptail (*Cnemidophorus inornatus*)	Visual	Several

[1] One = one individual; Few = two to 10 individuals; Several = 11 to 24 individuals; Many = ≥ 25 individuals

Federally-listed TES with the potential to occur in Otero County

Species	Status[1]	Known Distribution and Habitat Needs	Likelihood of Occurrence in Project Area
Mammals			
Black-footed ferret *Mustela nigripes*	E	Closely sympatric with prairie dogs. All viable breeding populations (although not all records) have been associated with prairie dog colonies, which are used for food and shelter.	Unlikely to occur – no suitable habitat or prey base located in the project area.
Birds			
Least tern *Sterna antillarum*	E	Nests on the ground, typically on sites that are sandy and relatively free of vegetation. Areas such as sandbars are used in rivers, and beaches and spits in coastal areas. In New Mexico, alkali flats are selected for nesting.	Unlikely to occur – no suitable nesting, foraging, or resting habitat located within the project area.
Northern aplomado falcon *Falco femoralis septentrionalis*	E	Prefers grassy plains interspersed with mesquite, cactus, and yucca. Territories located in desert grassland/savanna.	Unlikely to occur – no suitable habitat
Southwestern willow flycatcher *Empidonax traillii extimus*	E	Found in close association with dense groves of willows, arrowweed, buttonbush, tamarisk, Russian olive, and some other riparian vegetation, often with a scattered overstory of cottonwood. Breeds in riparian habitats—along rivers, streams, and other wetlands.	Occurrence possible – suitable nesting, foraging, or resting habitat located within the project area.
Mexican spotted owl *Strix occidentalis lucida*	T	Dependent on the presence of large trees, snags, down logs, dense canopy cover, and multi-storied conditions within predominantly mixed-conifer and pine-oak habitats.	Unlikely to occur – no suitable nesting, foraging, or resting habitat located within the project area. No designated critical habitat located within the project area.

[1] E= Endangered species; T= Threatened species

11 **Special status species with the potential to occur in Otero County**

Species	Status[1]	Known distribution and habitat needs	Likelihood of Occurrence in the Project Area
Mammals			
Spotted bat *Euderma maculatum*	NMT, BLMS	Riparian communities, piñon-juniper woodlands, ponderosa pine and spruce-fir forests	Occurrence Possible - suitable habitat within the project's region of influence
Cave myotis bat *Myotis velifer*	BLMS	Shortgrass plains, sacaton grasslands, sycamore, cotton- wood, rabbitbrush, oak savanna, never more than a few miles from water	Occurrence Possible
Long-legged myotis bat *Myotis volans interior*	BLMS	Sycamore, cottonwood, and rabbitbrush riparian habitats; primarily montane, but more common in lowlands during migration	Unlikely to occur - no suitable habitat within the project area
Fringed myotis bat *Myotis thysanodes thysanodes*	BLMS	Desert-scrub, oak-woodland, oak-juniper, piñon-juniper, ponderosa pine, spruce-fir, deciduous and coniferous riparian	Occurrence Possible
Pale Townsend's big-eared bat *Plecotus townsendii pallescens*	BLMS	Xeric to mesic habitats, including desert scrub, sagebrush, chaparral, deciduous and coniferous forests	Occurrence Possible
Big free-tailed bat *Nyctinomops macrotis*	BLMS	Coniferous and mixed woodland, sycamore, cottonwood, and rabbitbrush riparian habitats; rocky cliffs for roosting	Unlikely to occur - no suitable habitat within the project area
Penasco least chipmunk *Tamias minimus atristriatus*	NME	Mesic meadows and herbaceous riparian communities adjacent to agricultural fields, ponderosa pine, and juniper woodlands, high elevation talus slopes and glacial cirques	Unlikely to occur - no suitable habitat within the project area
Gray-footed chipmunk *Tamias canipes sacramentoensis*	BLMS	Forests upward from piñon-juniper to spruce-fir, downed logs at the edge of clearings, dense stands of mixed timber, brushy hillsides	Unlikely to occur - no suitable habitat within the project area
Gray-footed chipmunk *Tamias canipes canipes*	BLMS	Primarily forest dwelling, upward from piñon-juniper to spruce-fir, downed logs at the edge of clearings, dense stands of mixed timber, brushy hillsides	Unlikely to occur - no suitable habitat within the project area
Botta's or Guadalupe pocket gopher *Thomomys bottae guadalupensis*	BLMS	Moderate to high elevations within Guadalupe National Park; shallow, rocky soil often in association with *Agave lecheguilla*	Unlikely to occur - no suitable habitat within the project area and outside the species geographic range
Desert pocket gopher *Geomys arenarius brevirostris*	BLMS	Barren land indicative of sand dunes, sandy or loamy soils of the White Sands area	Occurrence Possible

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13 **Special status species with the potential to occur in Otero County, continued**

Species	Status[1]	Known distribution and habitat needs	Likelihood of Occurrence in the Project Area
Mammals, continued			
New Mexico meadow jumping mouse *Zapus hudsonius luteus*	NMT, BLMS	Riparian and wetland habitats characterized by spikerush, sedges, and rushes; close proximity to permanent water	Occurrence Possible - suitable habitat within the project's region of influence
Plains pocket mouse *Perognathus flavescens qypsi*	NMS	Has been found to inhabit Plains-Mesa Sand Scrub habitat in New Mexico; white or pale plains pocket mice have a particular association with the gypsum sands of the White Sands area	Occurrence Possible - suitable habitat within the project's region of influence
White Sands woodrat* *Neotoma micropus leucophaea* *This subspecies is now considered to be the Southern Plains Woodrat *Neotoma micropus canescens*	USFWS S	Typical of Plains-Mesa Grasslands in New Mexico; White or pale southern plains woodrats have a particular association with the gypsum sands of the White Sands area	Occurrence Possible - suitable habitat within the project's region of influence
Common hog-nosed skunk (*Conepatus mesoleucus*)	NMS	Inhabits 7 ecozones in Chihuahuan Desert Scrub habitat in New Mexico; preferred habitat has rocky areas that are used for denning	Occurrence Possible - suitable habitat within the project's region of influence
Desert bighorn sheep *Ovis canadensis mexicena*	Status not defined for Otero County	Desert bighorn tended to be within 1 mi (1.6 km) of a water source. Sheep preferred grass/desert shrub and live oak communities and avoided grassland and pinon pine-juniper communities.	No longer occurs in Otero County
Birds			
Baird's sparrow *Ammodramus bairdii*	NMT, BLMS	Shortgrass prairie, desert grassland	Occurrence Possible
Brown pelican *Pelecanus occidentalis carolinensis*	NME	Coastal, large lakes, major rivers, occasional visitor to inland New Mexico	Unlikely to occur - no suitable habitat within the project area
Neotropic cormorant *Phalacrocorax brasilianus*	NMT	Larger water bodies with stands of trees or shrubs	Unlikely to occur - no suitable habitat within the project area
Peregrine falcon *Falco peregrinus*	USFWS S	In New Mexico, the breeding territories of peregrine falcons center on cliffs that are in wooded/forested habitats. Sporadic occurrence in Bernardo and La Joya refuges -- in association with open expanses of water.	Occurrence Possible - suitable habitat within the project's region of influence
White-faced ibis *Plegadis chihi*	BLMS	Shoreline, marsh habitats bordered by open water, desert streams with a narrow band of trees and shrubs along the margins, reservoir habitats	Occurrence Possible - suitable habitat within the project's region of influence

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15 **Special status species with the potential to occur in Otero County, continued**

Species	Status[1]	Known distribution and habitat needs	Likelihood of Occurrence in the Project Area
Birds, continued			
Northern goshawk *Accipiter gentilis*	BLMS	Mature, closed canopied coniferous forests of mountains and high mesas	Unlikely to occur - no suitable habitat within the project area
Ferruginous hawk *Buteo regalis*	BLMS	Grassland, semidesert grass-shrub, sagebrush-grass, piñon-juniper, open country, prairies, plains, badlands	Occurrence Possible
Black tern *Chlidonias niger surinamensis*	BLMS	Prairie wetlands, taiga bogs, marshes, rivers, riparian woodlands, subalpine marsh	Unlikely to occur - no suitable habitat within the project area
Western burrowing owl *Athene cunicularia hypugaea*	BLMS	Grasslands, prairies, or open areas near human habitation, especially golf courses and airports, open stands of creosote bush and large succulents	Observed
Elegant trogon *Trogon elegans canescens*	NME	Arid shrublands up into pine-oak woodland, broadleaf woodlands in montane canyons, cottonwood woodlands where desert streams provide sufficient moisture for a narrow band of trees and shrubs along the margins	Unlikely to occur - no suitable habitat within the project area
Loggerhead shrike *Lanius ludovicianus*	BLMS	Agricultural land, prairies, montane meadows, sagebrush, desert scrub, piñon-juniper woodlands, and woodland edge; open stands of creosote bush and large succulents	Observed
Common ground dove *Columbina passerina pallescens*	NME	Agricultural and undeveloped areas at elevations below 5,400 feet; open stands of creosote bush and large succulents	Occurrence Possible - suitable habitat within the project's region of influence
Gray vireo *Vireo vicinior*	NMT	Arid juniper woodlands on foothills and mesas usually with a well-developed grass component	Unlikely to occur - no suitable habitat within the project area
Mountain Plover *Charadrius montanus*	NMS USFWS	Shortgrass prairies and dry playas dominated by blue grama and buffalo grass and scattered taller vegetation during the breeding season; appears to require some degree of bare ground, which may be provided by livestock grazing, prairie dog towns, disturbed areas around windmills and water tanks, and barren playas	Occurrence Possible - suitable habitat within the project's region of influence
Varied bunting *Passerina versicolor*	NMT	Shrublands, second growth, dense stands of mesquite in canyon bottoms	Unlikely to occur - no suitable habitat within the project area

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Special status species with the potential to occur in Otero County, continued

Species	Status[1]	Known distribution and habitat needs	Likelihood of Occurrence in the Project Area
Birds, continued			
Yellow-billed cuckoo *Coccyzus americanus*	USFWS S	Western race associated with lowland deciduous woodlands, willow and alder thickets, second-growth woods, deserted farmlands, and orchards; Chihuahuan Desert Scrub, open stands of creosotebush and large succulents in southern New Mexico and southwest Texas	Occurrence Possible - suitable habitat within the project's region of influence
Reptiles and Amphibians			
Mottled rock rattlesnake *Crotalus lepidus lepidus*	NMT	Rocky canyons or hillsides in pine-oak forests, mesquite-grasslands, and desert; talus slopes	Occurrence Possible
Sacramento Mountain salamander *Aneides hardii*	NMT	Douglas fir and spruce forests at elevations from 7,850-11,700 feet	Unlikely to occur - no suitable habitat and outside of species altitudinal range at project location
Texas horned lizard *Phrynosoma cornutum*	BLMS	Arid and semiarid open country with loose soil supporting bunchgrass, cactus, juniper, mesquite, or acacia	Observed
Fishes			
White Sands pupfish *Cyprinodon tularosa*	NMT	Fine mud-silt and sand-gravel bottoms of clear, shallow, strongly alkaline pools and streams with saltgrass and salt cedar along the border; endemic to the Tularosa Basin	Unlikely to occur – known populations are outside of project's region of influence
Invertebrates			
Woodlandsnail *Ashmunella amblya cornudasensis*	BLMS	Igneous-rock talus, where woody plants consist of shrubs and some low junipers and live oaks, which provide sparse leaf litter	Unlikely to occur - no suitable habitat within the project area
Sacramento Mountains blue butterfly *Icaricia icarioides*	USFWS S	Known to occur in Otero County; distribution and habitat needs not completely known; high likelihood of occurrence restricted to the geographic limits of the Sacramento Mountains (outside of the project area)	Occurrence Possible - suitable habitat within the project's region of influence

[1] NME = listed as endangered by the State of New Mexico; NMT = listed as threatened by the State of New Mexico; BLMS = listed as sensitive by the Bureau of Land Management; USFWSS = listed as a species of concern by the US Fish and Wildlife Service

Descriptions of Special Status Wildlife Species with the Potential to Occur at the Proposed Project Location.

Cave Myotis Bat (Myotis velifer)

Both the State of New Mexico and the Bureau of Land Management list the cave myotis bat as a Sensitive Species (USFWS 2005a; NMDGF 2003). Of North America's bats, cave myotis appear to be among the most dependent on the availability of abandoned or inactive mines (Snow et al. 1993). This is a desert and grassland bat that frequents watercourses and roosts primarily in caves, although occasionally it will be found in man-made structures. In New Mexico the uninhabited Rio Grande Valley divides the range of the species into two disjunct areas. Our highest record of occurrence is from 5,200 feet (Findley et al. 1975). Cave myotis inhabit mineshafts, tunnels, caves, and even under bridges in the desert areas of creosote bush, palo verde, brittlebush, and cacti of Arizona. Even though they are found in xeric areas, they are never more than a few miles from some water source such as tanks, canals, or creeks. Within mine shafts or tunnels, cave myotis are usually near the entrance. Thus, tunnels as short as 100 feet may be useable by these bats (Hoffmeister 1986). Since reopening abandoned or inactivated mines can negatively affect bat colonies, it has been recommended that multi-seasonal surveys be conducted prior to allowing any renewed mining. Human disturbance can be extremely detrimental to bat colonies, especially to non-volant young and hibernating adults, depending on the season and severity of the disturbance. Mines that are in close proximity to roads, towns, hiking trails or camp grounds are more susceptible to disturbance than those in remote areas with difficult access (Snow et al. 1993). This species is considered uncommon within the White Sands Missile Range, and was documented there in 1989 (Burkett and Kamees 1996a).

Fringed myotis bat (Myotis thysanodes thysanodes)

The fringed myotis bat is considered a Sensitive Species by the State of New Mexico and by the Bureau of Land Management (NMDGF 2003). Fringed myotis are found from chaparral to ponderosa pine, but the preferred habitat is probably the oak woodland, from which they forage out into a variety of other habitats (Hoffmeister 1986). Fringed myotis have been noted to roost in colonies in ponderosa pine snags of 23 - 33 inches diameter breast height (DBH) (Green et al. 1994). This species has commonly been recorded roosting and breeding in caves and buildings. In fact, the majority of our specimens come from roosts, although many have been taken in mist nets over water holes (Findley et al. 1975). Fringed myotis nursery colonies have been found in caves and abandoned mines as well as beneath exfoliating bark of 150-350 year old ponderosa snags (Tuttle 1996). Fringed myotis maternity roosts have been found in ponderosa pine snags and in live ponderosa pines with long, vertical cracks and loose bark. Such cracks are likely the product of lightning strikes (Chung-MacCoubrey 1995). To manage snags for bats, sufficient numbers of large trees should be retained and allowed to die in place. All existing snags should be preserved. Fuelwood cutting of large snags is of particular concern. Because roosts under exfoliating bark may be relatively short-lived resources, bats may require higher snag densities than birds (2.6 snags/acre may not be adequate). Where snag density and natural snag recruitment is not adequate, it may be necessary to kill large trees to maintain adequate densities of suitable snags (Rabe, 1997). This species commonly occurs within at least portions of the White Sands Missile Range (Burkett and Kamees 1996a).

Spotted Bat (Euderma maculatum)

The spotted bat is currently listed as a Sensitive Species by the Bureau of Land Management, and threatened by the State of New Mexico (USFWS 2005a; NMDGF 2003). Spotted bats are migrants of the Lincoln National Forest (USFS, 1995). This species may occur and should be sought in the Tularosa Mountains, Corner Mountains, and Beaverdam Canyon, NM (Frey, 1995). Spotted bats have been observed on a building at Holloman Air Force Base, summer, 1994 (NMNHP, 1996). New Mexico records of spotted bats are only from warmer months (April - September), though Ruffner et al. (1979) captured several specimens in Utah in January and February (NMDGF, 1996). Spotted bats are a "probable" species within the White Sands Missile Range. Although this species has not been recorded on WSMR, collections near Soccoro and Mesilla Park indicate wanderers through WSMR are likely (Burkett and Kamees, 1996). The animal has been captured in ponderosa pine of montane forests, pinon-juniper woodlands, and open semidesert shrublands. Rocky cliffs are necessary to provide suitable cracks and crevices for roosting, as is access to water. The animals show apparent seasonal change in habitat, occupying ponderosa pine woodlands in the reproductive season and lower elevations at other times of the year.

Townsend's big-eared bat (Plecotus townsendii pallescens)

The Townsend's big-eared bat is currently listed as a Sensitive Species by the Bureau of Land Management, the State of New Mexico, and the USFWS (USFWS 2005a; NMDGF 2003). Of North America's bats, Townsend's big-eared bats appear to be among the most dependent on the availability of abandoned or inactive mines (Snow et al. 1993). With few exceptions the specimens of this species that we have taken in New Mexico have come from caves, rock shelters, or mines. It is the only species of New Mexican bat that may regularly be found in winter. During that season big-eared bats are often located in caves and mine shafts (Findley et al. 1975). Population concentrations occur in areas with substantial surface exposures of cavity forming rock (e.g., limestone, sandstone, gypsum or volcanic), and in old mining districts (Idaho State 1995). Townsend's big-eared bat is primarily a cave dwelling species, which also roosts in man-made cave analogues, especially old mine workings. In some areas, it has been found in old, mostly abandoned buildings with cave-like attics and other man-made structures (e.g. water diversion tunnels and bridges) (Idaho State 1995). Because of its extreme sensitivity to human disturbance, vandalism of roost caves by recreationists, and its low reproductive rate, the Townsend's big-eared bat is a species that requires special protection (Finch 1992). The presence of suitable shelters seems to be one of the important limiting factors (Snow et al. 1993). This species commonly occurs within the White Sands Missile Range (WSMR), and is a fairly common inhabitant of WSMR year-round (Burkett and Kamees 1996a).

Desert pocket gopher (Geomys bursarius arenarius)

This subspecies of the desert pocket gopher is considered a Sensitive Species by the State of New Mexico and by the USFWS (USFWS 2005a; NMDGF 2003). It is commonly associated with barren land designations indicative of sand dunes (USFWS 2003). This pocket gopher is isolated in sandy or loamy soils of the White Sands area (Findley et al. 1975). Marginal distribution records include -- New Mexico: 5 miles south, 11.8 miles east of San Antonio; type

locality; 10 miles southwest of Tularosa; 18 miles west of Alamogordo. These records occur in Otero and Socorro counties (Hall 1981). Pocket gophers spend most of their time underground maintaining a complex burrow system. As such, habitat for gophers is typically defined by preferred soil type within their range, and they can be expected to occur anywhere that soil conditions meet those criteria.

Botta's pocket gopher also known as ***Guadalupe Pocket Gopher (Thomomys bottae guadalupensis)***

The Botta's pocket gopher is considered a Sensitive Species by the State of New Mexico (NMDGF 2003). This species is commonly associated with several variations of Chihuahuan Desert habitat year-round, dependent on the dominant plant species. Chihuahuan Desert dominated by both creosotebush and tarbush/mesquite/ocotillo experience casual use by the Botta's pocket gopher. Chihuahuan Desert Grassland dominated by tabosa/sacaton will also have casual use by this species, and this habitat type dominated by black grama seems to be the most important or most used by this pocket gopher (BISON 2004). The holotype specimen of Botta's pocket gopher was collected at Cook Ranch, 1/2 mile west of Tularosa, Otero County, New Mexico (Frey 1996). Pocket gophers spend most of their time underground maintaining a complex burrow system. As such, habitat for gophers is typically defined by preferred soil type within their range, and they can be expected to occur anywhere that soil conditions meet those criteria.

Desert pocket gopher (Geomys arenarius arenarius)

This subspecies of the desert pocket gopher is considered a Sensitive Species by the Bureau of Land Management (NMDGF 2003). Plains pocket gophers are typical of Plains-Mesa Grasslands and Sand Scrub habitat in New Mexico (Frey and Yates 1996). This species is commonly associated with barren land designation indicative of sand. (Frey, 1999). Near El Paso, Texas these gophers are especially common along irrigation ditches in the sandy river-bottom area. They seemingly cannot tolerate clayey or gravelly soils, a characteristic common to all species of Geomys (Davis & Schmidly 1994). Plains pocket gophers occupy grasslands over the Great Plains as well as the margins of agricultural lands. ... Habitat includes borrow pits, roadside edges, agri-systems, and lands with plant communities influenced by drought (Fitzgerald et al. 1994). In the eastern plains where other subspecies of this species occurs, it is most common in soft alluvial soils of arroyo bottoms and flood plains (Findley et al. 1975). Plowing or disking for agriculture destroys habitat through burrow destruction (Downhower and Hall 1996). This species is isolated in sandy or loamy soils of the White Sands area, the lower Rio Grande Valley, and the eastern half of the Deming Plain. Most of the range of the desert pocket gopher, in fact, lies in New Mexico. In Texas it occurs only in El Paso and Hudspeth counties along the Rio Grande, while in Chihuahua it occurs only for a few miles south of Ciudad Juarez (Findley et al. 1975; Davis and Schmidly 1994).

New Mexico meadow jumping mouse (Zapus hudsonius luteus)

The New Mexico meadow jumping mouse is listed as Threatened by the State of New Mexico, and/or considered Sensitive by the USFWS and the Bureau of Land Management (NMDGF 2003). The meadow jumping mouse is uncommon in wetland impoundments and canal banks of the Bosque del Apache National Wildlife Refuge (Stolz and Najera, 1994). Meadow jumping mice captures (in a study at Bosque del Apache) were often associated with a grass perennial forb community with at least 65% vegetative cover (Zwank, 1994). *Z.h.luteus* habitat in the Guadalupe River drainage of the Jemez Mountains may be characterized as the narrow grass-forb-willow streamside riparian zone along permanent waterways, and is described in Morrison (1990). In some areas, such as Bosque del Apache NWR, the subspecies inhabits narrow riparian zones along irrigation ditches (Morrison, 1992).

Plains pocket mouse (Perognathus flavescens qypsi)

The State of New Mexico lists the plains pocket mouse as a Sensitive Species (NMDGF 2003). Plains pocket mice have been found to inhabit Plains-Mesa Sand Scrub habitat in New Mexico, and this species has a particular association with the gypsum sands of the White Sands area in New Mexico (Frey and Yates 1996). The plains pocket mouse is commonly associated with barren land designation indicative of sand dunes (Frey 1999). Marginal distribution records for the subspecies include – New Mexico: 14 miles west of Tularosa; 10 miles southwest of Tularosa; type locality; and 18 miles southwest of Alamogordo (Hall 1981).

Common hog-nosed skunk (Conepatus mesoleucus)

The common hog-nosed skunk is considered a Sensitive Species by the State of New Mexico (NMDGF 2003). Common hog-nosed skunks have been found to inhabit Chihuahuan Desert Scrub habitat in New Mexico (Frey and Yates 1996). Hog-nosed skunks occur in southern New Mexico from creosote desert to at least pine-oak forest, where we saw signs of their activity on Animas Peak, Hidalgo County. They are most common in warm woodland, grassland, and desert (Findley et al. 1975). These skunks take refuge during the day in holes in the ground, crevices in rocks, or in caves (Hoffmeister 1986). This species is rare in the White Sands National Monument. They frequent both marginal and interior dunes (WSNM 1993). The Hog-nosed skunk is uncommon within the White Sands Missile Range (Burkett and Kamees 1996a).

White Sands woodrat (Neotoma micropus leucophaea)

The White Sands woodrat is currently listed as a Species of Concern by the USFWS (USFWS 2005a). White Sands woodrat is a grassland species that is often found far from rocky habitats. It may live around the bases of chollas or in burrows along the sides of arroyos or at the bases of shrubs (Findley et al. 1975). Plains woodrats from the area formerly considered the range for the "White Sands" subspecies (no longer considered a separate taxon for the surrounding subspecies) build nests in burrows that they construct beneath allthorn (Koeberlinea sp.) bushes. They do not construct the stick houses typical of the species elsewhere (Bogan 1996). Near Tularosa, Gaut found them common along the irrigation ditches and over the low foothills along the edge of the valley, and he found old houses near the salt marshes and lava beds in the middle part of the

valley (Bailey 1931). Overgrazing observed to increase abundance of cactus and thus favor abundance of this species (Finley 1958; Birney 1973). The southern plains woodrat is common in the White Sands National Monument (WSNM 1993). The subspecies occurred in White Sands Missile Range (NM Military Lands), and White Sands National Monument, (Park Service Lands). Distribution was considered "very limited" (Patton 1994).

Desert bighorn sheep (Ovis canadensis mexicana)

No description provided, species no longer occurs in Otero County.

Peregrine falcon (Falco peregrinus)

The full species Falco peregrinus and all subspecies are listed as Threatened by the State of New Mexico, and/or considered Sensitive by the USFWS, and is protected under the MBTA (USFWS 2005a; NMDGF 2003; MBTA 1918). These birds occupy non-riparian habitats exclusively or nearly so in the breeding season, except for drinking and bathing (Schmitt, 1976). Peregrine falcons are listed rare migrants at the White Sands National Monument of Dona Ana and Otero counties (WSNM, 1993). The peregrine falcon was listed as a rare species, occurring mainly in the breeding months (March-August), at the White Sands Missile Range (Kamees and Burkett, 1996).Peregrine Falcons are a rare transient on Holloman Air Force Base from April to May and from July to October (MVAS, 1996).

White-faced ibis (Plegadis chihi)

The white-faced ibis is listed as Sensitive by the Bureau of Land Management (NMDGF 2003). White-faced Ibis are occasional migrants at the White Sands National Monument, in Dona Ana and Otero counties (USFWS, 1980). The white-faced ibis was listed as a rare species, occurring during the summer months, at the White Sands Missile Range (Kamees and Burkett, 1996). The white-faced ibis is an uncommon resident on Holloman Air Force Base during the months of April, August, and Spetember; it is a rare resident during May through July and October (MVAS, 1996). White-faced Ibis were generally seen in association with shoreline and marsh habitats that bordered open water. Vegetation within these areas often consisted of cattails and rushes, but other plant species (including occasional woody shrub and tree sp.) were frequently present. Nesting colonies are located in shrubs and low trees or in dense standing reeds and tules near or in marshes. Desert Riparian Deciduous Woodland, Marsh. Woodlands, especially of cottonwoods, that occur where desert streams provide sufficient moisture for a narrow band of trees and shrubs along the margins. Annual Grasslands, Farms. Grasslands dominated by wild oat (Avena spp.) ripgut brome (Bromus rigidus), soft chess (Bromus mollis), bur clover (Medicago hispida), and filaree (Erodium spp.) with less than 5 percent woody cover.

Baird's sparrow (Ammodramus bairdii)

The Baird's sparrow is listed as Threatened by the State of New Mexico, is considered Sensitive by the Bureau of Land Management and the USFWS, and is protected under the MBTA (USFWS 2005a; NMDGF 2003; MBTA 1918). This is a retiring sparrow of grasslands. In New

Mexico it has been found in a variety of habitats, ranging from desert grasslands in the south to prairies in the northeast and mountain meadows in the San Juan and Sangre de Cristo mountains--including to an elevation of approximately 11,800 feet (NMDGF 1988). Baird's sparrows are commonly found in grasslands at lower elevations (2800-5500 feet) (Hubbard 1978). Baird's sparrows using grasslands of the North American Great Plains and Southwest for breeding and/or wintering usually respond negatively to grazing (Bock et al. 1992). The species may be susceptible to habitat alterations brought about by agriculture and plowing of native prairie (Finch 1992). In particular, range improvement practices are needed that would leave more cover for the sparrows, as well as to allow for greater production of grass seeds (NMDGF 1988). Baird's sparrows are rare winter residents at the White Sands National Monument, in Dona Ana and Otero counties (WSNM 1993).

Ferruginous hawk (Buteo regalis)

The Ferruginous hawk is currently listed as a Sensitive Species by the Bureau of Land Management and is protected under the MBTA (USFWS 2005a; NMDGF 2003; MBTA 1918). Ferruginous hawks are an open-country species that inhabit grasslands, shrubsteppes, and the deserts of southwestern North America. These birds seem to show a strong preference for elevated nest sites and may use nesting substrates ranging from trees, cliffs, utility structures, and buildings (Bechard and Schmutz 1995). Occurring within a wide range of elevations (2800 – 7500 ft), ferruginous hawks are year-round residents in northern New Mexico and winter in southern New Mexico (NMDGF 2004; Bechard and Schmutz 1995). In northern United States, the southward migration begins in August and extends to early October and in the spring, the birds return north in late March to early April. The primary prey of ferruginous hawks are rabbits (Lepus spp.), ground squirrels (Spermophilus spp.), and prairie dogs (Cynomys sp.). In winter, ferruginous hawks typically aggregate where ground squirrels and especially prairie dogs are numerous. In the winter, they primarily inhabit grasslands east of the Rocky Mountains, especially where prairie dogs are abundant. West of Rocky Mountains, grassland and arid areas of California, Arizona, and New Mexico are used heavily where prairie dogs, lagomorphs, or pocket gophers (Thomomys spp.) are abundant. Although, population trends indicate a drop in numbers over the last twenty years, it has been suggested that ferruginous hawk populations naturally fluctuate over time as habitat and prey availability change (Hoffman and Smith 2003; Bechard and Schmutz 1995).

Western burrowing owl (Athene cunicularia hypugaea)

The western burrowing owl is listed by the USFWS and the Bureau of Land Management as a Sensitive Species, and is protected under the MBTA (USFWS 2005a; NMDGF 2003; MBTA 1918). The burrowing owl is considered a year-round resident in Otero County and is within its breeding range (NMDGF 2004). Suitable habitat for this species includes open, well-drained grasslands, stands of creosote bush, grasslands, open shrubland, and woodland at elevations between 2,800 and 7,500 feet (855–2,285 m) with abandoned mammal burrows (NMDGF 2004). Burrowing owls are also know to inhabit golf courses, cemeteries, open roads within cities, airports, and vacant lots in residential areas and university campuses (Haug, et al. 1993). Generally, the western burrowing owl breeds between March and July and produces one brood of three to five fledglings (NatureServe 2005). A significant threat on the survival and

reproductive success are believed to be due to direct toxicity by pesticides and other contaminants/toxins. This type of poisoning and others are likely from human efforts to control squirrels and prairie dogs (NMDGF 2004; Haug, et al. 1993). This species was observed at the project location during field surveys in 2005.

Loggerhead shrike (Lanius ludovicianus)

The loggerhead shrike is considered a Sensitive Species by the State of New Mexico and by the Bureau of Land Management, and is protected under the MBTA (USFWS 2005a; NMDGF 2003; MBTA 1918). The loggerhead shrike is considered a resident statewide, with a winter range from eastern New Mexico and western Texas south into Mexico (Pruitt 2000). Loggerhead shrikes were usually seen in relatively xeric habitats dominated by shrubs and desert saltgrass, interspersed with important shrubs such as honey mesquite and four-wing saltbush (Atriplex canescens). Trees were uncommon, but a few screwbean mesquites, saltcedars, or Russian olives were occasionally present. Bare ground was also a key component in some areas. Loggerhead shrikes inhabit open habitats, including shrubland and shrubby grasslands at lower (2,800–5,500 feet [855–1,675 m]) to middle (5,000–7,500 feet [1,525–2,285 m]) elevations (NMDGF 2004). Open country interspersed with improved pastures, grasslands, and hayfields is primary shrike habitat throughout its range. Loggerhead shrike populations have declined in recent decades most likely due to changes in human land-use practices, the spraying of biocides, and competition with species more tolerant of human-induced changes (Yosef 1996). This species was observed at the project location during field surveys in 2004 and 2005.

Common ground dove (Columbina passerina pallescens)

The Common ground-dove is considered Endangered by the State of New Mexico, and is protected under the MBTA (NMDGF 2003; MBTA 1918). Considered rare in Otero County, this dove is mainly a warm-season (April-September) visitor to the southernmost part of the state. It occurs scarcely in the lowermost Rio Grande and Pecos valleys and irregularly northward to the lower Gila Valley and the Socorro area (NMDGF 2004). This species is strongly associated with arid, early-successional open woodlands and shrub or scrub habitats at lower elevations (particularly in riparian areas), but also is found around human habitations, especially irrigated agricultural fields and low-density residential development. This species builds flimsy nests and lays two eggs. It breeds nearly year-round, but breeding appears to peak in response to resource availability. It feeds predominantly on tiny seeds of grasses and weeds, and adults feed nestlings a mixture of seeds and crop milk. Because adults can re-nest rapidly, they have the potential to produce several broods per year; however, the loss of native habitats and/or the absence of water in them may be limiting this dove in the state (NMDGF 2004; Bowman 2002). Despite its relatively large reproductive potential, the common ground-dove has been declining in portions of its North American range. These declines may be associated with habitat losses to agricultural and residential development and to habitat degradation, through fire suppression and the resulting changes in vegetative community structure (Bowman 2002).

Mountain plover (Charadrius montanus)

The mountain plover is considered a Sensitive Species by the State of New Mexico and the USFWS, and is protected under the MBTA (USFWS 2005a; NMDGF 2003; MBTA 1918). This species requires shortgrass prairie or other disturbed ground, such as ephemeral playas, for breeding. A free water source is not necessary. Mountain plovers tend to utilize shortgrass areas with scattered clumps of tall grasses, cow manure, rocks, and a variety of cacti and shrubs (Sager 1996). Excessive hunting and loss of native prairie to agriculture (agricultural conversion of shortgrass prairie) apparently caused contraction of its breeding range by 50% (Graul and Webster 1976). Their survival may be jeopardized by habitat loss from practices like mining and rangeland conversion (Finch 1992). In New Mexico, this species breeds locally in dry, open shortgrass prairie habitats from the eastern plains west locally to central-western areas, and migrates through the state (NMDGF 1994).

Southwestern willow flycatcher (Empidonax traillii extimus)

The southwestern willow flycatcher is listed as Endangered by the State of New Mexico and the USFWS, and is protected under the MBTA (USFWS 2005a; NMDGF 2003; MBTA 1918). The species occurs statewide in spring and autumn migration, while birds presumably of the subspecies E. t. extimus breed in the Chama, Rio Grande, Zuni, San Francisco, Gila, and probably the Hondo (Lincoln Co.) basins and in the San Juan and western Sangre de Cristo mountains; reports of breeding elsewhere are unverified, dubious, or incorrect (Hubbard 1987). The willow flycatcher, Empidonax traillii, was listed as a rare to uncommon species, occurring mainly in the breeding season (March - August), at the White Sands Missile Range (Kamees and Burkett, 1996). The Southwestern willow flycatcher breeds in riparian habitats along rivers, streams, and other wetlands. Although occurring widely in New Mexico during migration, willow flycatchers are confined to riparian woodlands in the breeding season (Hubbard 1987). These habitats are typically dominated by cottonwoods (Populus spp.), often with an understory of small trees or tall shrubs and surface water nearby. The southwestern willow flycatcher occurs in riparian habitats along rivers, streams, or other wetlands, where dense growths of willows (Salix sp.), Baccharis, arrowweed (Pluchea sp.) tamarisk (Tamarix sp.) or other plants are present, often with a scattered overstory of cottonwood (Populus sp.) (Grinnell and Miller 1944, Phillips 1948, Zimmerman 1970, Whitmore 1977, Hubbard 1987, Unitt 1987, Whitfield 1990, Brown and Trosset 1989, Brown 1991).

Yellow-billed cuckoo (Coccyzus americanus)

The yellow-billed cuckoo is listed as a Sensitive Species by the USFWS, and is protected under the MBTA (USFWS 2005a; MBTA 1918). This species breeds in riparian woodlands and similar habitats at lower (2800 - 5500 ft) to middle (5000 - 7500 ft) elevations (Hubbard 1978). Yellow-billed cuckoos can occur in Chihuahuan Desert Scrub characterized by open stands of creosote bush and large succulents (Ferocactus pringlei, Echinocactus platyaconthus) in southern New Mexico and southwest Texas (USFS 1991). Population declines resulting from loss or disturbance of riparian habitat have been consistently reported in the West for this species (Finch 1992). The greatest factors affecting the yellow-billed cuckoo have been the invasion of exotic woody plants into Southwest riparian systems, and clearing of riparian woodlands for

agriculture, fuel, development, and attempts at water conservation (Howe 1986) The yellow-billed cuckoo was listed as a rare species, occurring mainly in the breeding season (March - August) at the White Sands Missile Range (Burkett and Kamees 1996b).

Mottled rock rattlesnake (Crotalus lepidus lepidus)

The mottled rock rattlesnake is considered Threatened by the state of New Mexico (NMDGF 2003). This snake favors rocky habitats (NMDGF 1988), but can also be found in a variety of habitats, including pine-oak forests, mesquite-grasslands, and deserts (Campbell and Lamar 1989). The mottled rock rattlesnake is primarily a mountain dweller, but it also occurs in bordering lowlands in some areas. As the name suggests, this species favors areas of boulders and rocks--including talus slopes with their abundant hiding places (NMDGF 1988). Rock rattlesnakes (Crotalus lepidus) occur between 3900 and 8500 feet in elevation in New Mexico (Degenhardt, et al. 1996). The mottled rock rattlesnake is a montane species, rarely found away from rocky canyons or hillsides (NMDGF 1994). The rock rattlesnake has been verified on the White Sands Missile Range (Burkett 1996).

Texas horned lizard (Phrynosoma cornutum)

The Bureau of Land Management currently lists the Texas horned lizard as a Sensitive Species (NMDGF 2003). This lizard inhabits flat, open, generally dry country with little plant cover, except for bunchgrass and cactus. Strictly terrestrial, this lizard can bury itself in loose soil that is sandy, loamy, or rocky. It seeks shelter under rocks (Garrett and Barker 1987). Texas horned lizards (Phrynosoma cornutum) occur between 3000 and 6900 feet in elevation in New Mexico (Degenhardt, et al. 1996). This lizard occupies arid and semiarid open country with loose soil supporting bunchgrass, cactus, juniper, mesquite, or acacia (Finch 1992). Texas horned lizards are common at the White Sands National Monument, in Dona Ana and Otero counties (WSNM 1993). This species was observed at the project location during field surveys in 2005.

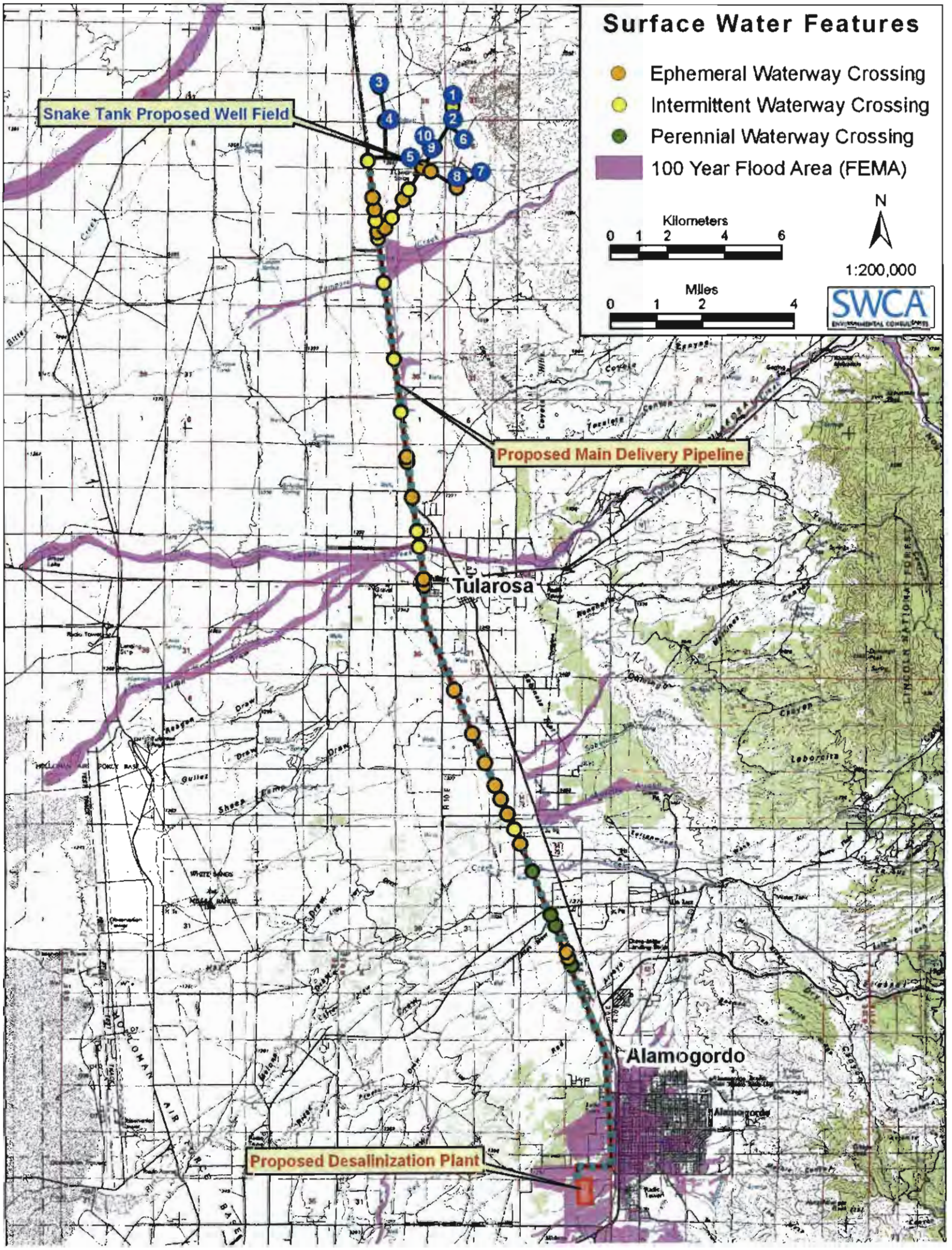
White Sands Pupfish (Cyprinodon tularosa)

The White Sands Pupfish (*Cyprinodon tularosa*) is currently classified as Threatened by the state of New Mexico (19 NMAC 33.1). *Cyprinodon tularosa* may be found in clear shallow pools, 7-20 cm deep, with sand or silt as substrate and strongly alkali (Miller and Echelle 1975 and Sublette et al 1990). The pools are also usually high in salinity, between 15–35 ppt total dissolved salt (Miller and Echelle 1975). White Sands pupfish are omnivorous and usually feed heavily on Culicidae (mosquito larvae) as well as other invertebrates, conspecific eggs and fry, and algae (Suminski 1977). They can live for up to five years and females begin spawning at age one (Jester and Suminski 1982). The pupfish spawn in shallow habitats from mid April, when water temperatures reach 18° C, to mid September with peak spawning during July (Suminski 1977). In a laboratory setting, females were observed releasing 12-15 eggs during a single spawning episode (Suminski 1997) but it is unknown how many spawning episodes a female may have throughout the season. Females have been known to carry up to 6000 eggs (Jester and Suminski 1982). Long-term monitoring data (1995 to present) indicate that the populations fluctuate with available wetted habitat and are stable under conditions over the past 12 years (Stephanie Carman, pers. comm.).

The main threats to White Sands pupfish include nonnative species introductions, dewatering, chemical contamination to habitats, and habitat degradation (Pittenger and Springer 1999; Propst and Pittenger 1994). A conservation plan was constructed in 1994 (Propst and Pittenger 1994) and in 2006, a Cooperative Agreement was signed by representatives of WSMR, HAFB, White Sands National Monument, U.S. Fish and Wildlife Service, and New Mexico Department of Game and Fish (NMDGF 2006).

Sacramento Mountains blue butterfly (Icaricia icarioides)

The Sacramento Mountains blue butterfly is currently listed as a Sensitive Species by the USFWS (USFWS 2005a). The small population in the Sacramento Mountains may warrant description as a separate taxon. This subspecies was listed in Lincoln and Otero Counties in Cary and Holland's 1992 Checklist (Cary and Holland 1992). However, in The Distribution of Butterflies in New Mexico, an unnamed subspecies is listed for these two counties (See account 084097)(Toliver, et al. 1994). This same reference lists three subspecies of Icaricia icariodes: I.i. lycea, I.i. buchholzi, and I.i ssp., which are recognized in New Mexico (Toliver, et al. 1994). Clearly, current information available for this species/subspecies is insufficient to make a concrete determination on location and impacts in relation to the proposed project. It is suspected that these insects are restricted to higher elevations in the Sacramento Mountains, but the possibility of occurrence at the project location cannot be ruled out.


Surface Water Features
Ephemeral Waterway Crossing
Intermittent Waterway Crossing
Perennial Waterway Crossing
100 Year Flood Area (FEMA)
Kilometers
0 1 2 4 6
Miles
0 1 2 4
N
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SWCA
Snake Tank Proposed Well Field
Proposed Main Delivery Pipeline
Tularosa
Alamogordo
Proposed Desalinization Plant
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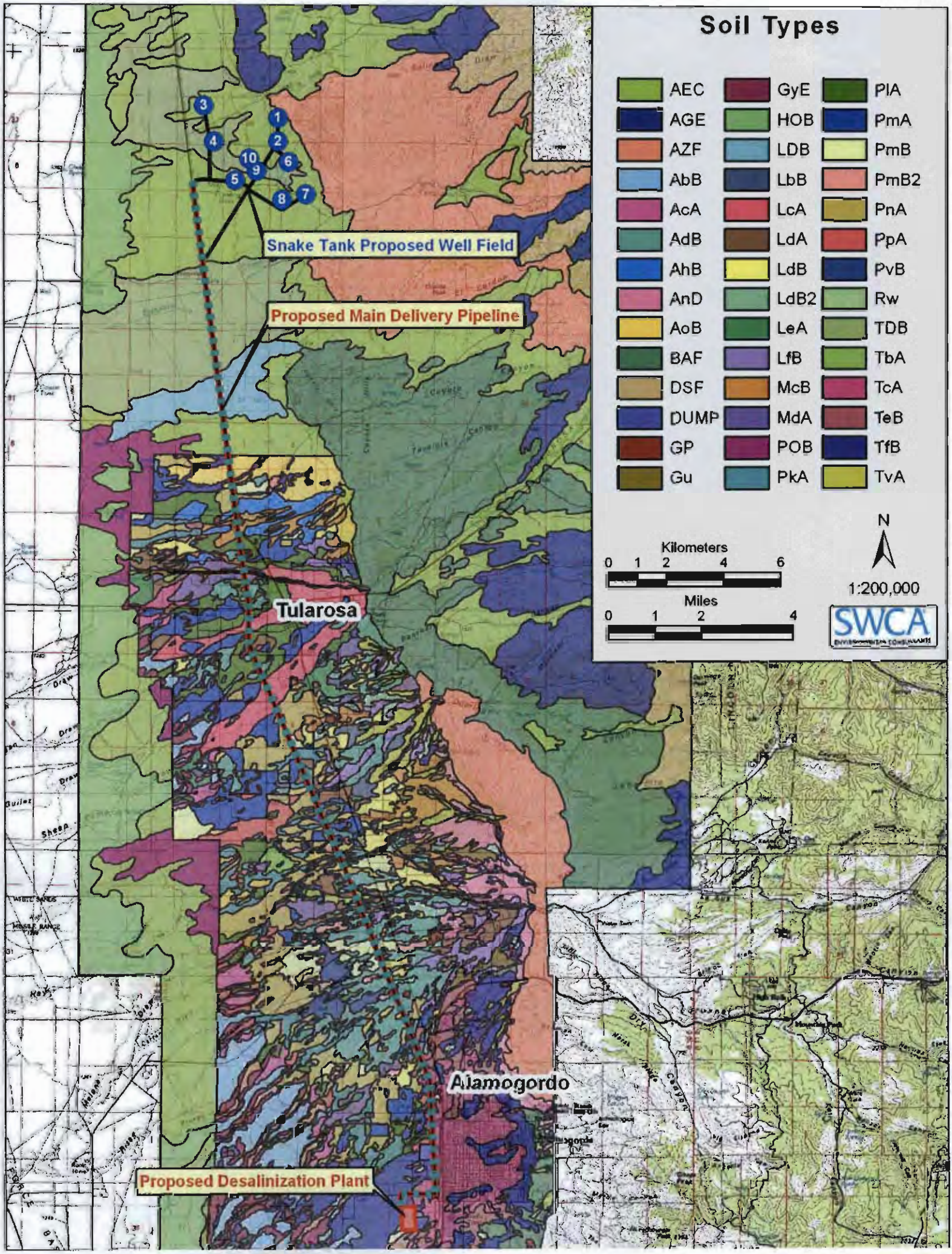
Soil Types
AEC
AGE
AZF
AbB
AcA
AdB
AhB
AnD
AoB
BAF
DSF
DUMP
GP
Gu
GyE
HOB
LDB
LbB
LcA
LdA
LdB
LdB2
LeA
LfB
McB
MdA
POB
PkA
PlA
PmA
PmB
PmB2
PnA
PpA
PvB
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TDB
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TcA
TeB
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TvA
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SWCA
Snake Tank Proposed Well Field
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Tularosa
Alamogordo
Proposed Desalinization Plant
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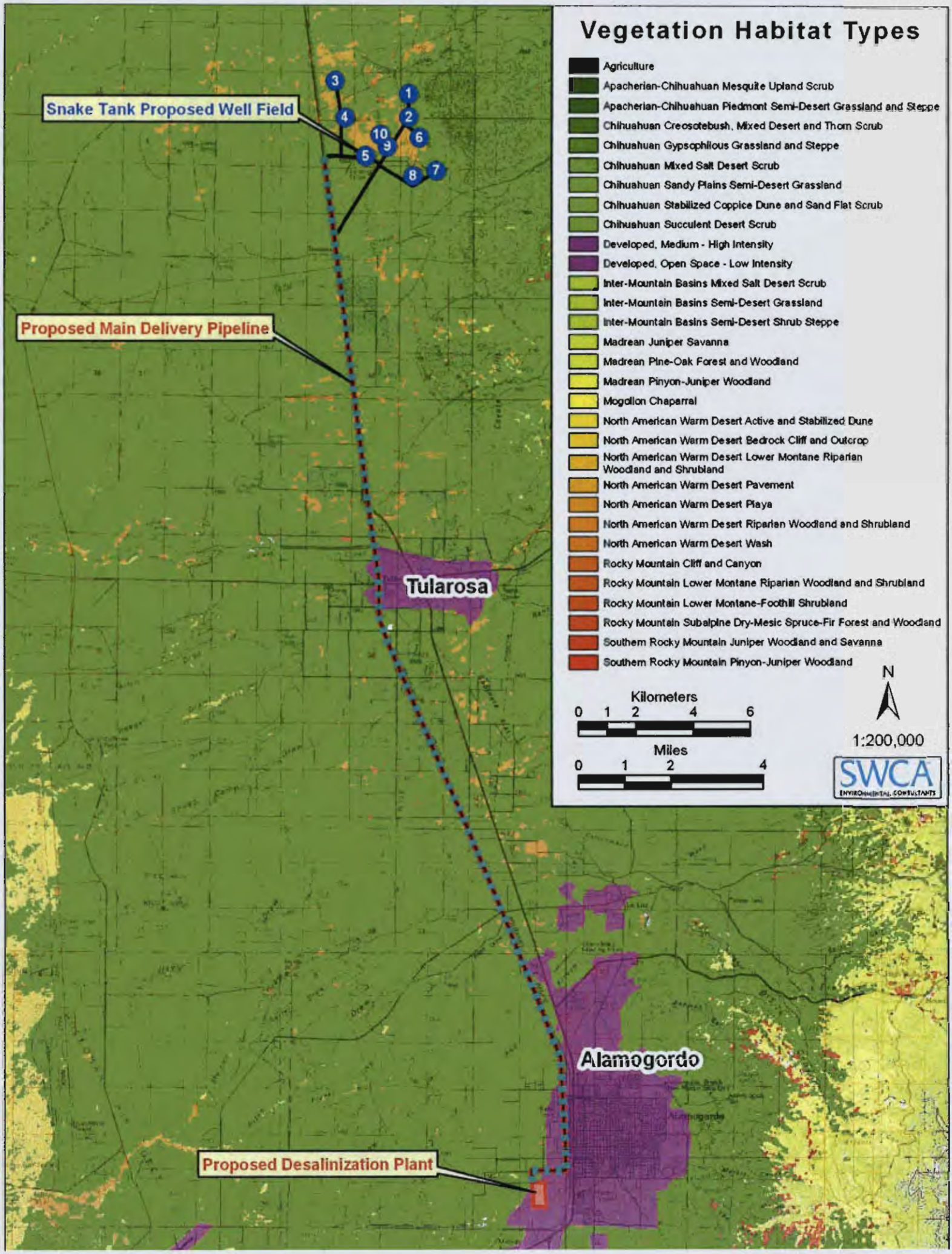
Vegetation Habitat Types
Agriculture
Apacherian-Chihuahuan Mesquite Upland Scrub
Apacherian-Chihuahuan Piedmont Semi-Desert Grassland and Steppe
Chihuahuan Creosotebush, Mixed Desert and Thorn Scrub
Chihuahuan Gypsophilous Grassland and Steppe
Chihuahuan Mixed Salt Desert Scrub
Chihuahuan Sandy Plains Semi-Desert Grassland
Chihuahuan Stabilized Coppice Dune and Sand Flat Scrub
Chihuahuan Succulent Desert Scrub
Developed, Medium - High Intensity
Developed, Open Space - Low Intensity
Inter-Mountain Basins Mixed Salt Desert Scrub
Inter-Mountain Basins Semi-Desert Grassland
Inter-Mountain Basins Semi-Desert Shrub Steppe
Madrean Juniper Savanna
Madrean Pine-Oak Forest and Woodland
Madrean Pinyon-Juniper Woodland
Mogollon Chaparral
North American Warm Desert Active and Stabilized Dune
North American Warm Desert Bedrock Cliff and Outcrop
North American Warm Desert Lower Montane Riparian Woodland and Shrubland
North American Warm Desert Pavement
North American Warm Desert Playa
North American Warm Desert Riparian Woodland and Shrubland
North American Warm Desert Wash
Rocky Mountain Cliff and Canyon
Rocky Mountain Lower Montane Riparian Woodland and Shrubland
Rocky Mountain Lower Montane-Foothill Shrubland
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland
Southern Rocky Mountain Juniper Woodland and Savanna
Southern Rocky Mountain Pinyon-Juniper Woodland
Kilometers
0 1 2 4 6
Miles
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1:200,000
SWCA
ENVIRONMENTAL CONSULTANTS
Snake Tank Proposed Well Field
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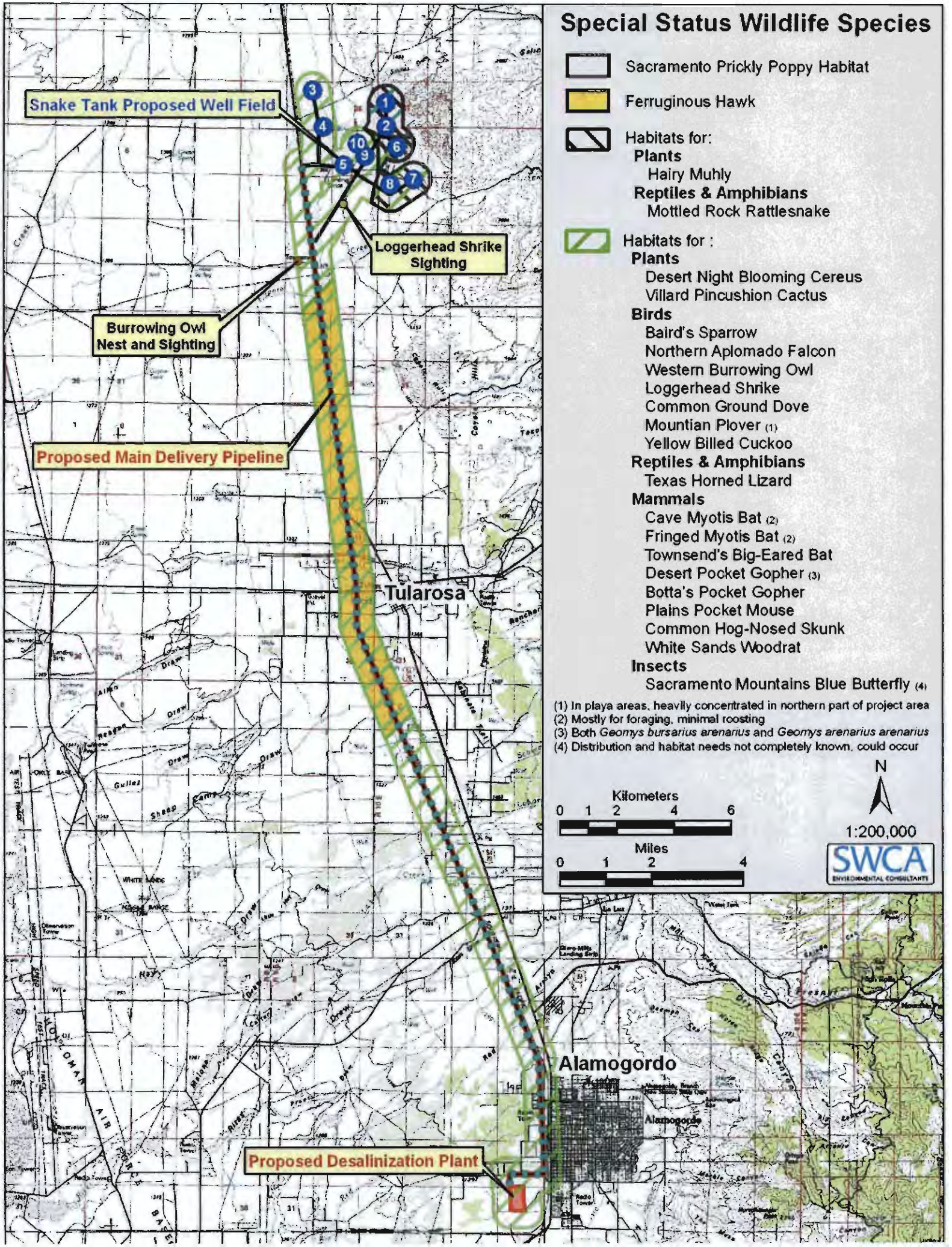
Proposed Main Delivery Pipeline
Tularosa
Alamogordo
Proposed Desalinization Plant


Special Status Wildlife Species
Sacramento Prickly Poppy Habitat
Ferruginous Hawk
Habitats for:
Plants
Hairy Muhly
Reptiles & Amphibians
Mottled Rock Rattlesnake
Habitats for :
Plants
Desert Night Blooming Cereus
Villard Pincushion Cactus
Birds
Baird's Sparrow
Northern Aplomado Falcon
Western Burrowing Owl
Loggerhead Shrike
Common Ground Dove
Mountian Plover (1)
Yellow Billed Cuckoo
Reptiles & Amphibians
Texas Horned Lizard
Mammals
Cave Myotis Bat (2)
Fringed Myotis Bat (2)
Townsend's Big-Eared Bat
Desert Pocket Gopher (3)
Botta's Pocket Gopher
Plains Pocket Mouse
Common Hog-Nosed Skunk
White Sands Woodrat
Insects
Sacramento Mountains Blue Butterfly (4)
(1) In playa areas, heavily concentrated in northern part of project area
(2) Mostly for foraging, minimal roosting
(3) Both Geomys bursarius arenarius and Geomys arenarius arenarius
(4) Distribution and habitat needs not completely known, could occur
N
Kilometers
0 1 2 4 6
Miles
0 1 2 4
1:200,000
SWCA
ENVIRONMENTAL CONSULTANTS
Snake Tank Proposed Well Field
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Loggerhead Shrike Sighting
Burrowing Owl Nest and Sighting
Proposed Main Delivery Pipeline
Tularosa
Alamogordo
Proposed Desalinization Plant

APPENDIX L

BLM Letter to USFWS

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Las Cruces District Office
1800 Marquess
Las Cruces, New Mexico 88005
www.nm.blm.gov

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:

NMNM 115773
6841 (L0310)

APR 1 2009

Memorandum

To: Field Supervisor, U.S. Fish and Wildlife Service, Albuquerque, NM
Attention: Wally J. Murphy

From: District Manger, Las Cruces, BLM, Las Cruces, NM

Subject: Amended Endangered Species Act Coordination and Consultation for the Alamogordo Regional Water Supply Project (SWCA Project No. 7938-149)

On August 23, 2004, SWCA personnel sent a scoping letter to the U.S. Fish and Wildlife Service (FWS) describing the proposed project and requested a list of potentially affected species afforded protection under the Endangered Species Act (ESA). In response, the FWS identified 11 listed or proposed species that could potentially be affected by the project, of which the Sacramento Mountains checkerspot butterfly proposal to list was withdrawn. The SWCA determined that 2 of the 10 remaining species have the potential to occur in the project area: Sacramento prickly poppy and northern aplomado falcon.

On October 4, 2006, a letter and biological assessment were sent to FWS requesting concurrence for the affects determinations of May Affect, Not Likely to Adversely Affect on the Sacramento prickly poppy and the northern aplomado falcon.

Since the time of the original letter of October 4, 2006, asking for concurrence, the Proposed Alamogordo Regional Water Supply Project Draft EIS has changed its original proposed action. The desalination plant has now been moved into the City of Alamogordo and no longer located on State land as originally planned. In addition, the desalination ponds are no longer part of the proposed action because the project proposes a re-injection process. The relocation of the desalination plant and the removal of the desalination ponds would eliminate impacts to grassland habitat and ultimately to the aplomado falcon (see attached map).

The impacts analysis for the Sacramento prickly poppy also has changed. The Bureau of Land Management (BLM) is changing the affects determination from May Affect, Not Likely to Adversely Affect, to No Affect. The determination change is based on the fact that the well field locations are located approximately 17 miles north of the northern-most known population of the subspecies occurring in Fresnal Canyon near La Luz, New Mexico. As you know, the subspecies is endemic to habitats on and immediately adjacent to the western escarpment of the

Sacramento Mountains from Fresnal Canyon south to Dog Canyon. Areas within the proposal are well away from known and potential habitat.

The revised Draft EIS recognizes the southwestern willow flycatcher (SWWF) as a species that could potentially occur in the project area. The SWWF was not included in the original biological assessment, dated November 2005, that was sent to your office. The proposed locations of the well pads are not in or within a 5-mile radius of any large riparian areas that could be considered SWWF habitat. Therefore, the proposed action will not affect the SWWF.

The BLM finds that the proposed Alamogordo Regional Water Supply Project would not affect the Sacramento prickly poppy. In addition, based on the new information contained in the Draft EIS, the BLM makes a determination of No Affect on the SWWF, and changes its determination of May Affect, But is Not Likely to Adversely Affect, to No Affect on the northern aplomado falcon.

As the lead Federal agency, the BLM is requesting to remand the concurrence request from the letter dated October 4, 2006. In addition, we are informing you on the change of determination of May Affect, Not Likely to Adversely Affect on the Sacramento prickly poppy to No Affect. All conservation measures set forth in the biological assessment, including additional surveys for Sacramento prickly poppy will no longer be required to minimize impacts.

The BLM is the lead Federal agency for compliance with National Environmental Policy Act, as well as the lead for compliance with Section 7 of the ESA. Joseph Fluder of SWCA Environmental Consultants is the consultants' Lead for this project.

Please feel free to contact Margarita Guzman, BLM Advisor, at (575) 525-4339; Lorraine Salas, Realty Specialist Project Lead, at (575) 525-4388; or Joseph Fluder of SWCA Environmental Consultants at (575) 254-1115; if you require further information or wish to discuss this project.

Tom Phillips
acting District Manager

Tom Phillips
Acting

1 Attachment

cc:
LLNML03110, L. Salas
✓ Mr. Joseph Fluder

APPENDIX M

Government to Government Letters

GOVERNMENT-TO-GOVERNMENT CONSULTATION PLAN FOR THE ALAMOGORDO REGIONAL WATER SUPPLY ENVIRONMENTAL IMPACT STATEMENT

The purpose of this plan is to define: (I) the responsibilities of the Joint Federal Lead Agencies (JFLA) (the U.S. Bureau of Land Management [BLM] and the U.S. Bureau of Reclamation [Reclamation]); (II) the goals of the consultation process for the Alamogordo Regional Water Supply Environmental Impact Statement (the Project); and (III) the actions required to complete government-to-government consultation.

I. RESPONSIBILITIES OF THE JOINT FEDERAL LEAD AGENCIES

In accordance with the Memorandum Of Understanding (MOU) between Reclamation and BLM, Reclamation has been designated responsible for the Government-to-Government consultation with all Tribes and Pueblos. As a result, all correspondence, after review by the BLM, will be sent to the Tribes and Pueblos from Reclamation, on Reclamation letterhead and signed by the manager of the Reclamation's Albuquerque Area Office. Copies of all written correspondence will be sent to the BLM and SWCA.

Consultation is defined according to the BLM's Procedural Guidance for Native American Consultation[1], which states that consultation is the active, affirmative process of (1) identifying and seeking input from appropriate Native American governing bodies, community groups, and individuals and (2) considering the interests of these groups as a necessary and integral part of the BLM's decision-making process. The aim of consultation is to involve affected Native Americans in the identification of issues and the definition of the range of acceptable management options. This process is required under Executive Order 13084 of May14, 1998 (*Federal Register* Vol. 63, No. 96).

NEPA compliance for Reclamation requires that Indian Trust Assets (ITAs) are identified and assessed for adverse impacts directed by Secretarial Order 3175 and Reclamation's Departmental Manual 3.13.5. ITAs are legal interests in property held in trust by the United States for Indian tribes or individuals, or property that the United States is charged by law to protect. Examples of resources that could be ITAs are lands, minerals, hunting and fishing rights, water rights, and in-stream flows. Reclamation's duty includes its obligation to carry out its activities in a manner which avoids adverse impacts to ITAs when possible. When adverse impacts cannot be avoided, appropriate mitigation or compensation will be provided. The following are procedures (but are not limited to) for carrying out Reclamation's ITA responsibilities: 1) required section in Environmental Assessments and Environmental Impact Statements; 2) public involvement activities; 3) consultation with potentially affected and interested Indian tribes, communities, and

[1] U.S. Bureau of Land Management, November 1994, Manual H-8160-1: General Procedural Guidance for Native American Consultation, 35 p. (BLM Manual H-8160-1)

individuals in the review and distribution of NEPA documents; and 4) required narrative in the Finding Of No Significant Impact or Record of Decision.
Under Section 106 of the National Historic Preservation Act of 1966 (as amended), Reclamation is required to conduct government-to-government consultation for projects that might affect historic properties, traditional cultural properties, or sacred sites. Reclamation protocol guidelines define consultation as: "The process for seeking and considering the views of others. It involves establishing, conducting, and maintaining formal communication with tribal governments and their members." This definition is consistent with the definition of Section 106 consultation in 36 CFR 800.16(f). Reclamation guidelines also suggest that a protocol be developed for tribal consultation, and that this protocol should be proactive, rather than reactive.

Because of the proximity of Native American Pueblos and Tribes to the Project area, it is possible that ITAs, sacred, ceremonial, and religious sites and landscapes, traditional cultural properties, and other significant areas exist within the Project area. While some areas of significance are known, others that have not been designated for protection are likely to be present as well. These areas may require inventory, protection, and interpretation to meet the requirements of Section 106 of the National Historic Preservation Act (NHPA) (16 U.S.C. 470f). The 1992 Amendments to the NHPA require that all Federal agencies consult with Indian Tribes for undertakings that may affect properties of traditional religious and cultural significance on or off Tribal lands. The Section 106 regulations (36 CFR 800) implementing the NHPA were revised on January 11, 2001, to reflect this change. Section 36 CFR 800.2(c)(2)(ii)(A) states that "the agency official shall ensure that consultation in the Section 106 process provides the Indian Tribe or Native Hawaiian organization a reasonable opportunity to identify its concerns about historic properties, including those of traditional religious and cultural importance, articulate its views on the undertaking's effects on such properties, and participate in the resolution of adverse effects."

FEDERAL GUIDELINES AND POLICIES

The policies, responsibilities, and procedures involved in operating on a government-to government basis with federally recognized Indian Tribes for the identification, conservation, and protection of American Indian trust resources to ensure the fulfillment of the Federal Indian Trust Responsibility for this Project will comply with the guidelines put forth by the Department of Interior[2], the BLM[3], and Reclamation[4].

[2] U.S. Department of the Interior, December 1995, Departmental Responsibilities for Indian Trust Resources, available at http://elips.doi.gov/elips/release/3049.htm
[3] BLM Manual H-8160-1
[4] U.S. Bureau of Reclamation, February 1998, Protocol Guidelines: Consulting with Indian Tribal Governments, U.S. Bureau of Reclamation Native Affairs Office, 94 p.

II. GOALS OF GOVERNMENT-TO-GOVERNMENT CONSULTATION

The goals of the consultation process are to:

- Operate within a government-to-government relationship with federally recognized Indian Tribes.
- Consult, to the greatest extent practicable and permitted by law, with Indian Tribal Governments before taking actions that affect federally recognized Indian Tribes.
- Assess the impact of Project activities on ITAs/Tribal Trust resources and assure that Tribal interests are considered before the activities are undertaken.
- Remove procedural impediments to working directly with Tribal Governments on activities that affect trust property or governmental rights of the Tribes.
- Cooperatively develop mitigation activities/protocols if ITAs or other Tribal Trust resources are adversely impacted.
- Work cooperatively to accomplish these goals.

III. PLAN OF ACTIONS

The following steps will be taken in the Environmental Impact Statement (EIS) process to review and consider ITAs, cultural resources, and/or traditional use concerns:

- Consulting with Tribal Governments.
- Consulting with the State Historic Preservation Officer.
- Identifying and protecting ITAs, and historical and cultural properties.
- Protecting, preserving, and enhancing sites listed on or eligible for inclusion on the National Register of Historic Places.

NEPA/ITA NOTIFICATION AND CONSULTATION

The tribes listed below have been notified via U.S. Mail regarding the environmental analyses for the NEPA process and for Indian Trust Assets identification. Reclamation will continue to contact these tribes to schedule government-to-government consultation meetings in accordance with the BLM/Reclamation Memorandum of Understanding (MOU). Additional notification will occur for the Section 106 consultation after the initial government-to-government consultation meeting which will likely focus on the NEPA process and identifying ITAs. Any additional written communication will be reviewed by both agencies with a final copy of the letter sent directly to SWCA so that it may be included in the Administrative Record. Also, all future written correspondence to the Tribes will be sent via registered mail.

Native American Tribes/Pueblos and Contact Names

Governor Alvino Lucero Pueblo of Isleta P.O. Box 1270 Isleta Pueblo, NM 87022	Jeff Houser, Chairman Fort Sill Apache Tribe of Oklahoma Rt. 2, Box 121 Apache, OK 73006	Wayne Taylor, Jr., Chairman Hopi Tribal Council P.O. Box 123 Kykotsmovi, AZ 86039
President Mark Chino Mescalero Apache Tribe P.O. Box 227 Mescalero, NM 88340	Governor Arturo Sinclair Ysleta Del Sur Pueblo 119 South Old Pueblo Rd. El Paso, TX 79917	Wallace Coffey, Chairman Comanche Indian Tribe P. O. Box 908 Lawton, OK 73502
Dallas Massey, Sr., Chairman White Mountain Apache Tribal Council P.O. Box 700 Whiteriver, AZ 85941	President Joe Shirley, Jr. Navajo Nation P.O. Box 9000 Window Rock, AZ 86515	Earl Yeahquo, Chairman Kiowa Tribe of Oklahoma P.O. Box 369 Carnegie, OK 73015

LIST OF PRE-MEETING ACTIVITIES FOR NEPA AND ITA CONSULTATION

All tribes will receive information packets explaining the project by November 30, 2004. A cover letter written by Nancy Umbreit, the principal point-of-contact for government-to-government consultation, will be included with these packets. The letter will describe the project and explain the contents of the information packets. In addition, the letter will indicate that if we do not receive a response on behalf of the Tribe by Friday, January 14, 2005, we will assume that the Tribe is not interested in government-to-government consultation.

Following the delivery of the packets and cover letter, Nancy Umbreit of Reclamation will phone each Tribe during the second or third week in December 2004 to:

- Request that the Tribe respond to the letter if they are interested in participating in government-to-government consultation.
- Communicate that the JFLA would like to better understand the Tribe's community values and how they may or may not be affected by the Project.
- Inquire whether the Tribes have their own government-to-government consultation procedures and request a copy of any existing Tribal procedures for consultation. State that the JFLA will strive to conduct government-to-government consultation in accordance with those procedures.
- If no Tribal procedure exists, request that consultation be carried out according to our plan.
- Communicate that the JFLA will follow up the letter with a phone call to hear the Tribe's thoughts on the proposed Plan of Consultation.
- Propose dates for consultation with the Tribe, to be scheduled by the JFLA and continue discussions until a meeting data is selected.

PLAN OF INITIAL NEPA CONSULTATION

Format

As at the Tularosa and Alamogordo public meetings, staffed information stations, and a 20-minute presentation will be given at the consultation meeting unless the Tribe prefers a different format. Following the presentation, community members from the Tribe or Pueblo will be able to provide their comments on project purpose and need, impacts, and alternatives either verbally to a facilitator or in written format.

Meeting Logistics

The following agenda assumes that the Tribe or Pueblo would prefer an evening meeting:

Agenda: 6:00 PM – 8:00 PM

6:00 PM Arrive and browse information stations
6:30 PM Welcome, overview of meeting, brief project presentation
6:50 PM Receive comments
8:00 PM Meeting adjourns

Room Specifics

Assuming that the Tribe or Pueblo does not have an established format for consultation, the JFLA Tribal point-of-contact will request that room where the consultation meeting will be held be appropriate for the anticipated number of Agency representatives, consultants, and Tribal members attending the meeting. The room should have a projection screen to accommodate a PowerPoint presentation and a microphone if one will be needed. Seating will be set up to accommodate general-area seating for all members and Agency and consultant attendees.

Attendees

Representatives from the JFLA and other selected project staff will travel to the location of the consultation meeting to participate in the government-to-government consultation process. Reclamation policy usually requires that either the Albuquerque Area Manager or the Deputy Area Manager attend the government-to-government consultation unless different arrangements are made with the Tribes. Per the written request of the JFLA, the SWCA Team's Project Manager, Deputy Project Manager, Archaeologist, Hydrologist, and/or Public Facilitator would be available to attend this meeting in support of the Agencies.

Roles and Responsibilities

The designated JFLA point-of-contact for consultation will be responsible for further contact with Tribal governments following the consultation meetings. As part of their role, the Tribal points-of-contact will update the Project points-of-contact for the BLM, Reclamation, and SWCA on a regular basis. The Agency and SWCA project leaders will receive a copy of all formal communications or records of communication with Tribes or Pueblos.

PLAN FOR ADDITIONAL CONSULTATION MEETINGS

Additional follow-up consultations may be required after any initial consultations with the tribes. As a result, the following procedures may need to be considered:

- The initial consultations may identify assets that will be defined in the EIS. As a result, Reclamation in cooperation with the BLM, shall provide a written request to each Tribal Representative and the BIA for participation (via additional consultations) in defining ITAs and health and safety issues related to specified assets or resources. This would also be part of the Administrative Record.
- Complete a list of identified trust assets and resources for each Tribe or Pueblo.
- Characterize the ITAs so that they can be described in the EIS.
- Describe effects to trust assets and resources for each Tribe or Pueblo to be used in the EIS.
- A statement of Reclamation's decision regarding the administration of the ITAs or resources would be included in the EIS for each Tribe or Pueblo.
- Administration of the ITAs would include mitigation as a result of adverse impacts.
- Describe in the EIS the reasons and factors that were considered for each Tribe or Pueblo's ITAs or resources.

SECTION 106 NOTIFICATION AND CONSULTATION

Pre-meeting Activities
In conjunction with BLM and SWCA, Reclamation will determine project issues, anticipate tribal concerns, and develop consultation strategy. Identify what we want to accomplish.

Send out consultation letters, signed by Reclamation AAO Area Manager, to the appropriate political head (governor, tribal president or tribal council chair) of the nine tribes requesting Section 106 government-to-government consultation. The letter should describe the nature of the proposed action, and be accompanied by a project map and cultural resources report. Follow-up with phone calls to the nine tribes to confirm letter status and to schedule meetings if requested should take place two weeks after receipt notification. If tribes have not responded after thirty days, send another letter. If there has been no response after 30 days of receipt of the second letter, assume the tribe has no concerns about the project: consultation has been completed.

If a tribe has expressed concerns in a letter form, or has indicated concerns from a follow-up phone call, schedule a meeting with the tribe at their convenience and in a setting of their choosing.

Meeting Activities
The Reclamation archaeologist (and BLM archaeologist if requested) will meet with tribally designated historic preservation officers or cultural resources specialists to conduct project consultations. The meeting will be held in a setting of their choosing. If sacred sites or traditional cultural properties become a concern, consultation protocol will respect the location and function of these sites.

If necessary, future meetings will be scheduled. This might be necessary considering intra-tribal consultation with religious leaders or elders.

If a tribe determines that the proposed action will not affect their cultural resources, the Reclamation archaeologist will request a letter to that affect. If a tribe determines that the proposed action will have an adverse effect on their cultural resources, Reclamation, SWCA, and BLM will jointly develop a mitigation plan to avoid any adverse affects, if possible.

Any Section 106 correspondence to and from the tribes will also be included in consultation with the SHPO, and be forwarded to SWCA to be included in the EIS and Administrative Record. BLM will be consulted and apprised throughout the consultation process.

LIST OF POINTS-OF-CONTACT

The following individuals have been identified as the points-of-contact for each group. These individuals should be included in all internal correspondence regarding government-to-government consultation, and any communication with the Tribes or Pueblos. The list includes representatives from the lead agency, the BLM; the cooperating agency, the BOR; and the consultant/contractor for the EIS:

- Lorraine Salas, Project Manager/NEPA (U.S. Bureau of Land Management)
- David Legare, Cultural Resources (U.S. Bureau of Land Management)
- Hector Garcia, Project Manager/NEPA (U.S. Bureau of Reclamation)
- Jeff Hanson, Cultural Resources (U.S. Bureau of Reclamation)
- Anne Huebner, Project Manager/NEPA (SWCA)
- Chris Carlson, Cultural Resources (SWCA)

APPENDIX N

Military Consultation Letters

SURNAME
Initials/Date
Initials/Date
Initials/Date
Initials/Date
Initials/Date

2000 (03000)

DEC 12 2005

Colonel Donald Gentry
Garrison Commander
100 Headquarters Avenue
White Sands Missile Range, NM 88002

Re: Alamogordo Regional Water Supply Project

Dear Colonel Gentry:

The City of Alamogordo is in the process of securing the right to drill ten wells on public land managed by the Bureau of Land Management (BLM) north of Tularosa, New Mexico. Part of this application process is the preparation of an environmental impact statement (EIS).

An alternative analysis that is part of the EIS has shown there is a deposit of potable water at the White Sands Missile Range Headquarters that could be considered for the City's use.

This inquiry is made to determine if this alternative would be considered by White Sands Missile Range Command, allowing the City of Alamogordo to utilize this water deposit to provide for domestic water for their community.

If you have any questions regarding this project, please contact Lorraine Salas, Project Lead at (505) 525-4388.

Sincerely,

/s/ Tim L. Sanders

Tim L. Sanders
Assistant District Manager
Division of Multi-Resources

03000:LSalas:cp:9/27/05.x4375:AlamoWaterSupplyProj_WSMRLtr

United States Department of the Interior
BUREAU OF LAND MANAGEMENT
Las Cruces District Office
1800 Marquess
Las Cruces, New Mexico 88005
www.nm.blm.gov

SURNAME
Initials/Date
Initials/Date
Initials/Date
Initials/Date
Initials/Date

IN REPLY REFER TO
2000 (03000)

DEC 12 2005

Colonel Kirby
USACAS BAN Commander
McGregor Range Bldg. 9500
Fort Bliss, TX 79916

Re. Alamogordo Regional Water Supply Project

Dear Colonel Kirby

The City of Alamogordo is in the process of securing the right to drill 10 wells on public land managed by the Bureau of Land Management (BLM) north of Tularosa, New Mexico Part of this application process is the preparation of an environmental impact statement (EIS).

An alternative analysis that is part of the EIS has shown there is a deposit of potable water at the Grapevine Canyon within the McGregor Range that could be considered for the City's use

This inquiry is made to determine if this alternative would be considered by Fort Bliss Command, allowing the City of Alamogordo to utilize this water deposit to provide for domestic water for their community

If you have questions regarding this project, please contact Lorraine Salas, Project Lead at (505) 525-4388

Sincerely,

/s/ Tim L. Sanders

Tim L. Sanders
Assistant District Manager
Division of Multi-Resources

03000:LSalas:cp:10/13/05:x4375:AlamoWaterSupplyProj.FtBlissLtr
Rewritten:03000:LSalas:cp:11/15/05:x4375:AlamoWaterSupplyProj.FtBlissLtr