City of Alamogordo
40-YEAR WATER DEVELOPMENT PLAN
2005-2045

November 2006

Livingston Associates, P.C.
Consulting Engineers
Alamogordo, NM

In association with

John Shomaker & Associates, Inc.
Albuquerque, NM

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EXECUTIVE SUMMARY

The City of Alamogordo has been active in water resource planning and development for more than twenty years. The City's most recent (decade-long) water planning has been in response to many factors, including:

- Historically the majority of the City's water supply has been obtained from surface water originating from spring flows in the Sacramento Mountains and Bonito Lake.
- A significant reduction in surface water supply due to drought conditions has placed critical limitations on the long-term reliance on surface water.
- There are significant hydrological, geological and New Mexico Office of the State Engineer (NMOSE) administrative limits on local ground water supplies which inhibit further development of the resource.
- The quality of most of the City's ground water supply does not meet the total dissolved solids (TDS) guidelines adopted by the City and would require treatment or blending with better quality water.
- The City has determined that desalination of brackish ground water, under the Alamogordo Regional Water Supply Project (ARWSP), represents a viable and economic source of supply that can be used to reduce the City's dependence on drought-sensitive surface waters.
- The ARWSP water supply can be used conjunctively with their existing supplies to optimize the use of the City's water resources.
- No other alternative water supplies have been identified that compare with the ARWSP in expected reliability and ability to deliver the City's total additional water needs through 2045.

This City of Alamogordo 40-Year Water Development Plan 2005–2045 is the first update to the previous Plan for 2000 to 2040, prepared in March 2003 (Livingston, John Shomaker). This Plan demonstrates that the City has urgent need for new water supplies, management flexibility, and for the conjunctive management of separate sources of surface and ground water made possible by the ARWSP.

The original Plan contained numerous water development recommendations for the City of Alamogordo. The Plan identified the ARWSP as the most desirable current and long-tem option to meet the City's needs. The City has been aggressively pursuing state and federal approvals for the ARWSP. However, those approvals have not come as quickly as the City had hoped. In the interim, the City has had to pursue short-term, stop-gap measures to supply water under these present drought conditions. To provide an immediate water supply, the City has rehabilitated the Prather Well Field, replaced the Golf Course well (T-814), and replaced the Mountain View well (T-3489), producing an additional firm yield water supply of 930 acre-feet per year (AFY) from these three sources combined.

In furtherance of the ARWSP, the City: 1) completed the Desalination Feasibility Study and Pilot Project; 2) completed the NMOSE water rights hearing process and was granted 3,000 AFY of brackish water for the ARWSP (the decision was appealed by several parties to the district court where a trial is pending); 3) initiated the National Environmental Policy Act (NEPA) process for the ARWSP and began preparing the draft Environmental Impact Statement (DEIS); 4) began developing the Snake Tank Well Field for the ARWSP, which included the drilling and testing of five test wells, with two of the wells considered production scale wells, and results of the testing verify that the well field will be suitable for the desalination facility; and 6) began developing documents for the right-of-way permitting and construction documents required for the ARWSP piping infrastructure.

While the City is implementing the ARWSP, it continues to examine other alternatives to meet the City's needs. Since the original Plan, the City has:

1) evaluated the feasibility of developing additional supplemental water supply wells or replacement wells within the City limits; 2) evaluated the potential for using reclaimed water for non-potable applications (car washes, etc.) and trading farmers some of the City's reclaimed water for their potable irrigation water; 3) performed a preliminary evaluation of the potential for utilizing re-purified water for aquifer recharge and/or surface water blending in indirect potable reuse applications; 4) completed covering and lining of the 180 million-gallon water storage reservoirs to reduce losses by approximately 788,500 gallons per day (GPD); 5) covered and lined the reclaimed water storage reservoirs to reduce evaporation losses and preserve the quality of this valuable non-potable water resource; 6) continued the waterline repair program to reduce water losses from leakage; and 7) continued to review proposals from the private industry for bulk water supply and potential City purchase.

Table ES.1 City of Alamogordo Surface Water Sources, Water Rights and Firm Yield

Surface Water	Water Right, AFY	Firm Yield, AFY
Bonito Lake	1,449	267
La Luz- Fresnal	891 AFY + 16 CFS*	1,772
Alamo Canyon	3,078	615
Total surface water	**5,418 AFY + 16 CFS***	**2,654**

* - 16 CFS (cubic feet per second) is time-of-day limited

Table ES.2 City of Alamogordo Ground Water Sources, Water Rights and Firm Supply

Ground Water	Water Right AFY	Firm Supply AFY
La Luz Wells (T-32-S-2 through T-32-S-9)	4,573	1,000
Prather Wells (T-33 and T-33-S)	1,354	500
Golf Course (T-814)	269.9	270
Mountain View (T-3489-repl)	161	160
Total ground water	**6,351**	**1,930**

The total combined water rights for the City of Alamogordo are 11,769 AFY plus 16 CFS and a total combined firm water supply is 4,584 AFY.

Historically, more than seventy percent of the City of Alamogordo's water supply is derived from surface water that is affected by drought. While there can be a hydraulic connection between surface water and ground water, ground water is typically considered a separate supply source that is more drought-resistant. Further expansion of the City's La Luz Well Field may not be possible due to hydrogeologic and New Mexico Office of the State Engineer (NMOSE) administrative constraints. Additionally, the quality of the ground water does not meet City criteria for a maximum total dissolved solids (TDS) level of 800 mg/L, which requires either blending with surface water or additional treatment.

The majority of fresh water (less than 1,000 mg/L TDS) in the Region is the surface water that originates in the Sacramento Mountains and from the small pocket of ground water south of Alamogordo. Adequate surface water is not available to meet increasing City of Alamogordo's demands. The pumping of any additional fresh ground water in this area is limited by NMOSE special administrative rules, available quantity, and land ownership (more than half of the fresh ground water south of Alamogordo lies beneath military lands). Holloman Air Force Base (HAFB) wells pump from this resource. It is not likely that the City could obtain additional water rights for this limited supply of fresh ground water.

Alamogordo's need for additional water supply is urgent.

The City has implemented conservation measures and utilized reclaimed water to reduce potable water demands by more than 3 MGD. Besides landscape watering restrictions, green-space irrigation with reclaimed water and other acceptable water conservation measures, an aggressive water rate structure has been imposed to force reduced consumption. These measures have resulted in the City of Alamogordo having one of the lowest per capita water use figures in the Southwest (*Overview*, 2005). The City is operating beyond the maximum water use restrictions acceptable to the public at the current time.

The current water usage by the citizens of Alamogordo is supply-driven rather than demand-driven. There is not an adequate water supply to provide the public with an acceptable level of typical water use needs.

There are numerous physical and legal constraints on the City's existing surface water and ground water supplies that prevent the City from having the current and future water supply it needs. See Section 6.0. A new, separate ground water supply is the most reliable source for meeting current and future water needs. The ARWSP is the only alternative evaluated that will provide the City of Alamogordo with the total quantity of new water required for the next 40 years. Desalination of brackish water is the solution to meeting the City of Alamogordo's future water demands, reducing the reliance on drought-sensitive surface water and for developing a long-term, redundant supply. Because the City uses both surface and ground water, the City should develop ground water supply (both in water rights and capacity) that will provide their total future water requirements as a drought contingency and supply redundancy.

The development of the ARWSP, as the water supply solution, is detailed as follows:

1) To meet current (2005) and future (2045) water demands, immediately implement the Alamogordo Regional Water Supply Project (ARWSP) desalination facility and infrastructure. This project consists of developing the Snake Tank Well Field, brackish water desalination facility and concentrate disposal system, treated water storage and pumping, and piping infrastructure to the City of Alamogordo.

2) Base the minimum ARWSP production capacity on **Table ES.3**. Production includes bulk water purchase agreement amounts by the Village of Tularosa.

Table ES.3 Minimum ARWSP Desalination Facility Production Capacity, 2005 to 2045, City of Alamogordo

Year	Minimum Capacity	Minimum Capacity
2005	2,876 AFY	2.6 MGD
2010	3,366 AFY	3.0 MGD
2015	3,995 AFY	3.6 MGD
2020	4,466 AFY	4.0 MGD
2025	5,057 AFY	4.5 MGD
2030	5,522 AFY	4.9 MGD
2035	6,303 AFY	5.6 MGD
2040	6,751 AFY	6.0 MGD
2045	7,218 AFY	6.4 MGD

3) Complete the Snake Tank Well Field and water rights permitting for the ARWSP desalination facility to meet minimum current and future 40-year water supply deficits, along with drought protection and system redundancy. The overall ground water diversion requirements for desalination are greater than the delivered potable water supply amounts due to the recovery rate of the desalination process (projected at 80%). Include the Village of Tularosa bulk water agreement amounts. Develop minimum Snake Tank Well Field capacity and water rights for 9,023 AFY. Analyze the well field pumping data periodically and evaluate the potential for increasing the well field capacity and water rights.

4) Phase in the ARWSP Snake Tank Well Field pumping schedule (including the Village of Tularosa bulk water purchase agreement amounts) as shown in the following **Table ES.4** (assumed desalination process recovery of 80%):

Table ES.4 Proposed ARWSP Snake Tank Well Field Pumping Schedule, 2005 to 2045, City of Alamogordo

Year	Avg. Pumping Rate	Avg. Pumping Rate
2005	3,595 AFY	3.2 MGD
2010	4,208 AFY	3.8 MGD
2015	4,994 FY	4.5 MGD
2020	5,582 AFY	5.0 MGD
2025	6,322 AFY	5.6 MGD
2030	6,903 AFY	6.2 MGD
2035	7,879 AFY	7.0 MGD
2040	8,439 AFY	7.5 MGD
2045	9,023 AFY	8.1 MGD

This updated *City of Alamogordo 40-Year Water Development Plan 2005–2045* is submitted pursuant to NMSA Section 72-1-9 (B) (1985).

1.0 INTRODUCTION

Background

The City of Alamogordo differs from most municipalities in the State of New Mexico in that the majority of its historical water supply (approximately 70%) comes from surface water. These surface water sources in the Sacramento Mountains north and east of the City, as well as Bonito Lake, are very susceptible to drought conditions that reduce supply. In fact, available water from these sources has diminished severely in recent years.

The problem facing the City at this time is the lack of water, even though the City owns an abundance of water rights. For example, the City has surface water rights of 5,418 AFY plus 16 CFS, however, between 2000 and 2005 an average of only 3,974 acre-feet of surface water was available for diversion and use.

The City's ground water right is very similar in that the City has ground water rights exceeding 6,300 AFY in wells that can only produce on average about 2,000 AFY (2001 data).

The City has been pro-active in its efforts to supply water. Water salvage through the use of reclaimed treated effluent is the prime example. After more than 10 years and millions of dollars, the reclaimed water system is supplying more than 3 MGD of reclaimed water for green-space irrigation.

Conservation through the lining and covering of the raw water storage reservoirs and reclaimed water storage reservoirs saves up to an estimated 788,500 gallons per day previously lost to seepage and evaporation during the summer months. The increasing block rate structure has been very successful in reducing residential consumption of water, and efforts identified in the conservation plan.

Over the last ten years, the City has reduced its water supply needs by over 40% through these efforts. However, conservation alone can not meet the current or future needs of the City. Therefore, it is critical for Alamogordo to develop new water resources to meet current shortfalls and provide for future growth and development.

Because of the large difference between paper water rights and actual wet water, a concept of "firm supply" from the various sources is used to calculate a minimum guaranteed water supply for the City. The "firm supply" is based on the worst years in the record for water supply, which includes hydrologic and system limitations, and ultimately reflects reliability of supply. The difference between the firm supply and the current and future demands is the additional amount of water resources that the City will need to secure and develop under this Plan.

This 40-year Water Development Plan was prepared for the City of Alamogordo by Livingston Associates, P.C. (consulting engineer), and John Shomaker & Associates, Inc. The contents of the Plan include analysis of available water resources, existing supplies, current and future water demands, and water supply development alternatives.

Purpose

The purpose of the Plan is to: 1) identify existing water supplies; 2) identify existing water needs; 3) identify future water needs; 4) identify water conservation savings; 5) identify potential future sources of water; 6) plan for the next 40 years and pursue new sources of water to meet current and future water needs.

Water-Planning Region

The water-planning Region for the City of Alamogordo (sub-Region 3 on **Fig. 1.1**) primarily encompasses the eastern part of the Tularosa Underground Water Basin. The water-planning Region will be referred to as “the Region”, “the water-planning Region” or the “planning Region”, throughout this report. Currently, the City of Alamogordo derives about 70 percent of its water supply from surface water that originates from the Sacramento Mountains and Bonito Lake, and the remaining 30 percent from the La Luz and Prather Well Fields completed in the basin-fill aquifer. The Tularosa Underground Water Basin was declared by an order of the NMOSE on July 7, 1982, and includes about 6,000 square miles. Availability of fresh ground water in the Tularosa Basin is limited by State Engineer administrative controls, geology, and supply. In addition, all of the surface water has been fully appropriated.

The water-planning Region’s eastern boundary is along the crest of the Sacramento Mountains from Three Rivers to the Oro Grande area approximately 40 miles south of Alamogordo. Military boundaries make up the water-planning Region’s western boundary. The water-planning Region is approximately 80 miles long and 20 miles wide and is located only within Otero County. The Region primarily encompasses the NMOSE Alamogordo-Tularosa Administrative Area (refer to **Figure 1.3**).

Temperature and precipitation vary within the Region because of the differences in land surface altitude. The lower elevation portion of the Region reflects an arid climate and the Sacramento Mountain portion along the eastern boundary of the Region reflects semiarid climates. Most of the precipitation falls during mid-summer as intense thunderstorms and as winter precipitation (rain on the basin floor and snow at higher elevations). Summer precipitation occurs during July through September. The average annual rainfall is about 12 inches (8 to 11 inches in the basin and 12 to 28 inches at higher altitudes). **Figure 1.2** is a graph showing the relationship between precipitation and surplus precipitation (precipitation in excess of evaporation) with elevation. Surplus precipitation is defined as the remaining precipitation after evapo-transpiration losses. The major recharge to the Region is through snow pack in the higher elevations. For the last ten years, a substantial reduction in snow pack in the watersheds feeding the spring systems has caused drought conditions (see Appendix for snowfall information and reduction in La Luz-Fresnal spring flows).

The Tularosa Basin is a hydrologic closed basin composed of basin-fill deposits in the center portion and bedrock in the surrounding mountain watersheds. Almost all of the water for the Region is surface water originating from the watersheds along the west side of the Sacramento Mountains, and ground water from the high-yield basin-fill deposits. Some domestic water supplies are obtained from the bedrock aquifer in the Sacramento Mountains. Ground water flow in the Region is from east to west, originating in the recharge areas along the crest of the Sacramento Mountains, and discharging to the playa lakes in the basin center (see **Fig. 3.2**).

The higher elevation Sacramento Mountain escarpment receives more precipitation and is covered with forests that give rise to several small streams that discharge into the desert. Most of the streams are perennial in their upper reaches and derive their base flow from runoff, primarily as snowmelt, on the western slopes of the Sacramento Mountains. All streams carry flood-flow from infrequent thunderstorms. Only the large drainage areas on the western slope of the Sacramento Mountains contain streams with any appreciable base flow, which is derived largely from snowmelt. These streams include Three Rivers, Rio Tularosa, La Luz Creek, and Alamo Canyon. Part of the total runoff recharges the basin-fill aquifer. Most of the available surface water in the planning Region has been appropriated for use with the exception of surface water in Rinconada Canyon (Temporal Creek). Surface water from Three Rivers, Rio Tularosa, La Luz-Fresnal Canyon, Alamo Canyon, and Sacramento River is diverted for irrigation, domestic, and municipal use.

The water-planning Region is located entirely within the Tularosa Underground Water Basin. In May of 1997, the NMOSE published criteria for water rights administration of the Alamogordo-Tularosa Administrative Area, a sub-area within the Basin centered on Tularosa and Alamogordo. The location of the Alamogordo-

Tularosa Administrative Area is shown on **Figure 1.3**. (Each administrative block is ½ square mile. The red blocks shown on **Figure 1.3** are deemed critical, orange blocks are near critical and gray blocks represent the Sacramento Mountains in which the administrative criteria do not apply).

New appropriations for fresh ground water are limited or nil under the current administrative criteria (where model cells are critical or near critical). This places a legal constraint on any further fresh ground water development within the Region.

The majority of the Region is rural, and agriculture and military related enterprises are dominant. As of 1997, the total irrigable area in Otero County was 19,290 acres and the total area irrigated was 8,650 acres. While the water-planning Region encompasses only a small portion of Otero County, most of the irrigated acreage in Otero County is located within the planning Region, including the vicinity of Alamogordo, La Luz, Tularosa, and Boles Acres.

The combined population of the Region is currently about 52,000 persons, including rural water systems and self-supplied homes which represent approximately 8,000 persons (based on 2003 data).

Water Supply System

The majority of the City of Alamogordo's water supply is derived from spring flows originating from the La Luz-Fresnal Canyon system, which flow via collection structures and pipelines to the La Luz Water Treatment Plant (WTP), located at the north end of Alamogordo. Bonito Lake water also flows via a 90- mile pipeline to the La Luz WTP. Additional spring flows from the Alamo Canyon and Caballero Canyon systems flow via pipeline to the Alamo Canyon Water Treatment Plant, located at the southeastern end of Alamogordo.

Ground water is used primarily during the summer months to augment the surface water supply. It is derived from seven wells within the La Luz Well Field located at the northern end of the City and two wells in the Prather Well Field located south of the City. Recently it has been necessary to rely on ground water more due to the drought causing reduced surface water supplies.

Three raw water storage reservoirs, totaling 180 million gallons in capacity, are used to store water at the La Luz WTP prior to treatment. All three of the reservoirs have been covered and lined to eliminate evaporation loss and leakage.

At the Alamogordo Water Reclamation Plant, more than 3 MGD of effluent is reclaimed and used for turf and green-space irrigation as well as construction and other needs of the City.

2.0 SURFACE WATER RESOURCES

Regional Setting

The spring flows from the Sacramento Mountains vary seasonally, and are generally greater during the months of March through May. Spring (and stream) flows generally occur after all of the demands for water in the watershed are satisfied (i.e.; vegetation use, evaporation, domestic wells, etc.). In wet years, rainfall and snowmelt runoff can be a substantial contributor to the amount of stream flow available for diversion. Stormwater runoff from summer thunderstorms occurs rapidly and is difficult to capture and clean to potable water standards.

The U. S. Geological Survey (USGS) has limited daily base flow and peak flow measurements for Tularosa Creek at Bent and near Tularosa, and for Alamo Creek, La Luz Creek and the Sacramento River. Only peak flow for Three Rivers was measured by the USGS from 1955 to 1977. A summary of available surface water data is presented as **Table 2.1**, and shows the period of record and annual mean stream flow in acre-feet per year.

Table 2.1 Summary of Available Surface Water Data in the Region

Station Name	Period of Record	Annual Mean Stream Flow, AFY
Tularosa Creek near Bent, NM	1948-95	9,495
Rio Tularosa near Tularosa, NM	1939-46	11,091
Rio La Luz near La Luz, NM	1911-12	8,536
Rio Fresnal near Mountain Park, NM	1911-12	1,050
Rio La Luz at La Luz, NM	1910-13; 1982-89	8,694
Alamo Creek near Alamogordo, NM	1933-50	1,283
Sacramento River near Sunspot, NM	1984-89	2,173

Listed in **Table 2.2** is a comparison of estimated watershed yield and estimated base stream flow for watersheds in the Region along the Sacramento Mountains. The watershed yield decreases to the south as a result of decrease in mean elevation and total area of the watersheds. Total watershed yield for the Region is estimated at 77,619 AFY, and total stream flow is estimated at 47,099 AFY. The difference between watershed yield and stream flow may be considered as losses to storage in soil (vadose zone) and recharge to the bedrock aquifer in the watershed area above the mountain front. This indicates that approximately 65 percent of the watershed yield in the Eastern Tularosa Basin area becomes stream flow and 35 percent is lost to soil storage or becomes recharge to the mountain bedrock.

Table 2.2. Major Watersheds in the Eastern Tularosa Basin, and Summary of Watershed Data and Estimated Yield

Watershed Name	Map ID[2]	Mean Annual Precip, in/yr	Elevation, feet	Watershed Area, mi^2	Estimated Mean Annual Stream Flow AFY	Estimated Watershed Yield AFY
Eastern Basin						
Three Rivers at Three R.	17	22.0	6,568	86.5	8,326	9,097
Boone and Salinas Draws	18	21.0	7,300	32.7	NA	1,261
Rinconada Canyon	19	21.2	6,840	97.5	9,194	10,897
Tularosa Canyon at Tularosa	20	21.2	7,280	157.0	17,520	25,237
Domingo & Rancheria Canyons	21	17.1	6,410	34.4	NA	1,249
Cottonwood Wash	22	18.3	6,750	15.4	NA	2,149
La Luz Canyon	23	21.1	7,464	65.2	5,285	10,906
Dry Canyon	24	19.4	7,093	9.0	318	1,276
Beeman Canyon	25	15.3	5,930	2.0	NA	87
Watershed between Beeman and Marble Canyons	26	15.5	6,015	4.5	NA	175
Marble Canyon	27	17.1	6,237	3.5	72	232
Alamo Canyon	28	21.0	7,146	24.9	1,433	3,462
Mule Canyon	29	16.2	6,207	6.7	159	984
San Andres Canyon	30	21.7	7,467	14.8	746	2,532
Dog Canyon	31	20.8	7,392	10.5	442	1,679
Mountain front between Dog and Escondido Canyons	32	16.8	6,327	2.6	NA	173

Table 2.2 Continued

Watershed Name	Map ID [2]	Mean Annual Precip, in/yr	Elevation, feet	Watershed Area, mi2	Estimated Mean Annual Stream Flow AFY	Estimated Watershed Yield AFY
Escondido Canyon	33	19.9	7,083	11.0	434	1,448
Mountain front between Escondido and Bug Scuffle	34	15.5	6,090	8.6	NA	585
Bug Scuffle Canyon	35	19.5	6,730	12.3	492	1,190
Grapevine Canyon	36	19.4	6,415	33.5	1,875	2,293
Pipeline Canyon		14.3	5,353	6.1	116	0
Culp Canyon	37	14.3	5,765	23.2	687	707
Eastern Basin total					**47,099**	**77,619**

[1] Waltemeyer, USGS, (2001)
[2] watershed map ID on Figure 1.1

City Surface Water Supplies

JSAI used historical meter records that document water diversions from La Luz-Fresnal Canyon, Alamo Canyon, and Bonito Lake to the City of Alamogordo. Meter records from a Parshall flume, referred to as the La Luz-Fresnal Flume, document diversions from springs in La Luz-Fresnal Canyons. Meter records for Alamo Canyon document diversions from the springs in Alamo Canyon. Meter records for the Bonito Lake Receival document diversions from Bonito Lake when they reach the La Luz WTP, where water is apportioned between Alamogordo and Holloman Air Force Base.

Table 2.3 summarizes the annual surface water diversions, shows the average diversion for the period of record, and shows the annual diversion rate that statistically will occur 95 percent of the time (the fifth percentile of the historical data-set).

Definition of Firm Yield

A water-supply definition for *firm yield* can be found in Linsley et al. (1982), and is "*Firm yield is the minimum yield during the life of the reservoir* [supply]." Therefore, the firm yield is based on the worst years in the record for water supply, which includes hydrologic and system limitations, and ultimately reflects reliability of supply. A case study in Linsley et al. (1982) demonstrates that simply using the average or median tends to overestimate supply. To base the availability of water supply on the assumption of stationarity of streamflows in semi-arid and arid regions is described by Evans (1985) as unrealistic, and other statistical analyses, such as the use of confidence intervals, provides a more realistic approach to determining firm yield (supply).

Firm Yield Method for Surface Water Sources

The firm yield analysis is based on diversion records, and it is assumed that the amount of water diverted is the maximum amount that could be taken. This assumption is based upon knowledge of the City's operations and communications with City staff. Because the data sets are not normally distributed, non-parametric statistical analysis of the fifth percentile of the historical surface water diversion data-set, and the tolerance interval associated with the fifth percentile, was determined to be the most sound and appropriate method for determining the firm yield of Alamogordo's surface water supplies. These methods rely on historical surface-flow data as opposed to assumptions about future flows (Helsel and Hirsch, 1992). Calculating a percentile of the historical data-set is essentially using observations from the past to make inferences about what can be expected for the future. The fifth percentile was chosen as a conservative flow value that is available upon demand, since 95 percent of historical flows exceeded the fifth percentile.

The tolerance interval is essentially a confidence interval centered around a percentile, and is "the most commonly reported statistic for analyses of low flows (Helsel and Hirsch, 1992)." A confidence level of 90 to 99 percent is commonly used for hydrologic applications (Yevjevich, 1982). A confidence limit of 95 percent was used in calculating the tolerance interval for the fifth percentile. Because the annual surface-water diversion data sets for La Luz-Fresnal Canyon, Alamo Canyon, and Bonito Lake do not have normal distributions (**Figures 2.1** through **2.3**), non-parametric methods were used to determine the fifth percentiles and the tolerance intervals presented in **Table 2.3**.

Alamo Canyon

Alamo Canyon, which has a drainage area of 25 square miles, debouches from the Sacramento Mountains into the lowlands of the Tularosa Basin about 3 miles southeast of Alamogordo. When the City was founded in 1898 its original water supply was brought by pipeline from Alamo Creek. Stream flow measurements from Alamo Creek from 1930 to 1950 indicated an average of 1,283 AFY (**Table 2.1**), and the USGS has estimated stream flow in Alamo Creek to average 1,422 AFY (**Table 2.2**). The chemical quality of the water is generally good; it commonly contains about 500 mg/L total dissolved solids and about 130 mg/L sulfate. The water rights of Alamo Creek (3,078 AFY) are owned by the City of Alamogordo. The City has extended its pipeline upstream to utilize springs in Alamo Canyon and its tributaries. A graph showing the diversions from Alamo Canyon is provided as **Figure 2.1**. Diversions from Alamo Canyon have averaged 1,278 AFY over the last 38 years (**Table 2.3** and **Fig. 2.1**). The minimum diversion of 605 AFY occurred in 2005.

La Luz Creek

La Luz Creek is a perennial stream fed by springs along La Luz and Fresnal Canyons and their tributaries. The drainage area of La Luz Creek above the community of La Luz is about 75 square miles. La Luz, located 6 miles north of Alamogordo, was established in 1864, and later the communities of Mountain Park and High Rolls were established upstream along Fresnal Canyon. The City of Alamogordo owns approximately 12,500 AFY of water rights associated with La Luz Creek. The USGS gauged daily base flow in La Luz Creek from 1982 to 1990, which showed an average daily base flow of 12 CFS or 8,694 AFY (**Table 2.1**). The La Luz Irrigation District has rights to the first 400 GPM diverted from the La Luz-Fresnal system, which can significantly limit the City's diversion during drought conditions.

The total dissolved solids content of La Luz Creek water varies from 672 mg/L at a spring in Fresnal Canyon to 1,700 mg/L near the La Luz railway station.

A graph showing the diversions from La Luz Creek is provided as **Figure 2.2**. Diversions from La Luz Creek have averaged 3,472 AFY over the last 38 years (see **Table 2.3**), but a significant decline in water diverted from La Luz Creek has occurred for the last nine years (**Fig. 2.2**). In the last 10 years, since the diversion system has been modified for optimum capture, the minimum diversion of 2,080 AFY occurred in 2005.

Table 2.3 Historical Diversions Measured at La Luz-Fresnal Flume, Alamo Canyon, and Bonito Lake Receival

Year	La Luz-Fresnal Diversion, AF	Alamo Canyon Diversion, AF	Bonito Lake* Diversion, AF
1967	1,961	784	1,608
1968	2,028	838	2,431
1969	2,046	1,034	2,204
1970	2,229	1,169	2,019
1971	2,412	(b)	524
1972	2,070	(b)	2,050
1973	2,232	(b)	2,196
1974	3,466	(b)	1,146
1975	3,891	(b)	2,196
1976	4,279	(b)	1,759
1977	4,209	(b)	2,027
1978	3,670	1,046	1,818
1979	1,951	1,823	1,383
1980	2,437	1,570	2,129
1981	2,189	1,390	1,290
1982	1,610	1,495	2,279
1983	3,299	1,475	1,853
1984	4,255	1,467	1,791
1985	(a)	(a)	(a)
1986	3,047	1,872	1,757
1987	4,326	1,920	(a)
1988	5,137	1,340	1,715
1989	4,237	1,471	(a)
1990	5,032	1,414	1,359
1991	3,869	1,491	1,637
1992	5,782	2,081	786
1993	5,099	1,760	748
1994	5,529	1,490	(a)
1995	5,330	1,368	(a)
1996	5,382	1,260	(a)
1997	5,739	1,111	1,236
1998	4,425	1,106	1,282
1999	3,542	1,108	788
2000	3,334	1,121	542
2001	2,765	888	1,484
2002	2,523	684	766
2003	2,232	683	1,200
2004	2,309	634	1,468
2005	2,080	605	2,535
average diversion, AF	**3,472**	**1,278**	**1,576**
diversion exceeded 95% of the time, AF[c]	**1,772**	**615**	**535**

* total diversions for City of Alamogordo and Holloman Air Force Base
(a) no data available
(b) diversion system under repair during this period and surface-flow diversion data-set incomplete
[c] based on the 5th percentile of the historical data-set

The recent decline in diversions from La Luz Creek is largely due to drought conditions and subsequent lack of snow pack, but other water demands (including more than 480 domestic wells) in the La Luz Creek watershed have increased over the last 10 years and contribute to reducing stream flow.

Bonito Lake

Bonito Lake is located approximately 15 miles northwest of the Village of Ruidoso, within the Lower Pecos River Drainage Basin. The Lake is owned and operated by the City of Alamogordo as a municipal water supply for Alamogordo, Holloman AFB, Carrizozo, Nogal and Ft. Stanton. Although the Lake is not physically within the Tularosa Basin, a 90-mile long pipeline carries Bonito Lake water to Alamogordo and Holloman AFB. The City of Alamogordo and Holloman each own 1,449 AFY of water rights (2,898 AFY combined). Annual quantities of water received from Bonito Lake, less than the combined right, are split evenly between Alamogordo and Holloman. Other Bonito Lake water right holdings total approximately 190 AFY.

Water from Bonito Lake, superior in chemical quality at 300 mg/L TDS, is mixed with the spring and ground water at the La Luz WTP to increase the overall supply and improve the quality.

Bonito Lake has a surface area of approximately 100 acres (US Bureau of Reclamation, 1989) with a maximum depth of about 75 feet. The Lake was constructed in 1931 and drains a watershed of more than 21,000 acres.

The average annual diversion from Bonito Lake to the City of Alamogordo is only 788 AFY. The total firm supply of Bonito Lake is calculated as 535 AFY. The City of Alamogordo's portion is one half of the firm supply based on the total diversion shared with Holloman AFB (**Table 2.3**). It should be noted that the diversions from Bonito Lake over the period of record account for only about 5 to 14 percent of the overall water supply to Alamogordo.

The Bonito Lake supply has been highly unreliable due to low storage during periods of drought, pipeline conditions, periods of poor water quality due to fall and spring turn over, and minimum lake-level requirements for fish, wildlife, and recreation (Jose Miramontes, City of Alamogordo, personnel communication). In addition, the reservoir is over 75 years old and has lost significant storage capacity due to sedimentation.

The Bonito Pipeline has been replaced, but it is unlikely that the full annual diversion of Bonito Lake water will be realized on a consistent basis. For future planning purposes, it is assumed that the City of Alamogordo's portion of the Bonito Lake supply is approximately 267 AFY (see **Table 6.1**).

Firm Yield Analysis

Based on the available period of record (1967-2005), the diversions that are equaled or exceeded 95 percent of the time, calculated for La Luz-Fresnal (1,772 AFY), Alamo Canyon (615 AFY), and Bonito Lake (267 AFY) water delivered to the City of Alamogordo, is an estimate of the firm yield from each of these sources. Including data from the 1980s and early 1990s leads to a higher estimate of firm yield, because above normal precipitation during this period caused an increase in streamflow during this time.

Therefore, the firm yield of Alamogordo's surface water sources indicates a potential minimum available supply of 2,654 AFY, based on recorded diversion data from the previous 39 years. However, it is possible that the City may experience extended severe drought conditions or other circumstances in the future where there is little to no surface water supply, and water demands must be offset entirely by ground water resources.

For planning purposes, the City of Alamogordo must rely on a minimum future surface water supply of 2,654 AFY.

3.0 GROUND WATER RESOURCES

Regional Supply

Ground water in the Region can be divided into two generalized geologic settings: 1) the basin fill aquifer, and 2) the bedrock aquifer. The extent and total dissolved solids content of water in the basin fill aquifer is shown on **Figure 3.1**. The majority of the wells in the planning Region produce from the basin fill aquifer. The basin fill aquifer is known to have the highest well yields in the planning Region, suitable for irrigation and municipal supply. Well yield from the bedrock aquifer varies according to rock type and location, and may range from less than one gallon per minute (GPM) to over 100 GPM (Shomaker and Finch, 2006).

Recharge to the Eastern Tularosa Basin area was previously estimated at 14,500 AFY by the NMOSE (Morrison, 1989). Morrison's estimate was based on the stream flow, remaining after diversion that infiltrated at the mountain front. This is a conservative estimate because it does not account for underflow from the bedrock aquifer to the basin fill or for smaller streams that contribute recharge to the basin fill. For this 40-Year Water Development Plan, the recharge was estimated using the ground water flow model developed by JSAI (2006). Estimated recharge and components of recharge to the entire Region can be referenced from **Table 3.1**. Since development of surface water sources began in the late 1890s, a reduction in recharge to the basin fill aquifer has occurred as a result of stream flow diversions in the planning Region, particularly during the 1950s drought. The reduction in recharge to the basin fill aquifer is concentrated in both La Luz Canyon and Alamo Canyon, which has limited recharge and development of ground water resources.

Table 3.1 Summary of Estimated Ground Water Recharge Rates and Recharge Components for Region

Component	Estimated Rate, AFY
Prior to Development	
Recharge to basin fill from stream flow	22,887
Recharge to bedrock aquifer from precipitation	6,662
Total recharge to Region	29,920
1950s Drought	
Recharge to basin fill from stream flow	17,002
Recharge to bedrock aquifer from precipitation	6,662
Total recharge to Region	23,664

** based on JSAI ground water flow model of the eastern Tularosa Basin (JSAI, 2006)

Estimates of ground water in storage for different ranges in salinity are provided in **Table 3.2** and the distribution of salinity is shown on **Figure 3.1**. Fresh water storage (<1,000 mg/L TDS) within the Eastern Tularosa Basin area is mainly limited to alluvial fan (basin fill) deposits along the Sacramento Mountain front. The Region is estimated to have approximately 1.9 million acre-feet of recoverable fresh water from the basin fill aquifer. The estimated 3.8 million acre-feet of recoverable fresh water in the bedrock aquifer is located in the mountain watershed areas, and will yield low flows to small diameter wells, but large amounts of fresh water cannot be obtained. These estimates do not account for ground water removed from storage since ground water development began. Practically all of the fresh water in the Region is south of Alamogordo in the NMOSE administrative area or within Fort Bliss military lands (**Fig. 3.1**). The NMOSE administrative criteria in this area limits ground water development to approximately existing diversion amounts. The fresh water underlying military land is unavailable for City (or any other) development due to access security concerns.

Table 3.2 Estimated Total and Recoverable Volume of Ground Water Stored in the Eastern Tularosa Basin Area

TDS Range mg/ L	Basin Fill Total Volume in Storage AF	Basin Fill Recoverable Volume in Storage AF	Bedrock Total Volume in Storage AF	Bedrock Recoverable Volume in Storage AF
>10,000	2,764,800	691,200	0	0
5,000-10,000	46,786,560	11,696,640	0	0
4,000-5,000	22,256,640	5,564,160	0	0
3,000-4,000	27,095,040	6,773,760	599,040	299,520
2,000-3,000	6,819,840	1,704,960	1,739,520	869,760
1,000-2,000	44,928,000	11,232,000	11,669,760	5,834,880
<1,000	7,879,680	1,969,920	7,637,760	3,818,880
total	158,530,560	39,632,640	21,646,080	10,823,040

Notes:

- Total volume of water stored in basin fill is based on 1,000 feet average saturated thickness and porosity of 0.2
- Total volume of water stored in bedrock is based on 1,000 feet average saturated thickness and porosity of 0.05
- Total volume of fresh water stored in basin fill is based on 500 feet average saturated thickness and porosity of 0.2 (area south of Alamogordo)
- Total volume of recoverable water stored in basin fill is based on ability of the aquifer to liberate one half of the total in storage to wells and specific yield of 0.1
- Total volume of recoverable water stored in bedrock is based on ability of the aquifer to liberate one half of the total in storage to wells and storage factor equal to 0.05

The estimate of total recoverable ground water with less than 3,000 mg/L TDS stored in the basin fill aquifer between Three Rivers and Orogrande is 14.9 million acre-feet of which 3.73 million acre-feet would equal to dewatering the upper 250 feet of the aquifer. This would be equal to a ground water yield of approximately 37,250 AFY for 100 years. The NMOSE Administrative criteria for the Alamogordo-Tularosa Administrative Area may allow draw-downs of up to 2.5 feet per year.

Fresh water in the basin fill aquifer south of Alamogordo is typically less than 500 feet in thickness, and in some areas dewatering 250 feet would remove one half of the thickness or potentially all of the fresh ground water. Besides the hydrologic limitations in this area, the NMOSE Administrative Criteria also limits the appropriation of ground water. A preliminary administrative model run was attempted for this area and determined that additional appropriations would be difficult (Tularosa Basin and Salt Basin Regional Water Plan 2000-2040, May 2002).

Many of the irrigation wells in the Region that have high yields (>100 GPM) are located along the base of the mountain front where sediments are coarse grained. This zone of high well yield is 5 to 10 miles in width and contains ground water with a TDS ranging from 1,500 to 5,000 mg/L north of Alamogordo, and TDS less than 1,000 mg/L south of Alamogordo. Well yield decreases significantly with distance west of the Sacramento Mountain front, potentially from 1,000 GPM down to 100 GPM (McLean, 1970).

Over the last twenty years domestic well drilling in the bedrock aquifer between High Rolls and Bent has significantly increased. Well yields in the bedrock aquifer vary drastically, from less than 1 GPM to over 100 GPM, and are highly dependent on local geologic conditions. Well yields in the bedrock aquifer can be reduced dramatically by a slight lowering of the water table because of the decrease in permeability that occurs with depth.

City Ground Water Supply

The City has ground water supply wells associated with the La Luz Well Field (T-32-S through T-32-S9), the Prather Well Field (T-33 and T-33-S), the Golf Course Well (T-814) and the Mountain View Well (T-3489-Replacement). JSAI used historical meter records that document water diversions from the La Luz Well Field.

La Luz Well Field (T-32-S through T-32-S-9)

Some of the most prolific wells in the Region produce from the combined basin fill and bedrock aquifers. One example of production from the basin fill and bedrock aquifers is the City of Alamogordo's La Luz Well Field, where well yields range from 200 GPM to 1,400 GPM. Alamogordo's La Luz Well Field is located a few miles north of Alamogordo. La Luz Well Field data are summarized in **Table 3.3**.

Table 3.3 List of Well Data for the City of Alamogordo's La Luz Well Field, Otero County, New Mexico

Well	Well No. 2	Well No. 3	Well No. 4	Well No. 5	Well No. 6 repl.	Well No. 7	Well No. 8
Date drilled	1956	1957	1964	1965	1992	1971	1999
Total depth, feet	703	700	780	767	844	750	991
Water level, feet bgl	362	391	440	390	359	336	408
Water column, feet	341	309	340	377	485	414	583
Pumping level, feet bgl	560	483	516	n/a	500	481	625
Instantaneous production rate, GPM	320	320	320	460	900	850	250

feet bgl feet below ground level
GPM gallons per minute
n/a not available

The La Luz Well Field consists of seven wells, and is used to meet summer water demands when surface-water diversions are low. Historically, the well field is pumped approximately six months out of the year from April to September. Annual diversions from the La Luz Well Field have ranged from 147 AFY to 2,674 AFY, with an average of 1,700 AFY over the last 5 years. The fluctuation in diversions from the well field has varied as a result of changes in surrounding demand from other ground water users, encroachment of junior water rights, variable recharge, and aquifer storage capacity (see **Figure 3.4**).

Water level declines that have accumulated in the La Luz Well Field area over the last 45 years are shown on **Figure 3.3**. The average water level decline is approximately 0.5 feet per year, but varies from well to well (see hydrographs in **Appendix**). The observed water level declines in the La Luz Well Field area are a result of local and regional ground water pumping, reduced recharge from captured stream flow, and numerous domestic wells. Additionally, the water quality diminishes throughout the pumping season. During the last five years, water level declines have accelerated (up to 5 feet per year), although production has decreased (see **Fig. 3.4**).

The most plausible explanation is increased demand on the aquifer from surrounding users and decreased recharge from La Luz Canyon; both conditions resulting from the recent drought.

Reliable supply from the La Luz Well Field is difficult to estimate because it would depend on successful NMOSE applications to replace wells, management decisions, such as acceptable levels of long term drawdown and pumping rates of individual wells, as well as recharge and aquifer management.

An analysis of the potential yield from the La Luz Well Field was performed using the JSAI ground water flow model (JSAI 2006). The long-term predicted yield from the La Luz Well Field, assuming a successful well replacement program and optimum well efficiency, is 2,560 AFY as shown in the following **Table 3.4**.

Table 3.4. Summary of predicted yield from the La Luz Well Field, assuming optimum well efficiency and the ability to replace wells to maintain efficiency.

Well	Predicted yield, AF
2	314
3	480
4	340
5	285
6	387
7	580
8	174
total	2,560

Another factor limiting yield from the La Luz wells is water quality. The average TDS concentration is approximately 1,500 mg/L to 1,800 mg/L in water produced from the well field. Without blending with surface water, the water produced from the wells would need to be treated to meet the desired water quality requirement of 800 mg/L TDS. Therefore, the production from the La Luz wells is limited by the available surface water for blending or would be reduced to reflect losses due to treatment.

Prather Well Field (T-33 and T-33-S)

Prather Wells No. 1 (T-33) and No. 2 (T-33-S) were placed back into service in the summer of 2003. Due to land ownership issues the wells could not be replaced. Instead, they were temporarily repaired by installing liners to protect the pump and reduce sand production. Currently, based on evaluation of pumping test data, the two Prather wells can produce a combined 500 AFY, which is only about one-third of the permitted water right of 1,354 AFY.

Golf Course Well (T-814)

The Golf Course Well (T-814) was in poor condition and replaced in 2005. The replacement well was drilled deeper and produced better quality water than the old well. The replacement well is capable of producing 423 AFY, which is 153 AFY more than the permitted right of 269.9 AFY. An application to make a portion of the Golf Course well diversions supplemental to T-32-S-2 through T-32-S-9 (La Luz wells) for 160 AFY was filed with the NMOSE, and is pending permit approval.

Mountain View Well (T-3489-Replacement)

The Mountain View Well was replaced during the summer of 2006. The City filed an application to replace T-3489 (True Value Well) at a location 500 feet to the west and in the same administrative block. The application was published and protested, although the NMOSE granted the City emergency authorization to replace T-3489. The Mountain View well was completed to 500 feet and is capable of producing the allocated water right of 160 AFY. Water produced from the Mountain View Well is slightly saline and will require treatment prior to use in the potable water supply.

Firm Ground water Supply

As a way to quantify the City's current and future need and consistent with the approach used for surface water, it is necessary to estimate firm ground water supply of existing ground water rights using the potential long-term yield of existing wells in their current (2005) condition.

Since the development of the previous 40-Year Water Development Plan for the City (Livingston and JSAI, 2003), the Prather Wells have been brought into production and the Golf Course and Mountain View Wells have been replaced. **Table 3.5** presents a revised estimate of the firm ground water supply currently available to the City of Alamogordo.

The historical diversions from the La Luz well field are shown on Figure **3.4.**

Table 3.5. Summary of City of Alamogordo ground water rights and firm supply

Supply Name	NMOSE File Number	Water Right, AFY	Firm Supply AFY
La Luz Wells	T-32-S-2 to T-32-S-9	4,573	*1,000
Prather Wells	T-32, T-32-S	1,354	500
Golf Course	T-814	269.9	**270
Mountain View	T-3456	161	160
Total		**6,358**	**1,930**

*- firm supply from Livingston and JSAI (2003).

**- rounded

For planning purposes, the City of Alamogordo must rely on a minimum existing ground- water supply of 1,930 AFY.

4.0 WATER DEMAND

Present Water Demand

The City of Alamogordo's annual water demand is currently (2005) about 1.6 billion gallons per year (4,963 acre-feet). Of this, single-family residences use approximately 68%; multi-family residences use approximately 12%; and commercial, institutional and other uses are about 20%. The average daily use is currently (2005) about 4.4 MGD and the peak use during the summer months is about 6.8 MGD (refer to the **Appendix** for water production graphs). These current demands represent the effects of extreme water use restrictions mandated over the last few years, which reflect a supply-limited demand. Average water demands have dropped substantially from the previous 6.6 MGD occurring in 2000.

The current water demands are supply-driven and there is not an adequate water supply.

Projected Populations

The City developed a Comprehensive Plan (2000), which projected population growth to the year 2020. For the Plan, the University of New Mexico Bureau of Business and Economic Research (UNM-BBER) developed population projections for low, medium and high growth scenarios. After public comment, the medium growth scenario was adopted for planning purposes. Population projections from 2020 to 2040 were also estimated for a medium growth scenario (by UNM-BBER) and extrapolated to 2045.

The following **Table 4.1** shows the projected populations for the City of Alamogordo for the period year 2000 to 2045:

Table 4.1 Projected Populations for City of Alamogordo for 2000 to 2045

Year	Future Projected Population	Difference from Yr 2000 Population	Average Annual Growth Rate
2000	35,969	0	N/A
2005	38,631	2,662	1.5 %
2010	41,283	5,314	1.4 %
2015	43,822	7,853	1.2 %
2020	46,366	10,397	1.2 %
2025	48,702	12,733	1.0 %
2030	51,219	15,250	1.0 %
2035	53,710	17,741	1.0 %
2040	56,137	20,168	0.9 %
2045	58,663	22,694	0.9 %

Per Capita Water Use

As the result of an aggressive and highly successful conservation program, the City of Alamogordo has reduced its water consumption from over 260 gallons per capita per day (gpcd) in 1992 to an average of 165 gpcd during the years 1999 to 2001. Given the existing water supply during those three years, the level of success of the City's conservation programs, and what was considered a reasonable standard of living considering that the City is located in the desert Southwest, the City Commission adopted the 165 gpcd as the City's standard for water use.

Beginning in 2002, water supplies available to the City decreased dramatically, and particularly, the surface water supply. In response, the City passed ordinances that provided for strict water rationing and surcharges. The restrictions were necessary to ensure the City had an adequate water supply to meet essential services. While the City's average annual per capita use has been below 165 gpcd since 2002, these figures are supply driven and the result of aggressive rationing ordinances and surcharges.

An average overall per capita water demand estimate of 165 gpcd is reasonable and was previously adopted for current and future water use planning purposes by the City (Plan, 2003). Additionally, the NMOSE accepted the City's proposed 165 gpcd water use figure and utilized it in forecasting future water requirements for the City of Alamogordo during the previous water rights hearing in 2003.

An estimate of acceptable residential per capita water use was made using NMOSE criteria as outlined in the *Water Conservation Guidelines for Public Water Supply Systems* (Wilson, 1999). The estimate includes both indoor and outdoor (landscaping) water uses, and assumes acceptable levels of water conservation. The estimated residential per capita water use is computed to be around 125 gpcd, of which 76 gpcd is associated with indoor use and 49 gpcd is associated with outdoor uses. To develop an overall total water demand per capita estimate, non-residential uses and unaccounted water use (treatment and system losses, etc.) also have to be included. Based on the billed non-residential water use from 2000 to 2005, the average per capita non-residential water use is about 25 gpcd, bringing the sub-total water use to 150 gpcd. Unaccounted-for water is assumed at 15 gpcd, which reflects a level of approximately 10%. Therefore, an average overall per capita water demand estimate of 165 gpcd is reasonable.

Future Demand for Water

Future water demands for the City of Alamogordo are computed using an average per capita water use figure of 165 gpcd (refer to previous section). This assumes that the current proportion of single-family and multi-family residential, commercial, industrial and other water uses remain relatively constant for the planning period. This assumption also provides for the continued commercial and industrial economic development within the City (at approximately 15% of total water use).

The following **Table 4.2** summarizes the projected future water demands for the City of Alamogordo to 2045, in Acre-Feet per Year (AFY), Million Gallons per Year

(MGY), Average Daily use in Million Gallons per Day (MGD) and Peak Daily use in MGD:

Table 4.2 Projected Water Demands for the City of Alamogordo, 2005 to 2045

Year	Water Demand at 165 gpcd Overall Water Use			
	AFY	**MGY**	**Average MGD**	**Peak MGD**
2005	7,140	2,327	6.4	14.0
2010	7,630	2,486	6.8	15.0
2015	8,099	2,639	7.2	15.9
2020	8,570	2,792	7.7	16.8
2025	9,001	2,933	8.0	17.7
2030	9,466	3,085	8.5	18.6
2035	9,927	3,235	8.9	19.5
2040	10,375	3,381	9.3	20.4
2045	10,842	3,533	9.7	21.3

Note: Peak Day use estimated at 2.2 times Average Day use.

As shown in **Table 4.2**, future demand for water by the City of Alamogordo will reach approximately 10,842 AFY by 2045.

This projected future water use is demand-driven (rather than the current supply-driven condition), where there is adequate water supply for the public's consumption and beneficial use.

5.0 WATER CONSERVATION OVERVIEW

The City of Alamogordo has an aggressive water conservation program. A report prepared by the City of Alamogordo in April 2005 entitled *City of Alamogordo Water Conservation Overview* describes the water conservation program in detail. The following are some of the highlights in the conservation program overview:

- Water Conservation Ordinance No. 948 (1995 and updates) established days and times when outdoor watering is permitted; requires covers on swimming pools when not in use; prohibits outdoor decorative fountains; vehicle washing restrictions; new construction landscaping restrictions; and others.
- Water Rationing Ordinance No. 1008 (1997, amended 2003) mandates reduction in water usage during diminished water supplies; established automatic water rate surcharges; set trigger points for a 3-stage rationing plan.
- Water Rate Ordinance No. 1106 (2000, amended 2002) established increasing block water rates system; provided for surcharges in addition to block rates.
- Established a low-flow toilet rebate program (2001) and will be considering other potential rebate programs (evaporative coolers, etc.).
- Mandated use of reclaimed water for irrigation of City green spaces and for use in construction activities by contractors and City departments, which saves more than 3 million gallons of potable water each day (3,300 AFY).

- Established a per capita residential water use goal of 124.73 gallons per day.
- On-going water distribution system repairs to minimize loss through leakage.
- Lining and covering of the 180 million-gallon raw water storage reservoirs to reduce evaporation and leakage losses by 600 AFY (peak of 1.44 MGD).
- Replacement of water meters over 12 years old.
- Public education programs through the *City Profile* publication and xeriscaping workshops through the Keep Alamogordo Beautiful program.

The results of the various water conservation measures taken by the City over the last few years have been to reduce overall per capita water demand from about 261 gpcd in 1992 to 165 gpcd. Further reductions were supply driven.

The *Overview* concludes with the following statements:

> "The City of Alamogordo will continue to emphasize and encourage water conservation. This is our duty as a responsible community in the arid Southwest, and it will continue to be necessary due to characteristic long periods of drought. However, Alamogordo has done much already to achieve significant results in responsible water conservation and may in fact be reaching a plateau, where further water restrictions are no longer possible while maintaining a reasonable quality of life…"
>
> "**Continued conservation is, has been, and will remain a tool used by the City to exercise wise stewardship of our water resources. However, continued conservation will not be sufficient to provide for the future needs of the community, nor is it adequate to provide security during this period of drought. The City must secure additional sources of water to provide for the current and future needs of the people of Alamogordo.**" (p.14, 15).

6.0 WATER BUDGET

Supply and Demand

Municipalities have a special obligation to guarantee an adequate water supply at all times for their residents. In the City of Alamogordo's case, more than 40,000 people rely on the City to provide water for their health, safety, and welfare. Because of this significant responsibility to provide water at all times under all circumstances, each municipality must analyze its specific circumstances to assess its current and future water needs.

Alamogordo's need for a new, separate source of high quality ground water is the result of a number of physical and legal constraints on its present water supply. Some of these factors are summarized below.

Constraints on Existing Water Supply

1. Lack of supply due to drought

A municipality's first priority is to guarantee a water supply for the public. The American Water Works Association (AWWA) is the industry leader in public water supply since its beginning in 1881. The AWWA is an international nonprofit scientific and educational society dedicated to the improvement of water quality and supply. It has more than 57,000 members and 4,700 utilities serving water to over 180 million people.

The AWWA *Manual of Water Supply Practice* (AWWA, M50) serves as a guideline for water supply planners, engineers, and government officials in water supply planning. According to the *Manual*:

> A primary function of water resources planning is to provide water for periods of drought. Most municipal water supply plans consider the drought of record when estimating the firm or safe yield of a water source…. Therefore, according to the plan, there should be adequate water supply and system capacity to meet increased demand under drought conditions. (p.87).

The Manual of Water Supply Practice also discusses how firm yield or safe yield must be considered in determining a municipality's need for additional water supplies:

> To establish the need for additional sources of supply, reliable diversion rates must be established from water supply sources (safe yield) contributing to the water supply system. Most simply, safe yield [firm yield] is defined as the reliable withdrawal rate of acceptable quality water that can be supplied by available flows and/or storage releases from reservoirs and/or groundwater reserves throughout a critical drought period…..The yield [firm yield] of a water system combined with demand forecasts identifying a reasonable range of future needs provides the basis for evaluating actions that will need to be considered over the planning period. (p.121).

There has been recognition at a national level that the decade-long drought in the West is causing surface water supplies to dry up and forcing municipalities to consider new sources. The abundant supply of brackish ground water is allowing some cities in the Southwest to consider desalination as their new supply, as reported in the publication *New Scientist*:

> Desalination is also being considered for landlocked states such as New Mexico, Nevada and Utah, where a decade of drought has caused surface water to run dry, while saltwater lies untouched in underground reserves. (New Scientist Tech, June 30, 2006).

As discussed earlier in this Plan, the City of Alamogordo is overly-reliant on surface water that is susceptible to drought. This has been a significant factor in the City's lack of an adequate water supply since 2002.

2. Lack of supply due to infrastructure (supply) limitations

The La Luz well field has a limited ground water supply availability due to hydrologic conditions in the aquifer, NMOSE administrative limitations, local domestic wells affecting recharge, and well conditions. The wells have been cleaned numerous times, but continued growth of iron-bacteria on the well casing and screen causes encrustation and plugging of the screen openings, severely restricting flow into the well pump and causing pump cavitation. This *infrastructure-limitation* contributes to overall supply delivery and availability. Over time, the bacterial growth causes complete well failure due to aquifer plugging. Replacement well drilling permits may be applied for, but are subject to protest and/or denial and are time consuming. Even if replacement wells are authorized, there is a limit to total production from the well field due to aquifer and other limitations.

3. Lack of supply due to legal limitations

NMOSE administrative rules limit the amount of water withdrawn in certain areas, and are beyond the control of the City. This water is *administratively-limited*, and effectively constrains the City as to where it can (and more importantly, cannot) look for new water. This *administratively-imposed* constraint forces the City to look beyond its municipal boundaries for additional water supply. *The City has no choice*. The only remaining areas (outside the administrative area) which the City can consider for the development of new sources of water supply are north of Tularosa, south of Dog Canyon, and west of Alamogordo (the adjacent mountain areas to the east are now also administered). South of the City is not a feasible option because of military land ownership. West is not a feasible option because of military land ownership, hydrologic and water quality issues (too high a TDS to be treated economically, low well yields). The administrative restrictions imposed by the NMOSE have forced the City to go north of Tularosa for new water. This location is far away, costly, and requires desalination treatment.

Farther yet are the Salt Basin and Hueco-Bolson south of the City. These two areas have water rights issues. Further, developing these areas as water supply sources would be costly and require treatment and up-hill pumping of the water. The areas have not been substantially studied to make long-term decisions on feasibility, environmental concerns, or political (public) acceptability. The Regional Water Plan for the Lower Rio Grande water users includes both basins as a potential future water supply so there may be competition among regions of the State for these resources.

Additionally, there are no more available surface water sources. The surface water rights the City does hold are limited by maximum flow rates, so the City cannot divert the occasional large amount of storm generated stream flows. Additionally, the La Luz Irrigation District has the “first call” on the water in the La Luz-Fresnal diversion, which often leaves the City with minimal remaining water supply. Also, due to the adjudication of the surface waters, there are water rights holders along the stream with priority dates senior to the City’s. This means that the City cannot divert its flows with the later priority dates until the others’ earlier priority rights have been satisfied. This effectively stops any further development of surface water in the area.

4. Lack of supply due to water quality constraints

According to the *Desalination and Water Purification Technology Roadmap* (USBOR, SNL, 2004):

> Water availability includes issues of both water quantity and quality. After all, just as drought conditions can reduce the amount of water available, reductions in water quality can diminish the available water supply for its intended use.

The City’s water quality goal is established at 800 mg/L total-dissolved-solids (TDS). The limit recommended by the New Mexico Environment Department (for aesthetic purposes) is 500 mg/L. The actual quality of the blended water supply varies from about 800 mg/L to over 1,000 mg/L when the existing City wells are used extensively. Other cities in New Mexico provide a water supply with a quality better than the recommended 500 mg/L TDS, i.e., with lower TDS. Other communities, such as the White Cliffs Mutual Domestic Water Users Association, use reverse osmosis to treat their water supply. If the City adopted the 500 mg/L TDS goal, the actual available supply would be even less because the surface water would require treatment. Additionally, the United States Environmental Protection Agency (USEPA) has considered adding sulfates to the list of contaminates for required removal, which would add further burden to necessary water treatment for the City. Many residents of Alamogordo use water softeners to reduce hardness and minimize its corrosive effect on appliances (dish washer, washing machine, evaporative coolers, etc.), and many use reverse osmosis systems to create better tasting water for drinking and cooking. The cost of treating down to a 500 mg/L TDS would be enormous. The ARWSP allows the City flexibility in supplying less than 800 mg/L TDS water through blending, when other supplies allow. This is an operational decision for the City of Alamogordo, and would be more costly, but should have the flexibility to serve better water to the citizens if so desired. Quality also plays an important part in general O&M issues in the distribution system. Typically, higher TDS waters cost cities more in repair/replacement of pumping components, valves, etc. Also, the costs to the public in increased maintenance for evaporative coolers, washing machines, dishwashers, etc., is a real cost.

5. Vulnerability to contamination by accidental (fire, flood), emergency (spill) or deliberate (terrorist) causes

Watersheds are vulnerable to forest fires, mudslides, and other “acts of nature” that may impair the water quality to the point that it cannot be treated. In some cases in the past, the City has had to decline to divert stream flows that are highly turbid (muddy) because the treatment plant could not treat the water. Ash created by forest fires can plug treatment works. Forest fires also leave the affected watershed areas void of ground cover vegetation, which allows topsoil runoff (containing high levels of organic material) that is highly turbid and creates treatment challenges. Floods can have the same effect, and as demonstrated in the Village of Cloudcroft this summer, floods there rendered the surface water pond unavailable. In addition, watersheds can become unsuitable as sources of surface water because of high levels of pathogens from livestock or native wildlife. These can create a human health hazard (such as occurred in the Milwaukee outbreak in 1993, where many got sick). Redundant supplies are needed for this reason.

Accidental contamination from environmental spills (fuel, fertilizer, etc.) are a concern along transportation routes, and can render an entire surface water supply unusable for extended periods of time, if not forever. Deliberate contamination from human activity is also possible as an act of terrorism. Surface water supplies are most vulnerable. Precautions against this threat are important at this time. Because water supplies are vulnerable to contamination, redundant supplies are necessary.

6. The need to guarantee a water supply for the public health, safety and welfare

An essential responsibility of a city is to guarantee the water supply for the public. Water supply has to be there 100% of the time, in all conditions, all climates. The only way to ensure a guaranteed water supply availability is to rely only on the "firm yield" of existing supplies and develop additional water supplies.

Again, *AWWA Manual M50* states:

> "Safe yield [firm yield] is the *maximum* quantity of water that can be guaranteed to be available …during a critical dry period." (p.163, emphasis supplied).

Certainly amounts of storage are important for maintaining daily, weekly or monthly peaking delivery capacity, but annual (or multiple year) storage is not practical nor generally practiced. Therefore, the City's actual water supplies must be able to meet all of the public's water needs each and every day and year, even (and especially) during times of limited availability. Unfortunately, no one can predict when a drought will be over or when one will recur, so a city is faced with making sure that its water facilities (both supply and distribution) are capable of providing all of the water needed, each and every day and all year, under "worst case" conditions of drought.

This is prudent, textbook water planning. To do anything else would be gambling on the ability to provide water to the public, and potentially endangering public health and welfare. Because water planning and acquisition can take years to accomplish, beginning after the drought has started *is already too late*. Prudent and responsible water planners must begin long before a crisis happens. This goes for emergency supply planning, too.

7. Availability/Reliability

The City is moving toward more expensive water supplies. Surface water is the least expensive alternative, followed by the La Luz wells, the Golf Course and Prather wells (once shut down due to expensive pumping), and then the desalination facility because of no remaining alternative. The "cost" of conservation has been paid-in-full. If there were other less-costly available supplies, the City would pursue them first. Conjunctive management of separate sources of water is a defined "need" because it allows the City to most efficiently and economically manage its supplies for quality and redundancy.

Reliability defines the level of a "guaranteed supply".

Reliability in meeting long-term water demands is a recommended criterion for water development alternative evaluation. Again, *AWWA Manual M50* states:

> "Reliability to meet long-term demands. In this case, goals should be set to balance supply and demand during below-normal water supply years." (p. 279).

8. City 40-Year Need

The City would be justified in claiming a greater need for a new separate water supply for its 40-year planning period based on the above discussions. However, it has taken a conservative approach and quantified needs based on demands calculated from average per person daily usage times future population projection, less the firm yield.

For planning future water needs for the City of Alamogordo, the available firm water supply must satisfy the projected demands. **Table 6.1** below summarizes the water rights, firm combined supply and average diversion from 2000 to 2005 for each current source.

Table 6.1 Water Supply Source, Water Right, Firm Supply and Average Production 2000 to 2005 for City of Alamogordo

Water Supply Source	Water Rights AFY	Firm Supply AFY	Avg. Production 2000 to 2005 AFY
Total surface water	5,418 AFY + 16 CFS	2,654	3,974
Total ground water	6,351 AFY	1,930	1,880
Totals	**11,769 AFY + 16 CFS**	**4,584**	**5,854**

As indicated in **Table 6.1** above, the current water rights (11,769 AFY + 16 CFS) are substantially greater than the available combined firm supply (4,584 AFY). In addition, water quality constraints (TDS limits) are not reflected in the above information, which would further limit existing ground water supply. As previously stated, the firm supply is based on the worst years in the record, which includes drought, hydrologic and system limitations, and ultimately reflects reliability of the supply.

For planning purposes, the City of Alamogordo will rely on a minimum combined firm surface and ground- water supply of 4,584 AFY.

Need for Additional Water Supply

Projected future water demands for the City of Alamogordo are indicated in **Table 4.3**, and increase from 7,140 AFY in 2005 to 10,842 AFY by 2045. Using the combined firm surface and ground water supply of 4,584 AFY, a potential deficit in water supply of 2,556 AFY occurs currently (2005), and will grow to 6,258 AFY by 2045.

Table 6.2 below summarizes the projected water demands, firm water supply and estimated shortfalls in supply for the City of Alamogordo, for the period 2005 to 2045, and are shown graphically on **Figure 6.1**.

Table 6.2 - Projected Water Demands, Firm Water Supply and Water Supply Shortfalls for the City of Alamogordo, 2005 to 2045

Year	Projected Water Demand			Firm Water Supply			Projected Water Supply Shortfall		
	AFY	MGY	Avg MGD	AFY	MGY	Avg MGD	AFY	MGY	Avg MGD
2005	7,140	2,327	6.4	4,584	1,494	4.1	2,556	833	2.3
2010	7,630	2,486	6.8	4,584	1,494	4.1	3,046	993	2.7
2015	8,099	2,639	7.2	4,584	1,494	4.1	3,515	1,145	3.1
2020	8,570	2,792	7.7	4,584	1,494	4.1	3,986	1,299	3.6
2025	9,001	2,933	8.0	4,584	1,494	4.1	4,417	1,439	3.9
2030	9,466	3,085	8.5	4,584	1,494	4.1	4,882	1,591	4.4
2035	9,927	3,235	8.9	4,584	1,494	4.1	5,343	1,741	4.8
2040	10,375	3,381	9.3	4,584	1,494	4.1	5,791	1,887	5.2
2045	10,842	3,533	9.7	4,584	1,494	4.1	6,258	2,039	5.6

The City of Alamogordo is currently deficit in critical water supply by more than 2,500 AFY, and will be more than 6,200 AFY by 2045.

7.0 WATER SUPPLY ALTERNATIVES

Required Minimum Quantity

As discussed in **Section 6.0** and indicated in **Table 6.2**, the minimum quantity of additional water resources required by the City of Alamogordo ranges from 2,556 AFY at the present (2005) up to 6,258 AFY by 2045. These are considered minimum amounts for the reasons described in Section 6.0. Because of the constraints on the use and management of the City's existing surface and ground water supplies, the City needs a new, separate source of ground water that will allow true conjunctive management of separate water supplies and flexibility in system operations and optimization.

Therefore, this Plan considers water development alternatives to achieve a minimum of 6,258 AFY of additional delivered water supply by 2045, and recommends full development of ground- water to 10,842 AFY for redundancy, emergencies, and future needs.

Water Quality Considerations

The City has adopted water quality criteria for new water supplies. All new water supplies must contain a total dissolved solids (TDS) level of 800 mg/L or less. This criterion will provide new water supplies with a quality that approximates the La Luz-Fresnal and Alamo Canyon spring water.

Water Supply Development Alternatives

Described below are a number of development alternatives being considered and evaluated by the City. The ARWSP is currently the only technically feasible cost effective project that also meets the City's water quality requirements. Other alternatives may be pursued by the City dependant o n many factors

Alamogordo Regional Water Supply Project (ARWSP)

Desalination of brackish ground water as a municipal supply in the Tularosa Basin has been studied since the 1950s (1958, Armor Foundation; 1970, OSW; 1986, BOR; 2002, Regional Water Plan; 2003, COA Desalination Study; others). The Alamogordo Regional Water Supply Project (ARWSP) is the result of the City of Alamogordo's effort towards the development of a desalination water supply alternative. The ARWSP will assist in producing the water supply needed to meet current and future demands. The desalinated water will meet the City's water quality goal of 800 mg/L TDS.

A feasibility study for desalination of brackish water south of Three Rivers (Snake Tank Well Field) has been completed (Livingston, 2003, Shomaker, 2006), and shows this project to be feasible with an acceptable implementation schedule. Of the alternatives considered, the ARWSP is the <u>only</u> one that produces the total quantity and quality of new water needed by the City of Alamogordo in the required time frame. In addition, the ARWSP provides a regional water supply. The Village of Tularosa, by agreement, has an option for 400 AFY to 1,200 AFY of ARWSP diversions, through the year 2040 (and assumed to be extended to 2045). Other entities such as rural water suppliers, Holloman Air Force Base, etc., may desire to participate in the ARWSP in the future. However, for this Plan, the Village of Tularosa is the only other entity considered participating in the project at this time, and their bulk water delivery amounts are included. A substantial financial investment and investigation has been performed for the ARWSP, including well field evaluations, pilot project and feasibility study, beginning the environmental process (NEPA), and the water rights permitting process.

If approved by all state and federal agencies in full, implementation of the ARWSP will result in the production of a minimum 2,556 AFY and up to 6,258 AFY of new water supply for the City of Alamogordo. Expansion of the Snake Tank Well Field may be possible in the future, or other additional sources of brackish ground water (if located) could be used for future expansion of the ARWSP.

The costs associated with this alternative may range from $45.5 million to $75.5 million capital, and approximately $0.86 per 1,000 gallons O&M.

The Alamogordo Regional Water Supply Project will provide the future water supply needed by the City of Alamogordo to at least 2045. This project should be implemented immediately, including the required ground water diversions from the Snake Tank Well Field.

Supplemental and Replacement Wells

The City could potentially increase local ground water supply by successfully permitting and drilling replacement wells and one supplemental well. This alternative includes replacing La Luz Wells 2 through 5, and Prather Wells 1 and 2. After an extensive analysis of the NMOSE administrative criteria, evaluating the validity of existing water rights and impacts to wells of other ownership, one location (in addition to the Golf Course well) has been identified for a potential supplemental well to the La Luz Well Field. The location is west of Highway 54 between the Golf Course and the Airport (known as proposed Airport well). Also, the recently submitted application to use 160 AFY from the Golf Course Well supplemental to the La Luz Wells is being reviewed by the NMOSE. This alternative may not generate any additional ground water supply if NMOSE permits are not approved, or up to a maximum of 1,970 AFY if permits are obtained and successful wells drilled.

However, this alternative cannot provide the additional future water supply needed by the City of Alamogordo.

Recycled Water Reuse

The reclaimed water system is a valuable resource. This reclaimed water is used for turf irrigation, construction and other City's needs. Utilizing reclaimed water for these uses offsets the demand for potable water. Currently the City uses all of the approximate 3 MGD reclaimed water during the spring through fall months, and has plans to expand the system to use around 4 MGD in the future (Boyle, 2002). However, during the winter months, approximately 1,000 acre-feet of reclaimed water is not needed for irrigation and is diverted to the center pivots located near the Water Reclamation Plant or to land disposal (within Section 16).

Planned indirect potable reuse is the addition of highly treated wastewater (re-purified water) into the potable water system through aquifer recharge or surface water augmentation. Many communities throughout the United States are practicing indirect potable reuse, including the cities of El Paso (for more than 25 years) and Dallas, Texas. Communities in New Mexico are also planning indirect potable reuse projects, including Cloudcroft, Gallup and Rio Rancho. For Alamogordo, some of the reclaimed water produced during the winter months could be re-purified and used for aquifer recharge at the Prather wells or a new injection well, or for surface water blending at the La Luz reservoirs. Public hearings, NM Environment Department permitting and feasibility studies would need to take place prior to a City's final decision for implementation. However, this alternative cannot provide the additional future water supply needed by the City of Alamogordo.

The costs associated with this alternative are variable and have not been determined.

Agricultural Water Exchange

A new concept called Multiple Use Water Conservation (MUWC) uses agricultural water for a municipal water supply first, then for farm irrigation using the reclaimed water. The agricultural water right is utilized, and a portion of the municipality's water is used to keep the diverted water amount and irrigated water amount equal. A study was conducted (Livingston, 2006) on the MUWC concept, and evaluated a 1,000 AFY project for Alamogordo. Considering desalination of the agricultural ground water, the City would realize about 850 acre-feet of additional new water supply from a City's contribution of only 365 acre-feet (1,215 acre-feet total water supply). The project would require about 300 acres of farm land for irrigation and 1,000 AFY of agricultural water rights. Additionally, the new Mountain View well could be used to provide all or a portion of the City's water contribution. A meeting with the NMOSE in March 2006 indicated that this concept would likely be permitted. NM Environment Department permitting would be needed prior to implementation. However, this alternative cannot provide the additional future water supply needed by the City of Alamogordo.

Outside Bulk Water Purchases

As the market for water expands in the Region, some outside bulk water purchase scenarios may be feasible. New water purchases considered should meet the City's adopted water quality goal of 800 mg/L TDS or less. Additionally, the facilities to convey the water into the City distribution system should be provided. The cost of purchased water should be equal or less than the cost to produce the same quality and quantity of water under the ARWSP (or other) water supply alternative. Water that may be used for blending in the ARWSP should also be considered. This alternative may also become more attractive for longer-term (beyond 2045) water needs, such as the Salt Basin water.

The costs associated with this alternative vary with each proposal, and should be evaluated on a case by case basis.

Aquifer Storage and Recovery (ASR)

Aquifer Storage and Recovery (ASR) may allow the City to store winter spring flows in the La Luz Well Field aquifer, for pumping out during the peak summer months. A draft study was conducted (Livingston, Shomaker, 1997) which showed that an average of 2,000 AFY might be stored and recovered (if available). All diverted and stored winter flows would be held under the City's current water rights. This alternative is susceptible to drought conditions, however, as there may not be the winter spring flows available to divert, treat and store. Alternatively, re-purified water may be used for aquifer recharge.

An ASR program could also provide for a more flexible conjunctive use water resource management, where more ARWSP water is produced and available surface water is stored in the aquifer. A hybrid injection and recovery well was drilled in 2001 in the La Luz Well Field for the purpose of ASR, but the project is yet to be permitted and implemented due to the lack of available winter spring flows. However, this alternative cannot provide the additional future water supply needed by the City of Alamogordo.

The costs associated with this alternative have not been determined.

Water Conservation

The City has adopted an aggressive water conservation program. This should be continued. Educational programs, rebates for replacing existing plumbing fixtures, landscaping restrictions, change in water rate structure and other strategies will assist in maintaining the City's per capita water use goals of 165 gpcd overall and 124.75 gpcd residential. However, this alternative cannot provide the additional future water supply needed by the City of Alamogordo. In addition, because it is associated with the use of existing supplies, does not provide any additional drought protection.

The costs associated with this alternative are variable and are not determined.

Other Alternatives

There exist other potential water resources within the Region which are currently not recommended alternatives at this time. Economic or other considerations may necessitate another evaluation of any of these in the future.

Salt Basin Water Supply

Although a substantial quantity of good quality ground water is in storage in the Salt Basin aquifer, the capital and operational costs associated with the City independently developing a system to convey this water to Alamogordo are greater than the desalination alternative (Regional Water Plan, 2002). Secondly, this water will need to be treated to reduce the TDS down to the 800 mg/L goal. There may be potential for a regional water supply system which, if economical for the City to participate in, should be considered in the future. Additionally, other entities have already filed for water rights from the Salt Basin, and it is not likely that the City of Alamogordo could obtain separate water rights there. However, a regional water supply from the Salt Basin could be considered for longer-term City needs.

Bonito Lake Watershed Enhancement

Currently, the Bonito Lake system does not deliver the full water right for the City of Alamogordo. Drought conditions have substantially reduced the amount of snow pack, and hence, watershed yield to the Lake. Historically, Bonito Lake has contributed only 5% to 15% of the water supply. Additionally, the storage capacity of the reservoir is diminished due to sedimentation. A watershed restoration program could be implemented, which may increase the yield from the watershed. However, this alternative is a long-term management program and would take years to realize any additional water yield in the Lake. Additionally, the Bonito Lake watershed is primarily US Forest Service wilderness area, which may prohibit extensive restoration efforts. This alternative cannot provide the additional water supply needed by the City of Alamogordo (Regional Water Plan, 2002).

Agricultural Water Conversion to Municipal Use

There may be available agricultural water rights that could be purchased and converted to municipal use. However, the water right would first need to be converted from agricultural use to municipal use. Because only the consumptive portion of the water right is convertible for municipal use, about forty-percent of the right is lost (non-convertible). In addition, the City has adopted a policy not to purchase and convert agricultural water rights, because of the potential loss of production and economy from the agricultural community. To supply the entire additional water requirements of the City, most of the farmland (approx. 3,000 acres) from Tularosa to Alamogordo would need to be removed from production and their water rights converted. Because of the distances between farms and the need for water treatment, this alternative is currently considered impractical and not feasible for a long-term City supply. (Information derived from Regional Water Plan, 2002).

Flood Control Aquifer Recharge

The Corps of Engineers flood control project has potential to store flood waters and recharge the shallow aquifer. However, because flood quantity is unreliable and drought-sensitive, this is not considered a reliable supply for planning purposes.

Sacramento River Pipeline

The Sacramento River flows are drought-sensitive and unreliable. The cost of facilities to convey water to Alamogordo (via the Alamo Canyon Water Treatment Plant) are not justified by the potential resource (BOR, 1986).

8.0 WATER DEVELOPMENT PLAN

Water Development Recommendations

Historically, the La Luz Well Field, Bonito Lake, and surface water from La Luz Canyon were alternative sources developed in the 1950s to supplement Alamogordo's primary water supply from Alamo Canyon during the 1950s drought. Fifty years and more than 30,000 additional people later, the City of Alamogordo is in need of alternative water supply sources to meet current and future demands. The recommended solution is developing additional ground water supply by implementing the Alamogordo Regional Water Supply Project (ARWSP) and desalinating brackish ground water located south of Three Rivers.

The solutions for developing the additional water supply required by the City of Alamogordo for the 40-year period (2005 to 2045) include the following:

1) To meet current (2005) and future (2045) water demands, immediately implement the Alamogordo Regional Water Supply Project (ARWSP) desalination facility and infrastructure. This project consists of developing the Snake Tank Well Field, brackish water desalination facility and concentrate disposal system, treated water storage and pumping, and piping infrastructure to the City of Alamogordo.

2) Base the minimum ARWSP production capacity on amounts shown on **Table 8.1**. Production includes bulk water purchase agreement amounts for the Village of Tularosa.

Table 8.1 Minimum ARWSP Desalination Facility Production Capacity, 2005 to 2045, City of Alamogordo

Year	Minimum Capacity	Minimum Capacity
2005	2,876 AFY	2.6 MGD
2010	3,366 AFY	3.0 MGD
2015	3,995 AFY	3.6 MGD
2020	4,466 AFY	4.0 MGD
2025	5,057 AFY	4.5 MGD
2030	5,522 AFY	4.9 MGD
2035	6,303 AFY	5.6 MGD
2040	6,751 AFY	6.0 MGD
2045	7,218 AFY	6.4 MGD

3) Complete the Snake Tank Well Field and water rights permitting for the ARWSP desalination facility to meet minimum current and future water supply deficits. The overall ground water diversion requirements for desalination are greater than the delivered potable water supply amounts due to the recovery rate of the desalination process (projected at 80%). Include the Village of Tularosa bulk water agreement amounts. Develop minimum Snake Tank Well Field capacity and water rights for 9,023 AFY. Analyze the well field pumping data periodically and evaluate the potential for increasing the well field capacity and water rights.

4) Phase in the ARWSP Snake Tank Well Field pumping schedule (including the Village of Tularosa bulk water purchase agreement amounts) as shown in the following **Table 8.2** (assumed desalination process recovery of 80%):

Table 8.2 - Proposed ARWSP Snake Tank Well Field Pumping Schedule, 2005 to 2045, City of Alamogordo

Year	Avg. Pumping Rate	Avg. Pumping Rate
2005	3,595 AFY	3.2 MGD
2010	4,208 AFY	3.8 MGD
2015	4,994 AFY	4.5 MGD
2020	5,582 AFY	5.0 MGD
2025	6,322 AFY	5.6 MGD
2030	6,903 AFY	6.2 MGD
2035	7,879 AFY	7.0 MGD
2040	8,439 AFY	7.5 MGD
2045	9,023 AFY	8.1 MGD

5) Continue exploration of additional brackish ground water sources for potential expansion of the ARWSP desalination facility beyond 2045; and to provide for additional regional water user participation.

6) Continue the process of evaluating water supply needs and water development alternatives for the longer-term (2045-2085).

7) Evaluate opportunities for outside bulk water purchases that meet the City's water quality criteria, delivery requirements, blending potentials and cost comparisons with the other water development alternatives.

8) Apply to NMOSE for permits to replace the two Prather wells, four La Luz wells (No. 2-5) and one supplemental well (Airport). If permits are granted, drill replacement wells and supplemental well to increase ground water production potential up to 3,900 AFY.

9) Develop an integrated water resource management plan that will optimize the conjunctive operation of the various water supply sources.

10) Maintain the water conservation program to continue to meet the 125 gpcd residential water use goal and overall 165 gpcd water use.

11) Expand the reclaimed water system as described in the master plan to provide a water supply for future non-potable uses (development of additional green spaces, etc.); evaluate the opportunity for winter water storage and reuse; evaluate the potential for industrial and commercial uses.

12) Evaluate opportunities for up to 1,000 AFY of indirect potable reuse of re-purified water to augment the potable water supply through aquifer storage at the Prather wells or a new supplemental well site, and/or surface water blending and storage at the La Luz raw water reservoirs.

13) Evaluate opportunities for trading a portion of the City's reclaimed water to local farmers for irrigation, in exchange for their irrigation well water, which would be treated and used in the water supply.

14) Develop the aquifer storage and recovery (ASR) program. Extend the pilot and demonstration program at Well No. 9; complete the Well No. 9 ASR permitting; implement ASR by conjunctive use of ARWSP water and surface water.

15) Develop the remaining (and permitted) spring diversion on the La Luz-Fresnal system.

16) Continue replacement and upgrade of water system infrastructure to reduce leakage and unaccounted-for water losses to around 10%.

F I G U R E S

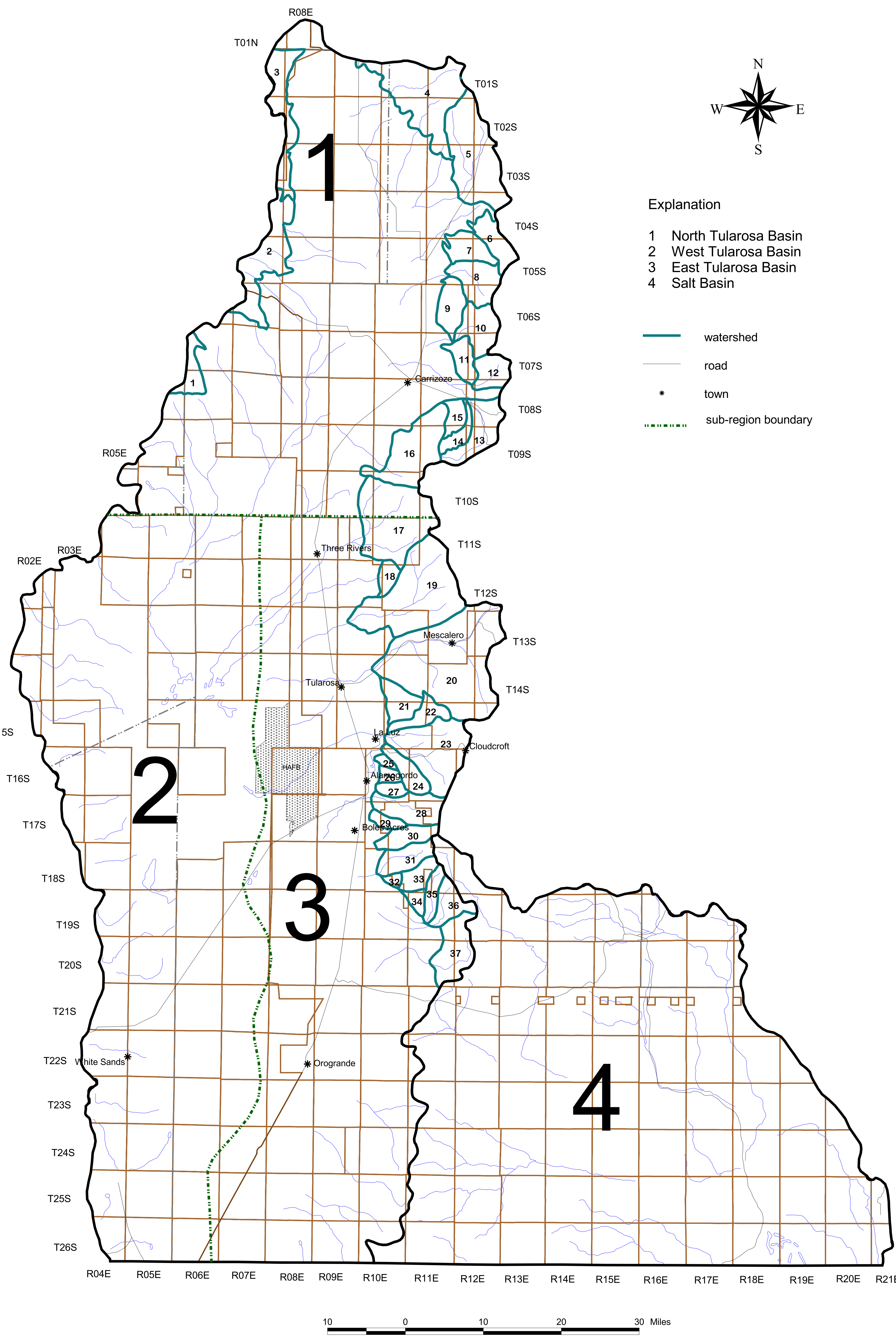


Figure 1.1. Map of the Tularosa and Salt Basins showing sub-regions, major watersheds, and geographic details.

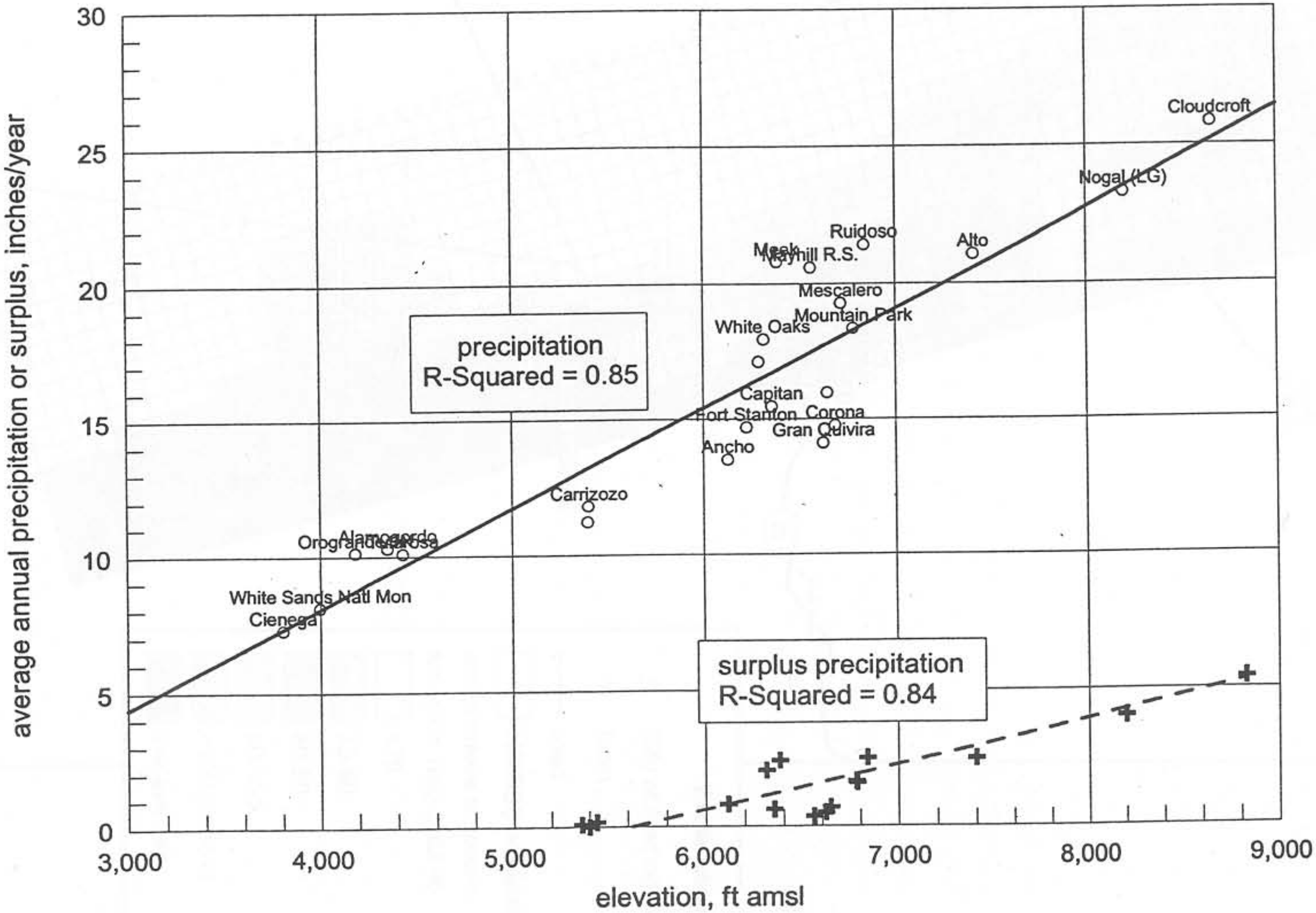


Figure 1.2 Graph of precipitation and surplus versus elevation for the planning region.

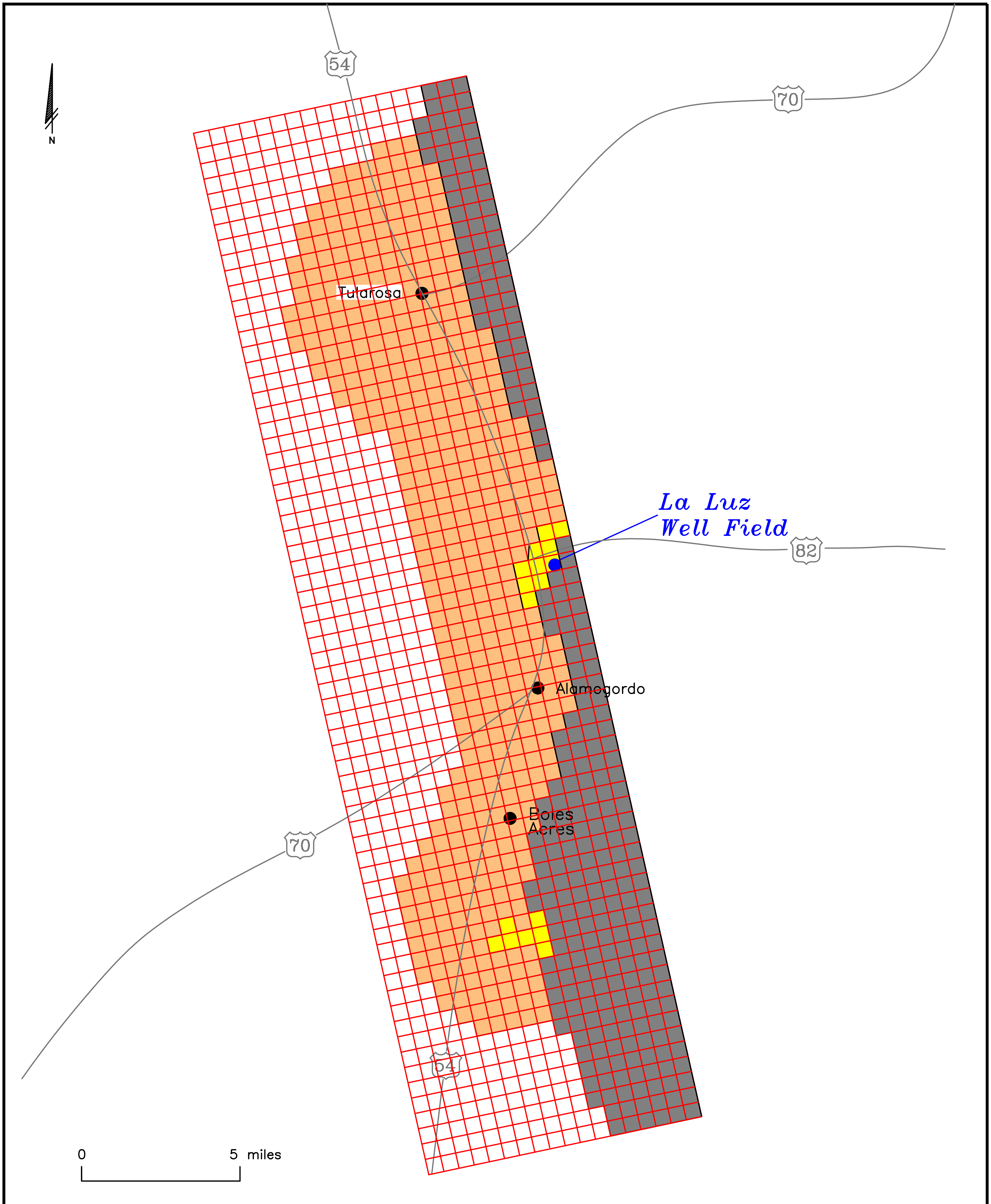


Figure 1.3 Map showing Alamogordo and Tularosa Administrative Area.

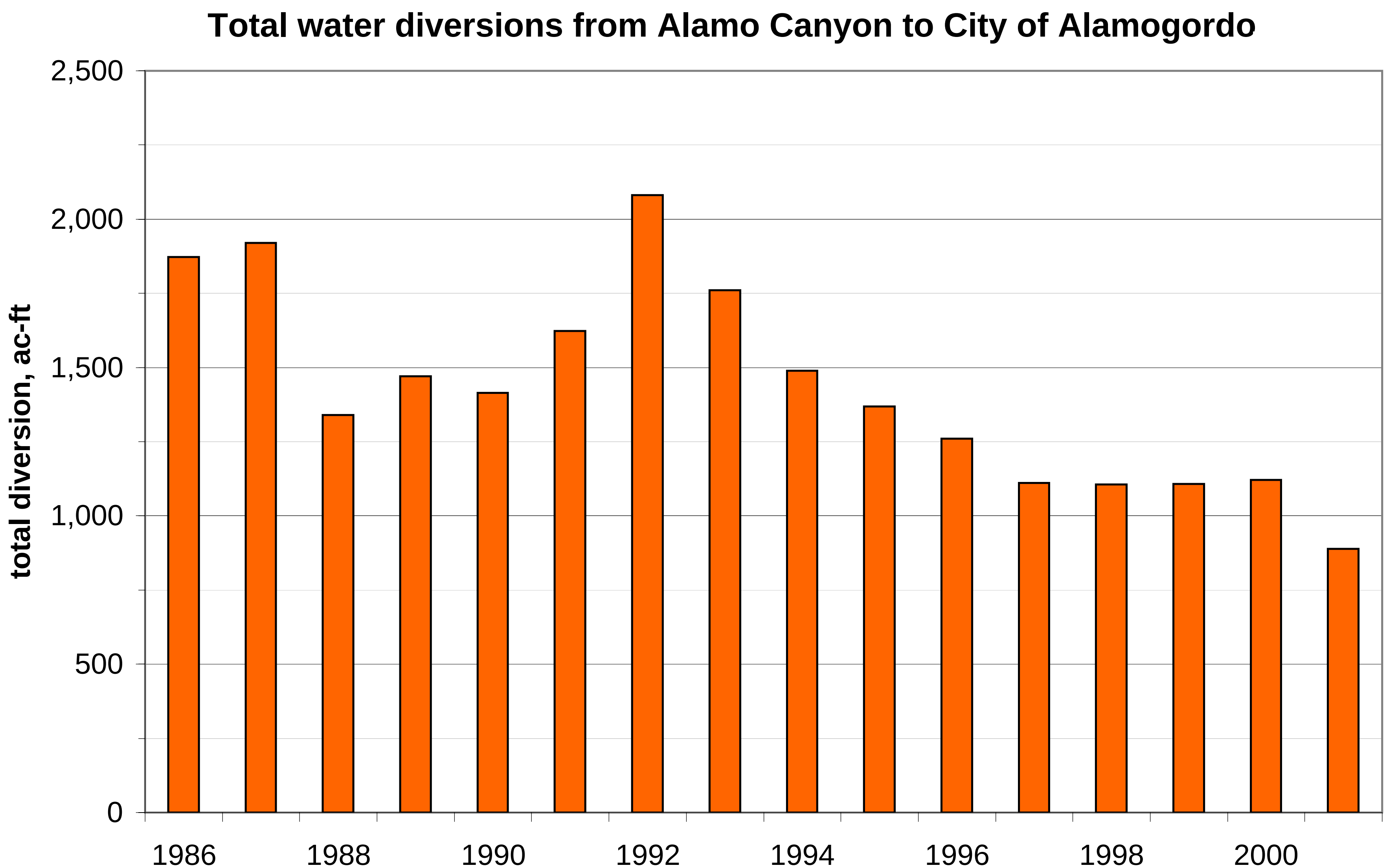


Fig. 2.1 - Alamo Canyon Water Diversions

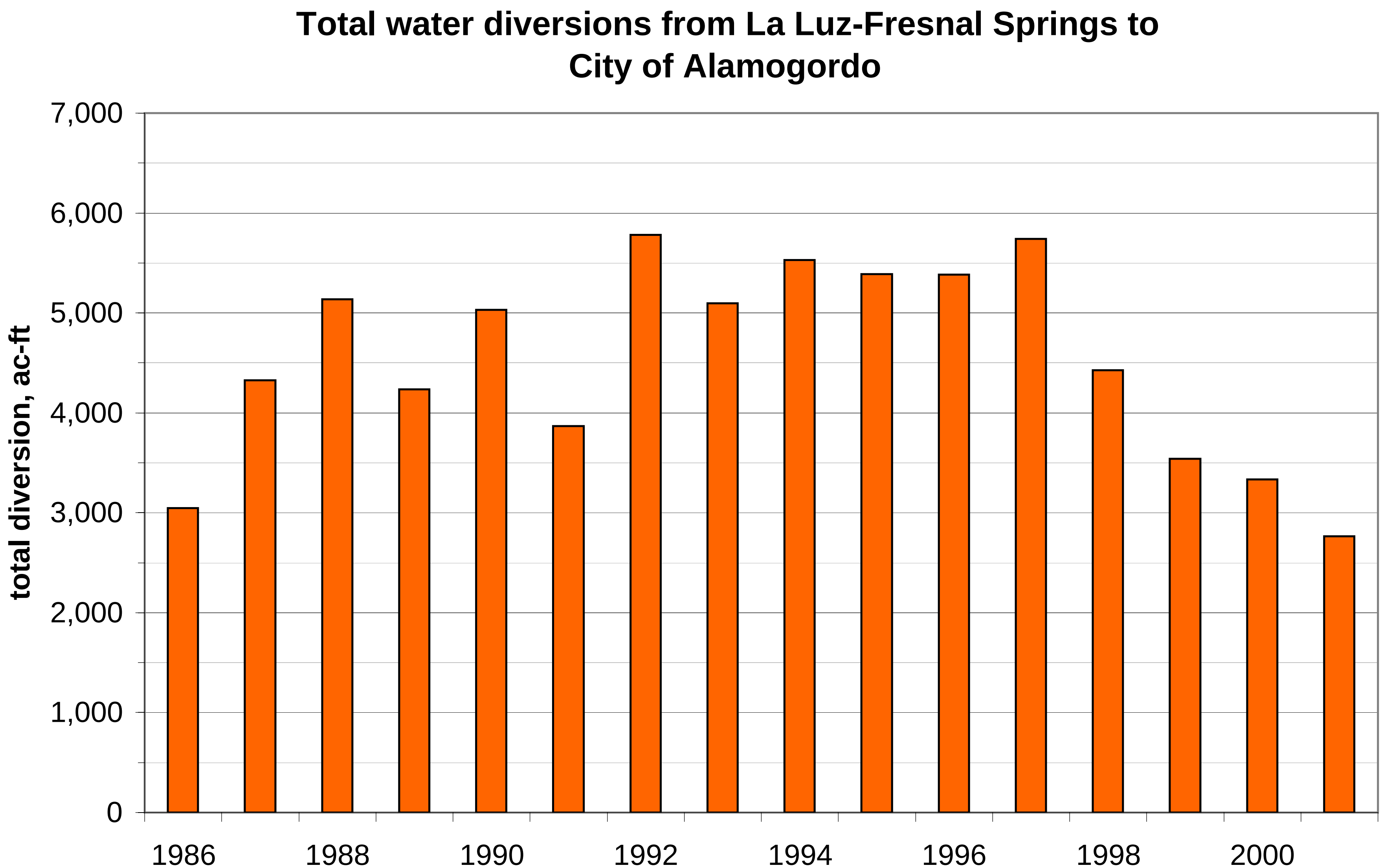


Fig. 2.2 - La Luz-Fresnal Water Diversions

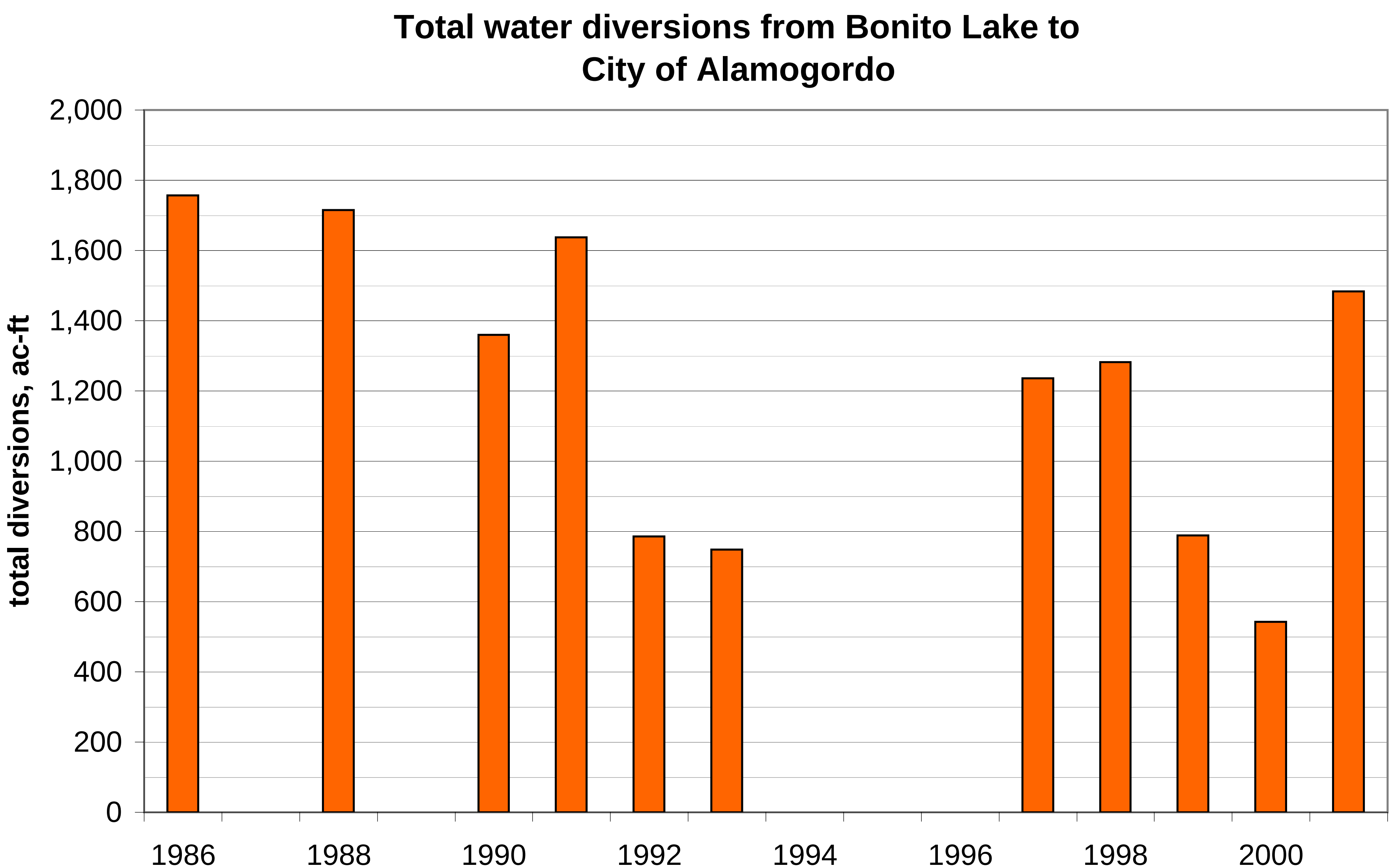


Fig. 2.3 - Bonito Lake Water Diversions

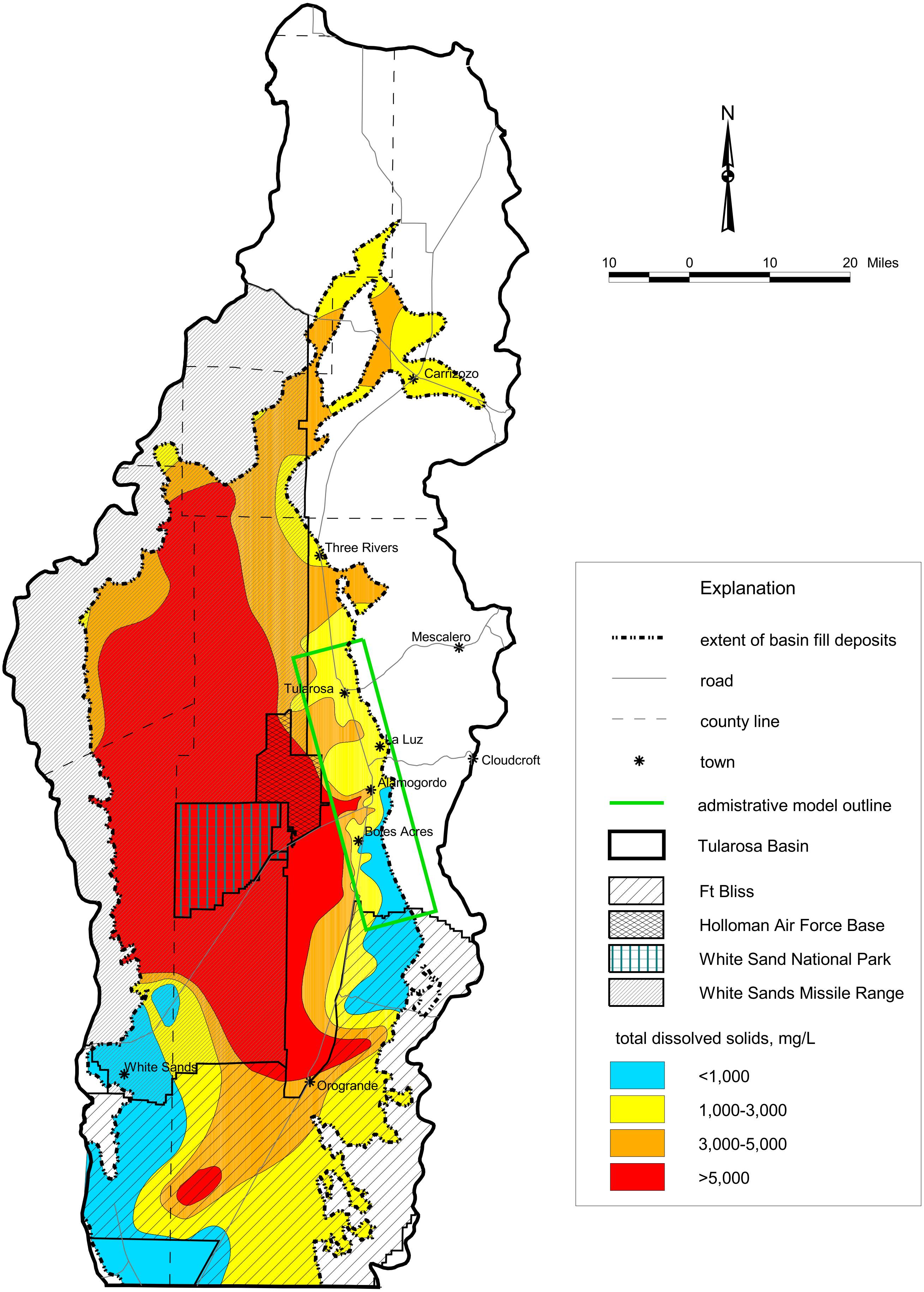


Figure 3.1. Map of Tularosa Basin showing distribution of total dissolved solids in basin-fill aquifer and location of Alamogordo-Tularosa Administrative area and other geographic features.

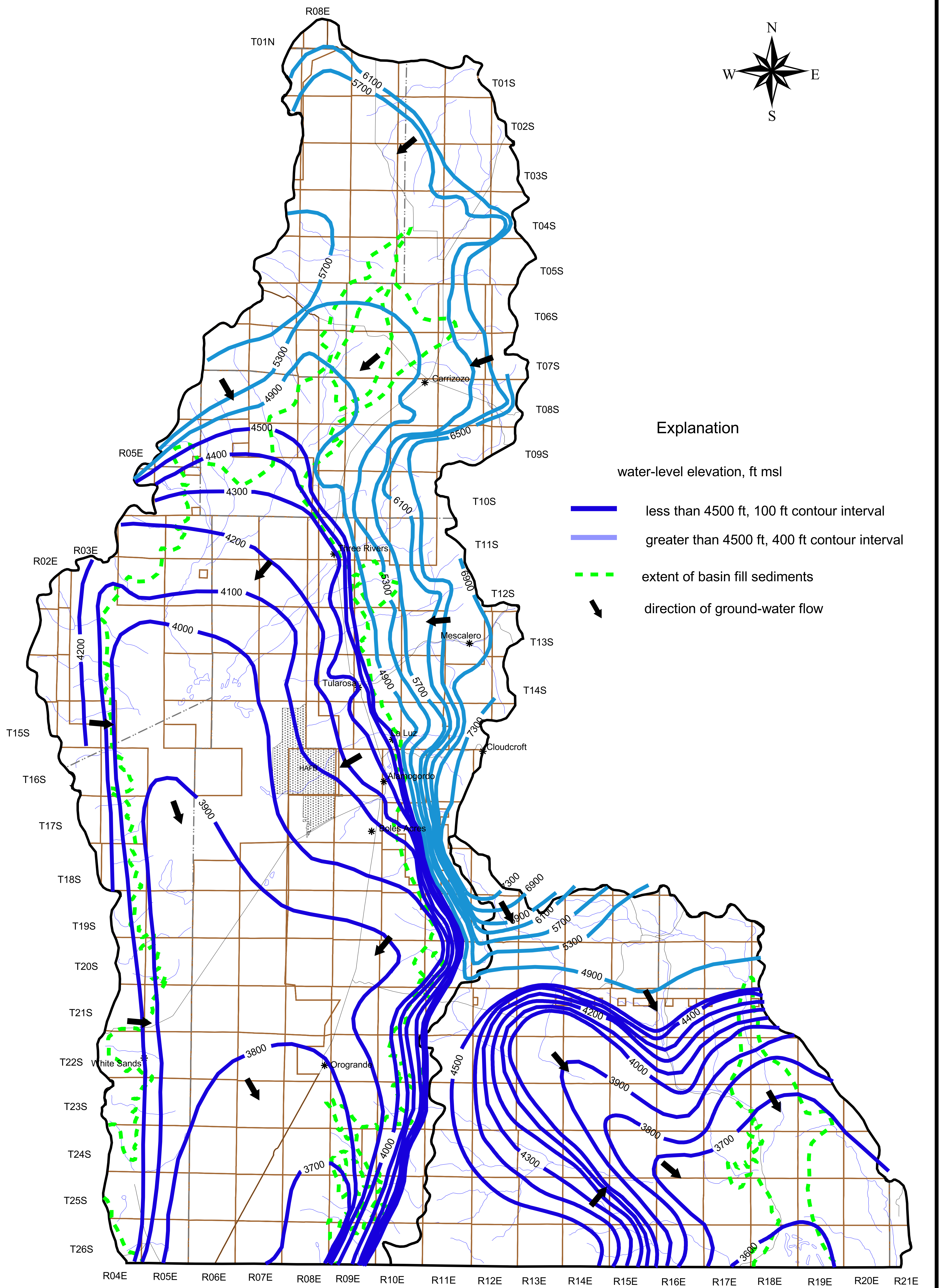


Figure 3.2. Map of the Tularosa and Salt Basins showing water-level elevation contours and ground-water flow direction.

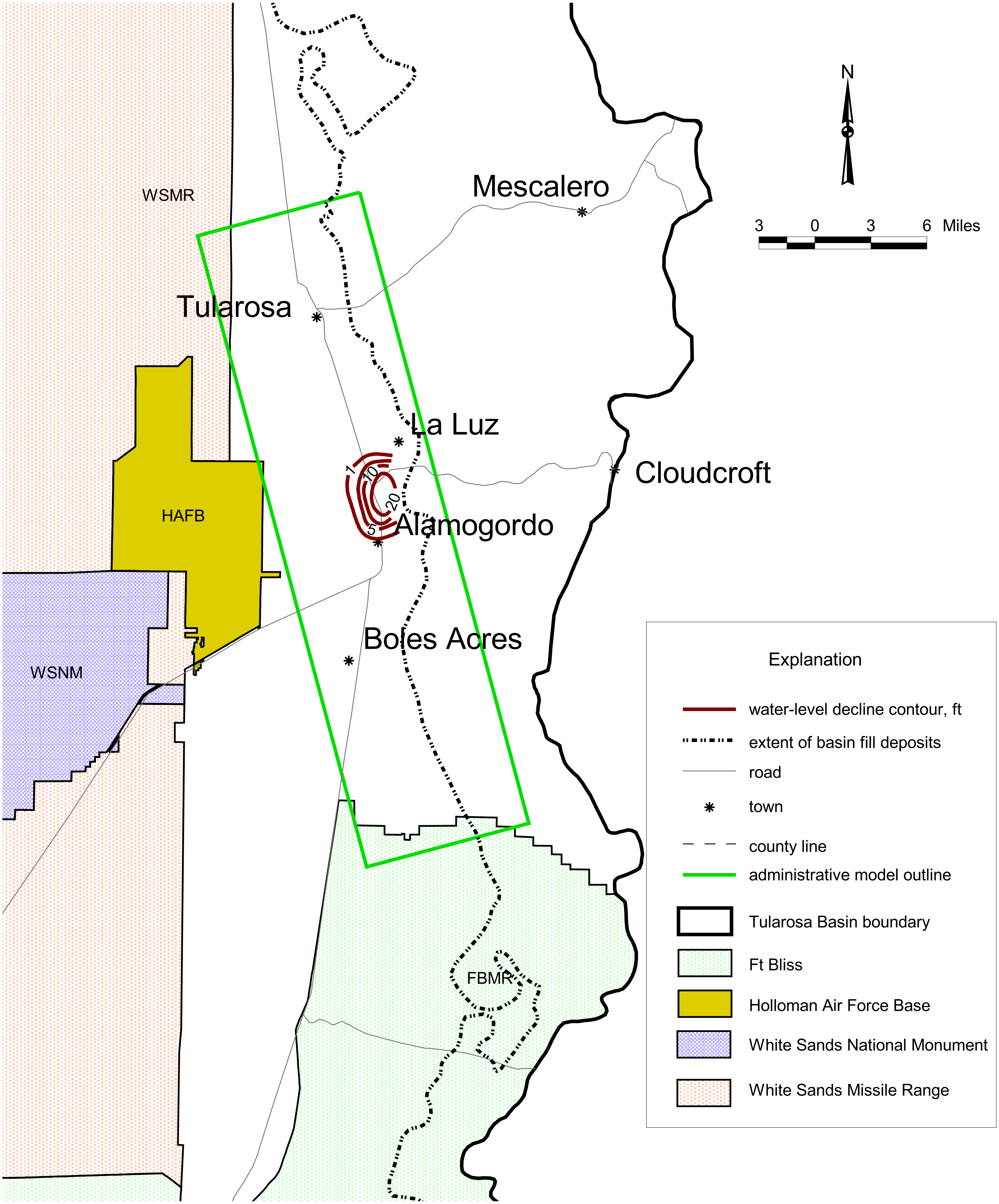


Figure 3.3. Map of the La Luz area within the Tularosa Basin showing historic water-level decline contours, 1900 through 1995.

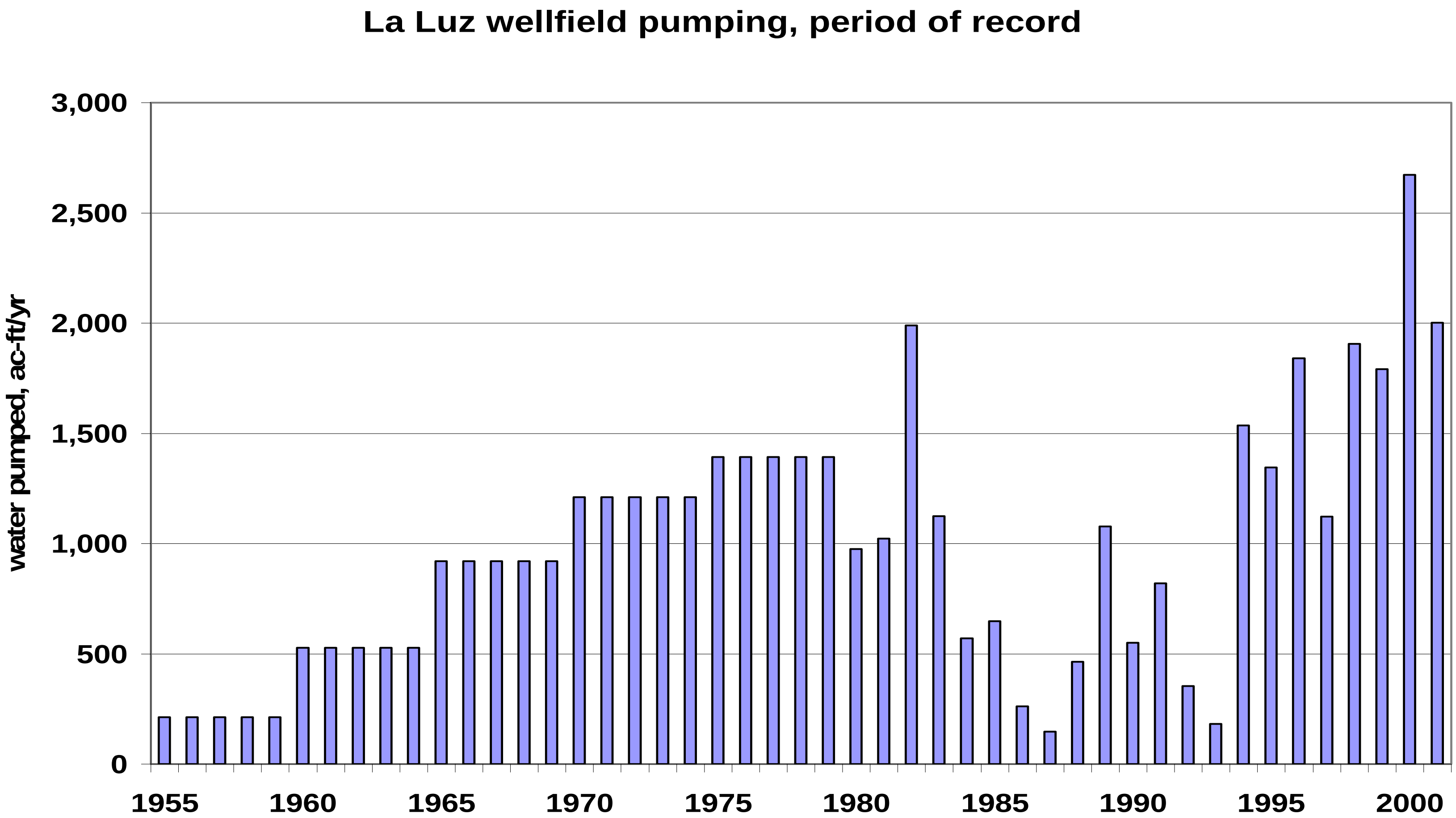


Fig. 3.4 – La Luz Well Field Pumping

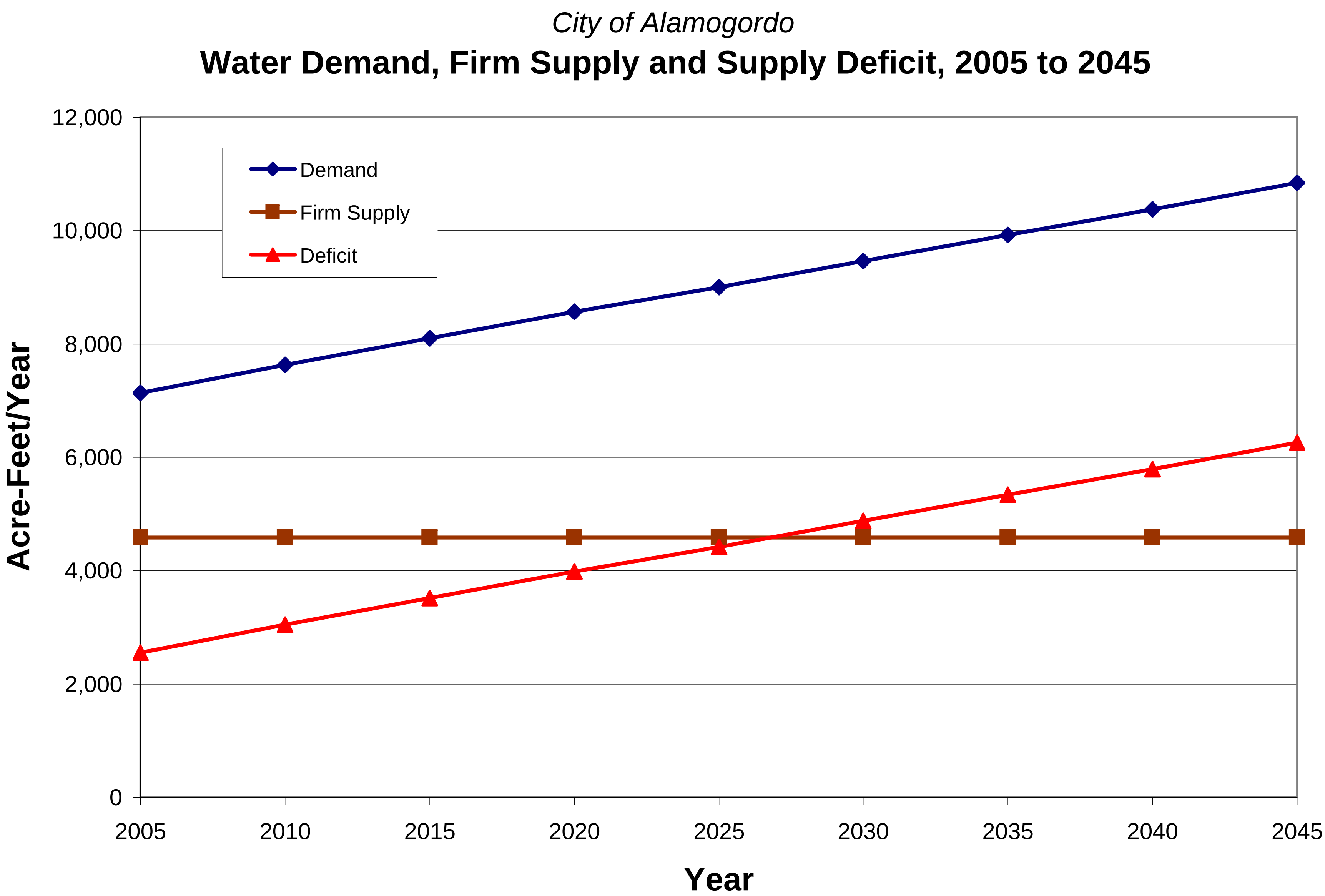
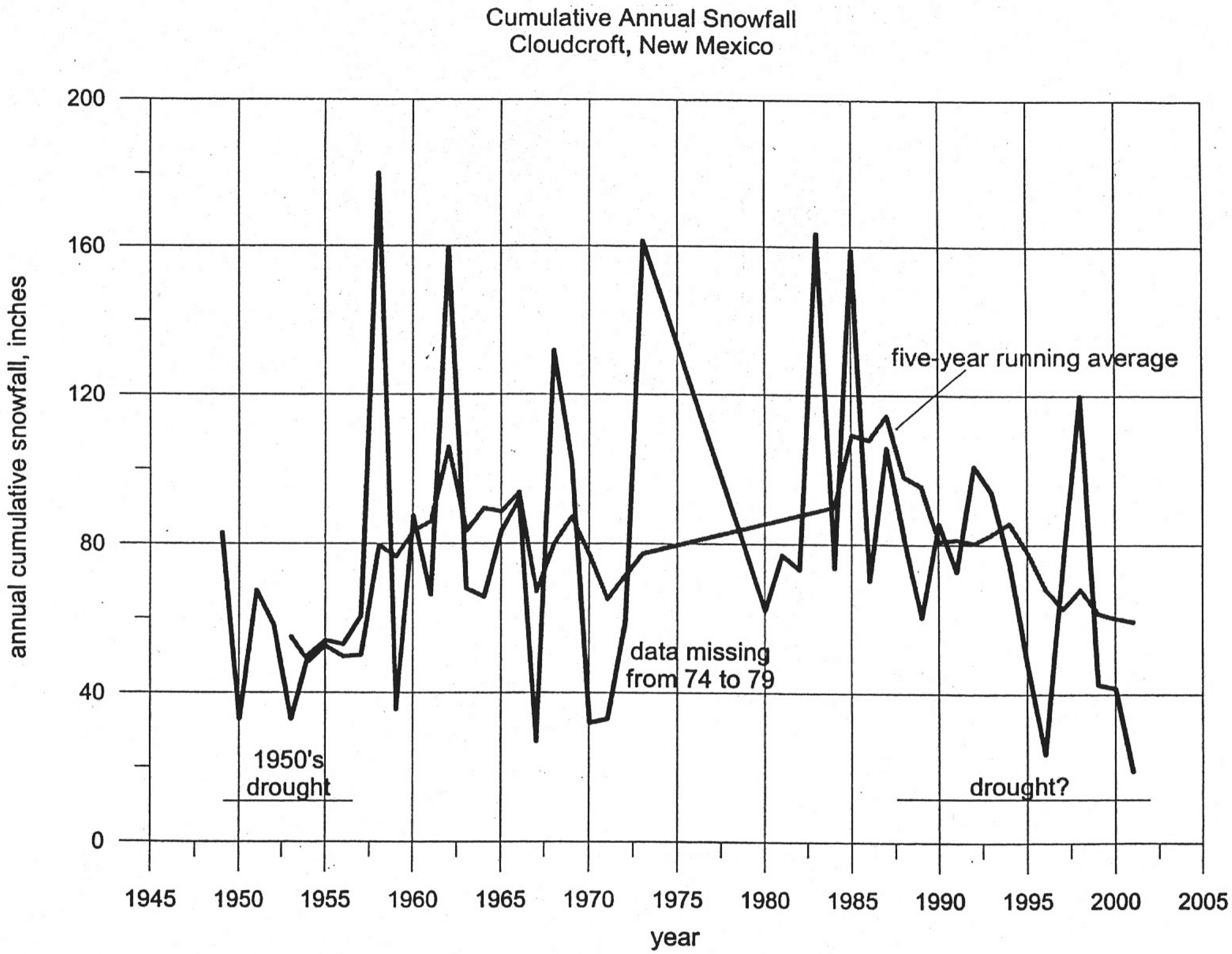
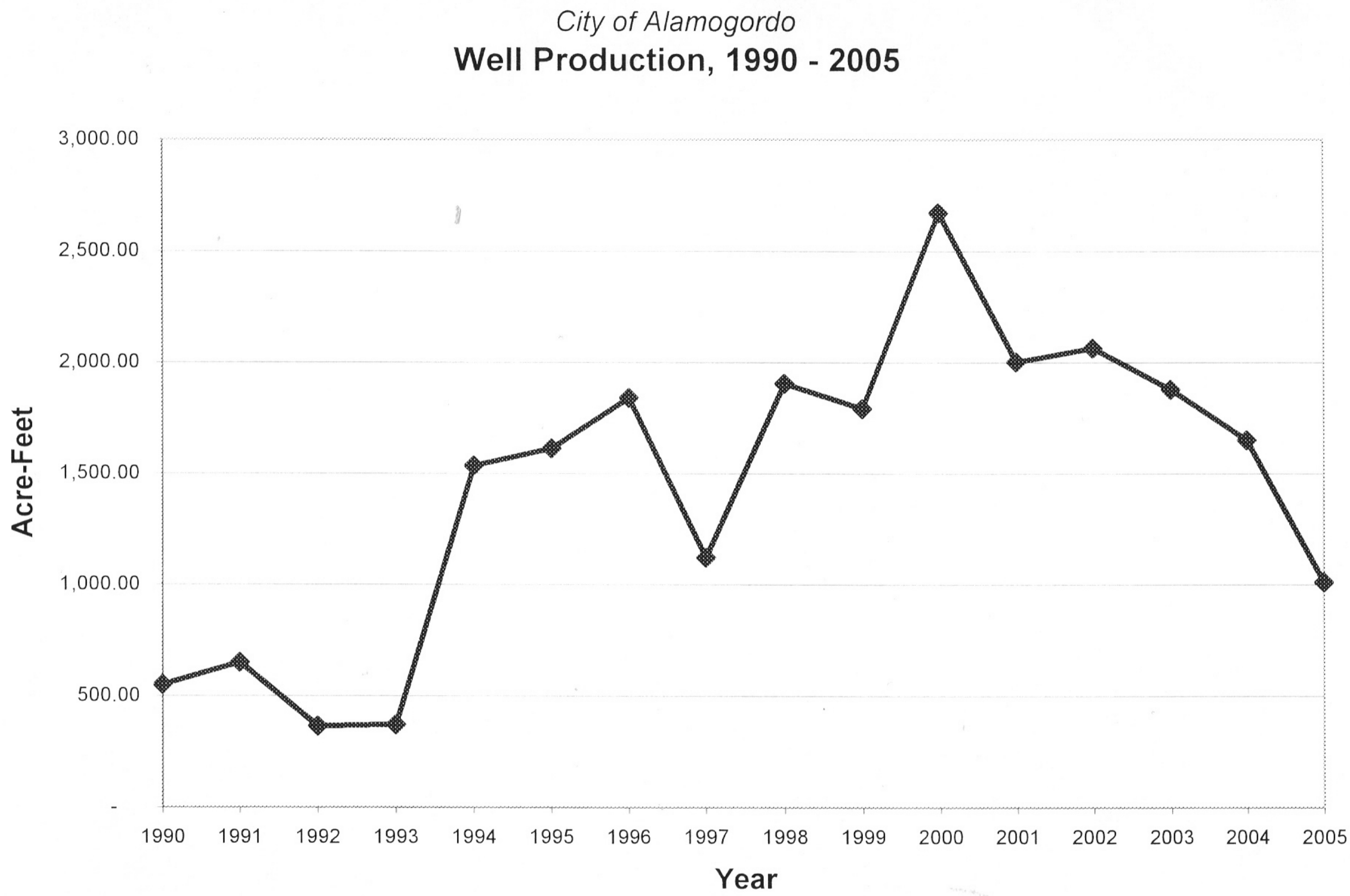


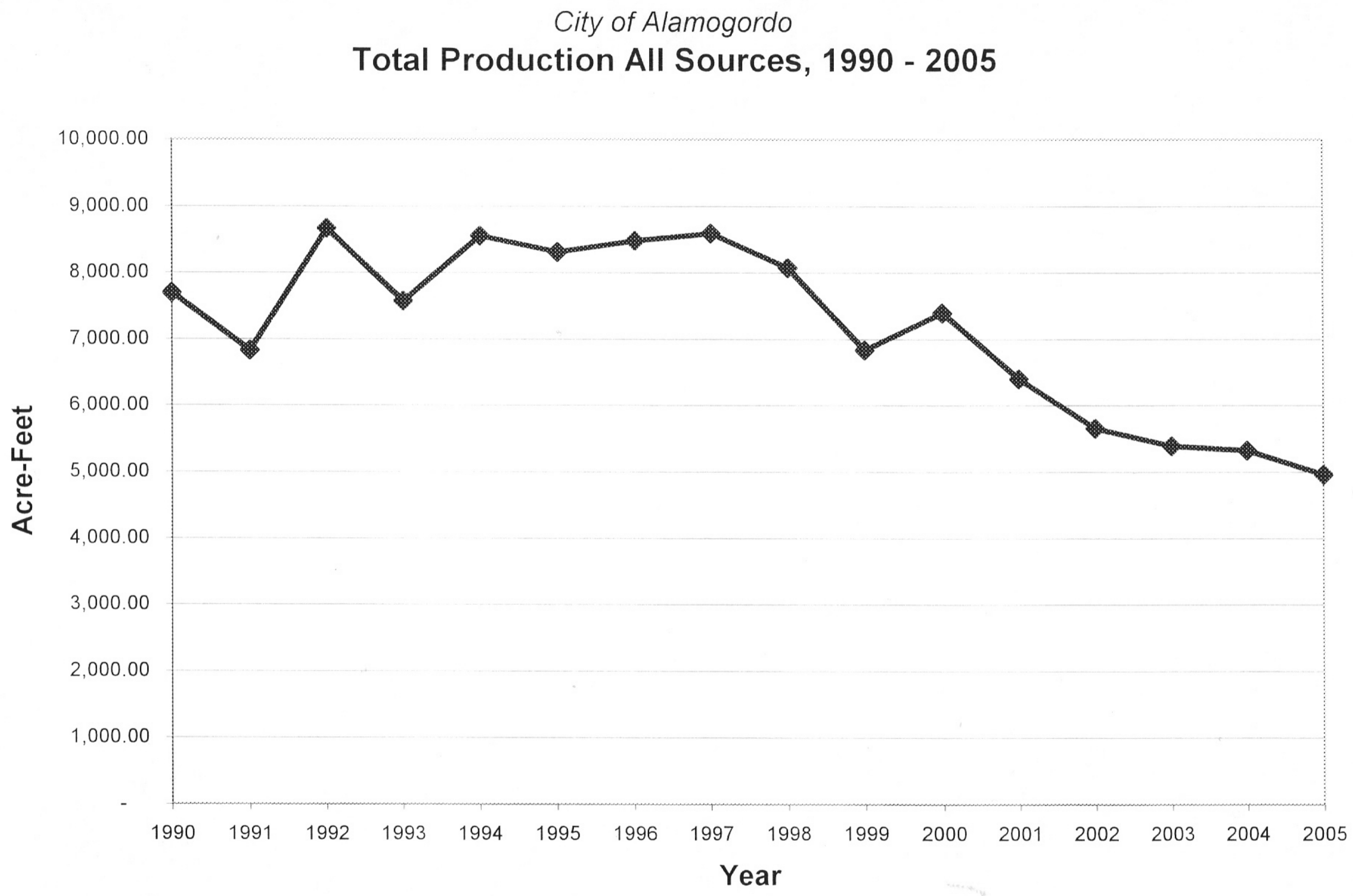
Figure 6.1 - Water Demand, Firm Supply and Supply Deficit 2005 to 2045

A P P E N D I X



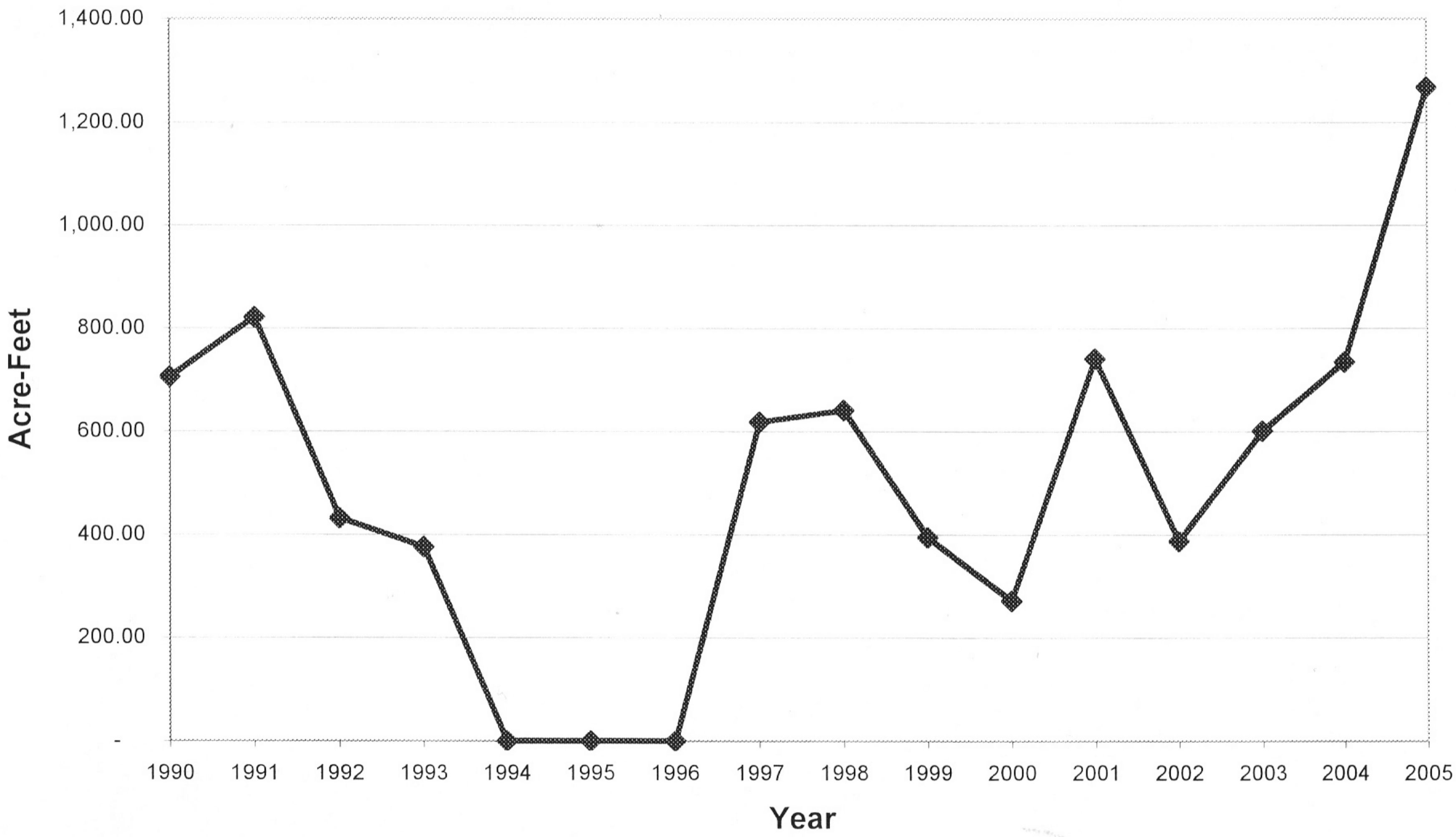
Graph of annual cumulated snowfall, Cloudcroft, New Mexico.


City of Alamogordo
Well Production, 1990 - 2005
3,000.00
2,500.00
2,000.00
1,500.00
1,000.00
500.00
-
Acre-Feet
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
Year


City of Alamogordo
Total Production All Sources, 1990 - 2005
10,000.00
9,000.00
8,000.00
7,000.00
6,000.00
5,000.00
4,000.00
3,000.00
2,000.00
1,000.00
-
Acre-Feet
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
Year

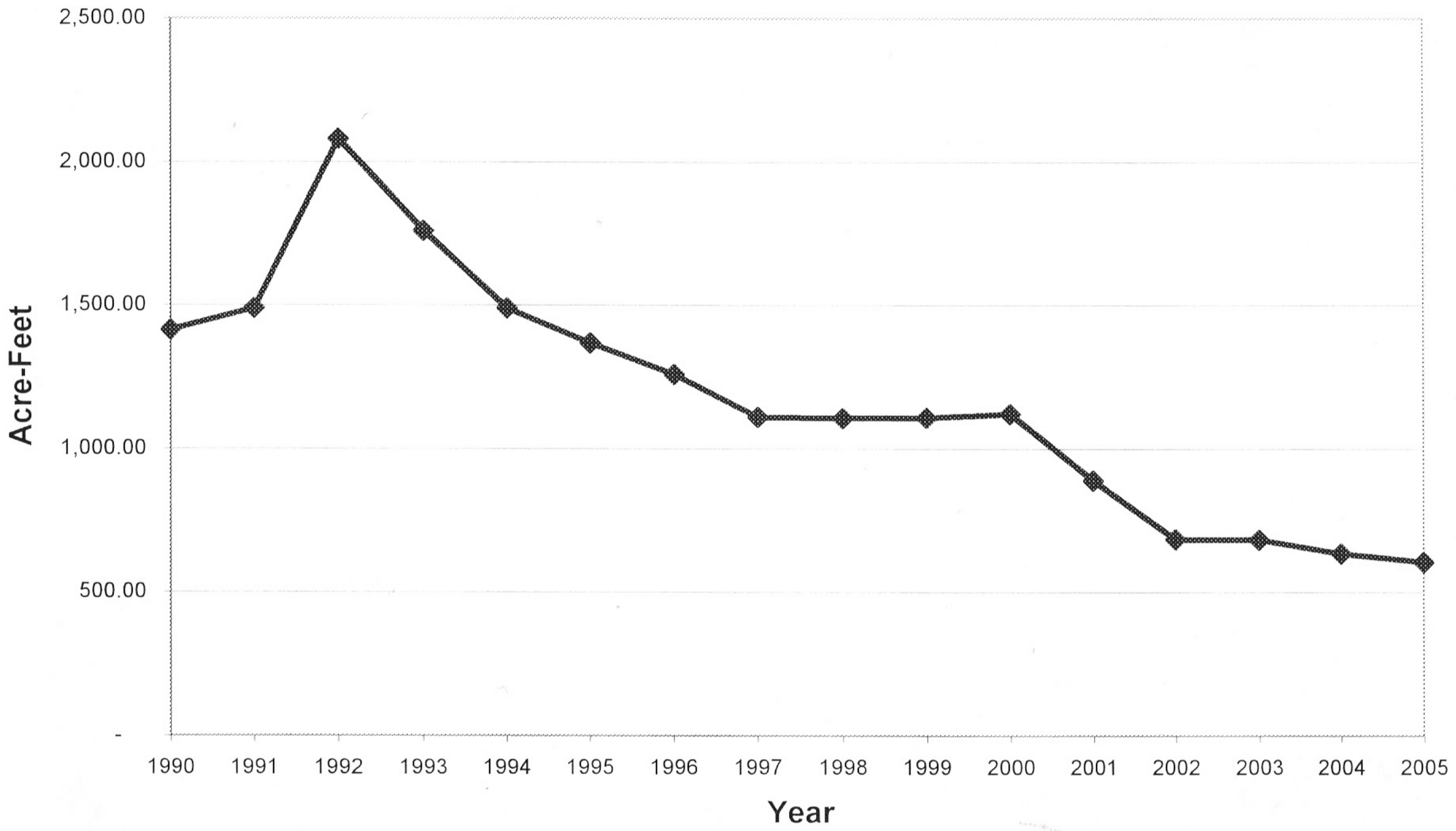
City of Alamogordo

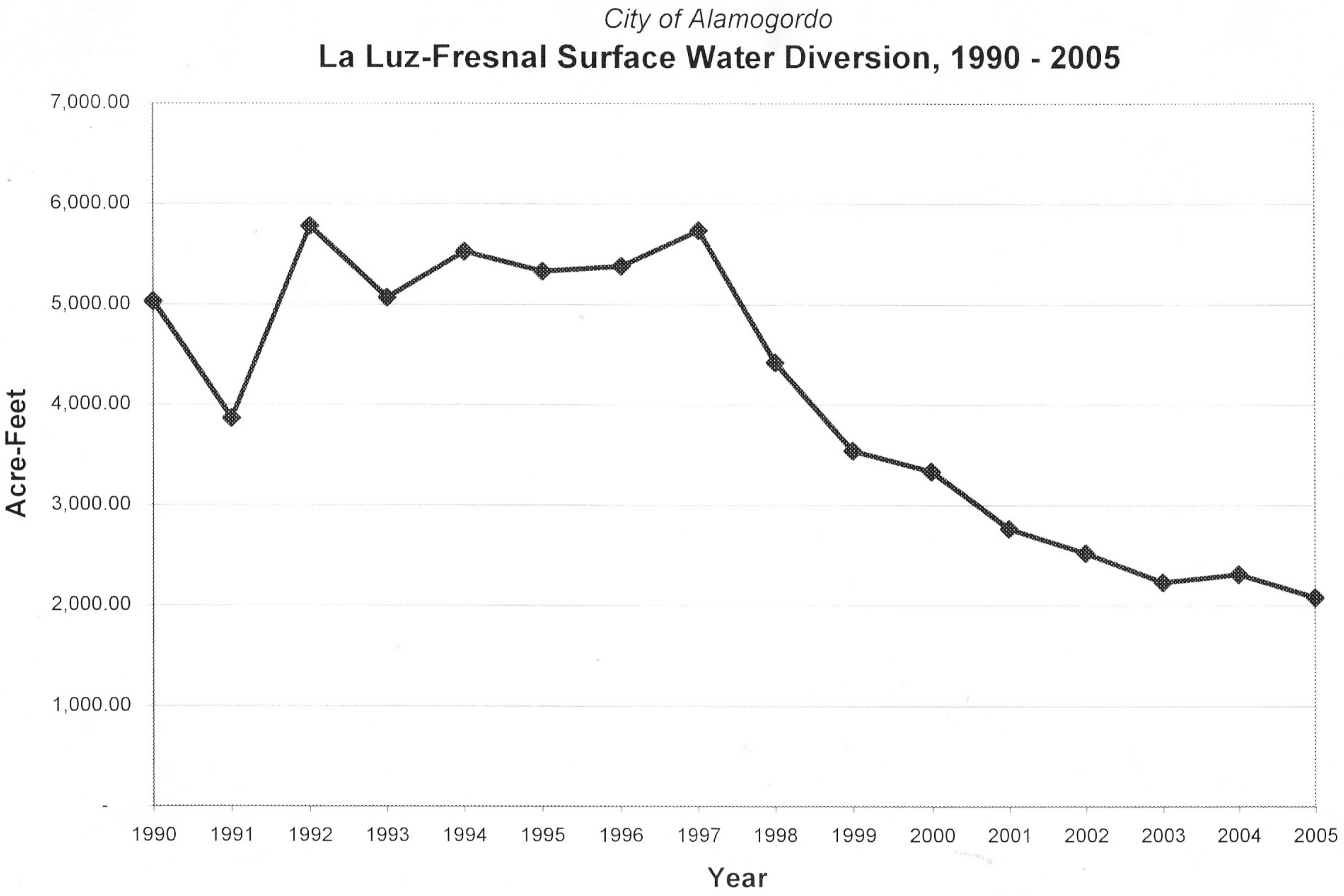
Bonito Lake Surface Water Diversions, 1990 - 2005



City of Alamogordo

Alamo Canyon Surface Water Diversion, 1990 - 2005




City of Alamogordo
La Luz-Fresnal Surface Water Diversion, 1990 - 2005
7,000.00
6,000.00
5,000.00
4,000.00
3,000.00
2,000.00
1,000.00
-
Acre-Feet
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
Year