DRAFT REPORT
CHAPARRAL WATER SUPPLY STUDY
CHAPARRAL, NEW MEXICO

Zia Project No. Z04-047

Prepared for

Lower Rio Grande Regional Water Users Organization
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INTRODUCTION

The unincorporated community of Chaparral is split between the southeastern portion of Doña Ana and the southwestern portion of Otero Counties in South-Central New Mexico. The community is currently served by three private water companies. Although Chaparral is a population center in the area that will grow over the next several decades, regional water planning to date has not addressed the future water supply needs of the area. Due to their proximity to the Mesilla Valley and demands on the Hueco Bolson aquifer by the City of El Paso and others, there is concern that the water resources of the Chaparral area will need to be augmented. Consistent with the planning period of the El Paso-Las Cruces Sustainable Water Project, this study contains an analysis of future demands and possible methods for augmenting the water supply of Chaparral through 2040.

SCOPE

The purpose of this report is to address the concerns of regional water planners, with regards to Chaparral's water use over the next forty years. In order to accomplish this goal, the project was subdivided into the following four tasks.

- Population and water demand forecasts for the area through 2040 (Section 2)
- Evaluation of the current water supply and groundwater use from the Hueco Bolson based on historic basin studies (Section 3)
- Analysis of Hueco Bolson water quality and quantity looking at both the current status of the aquifer and the anticipated effects of continuing current practices (Section 4)
- Evaluation of the options for supplementing or replacing freshwater supplies from the Hueco Bolson; including potential new water sources and the technology needed to utilize these supplies (Section 4 & 5)

POPULATION AND WATER USE PROJECTIONS

The base population of Chaparral was assumed to be 18,000 (2004) calculated from the 1998 community house count. This base population was projected forward at a rate of 5.5% until the year 2010 and 2.5% for the years 2010 to 2040. Combining historic community and regional water use per customer with the projected population growth, the municipal water demand was calculated through the year 2040. Other needs, such as agricultural and commercial, were added to evaluate Chaparral's total water demand (in acre-ft/year), as shown in Table E1.

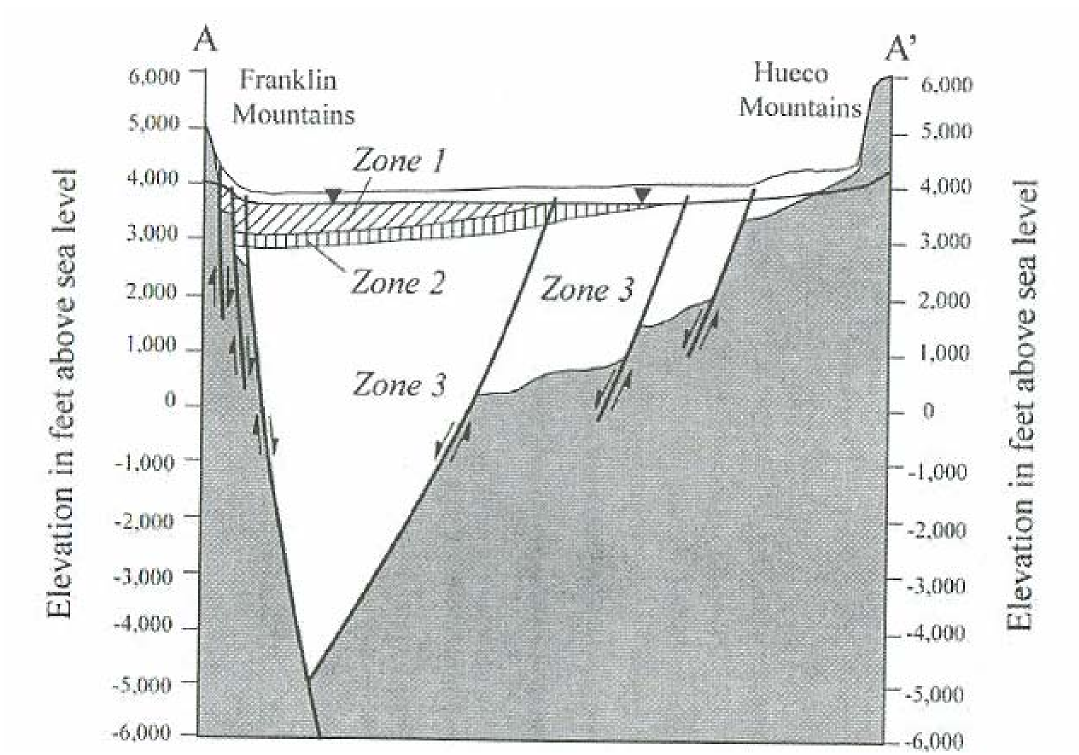
Table E1: Projected Population and Water Demand for Chaparral

	2000	2010	2020	2030	2040
Population	14,213	23,152	29,637	37,938	48,563
Municipal Water Demand (AF/yr)	2,416	3,936	5,038	6,449	8,256
Total Water Demand (AF/yr)	3,770	5,315	6,442	7,878	9,710

HUECO BOLSON GROUNDWATER RESOURCES

The community of Chaparral currently relies on the Hueco Bolson freshwater aquifer as its source of freshwater. The Hueco Bolson aquifer is also the groundwater source for the cities of El Paso, Texas and Ciudad Juarez, Chihuahua, Mexico. Historically, the groundwater withdrawals of El Paso and Ciudad Juarez have overshadowed those of Chaparral. Over-pumping by these cities has caused water level drawdowns, storage depletion, and brackish water intrusions within the Hueco Bolson aquifer.

Figure E1: General Cross-Section of the Hueco Bolson



(Hutchinson, 2004)

Figure E1 shows a general west-east cross-section of the Hueco Bolson. Zone 1 represents the freshwater lens; Chaparral is located directly above this zone. To the east, Zones 2 and 3 are constituted of brackish water which sinks under the freshwater lens and extends through the entire aquifer. There is concern that this brackish water may intrude into the freshwater supplies. Projections based on published estimates of groundwater use in the area indicate that Chaparral may experience brackish water intrusions by 2030. This projection is based only on withdrawals in El Paso; and does not include the anticipated withdrawals of Chaparral which will likely accelerate the process. There is additional concern that over-pumping may cause deep brackish waters to move vertically upward into the freshwater lens through upconing.

In order to develop an accurate assessment of water availability in the Chaparral area it is necessary to include the future groundwater withdrawals of El Paso. Table E2 summarizes the expected groundwater withdrawals for the area over the next 40 years. The aquifer's "natural" yearly recharge of 5,640 acre-ft is exceeded in all years leading to an overall decline in groundwater storage. Though continuing to rely on groundwater supplies alone would constitute mining and is not recommended, it is clear that there are adequate volumes of freshwater to sustain predicted withdrawals over the time period of this study. The quantity of freshwater resources in the Hueco Bolson aquifer is not of concern; the quality, however, is of major concern.

Table E2: Regional Demand and Storage

	2000	2010	2020	2030	2040
"Natural" Recharge	5,640	5,640	5,640	5,640	5,640
Chaparral Demand	3,770	5,315	6,442	7,878	9,710
Texas Demand	16,500	15,000	15,000	17,500	16,500
Storage (acre-ft)	**6.5×10^6**	**6.4×10^6**	**6.3×10^6**	**6.1×10^6**	**5.9×10^6**

OPTIONS TO AUGMENT OR REPLACE WATER SUPPLY

In order to protect the Hueco Bolson freshwater source and secure a reliable water supply for Chaparral the community must develop additional options to either augment or replace their current sole reliance on the groundwater aquifer. It is estimated that additional water sources will be necessary within the next 10-15 years. Chaparral will need an additional 5,840 acre-ft/year (5.2 MGD) of water in order to meet their increased municipal water demand over the next 40 years. This assumes that agricultural and commercial users can use substandard water (non-drinking water quality) to meet their increased demand.

Two main methods of augmentation should be considered: utilizing techniques to get more benefit out of existing supplies and obtaining new sources. Techniques to gain more from existing supplies include methods such as conservation, retiring agricultural water rights, and water re-use. While these methods are important and should play a role in the community's future water plan, these methods alone will not provide enough water to meet Chaparral's demands.

Table E3 contains a weighted feasibility matrix for the proposed water augmentation methodologies. The primary purpose of this matrix is to provide a basis for objective decision making. Each category (technical, cost, social, etc.) was given a weight in order of importance ranging from 1 to 3. Then each option was assigned a score (ranging from 1 to 5) on the desirability of the option within each category. The total score is calculated by multiplying the category score by the category weight and adding the products. Ranking of options is based on total weighted score.

Table E3: Feasibility Matrix
(1 = Not Desirable; 5 = Highly Desirable)

	Technical (3)	Cost (3)	Social (1)	Jurisdictional /Legal (2)	Total Score	Rank
Import Potable Water (El Paso, TX)	4	2	3	1	23	3
Import Potable Water (Anthony , NM)	3	1	3	3	21	4
Local Desalination Facility	4	4	4	4	36	1
Utilizing Regional Desalination Facility	4	4	3	1	29	2

RECOMMENDATIONS

The following recommendations are offered for consideration:

1. Chaparral must start actively seeking alternative sources of water to meet its projected demands, simple conservation measures will be inadequate over the 40-year planning period.
2. Chaparral must begin the process of seeking brackish water rights in the Hueco Bolson while this basin is open and rights readily available.
3. Desalination of brackish water in a centralized local facility has been demonstrated to be the most desirable option based on preliminary analysis presented in this study. A more detailed study of this alternative should be undertaken to further validate its feasibility.
4. Joint venture and cooperative ventures with EPWU should be actively pursued both as a short and long term solution to Chaparral's water supply needs. In this regard, efforts should be undertaken to promote such cooperative ventures and resolve legal and jurisdictional issues that seem to hinder some options.
5. Regular periodic monitoring of TDS levels in all existing public water supply wells in Chaparral should be undertaken. This data base will help in identifying potential salt water intrusion into the freshwater of Hueco Bolson.
6. Metering of water at existing wells should be considered, since this will aid in water conservation and better predictability of pumping data in the Chaparral area.
7. A local groundwater modeling effort should be undertaken to quantify the effects of Chaparral's withdrawals from the Hueco Bolson aquifer.
8. A community wastewater system should be a priority for Chaparral. Once the public system is in place, beneficial re-use of treated water should be considered to enhance recharge and improve storage.

1.0 INTRODUCTION

1.1 Background

1.1.1 Community Dynamics

The unincorporated community of Chaparral is split between the southeastern portion of Doña Ana and the southwestern portion of Otero Counties in South-Central New Mexico. A map of the region is included in Appendix A. The 2000 federal census reported a population of 10,170 with 2/3 of the residents in Doña Ana County and 1/3 in Otero County. Due to the transient nature of the population census figures may have underestimated the number of residents in the area. Based on historic growth patterns, it is expected that the population could grow up to 50,000 within the next 40 years.

1.1.2 Water Use and Regional Water Planning

The community is currently served by three private water companies. Although Chaparral is a population center in the area that will grow over the next several decades, regional water planning to date has not addressed the future water supply needs of the area. Studies associated with the El Paso-Las Cruces Sustainable Water Project and others have largely ignored Chaparral since it has been served by private utilities and also due to its location within the Hueco Bolson instead of the Mesilla Valley (where most of these efforts have focused). However, due to their proximity to the Mesilla Valley and demands on the Hueco Bolson aquifer by the City of El Paso and others, there is concern that the water resources of the Chaparral area will need to be augmented or replaced by waters from the Mesilla Basin, or elsewhere within the planning period of the El Paso-Las Cruces Sustainable Water Project.

Based on historic and current groundwater studies, it is anticipated that pumping and drawdowns of the Hueco Bolson will continue on the Texas side of the state line, just south of Chaparral. Negative consequences are expected for both water quantity and quality. Taking Chaparral's future demands into account, effects on the aquifer will be accelerated. In addition, increased growth rates and the lack of a centralized wastewater system (although one has now been proposed) are affecting groundwater quality through increased salinity in general, saline water infiltration, and, in some localized areas, concern over nitrate levels.

1.1.3 Scope of Study

For reasons discussed above, Doña Ana County, through the Lower Rio Grand Water User's Organization (LRGWUO), requested a more detailed study to be conducted for Chaparral's water supply needs through 2040. This study would identify existing and projected water usage, future water resource options, infrastructure needs and costs, and potential water rates for the 2000 through 2040 time period. This information will be utilized and incorporated into regional planning efforts.

The purpose of this report is to address the concerns of regional water planners, with regards to Chaparral's water use over the next forty years. In order to accomplish this goal, the project was subdivided into the following four tasks.

- The first task will include forecasting population for the area over the planning period through 2040.
- Task two includes an evaluation of current water supply and groundwater use from the Hueco Bolson based on historic basin studies.
- The third task will involve water quality and quantity looking at both the current status of the aquifer and the anticipated effects of continuing current practices.
- Finally, an evaluation of options for supplementing or replacing freshwater supplies from the Hueco Bolson; including potential new water sources and the technology needed to utilize these supplies.

2.0 POPULATION AND WATER USE PROJECTIONS

2.1 Background

Forecasting population with a reasonable degree of confidence through the planning period is one of the first and foremost tasks in planning for anticipated water supply needs of the Chaparral area. This task is even more critical for the Chaparral area where Federal census data is suspected of having underestimated the historical population due to the transient nature of the population in the area. Chaparral serves and will continue to grow as a bed-room community for the greater El Paso metro area. This growth may take a substantial upturn if the proposed Northeast Parkway extension to I-10 is successful (a project map is included in Appendix B). The extension would funnel large amounts of I-10 traffic through Chaparral and increase the community's easy access to El Paso. Population projections through the year 2040 were made using a realistic growth model and a more accurate base population (than relying entirely upon the federal census figures). Projections were combined with water use data (from the water companies, state engineer's office, and regional water reports) in order to predict the area's future water demand.

2.2 Base Population

Numerous resources were used in order to identify estimates of the current and historical population of Chaparral. Reliable base population figures are the foundation for an accurate projection of the community's population growth through the year 2040. A large transient population, a potentially high numbers of non-citizens, and many extended families sharing a single dwelling unit (DU) contribute to the suspicion that federal census data may be inaccurate for the Chaparral area. This concern was addressed by using additional sources that estimate the current base population. Local water suppliers, school districts, community organizations, and researchers, along with the Chaparral *Wastewater Collection and Treatment System Facility Plan*, were all consulted in an effort to obtain accurate information on existing base population.

2.2.1 Federal Census Data

Federal Census data was obtained for both the 1990 and 2000 Census periods. In both cases, the community of Chaparral was defined as a census designated place (CDP) with its boundaries completely within Doña Ana County; these boundaries, however, were redefined between the two census counts, making direct comparisons difficult. In the 2000 Census, definitions of Blocks were developed for the area of Chaparral that is contained in Otero County; similar definitions did not exist in 1990. Maps of the census geographic areas are included in Appendix B.

Due to the redefinition of the CDP boundaries, and in order to include the area of Chaparral that is contained in Otero County, it was necessary to obtain and manipulate Census Tract, Block Group, and individual Block data to estimate the 1990 population in an area equivalent to that of the 2000 Chaparral defined area involving both counties.

In Doña Ana County, 1990 Census Tract 18, Block Groups 7 and 8 were summed and assumed to be an equivalent area to the 2000 Census Tract 18.04 (knowledge of local topography and residential patterns lead to this assumption). These figures were taken to represent the population of Chaparral within Doña Ana County during these years.

In Otero County, a common geographic area was found by adding 1990 Census Tract 9 Block Group 9 and Tract 6.01 Block Group 1 together and comparing them with the area encompassed by the sum of the 2000 Census Tract 6.01 Block Group1, and Tract 9 Block Group 9 Blocks 9104-9107, 9116-9172, and 9177-9181. It was then assumed that the population of Chaparral within Otero County in the year 2000 was equal to the sum of Blocks 9122-9170. The percent of residents within Chaparral in 2000 compared to the larger summed area was calculated to be over 97%; this percentage was used to back calculate the 1990 Chaparral population.

Populations within Doña Ana and Otero Counties were summed in order to obtain an overall community population of 5,123 in the year 1990 and 10,170 in 2000. Comparison of 1990 and 2000 figures yields an average compounded yearly growth rate of 7.1%.

2.2.2 Local Water Suppliers' Information

Using data provided by local water suppliers, the total number of water connections was calculated for the years after 1977. In 1990 it is estimated that there were 1,497 connections; this number increased to 3,046 in the year 2000. Census figures show the average number of persons per household in the Chaparral area to be 3.31 in 1990 and 3.41 in 2000. Considering the higher incidence of extended families living together in one DU, it was assumed that 4 persons per household reside in a typical DU in Chaparral. This assumption appears prudently conservative. Using these unit values, the population of Chaparral was calculated to be 5,987 in 1990 and 12,184 in 2000; resulting in an average yearly growth rate of 7.4%. This rate of growth is comparable to the federal census growth rate of 7.1%. However, projections based on an extraordinarily high growth rate of 7.4% throughout the long planning horizon (40 years) appear unrealistic. Therefore, more recent trends of growth during the 1993 to 2003 period were evaluated showing a growth rate of 5.5%. Based on this information a growth rate of 5.5% annually through 2010 was considered more appropriate and realistic.

2.2.3 Local School District

The Gadsden Independent School District supplied data from their 2001 Facilities Master Plan. This document contained figures showing over 3,000 students enrolled in local schools, not including the large number of students who are attending El Paso area schools. Also shown in this report is an average annual growth rate of 4.9% from the years 1995-2000, declining to an estimated 3.4% for 2000-2005 and 2.2% for 2005-2010.

2.2.4 Local Community Organizations and Researchers

A number of local community organizations and researchers were consulted, including employees at the Chaparral Sheriff Substation and Community Health Council, members of the New Mexico State University (NMSU) staff, and employees at Doña Ana County Colonias Development Council. While none of the sources of information could provide definitive existing population counts, they unanimously agreed that the current population was well above 10,000 (with estimates ranging from 15,000-22,000). A 2002 survey completed by the Chaparral Community Health Council confirmed the average household size of 4 persons per residence.

2.2.5 Wastewater Facility Plan

As part of their efforts for the *Wastewater Collection and Treatment System Facility Plan for the Community of Chaparral*, Bohannan Huston conducted an aerial house count within the planning area in 1998 (based on the Chaparral area ortho-photo base map obtained from the Doña Ana County Flood Commission). 3,223 households were counted, including single family homes, mobile homes, and trailers. Using the assumption of 4 persons per household, a population estimate of 12,892 was obtained for the year 1998.

2.3 Population Projections

Base populations were projected using percent growth rates. Other methods of projection were considered, including the cohort compound method, but, upon consultation with Dr. James Peach of NMSU, it was concluded that a straight percent projection would result in the lowest error. This conclusion was based on the relatively small population of and limited data available for the community.

Several different combinations of growth rates were calculated for comparison. First, high growth rates were applied over the entire 40-year period. It seems unrealistic, however, that high growth rates will continue over the entire study period, therefore, in the second step, more sustainable reduced rates were applied to the planning period after 2010. Growth rates were determined by considering base population estimates and census defined growth rates over the past 14 years. As discussed above, census data and local water supply figures show a growth rate of approximately 7% between the years of 1990 and 2000. A growth rate of approximately 5% is shown by more recent water supply data (1993-2003) and 1995-2000 school district estimates; growth estimates from the school district are reduced after 2000. 2000 census data reports the average growth rate for Doña Ana County as 4.3%. The Lower Rio Grande Regional Water Plan uses growth rates of 2.5% and 1.5% in the medium growth scenario for the community of Chaparral. A growth rate of 3% for the years after 2010 was also calculated in order to mediate the 4.3% and 2.5% growth rates.

Tables B-1 through B-5, in Appendix B, show the results of population projections based on various growth rate and base population combinations. For comparison, projections from the Lower Rio Grande (LRG) Regional Water Plan are included in Table B-6.

2.4 Water Use Projections

Estimates of future municipal water use were based on projected populations. Using annual groundwater withdrawal and number of connections data (supplied by local water companies), with an estimate of 4 persons per household, the average usage rate was 124 gallons/capita/day (gpcd) (0.14 acre-ft/capita/year) over the last 10 years. The LRG Regional Water Plan estimates an average water use of 182 gpcd (0.2 acre-ft/capita/year) over the whole regional planning area and bases its projections for Chaparral on this figure. Technical Report 51, from the New Mexico Office of the State Engineer, lists an estimated use of 172 gpcd (0.19 acre-ft/capita/year) for the Chaparral Water System in 2000. Commensurate with these figures, an average use rate of 150 gpcd (0.17 acre-ft/capita/year) was used to calculate future water use. Per capita water consumption of 150 gpcd for predominantly domestic use with minimal commercial and light industrial uses, such as the Chaparral area is reasonably conservative. Tables B-7 through B-19, in Appendix B, show the results of these projections; again, for comparison, results from the Regional Water Plan are included in Table B-20.

2.5 Results

After reviewing the available data and estimates, it was determined that the population estimates based on the 1998 house count are the most reliable. Projecting the 1998 population of 12,892 to the present time results in approximately 18,000 residents in 2004, which is consistent with opinions of population count provided by local contacts.

Considering the growth observed during the past decade, it appears that most realistic population forecasts will result from a high growth rate of 5% annually until 2010 followed by a modest and more universally accepted (for Doña Ana County) rate of growth of 2.5% after 2010. The 5% growth rate is supported by recent data available from local water suppliers and school districts. The 7% growth rate evidenced from the 1990 and 2000 federal census data appears too high to be sustained for another decade and beyond. Table 1 shows the anticipated growth scenario.

Table 1: Recommended Population Projections
(Based on House Count Data)

	1998	2000	2010	2020	2030	2040
Estimated Base Population	12,892					
Forecasted Population		14,213	23,152	29,637	37,938	48,563

Local per capita water use is expected to increase over the study period as the community's economic and social demographics improve. However, the regional average of 182 gpcd estimate is too conservative for a predominantly domestic water use, such as that for a community like Chaparral. Table 2 contains the recommended water use projections for Chaparral based on an average water use of 150 gpcd.

Table 2: Recommended Domestic Water Use Projections
(Based on House Count Data and Use of 0.17 acre-ft/capita/year)

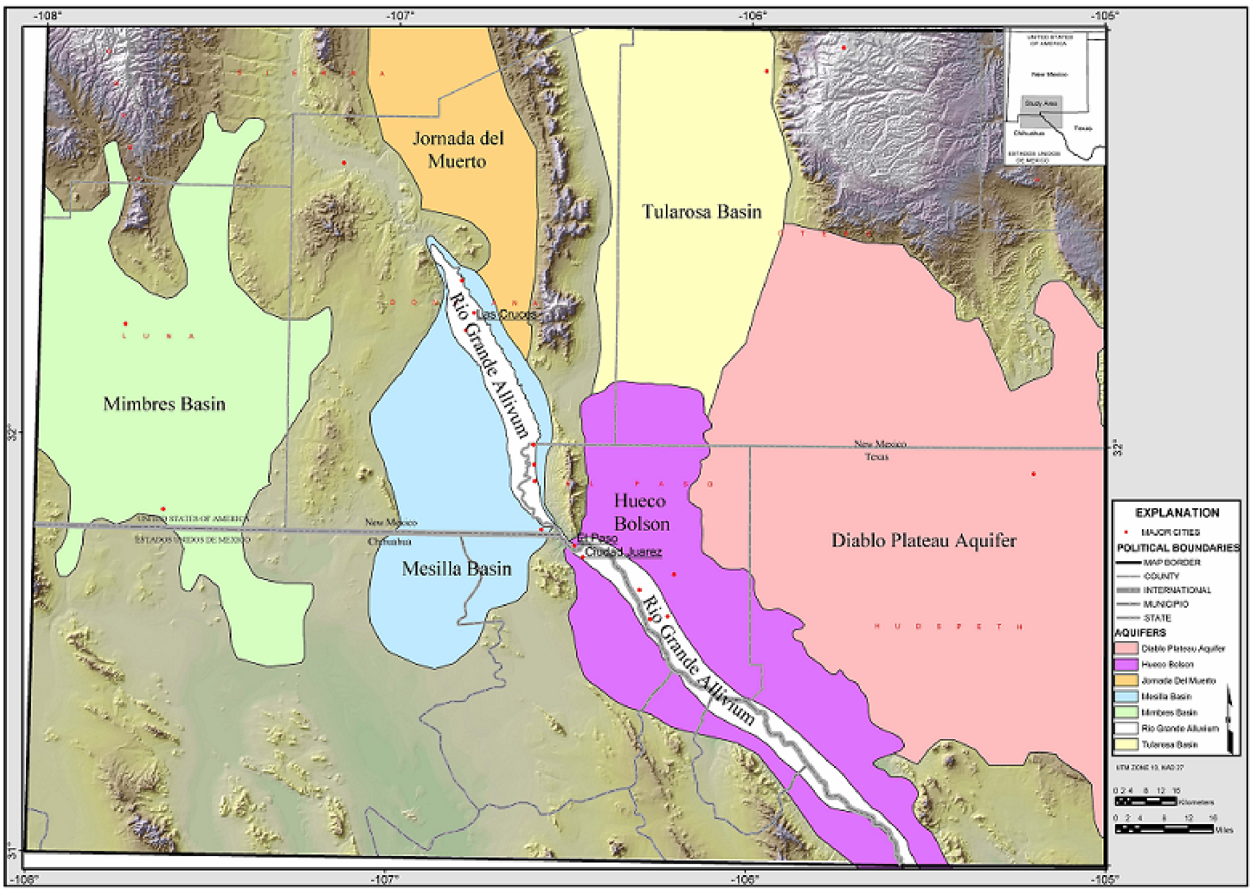
	2000	2010	2020	2030	2040
Estimated Use (acre-ft/year)	2,416				
Water Use Forecast		3,936	5,038	6,449	8,256

3.0 HUECO BOLSON GROUNDWATER RESOURCES

3.1 Background

The community of Chaparral obtains its water from the Hueco Bolson groundwater aquifer (Figure 1). The bolson covers an area of 2,500 square miles in New Mexico, Texas and Mexico; only 2-5% of this area lies north of the New Mexico-Texas border. The Hueco Bolson aquifer is the main groundwater source for the cities of El Paso, Texas and Ciudad Juarez, Chihuahua, Mexico; historic use by these cities has had a dramatic impact on the characteristics and availability of water within the formation.

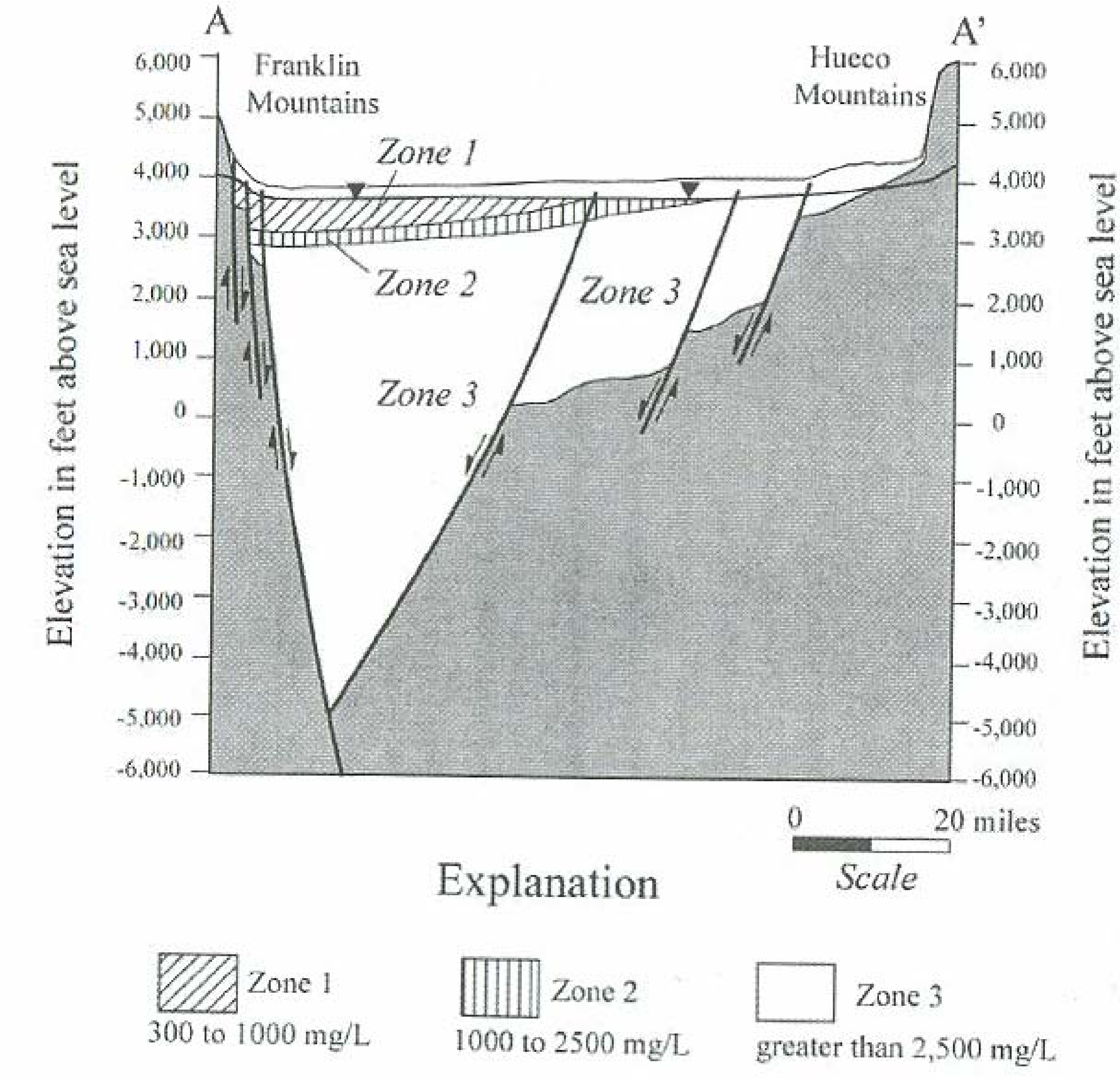
Figure 1: Groundwater Aquifers of Southern New Mexico and Western Texas



(Kennedy, Granados, and Alduri 2002)

Tertiary and Quaternary basin-fill sedimentary deposits lie in the north-south direction through the Hueco Bolson extending from its northern boundary with the Tularosa Basin to its southern limits. A general west-east cross-section of the basin, shown in Figure 2, depicts a down faulted shape with fill deposits of over 8,000 feet along the western boundary of the aquifer at the Franklin Mountains. Depths reduce to near zero along the easternmost boundary of the basin. Sub-parallel faults throughout the basin create a stepped cross-sectional area. The community of Chaparral lies along the western edge of the basin where fill thicknesses range from 2,000-8,000 feet.

Figure 2: General Cross-section of Hueco Bolson



(Hutchinson, 2004)

Figure 2 shows the general occurrence of fresh and brackish water within the aquifer. In this study, freshwater is defined as water that has a total dissolved solids (TDS) concentration of less than 1,000 mg/L; TDS concentrations over this amount constitute brackish water. Zone 1 depicts the thin lens of fresh water that is located along the western boundary of the basin. This lens ranges in depth from approximately 700 feet along the base of the Franklin Mountains tapering to zero about midway between the Franklin and Hueco Mountains (approximately 40 miles). The Total Dissolved Solids (TDS) of the water in Zone 1 ranges from 300 to 1,000 mg/L. This zone is underlain by another thin layer of brackish water with TDS ranging from 1,000 to 2,500 mg/L. While Zone 2 extends approximately 50 miles east from the base of the Franklin Mountains, the thickness is shown to be in the range of about 100 to 150 feet. The deep zone (Zone 3) of water in the aquifer has very high TDS concentrations of over 2,500 mg/L. The thickness of this zone varies greatly from west to east, ranging from a maximum of 8,000 feet tapering to bedrock at the base of the Hueco Mountains.

3.2 Aquifer Characteristics

Aquifer characteristics vary greatly throughout the basin, depending largely on the thickness and grain size of the basin fill. As stated, fill is generally thicker, and grain sizes larger, in the western and northern portions of the aquifer, decreasing as one moves east from the Organ and Franklin Mountains. In their 1958 study, Knowles and Kennedy estimated horizontal hydraulic conductivity values to range from 15-43 ft/day in the western side of the basin. Orr and Riser (1992) estimated conductivities on the order of 2 ft/day in the far eastern portion of the basin; values ranged from 31-40 ft/day in the Chaparral area. Studies near El Paso, Texas indicated conductivities of 5-60 ft/day (Meyer, 1976).

Vertical hydraulic conductivity measurements are less available for the area, though Meyer reported values ranging from 1×10^{-7} to 1.3 ft/day in the alluvium and bolson deposits near El Paso (Meyer, 1976). As these figures indicate, horizontal to vertical conductivity ratios are expected to be very large. Ratios of 22-319 were reported in the Mesilla Valley (Figure 1) by Wilson and White in a 1984 report; Frenzel and Kaehler (1990) used a ratio of 200 for the same area. Orr and Riser (1992) report that an estimated ratio of 200 is reasonable for our study area due to similarities between the Mesilla Valley Basin and the Hueco Bolson.

Transmissivity values of 5,000-22,000 ft^2/day were reported by Knowles and Kennedy (1958). Meyer (1976) calculated transmissivities of 13,000-37,000 ft^2/day and specific yields of 0.10-0.30. Orr and Riser (1992) used specific yield values of 0.05-0.20. Findings from these reports are summarized in Table 3.

Table 3: Summary of Hueco Bolson Aquifer Characteristics

	Horizontal Hydraulic Conductivity (ft/day)	Transmissivity (ft^2/day)	Specific Yield
Orr and Riser (1992)	Chaparral: 31-40 East Basin: 2	---	0.05 – 0.20
Heywood and Yager (2003)	---	---	0.10-0.20
Knowles and Kennedy (1958)	West Basin: 15 - 43	5,000 – 22,000	0.35
Meyer (1976)	El Paso: 5 – 60	1,300 – 37,000	0.10 – 0.30

3.3 Water Levels

Water levels in the Hueco Bolson have been largely affected by historic groundwater withdrawals, particularly from those in the El Paso and Ciudad Juarez areas. Generally, water levels are compared to those of 1903, which are considered to be "pre-development" levels for the region. In the year 2002 drawdown levels of over 150 feet were seen beneath El Paso; Ciudad Juarez drawdown levels of up to 200 feet were reported (EPWU, 2004). Drawdowns of this magnitude have a substantial impact on regional groundwater supplies and movement, including those near Chaparral.

Groundwater use at and north of the New Mexico-Texas border is also affecting water levels; withdrawal volumes in New Mexico, however, are much smaller and effects are therefore not nearly as drastic as those to the south. Drawdowns in the Chaparral/state border region (compared to 1903) are estimated at less than 50 feet (EPWU, 2004). Historic data from the USGS (2004) shows that the water table underlying the area of Chaparral has dropped an average of 29 feet over the last 39-50 years (resulting in an average drawdown of 0.6 ft/year); wells that lie just south of the New Mexico-Texas border show a larger decrease with an average drop of 39 feet during the same time period (average drawdown of 0.9 feet/year). Examples of water level drawdowns are shown in Figures C-1 and C-2, Appendix C.

Groundwater drawdowns affect both water quantity and quality. There is concern that as water levels drop brackish water from the eastern edge of the basin may migrate into regions of fresh water. Also of concern is the vertical migration of deep brackish water upconing as pumping rates exceed the levels of safe withdrawal. Studies have shown that wells in the eastern and northern portion of El Paso are already being affected by these intrusions, indicated by increased chloride and total dissolved solids levels (EPWU, 2004). There is concern that similar water quality degradation may be seen in the Chaparral community if groundwater mining continues.

3.4 Land Subsidence

Land subsidence may occur when groundwater has been removed from previously saturated soils, leaving pore spaces empty and unable to support the weight of the soil above them. The USGS has developed benchmarks in order to monitor elevation changes throughout the Hueco Bolson. Measurements were taken for the periods from 1953-81 and 1981-1993. In 1993, a subsidence, of 0.82 feet, was recorded near downtown El Paso (Heywood, 2003); corresponding with the area of the largest water table drawdowns. No other instances of subsidence were recorded in the bolson. Due to the relatively low water level depressions in the Chaparral area, at this point in time, land subsidence does not appear to be of concern.

3.5 Recharge

The main sources of recharge to the Hueco Bolson are from the Tularosa Basin to the north and precipitation runoff from the Organ and Franklin Mountains along the western boundary of the basin. Small quantities of water are exchanged with the Mesilla Basin near Fillmore Pass and Rio Grande surface water interacts with the aquifer in the southern portion of the basin (surface water interactions are not expected to affect the up gradient New Mexico portion of the basin). Orr and Riser (1992) estimated recharge due to runoff from the mountains to be 4,500 acre-ft/year (assuming that 3% of annual precipitation in the mountain drainage area is available for recharge and an annual rainfall of 12 inches). Meyer (1976) estimated that the sum of water recharged from the Tularosa Basin and the mountains is 5,640 acre-ft/year; the El Paso Water Utilities (2004) used a similar figure in their report, estimating a “natural” recharge rate of approximately 6,000 acre-ft/year at the state border.

In addition to these sources of “natural” recharge, additional recharge will occur due to groundwater use. Dropping water levels (due to pumping) will increase local hydraulic gradients, inducing flow toward the water table depression. The rate in which this “induced” recharge occurs depends on the rate of groundwater use and the properties of the formation that the water is drawn from. This form of recharge does not provide a sustainable increase of available water, but may provide a temporary source until alternate water supplies are developed.

3.6 Groundwater Flow

Pre-development groundwater flows, in the shallow freshwater portion of the aquifer, show water in the New Mexico portion of the Hueco Bolson moving primarily in a southerly direction (Figure C-3, Appendix C). Brackish waters in the eastern edge of the basin also flow south, parallel with the freshwater supplies. Recent studies have shown that as groundwater pumping has increased, and water levels have declined, groundwater flow patterns have been modified. In their 1992 report, Orr and Riser show the drawdown beneath the cities of El Paso and Ciudad Juarez to be pulling the flow back in the westerly direction (Figure C-4, Appendix C). This is having the effect of pulling brackish waters from the eastern side of the basin into the fresh water of the central Hueco Bolson. EPWU shows a similar situation in their model of 2002 groundwater flows. As noted earlier, wells in eastern and northern El Paso have experienced high chloride levels due to this change in groundwater flow. A high pumping scenario in the 1992 Orr and Riser report shows lateral intrusion of brackish waters by the year 2030 on the eastern edge of the Chaparral community, near Newman, New Mexico (Figure C-5, Appendix C).

The predevelopment hydraulic gradient through the area of Chaparral was 2.5 feet/mile (Terracon, 2003); data from 2004 shows that this gradient has been doubled to about 5 feet/mile. In their 2004 report, the El Paso Water Utilities estimated groundwater flow volumes across the New Mexico-Texas Border; flows due to natural recharge were estimated at slightly less than 6,000 acre-ft/year. Due to increased hydraulic gradients (from heavy pumping within the El Paso/Ciudad Juarez area), however, flows have increased to about 16,000 acre-feet/year in 2002, resulting in approximately 10,000 acre-ft/year of “induced” recharge.

Table 4: Changes in Groundwater Flow at the New Mexico-Texas State Border

	Hydraulic Gradient (ft/mile)	Flow Volume (acre-ft/year)
Pre-development (1903)	2.5	6,000
Year 2002	5	16,000

3.7 Water Availability

As stated above, the Hueco Bolson has a thin layer of fresh water that occurs along the western edge of the basin (Figure 2). Knowles and Kennedy (1958) conducted tests on over 30 wells throughout the Hueco Bolson in order to determine the occurrence of fresh and brackish water resources. Two of these cross-sections were located in the study area, one north of Chaparral and one immediately south at the state line. Combining this data with others, Orr and Riser updated the cross-sections throughout the Bolson in their 1992 report. Results of these studies show the layer of fresh water underlying the community of Chaparral ranges from 600 to less than 200 feet in thickness.

Knowles and Kennedy (1958) estimated that at least 21.2 million acre-ft of freshwater was present in the Texas portion of the basin and at least 17.6 million acre-ft in New Mexico. Recoverable freshwater volumes are reported as 7.4 million acre-ft and 6.2 million acre-ft, respectively. There was not enough data available to accurately evaluate volumes of brackish water in the basin. In their 2004 report, the El Paso Water Utilities estimated that 9.4 million acre-ft of freshwater are available in the El Paso Area of the Hueco Bolson; this estimate only includes supplies that are south of the state border. The EPWU defines freshwater as having less than 250 mg/L of chloride; other reports referenced in this study (and this study, itself) consider freshwater to be water with TDS concentrations under 1,000 mg/L. Due to the difference in definitions, EPWU estimates may be slightly more conservative than other figures presented in this study.

Based on the freshwater thickness data presented in the Orr and Riser report (and a specific yield of 0.35) the Lower Rio Grande (LRG) Regional Water Plan (2003) estimates that over 13 million acre-ft of freshwater is available in the New Mexican portion of the Hueco Bolson. Brackish water storage is estimated at 20.9 million acre-ft. Assuming that 50% of water would be recoverable, approximately 6.6 million acre-ft of the freshwater can be captured; 10.5 million acre-ft of brackish water could be recovered. These estimates are based on data from 1985 and are summarized in Table 5.

Drops in storage estimates from the 1950s to the 1980s show the effect of water table drawdown during this time. Current water level data shows that drawdown has continued since the most recent of these estimates was made; water levels in the Chaparral area have dropped up to 20 feet since the mid-1980s. Because water level data is not uniformly available throughout the basin it is difficult to estimate an overall average drawdown. Due to this lack of data, reliable estimates of current storage are difficult to make.

2004 USGS records show an average drawdown of 10.9 feet in New Mexican wells located in the Hueco Bolson since the mid-1980s. The majority of these wells are located in the southern portion of the study area, where drawdowns are expected to be higher due to more development. In an effort to obtain a rough estimate of current conditions, if we assume that this average drawdown number reflects general conditions throughout the basin, the Regional Water Plan estimate can be updated to 2004 water levels. This update leads to a volume of 13 million acre-ft of freshwater in storage and 6.5 million acre-ft of recoverable freshwater (using the same assumptions made in the LRG report for specific yield and recoverability). Because water withdrawals during this time period were mainly of freshwater, brackish water storage is expected to be largely unaffected; LRG Water Plan estimates were, therefore, not adjusted. Estimates of past and current water availability are given in Table 5.

Table 5: Summary of Water Availability in the New Mexico Hueco Bolson (acre-ft)

	Knowles and Kennedy (1958)	**LRG Regional Water Plan (2003)** [1]	**Current Estimate (2004)**
Freshwater in Storage	17.6×10^6	13.3×10^6	13.0×10^6
Recoverable Freshwater	6.2×10^6	6.6×10^6	6.5×10^6
Brackish Water in Storage	---	20.9×10^6	---
Recoverable Brackish Water	---	10.5×10^6	---

[1] Based on 1985 water level data

3.8 Water Quality

Limited water quality data has been recorded in the groundwater wells within the study area. USGS databases show chloride levels remaining constant at about 30 mg/L in a well north of Chaparral (chloride levels of 250 mg/L or greater indicate brackish water). USGS wells near the border in Texas show varying results. Well 49.05.309, which is located on the New Mexico-Texas border, shows chloride and TDS levels decreasing from the 1980s to 1995. Further south, however, wells 49.05.322 and 49.06.111 show chloride levels have exceeded 250 mg/L since the mid-1990s and 1980s, respectively. Figure C-6, in Appendix C, shows the location of these wells. Wells on the north and east side of El Paso have already exceeded the 250 mg/L level due to brackish water intrusion (EPWU, 2004).

Lake Section Water Company has monitored TDS levels in four of their wells since the mid-1990s. Results showing that Well HU 1 S (Edna Well) had exceeded 1,000 mg/L TDS caused the well to be taken off line in 2004; it is no longer used in the domestic water supply, instead supplying only irrigation water. TDS levels in three of Lake Section's other supply wells (HU 1 S2, HU 1 S6, and HU 1 S7) have been increasing over the last 10 years, though levels are still well below the 1,000 mg/L level (HU 1 S8 was drilled in 2003, therefore, no historical data is available for trend analysis). If current trends continue, HU 1 S2 (Rosencrans Well) will exceed freshwater TDS levels in 2026; HU 1 S6 and HU 1 S7 can maintain safe levels throughout 2040.

The New Mexico Environment Department (NMED) performs routine testing of domestic water supply wells. Total dissolved solids, however, are not a parameter that is analyzed, and chloride and specific conductance measurements are only taken periodically. On average, one chloride and specific conductance reading is available for each of the supply wells over the last 10 years. With the exception of the Edna well, these measurements are well below levels of concern. In order to track future degradation in water quality, it is advisable for the water companies to either conduct analysis for these parameters, or to request that the state perform these analyses annually.

Other contaminants that have historically been of concern, in the area, include fluoride, and arsenic. NMED testing of Desertaire Well HU 248 has found numerous times that the state maximum contaminant level (MCL) for fluoride was exceeded. Arsenic levels greater than 10-ppb (the new MCL as of 2006) were reported for Lake Section Well HU 1 S6 (Sylvia Well) in 1994; more recent tests of this well, and all reports from the other water supply wells, have been below this level.

3.9 Threats of Contamination

Chaparral has no major industry or commercial establishments located within its boundaries. Currently, the NMED lists 8 sites in Chaparral that have underground storage tanks on site. Three of these sites have been listed with the NMED's Leaking Underground Storage Tank (LUST) Program and remedial efforts have been undertaken; two sites are located in the community and one is located at the Doña Ana Range at Fort Bliss. As of 1996, the two community sites are classified as needing “No Further Action”. The site at Fort Bliss is currently listed as active; the threat of contamination from this site is unknown.

Six groundwater discharge permits have been issued by the NMED in Chaparral - four for the public schools and two for mobile home parks (a hog farm was permitted, however their permit was terminated in 1995). There is also a closed, unlined landfill located in the vicinity of Chaparral; the magnitude of threat for groundwater contamination from this site is unknown.

A main concern for groundwater contamination comes from the use of septic systems (particularly those without proper maintenance) within the community of Chaparral. Septic systems are known to cause high levels of organic and inorganic pollutants in underlying aquifers. Inorganic pollutants of concern include nitrogen, chloride, phosphorus, and metals. The high density of systems, in a community of this size, increases the likelihood of contamination. As was discussed in the previous section, water quality standards for the contaminants of concern have historically been low (two wells did test high for nitrate levels in the 1980s, however, levels have been low in other wells) (Terracon, 2003). It is expected, however, that as the population grows pollutant levels will increase. In 2000 a feasibility study was completed to address the construction of a wastewater treatment facility in Chaparral. The community is currently seeking funding to pursue the implementation of the facility plan. This report assumes that a community wastewater treatment and disposal system will be implemented within the planning period of this study.

The other concern for groundwater contamination is due to saltwater intrusion. As discussed above, continued groundwater withdrawals in the basin are expected to cause brackish water to intrude into the freshwater aquifer through lateral movement from the east side of the basin or upconing from underlying waters.

3.10 Aquifer Sensitivity

The New Mexico Environment Department lists the Hueco Bolson as a “less sensitive” aquifer. This is likely due to the high depth of water table throughout the basin.

3.11 Safe Yield

Pumping of wells within the Hueco Bolson freshwater lens may draw underlying brackish water vertically upward toward the well in a phenomenon known as upconing. The extent of this occurrence depends on aquifer properties, pumping rates, and density differences between the fresh and brackish water supplies. In their 1992 report, Orr and Riser developed estimated critical pumping rates for the Hueco Bolson. The critical pumping rate was defined as the “pumping rate at which the stabilized interface between freshwater and saline water reaches the well” (Figure C-7, Appendix C). Exceeding the critical rate will draw brackish water into the well. Orr and Riser’s findings are meant to be used as a guide to maximum pumping rates in the basin.

Critical pumping rates were shown to be very sensitive to aquifer characteristics and placement (depth) of the well within the freshwater saturated zone. Rates for the Chaparral area were based on a horizontal/vertical hydraulic conductivity ratio of 200 and a hydraulic conductivity of 35 ft/day. Based on these results, critical rates for Chaparral's water supply wells are shown in Table 6; the range in pumping rates is based on differing saline water densities. The information presented here is intended to be used only as a general guide to critical pumping rates in Chaparral. More detailed information would be necessary to accurately assess the threat of over-pumping (and upconing) at each well.

Table 6: Critical Pumping Rates for Chaparral Water Supply Wells (gpm)

Water Company	Well	Depth	Depth to Screen	Critical Pumping Rate[1]
CBG	HU 93	720	Unknown	Unknown
CBG	HU 93 S2	743	423	225-608
Desertaire	HU 248	910	550	High
Lake Section	HU 1 S	850	440	79-221
Lake Section	HU 1 S2	690	410	79-221
Lake Section	HU 1 S6	650	420	91-249
Lake Section	HU 1 S7	740	430	145-398

[1]H:V Conductivity Ratio = 200, Hydraulic Conductivity = 35 ft/day (Orr and Riser, 1992)

Table 7 shows average pumping rates for the Chaparral water suppliers. Based on the general guidelines above, Lake Section Wells HU 1 S2 and HU 1 S6 are pumping at rates that are higher than the calculated critical pumping rate. If these practices continue, there is a risk of brackish water upconing at these well locations. As discussed above, Lake Section has been monitoring TDS levels in these wells over the last decade; while levels have been increasing, readings for these wells are below 1,000 mg/L. If current trends continue, TDS concentration may exceed 1,000 mg/L after about 20 years. Figure C-8, in Appendix C, shows the locations of these wells.

Table 7: Average Pumping Rates by Local Water Providers (gpm)

	CBG		**Desertaire**	**Lake Section**			
Year	**HU 93**	**HU 93 S2**	**HU 248**	**HU 1 S**	**HU 1 S2**	**HU 1 S6**	**HU 1 S7**
2003	106	43	35	166	*234*	*456*	367
2002	141	---	30	102	*253*	*469*	327
2001	138	---	27	86	195	*460*	366

Wells HU 1 S and HU 1 S7 are currently pumping below the critical rate. However, the flow from HU 1 S7 is only slightly below the maximum recommended rate; an increase in withdrawals would cause it to exceed recommendations. Also, HU 1 S has recently been converted to an irrigation only well due to high TDS levels; it is unclear whether increased levels are due to upconing or some other source of contamination. Desertaire Well HU 248 is located in approximately 800 feet of freshwater thickness and is currently pumping at a low flow rate; it is, therefore, significantly below the critical pumping rate and is therefore of no concern. CBG Well HU 93 S2 is also of no concern due to its low pumping rate. Critical rate analysis could not be performed on CBG Well HU 93 due to lack of data.

3.12 Water Demand

Water demand projections are based on water use in the New Mexico portion of the basin. The primary use of water in the area is for domestic consumption. Public water supply figures are based on population projections and water use scenarios developed in Section 2 of this study. Domestic wells serve households that are not connected to the local water supply system. The New Mexico Office of the State Engineer (OSE) database lists a total of 103 domestic wells in the Hueco Bolson (2004); 93 of these wells serve single households, 9 serve multiple households, and 1 serves a mobile home development. Water demands for these wells were calculated based on a water allocation of 3 acre-ft/year for single and multiple household wells and 48 acre-ft/year for the mobile home development well (OSE, 2004). It is expected that domestic well consumption will remain consistent throughout the study period.

Substantial change in irrigation demand for agriculture and livestock use is not expected to occur over the next 40 years. Office of the State Engineer figures for the year 2000 are used as a baseline for these projections (Wilson, 2003) (OSE, 2004). There is currently no major commercial or industrial activity in the area of Chaparral; as the population grows, however, it is expected that these activities will experience minor increases. Commercial and industrial demands are based on the OSE database (2004) and the LRG Regional Water Plan (2003). There are no mining or power operations in the area and none are expected to begin in the time frame of this study.

Table 8: Projected Water Demand for the New Mexico Hueco Bolson (acre-ft/year)

	2000	2010	2020	2030	2040
Public Water Supply[1]	2,416	3,936	5,038	6,449	8,256
Domestic Wells	55	55	55	55	55
Irrigated Agriculture	850	850	850	850	850
Livestock	50	50	50	50	50
Commercial, Industrial, Mining, and Power	100	125	150	175	200
Total	**3,770**	**5,315**	**6,442**	**7,878**	**9,710**

[1] Based on recommended population growth and water use scenario from Section 2

3.13 Recharge vs. Demand

Accounting for recharge from the Tularosa Basin, and runoff from the Organ and Franklin Mountains, Meyer (1976) estimated that 5,640 acre-ft of water enters the northern Hueco Bolson each year. A comparison of the estimated recharge to total water demands (Table 8), provides an estimate of the storage within the aquifer. Based on projected demands, it is anticipated that water use in the Hueco Bolson will exceed recharge in the year 2012. A small portion of the recharge due to mountain runoff enters the aquifer south of the state line; recharge may, therefore, be slightly less and may be exceeded earlier than this comparison suggests.

Table 9: Groundwater Recharge vs. Demand in the NM Hueco Bolson (acre-ft/year)

	2000	2010	2020	2030	2040
"Natural" Recharge	5,640	5,640	5,640	5,640	5,640
Demand	3,770	5,315	6,442	7,878	9,710
Difference	**1,870**	**325**	**-802**	**-2,238**	**-4,070**

3.14 Future Development in Other Portions of the Hueco Bolson

Groundwater withdrawals by the Cities of El Paso and Ciudad Juarez have a large effect on groundwater flows and supplies in the Chaparral area. Both cities have seen significant effects from groundwater mining and will need to reduce their dependence on Hueco Bolson water supplies in the future. Though activities in both locations affect New Mexico groundwater, those of El Paso have a much larger influence; it is, therefore, important to note their plans for future water supply.

Over the past 15 years, the City of El Paso has activated strategies to reduce their impact on groundwater supplies. These methods have been effective in reducing pumping in the Hueco Bolson however additional efforts are needed. Future plans include a joint venture between the city and Fort Bliss to implement the 27.5 million gallon per day (MGD) Joint Desalination Facility (JDF); the plant is currently under construction at Fort Bliss Military Base and is expected to be in operation by the fall of 2006.

A 2004 study, completed by the EPWU, shows that the addition of the JDF plant will reduce negative impacts (historically caused by groundwater mining) on fresh groundwater supplies in the Hueco Bolson. Comparison of the "continuation of 2002 pumping conditions" and the "JDF" scenarios, presented in the 2004 report, show the effects that this facility is anticipated to have. If 2002 pumping conditions were continued for the next 50 years, the sum of natural and induced recharge rates to Texas (from New Mexico) would increase to a maximum of 21,000 acre-ft/year after 30 years, decreasing to a constant rate of 19,000 acre-ft/year for years 31-50. This scenario leads to additional drawdowns of 25-50 feet at the state border after 30 years and further repercussions in regional groundwater supplies. The JDF scenario predicts a maximum recharge rate of 18,500 acre-ft/year at year 30, leveling out at 16,500 acre-ft/year from year 31 to 50. This scenario predicts further drawdowns of 10-25 feet, after 30 years, at the state border. The addition of the JDF will, therefore, lower "induced" recharge, lessen drawdowns, and help to mitigate some of the concerns with brackish water intrusion.

El Paso is also looking into the possibility of expanding their aquifer storage and recovery (ASR) efforts. They currently have an ASR system operating in the northeast part of the city at the Fred Hervey Water Reclamation Plant. Depending on the location and operation of the recharge wells, ASR has the potential to mitigate negative effects on aquifers by reducing drawdowns and modifying groundwater flow patterns (which could be used to move brackish water away from source wells). Though additional artificial recharge is considered a viable option for the city, no plans are currently underway to implement this strategy in the foreseeable future.

3.15 Storage vs. Overall Demand

It has been shown that activities, which occur south of the state border, have historically had the largest influence on groundwater supplies in Chaparral. Up to this point, the demands by the community of Chaparral have been met through recharge from upstream; groundwater drawdowns, therefore, must be due to large withdrawals and storage depletions by El Paso (and, to a lesser extent, Ciudad Juarez). It has been noted, however, that within the next 10 years water demand in Chaparral is expected to exceed recharge, at which point community growth will begin to adversely affect the aquifer. It is important, therefore, to look at the compounded effects of future water demands in both Chaparral and El Paso.

A 2004 report on the Hueco Bolson aquifer looks at the effects of various water supply scenarios for the City of El Paso (EPWU, 2004). The "JDF" scenario outlines what can be expected when the JDF is operational (expected to occur in 2006). The "inflow from New Mexico" figure, presented in the report, is a drain on Chaparral's groundwater due to demand from Texas. Combining the predicted "inflow from New Mexico" with the demands of Chaparral will give a more precise view of regional demands and their effects on groundwater storage in the Hueco Bolson. Table 10 shows the results.

Table 10: Effects of Overall Regional Demand under El Paso "JDF" Scenario

Groundwater Storage vs. Overall Regional Demands (acre-ft/year)					
	2000	**2010**	**2020**	**2030**	**2040**
Recharge	5,640	5,640	5,640	5,640	5,640
Chaparral Demand	3,770	5,315	6,442	7,878	9,710
Texas Demand	16,500	15,000	15,000	18,500	16,500
Storage (acre-ft)	**6.5×10^6**	**6.4×10^6**	**6.3×10^6**	**6.1×10^6**	**5.9×10^6**

Table 10 outlines that as demands increase, depletions in water levels and storage will occur. During this process, the thinnest portion of the Chaparral freshwater lens (to the east) will disappear first. As eastern freshwater supplies are dried up, the community may find it necessary to move wells west toward the deepest freshwater supplies along the Organ and Franklin Mountains. Though continuing to rely on groundwater supplies alone would constitute mining and is not recommended, it is clear that there are adequate volumes of freshwater to sustain predicted withdrawals over the time period of this study (in the year 2040, under the "JDF" scenario, there is still 5.9 million acre-ft of recoverable freshwater in the New Mexico Hueco Bolson). The quantity of water is not of concern, however, the future quality of is of major concern.

Continued water level depressions will increase the likelihood of brackish water intrusion from the eastern portion of the basin. The eastern portion of Chaparral may experience intrusions by the year 2030 (Orr and Riser, 1992); further drawdowns could accelerate this process and, possibly, pull brackish waters further west into the community. Considering each of these concerns individually, and in combination, it is expected that the community of Chaparral will need to develop additional water sources to supplement their current supply within the next 10-15 years.

4.0 OPTIONS TO AUGMENT SUPPLY OR REPLACE CURRENT PRACTICES

4.1 Background

As discussed above, the community of Chaparral's water demand will increase from 3,770 acre-ft/year to 9,710 acre-ft/year between the years 2000 and 2040. In approximately 2012, Chaparral's demand will exceed the Hueco Bolson's natural recharge making it necessary to develop alternative water sources to supplement or replace their current sole reliance on freshwater from the aquifer. Two main methods of augmentation should be considered:

- Utilizing techniques to get more benefit out of existing supplies
- Developing new sources of water to augment or replace existing supplies

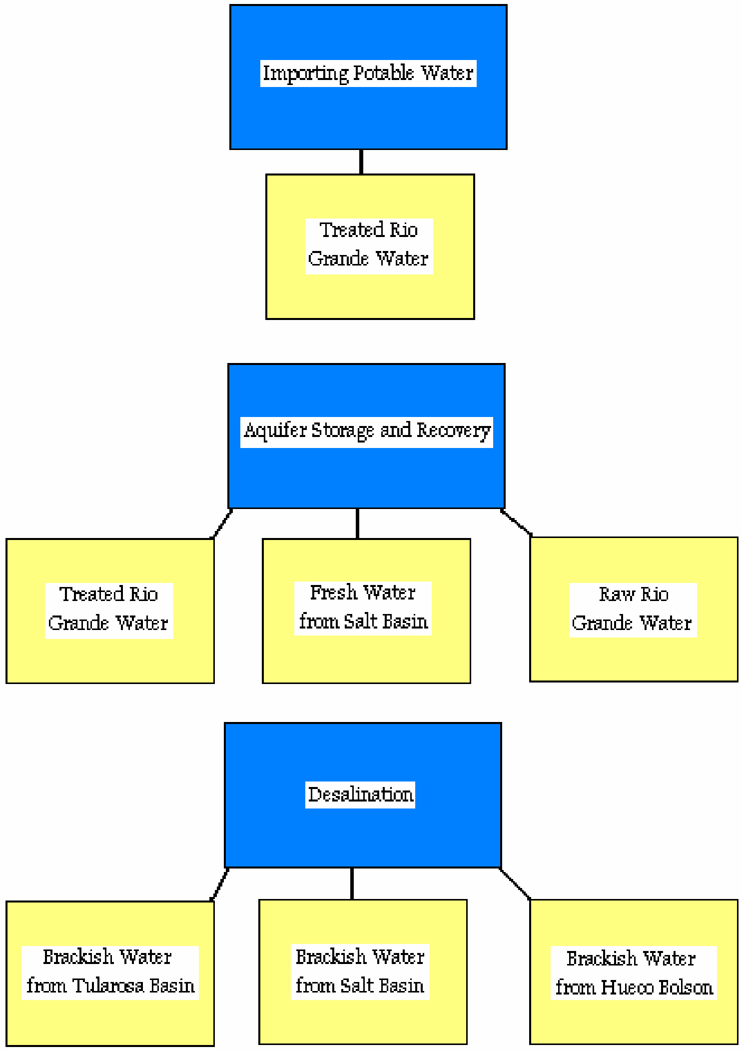
4.1.1 Techniques

Techniques to gain more from existing supplies include methods such as conservation, retiring agricultural water rights, and water re-use strategies. While these methods are important and should play a role in the community's future water plan, they, alone, will not provide enough water to meet Chaparral's demands.

4.1.2 Augmentation of Existing Supplies

The community must seek out new water supplies of which there are four main sources: water from the Rio Grande, potable water from other entities, freshwater from the Salt Basin, or brackish water from the Tularosa, Salt, or Hueco Basins. After consultation with the LRG Technical Advisory Committee, it was decided that three technology alternatives would be considered for the implementation of these water sources: importing potable water from another entity, aquifer storage and recovery, and desalination. Figure 3 shows a flow chart of the chosen alternatives and the new water source options that each could utilize. Each of the water sources and technologies will be addressed separately.

Figure 3: Flow Chart of New Water Source Options and Technologies



4.2 Projected Water Demand

Table 13 summarizes water demands for Chaparral over the next 40 years. These estimates are based on assumptions outlined in Section 2. Chaparral should use new water sources only to supplement the domestic use portion of the overall demand; agricultural and industrial needs could be met with substandard water (not meeting safe drinking water quality criteria) from the Hueco Bolson.

Table 11: Projected Domestic Water Demands for Chaparral

	2000	2010	2020	2030	2040
Overall Demand (acre-ft/year)	3,770	5,315	6,442	7,878	9,710
Average Domestic Demand (acre-ft/year)	2,416	3,936	5,038	6,449	8,256
Average Domestic Demand (MGD)	2.2	3.5	4.5	5.8	7.4

It is assumed that Chaparral will need to augment 5,940 acre-ft/year of water by the year 2040. This is based on the fact that at the 2000 demand of 3,770 acre-ft/year, no adverse effects were seen on the freshwater lens of the Hueco Bolson. This rate of withdrawal is, therefore, considered sustainable; any additional demands, however, should be augmented with another water source. This analysis will address the 5,840 acre-ft/year (5.2 MGD) that is due to the increased domestic demand. Non-domestic demand is assumed to be met by sub-standard water from outside the Hueco Bolson freshwater aquifer.

4.3 Alternative Sources of Water

Alternative water sources, for Chaparral, include both surface and groundwater resources. In both cases the resource can only be considered viable if it is legally, financially, technically, and jurisdictionally feasible.

Each of the three groundwater basins (Salt, Tularosa, and Hueco) are considered "mined" basins by the Office of the State Engineer (OSE) and permits for water rights, within the basins, are issued through their office. Each permit application is evaluated by the OSE and (because the Hueco and Salt Basins do not have their own criteria) water is allocated based on the Tularosa Basin Administrative Criteria. In general, there are three main criteria that must be met in order for a permit to be granted. Proposed withdrawals, in combination with existing activities cannot:

- Exceed an average yearly drawdown in the water table of more than 2.5 feet (for freshwater thicknesses greater than or equal to 400 feet).
- Cause a water resource that is originally considered fresh (defined by the OSE as having a TDS<1,000 mg/L) to exceed 1,000 mg/L of total dissolved solids.
- Reduce the freshwater thickness by more than 100 feet over a 40-year planning period (if the freshwater lens is greater than or equal to 400 feet); if the lens is less than 400 feet in thickness, it can't be reduced by more than ¼ of this thickness over the 40-year period.

In addition, groundwater withdrawals are not allowed to impinge on existing water rights and should not be contrary to water conservation or public welfare.

4.3.1 Rio Grande

Rio Grande surface water is administered by the Elephant Butte Irrigation District (EBID); discharges are controlled and monitored at the Elephant Butte Reservoir by the U.S. Bureau of Reclamation (BOR). An annual "full release" of water is defined as 790,000 acre-ft; the New Mexico portion of this is 416,000 acre-ft (60,000 is reserved for Mexico; the remaining water goes to Texas). Actual annual release volumes vary, however, and during dry years may be as low as 206,000 acre-ft, as was the case in 1964.

At this time, EBID water is allocated according to acreage; during a year of full release, for example, each acre of land is allotted 3 acre-ft of water. All of the available surface water rights are currently allocated. If Chaparral were to choose an alternative that relied on water importation from the Rio Grande, they would have to purchase or lease rights from existing water rights owners within EBID. EBID maintains a waiting list for parties that desire to purchase rights of users that have been delinquent or choose to transfer their ownership (the current waiting period is about 10 years). Otherwise, current owners will often sell or lease their rights directly, without going through the district.

The volume of available surface water is unknown at this time. Flows are highly dependent on weather conditions and the portion of these flows that would be available to Chaparral depends on the community's ability to acquire water rights. In addition, the manner that water is released from Elephant Butte Dam is of concern. Currently, water is released only during the irrigation season. For a successful domestic supply system to be operated, however, a year round supply of water would be needed. It is expected that these issues will be addressed in the next five to ten years, as other entities in the region move toward implementing surface water treatment and the regulations for this technology are completed.

4.3.2 Potable Water

Chaparral may have the option of purchasing, and importing, potable water from either El Paso Water Utilities (EPWU) or the Anthony Water and Sanitation District (AWSD). The EPWU service area extends north from El Paso up to the state line (3 miles south of Chaparral). Anthony, NM lies 15 miles west of Chaparral across the Anthony Gap (through the Franklin Mountains north of the Texas state line). If purchased from these entities, the water would be conveyed to Chaparral through a pipeline. The volume of water available would depend on negotiations with the facility that is supplying the resource.

4.3.3 Salt Basin

The Salt Basin lies approximately 100 miles east of Chaparral (Figure D-1, Appendix D), just north of Dell City, TX. Most of the available water in the basin is in the bedrock aquifer. Land areas overlying the bedrock aquifers are largely undeveloped, with few water users and ample resources. It is estimated that 28.7 million acre-ft of recoverable water is contained in the bedrock; more than half of this supply is fresh (Livingston, 2002). The Crow Flat Basin fill aquifer (in the eastern portion of the Salt Basin) contains an additional 1.5 million acre-ft of recoverable water; 115,000 acre-ft of this is fresh (Livingston, 2002).

The Salt Basin was declared in 2000 and the state engineer currently lists 165,800 acre-ft of water as either declared or permitted (OSE, 2004); they are accepting permit applications for both fresh and brackish water resources. The 2000 declaration was in part due to the intent of the Hunt Building Corporation (now operating under the name Cimarron Agricultural, Ltd.) to declare 45,000 acre-ft of groundwater for sale to agricultural or municipal and industrial users in either New Mexico or Texas. In 1997 a group of ranchers formed the Last Chance Water Company, with the intention of selling their water to both in and out of state users. There is recognition, therefore, of the water resources in the Salt Basin and the opportunity to market them to out of basin users. Both Last Chance Water Company and Cimarron currently have permit requests pending with the OSE.

4.3.4 Tularosa Basin

The Tularosa Basin surrounds the Hueco Bolson to the north and east (Figure D-1, Appendix D) and has extensive storage of brackish water that is currently not used. The 2002 Tularosa and Salt Basin Regional Water Plan separates this basin into three sub-basins (Figure D-2, Appendix D). The west and east Tularosa sub-basins are those portions that would be the most likely sources of water for Chaparral to access.

The primary water user in the west Tularosa sub-basin is White Sands Missile Range. Due to the interconnection of the Tularosa western sub-basin and the Hueco Bolson, freshwater supplies from this area are not considered to be an alternative supply option. Ground water from the Tularosa provides the main recharge to the Hueco; therefore, pumping this water would not constitute utilizing a new source, but merely “moving the well upstream”. The brackish water resources in this area, however, are not currently being utilized and should be considered a viable source. It is estimated that 56 million acre-ft of recoverable brackish water is contained in the western sub-basin (Livingston, 2002).

Figure D-3 (Appendix D) shows that water supplies immediately east of Chaparral have total dissolved solid (TDS) levels ranging from 1,000-3,000 mg/L. As defined by the 2002 Tularosa RWP, the eastern sub-basin has a total volume of 44.7 million acre-ft of recoverable brackish water; 19.6 million acre-ft is in the 1,000-3,000 mg/L range (Livingston, 2002). This water is currently not allocated and is available for beneficial use.

4.3.5 Brackish Supplies of the Hueco Bolson

Details of the Hueco Bolson aquifer are presented in Section 3 of this report. As was shown, the freshwater lens of the bolson is underlain by a thick layer of brackish water ranging in thickness from 100 to 2,000 feet (Orr and Riser, 1992). Also, just east of Chaparral, the freshwater lens terminates and the brackish water is accessible. The LRG Regional Water Plan estimates that 10.5 million acre-ft of recoverable brackish water is stored in the Hueco Bolson. Similar to the Tularosa and Salt Basins, the Office of the State Engineer is accepting permit applications for both fresh and brackish water withdrawals in the bolson.

4.3.6 Water Sources and Quantities

The estimated availability of water from each of the potential sources is summarized in Table 12. The availability of potable water that can be purchased by Chaparral remains a subject of negotiations between Anthony, New Mexico and possibly EPWU. The proposed surface water treatment facility in Anthony is designed to supply 2,970 acre-ft/year of water to Chaparral. This water will have to be conveyed via a pipeline along the Anthony Gap. Perhaps such a pipeline could be constructed jointly with the proposed Northeast Parkway project whereby the Anthony Gap (Highway 404) will serve as a by-pass to El Paso for I-10. Similarly, potable water could be purchased by Chaparral from EPWU and piped approximately 3 miles north. However, due to jurisdictional issues it may be difficult to consummate such a purchase.

Table 12: Summary of Available Water Resources Available for Acquisition by Chaparral

	Available Water (acre-ft)	Recoverable Water (acre-ft)
Raw Rio Grande Surface Water[1]	416,000	----
Potable Water from Proposed Anthony, NM WTP[2]	2,970	----
Freshwater from the Salt Basin	30.2×10^6	15.1×10^6
Brackish Water from the Salt Basin	30.2×10^6	15.1×10^6
Brackish Water from the West and East Tularosa Sub-basins	500.8×10^6	100.7×10^6
Brackish Water from Deep in the Hueco Bolson	20.9×10^6	10.5×10^6

1 Overall volume available based on a full release of 790,000 acre-ft at Elephant Butte Reservoir; the amount available to Chaparral would depend on water rights that could be acquired

2 Based on 2000 report for a 16.0 MGD total plant design

Each of the options that include importing water to Chaparral from another groundwater basin would require an extensive effort to construct and maintain transmission pipelines. There may be an opportunity for Chaparral to decrease the burden if they could find another user to collaborate on the construction of a pipeline to convey water for the benefit of both users. The likelihood of finding another user, however, is unknown at this point; it is, therefore, assumed that Chaparral will assume the full burden. There are, also, legal and political issues that may arise from a proposal to move water between basins; these could come from complications in obtaining water rights or through obstacles encountered in the construction of an extensive pipeline (acquiring land or right-of-ways may be difficult). Due to these challenges and the availability of recoverable brackish water in the Hueco Bolson, salt water from the Salt or Tularosa Basin is not considered a viable brackish water source for Chaparral. Further analysis in this report will proceed under the assumption that the Hueco Bolson will be the source for brackish water resources. A similar argument is made against freshwater from the Salt Basin and, from this point on, Rio Grande water will be considered the optional source of additional freshwater for Chaparral.

4.4 Description of Alternatives

After consulting with the LRG Technical Advisory Committee, it was determined that four supply alternatives would be considered for this analysis. Minor additions to the water supply through conservation and other measures, importing potable water, aquifer storage and recovery, and desalination were the chosen options. The following sections explain these options as they relate to augmenting Chaparral's water demand.

4.4.1 Minor Additions

There are numerous actions that will allow Chaparral to use the freshwater resources of the Hueco Bolson in a more effective manner ultimately resulting in more benefit from the available water. These techniques include conservation (in both domestic and agricultural uses), retirement of agricultural water rights, and water re-use. However, the volume of water that may become available through these options alone will not be adequate to meet increased demands through the planning period.

The OSE encourages all water users to conserve water. The state engineer must, by law, consider conservation measures when reviewing an application for water rights. Any permits issued by the OSE state that the permittee must "utilize the highest and best technology available to ensure conservation of water to the maximum extent practical." Though official conservation policy is not yet in place, the OSE does have conservation guidelines for commercial, industrial, and institutional users. The OSE also offer a guide for municipalities on how to prepare a water conservation plan. When reviewing permit applications, the OSE will require that conservation measures be outlined.

The OSE requires publicly held utilities to develop a 40-year water plan in order to secure their future allocated water rights. As a part of this water plan, the issue of conservation has to be addressed. Each of the three water suppliers in Chaparral are privately owned and, therefore, not required to produce these plans. In 2000, however, Lake Section Water Company developed a 40-year plan in an effort to address how it will meet future community water needs. Lake Section did not address conservation as part of this plan, indicating only that they could adopt suggestions put forth by the OSE, if needed. These suggestions are outlined in the OSE

Water Conservation Guide for Public Utilities and include steps such as: public education, metering, performing water audits, leak detection and repair, ordinances for outdoor water use and landscaping, indoor conservation measures, and drought management. Most of the aspects addressed through conservation plans are currently not of concern in Chaparral. The community has a low use rate per capita, most likely due to socio-economics and predominantly low income demographics with a high population of immigrants (immigrant populations are reported to use less water). As the community grows, however, usage rates are expected to increase and conservation practices should be put in place.

Agricultural water conservation involves encouraging farmers to implement practices that use less water. Such practices may include upgrading irrigation systems (utilizing sprinklers or drip irrigation instead of flooding), laser leveling of fields, or lining conveyance ditches. These practices, however, do not always lead to a reduction in water use. Often times these modifications just supply more water for use by the farmer, who is encouraged to utilize the additional resource to increase crop yield. Due to the small agricultural use of water in the Chaparral area, agricultural conservation measures will produce little benefit through the planning period.

Because the groundwater of the Hueco Bolson has not been fully allocated, it is not necessary to purchase water rights from agricultural users in order to obtain rights in the basin. Purchasing (retiring) these rights, however, would reduce the number of users in the basin and free up more water for domestic uses (assuming that the agricultural users don't acquire new permits and continue their withdrawals). It is estimated that approximately 900 acre-ft of water is currently being used for irrigation and stock watering in the Chaparral area; this volume represents about a quarter of current demand and 10% of the demand in 2040. Once the basin is fully allocated, retiring these rights may be a reasonable option; at this point it is not.

Water reuse involves using treated wastewater or water from runoff for irrigation and non-consumptive water uses. Chaparral does not currently have a collection system or treatment plant for the community's wastewater. Therefore, at the present time a community wide reuse program is not an option. The community is pursuing the construction of a wastewater treatment facility; water reuse is the recommended method of effluent disposal in this plan (Bohannan Huston, 2000). It is assumed that the community will be successful in its efforts to phase out individual septic systems and implement this wastewater collection and treatment plan within the 40-year study period. Due to low levels of precipitation in this semi-arid region and high evaporation rates, storage and utilization of runoff water is not considered a viable alternative.

4.4.2 Purchasing Potable Water from Other Entities

The El Paso-Las Cruces Regional Sustainable Water Project commissioned studies in the late 1990s-early 2000s to develop alternative water supplies for the region. A portion of these efforts were directed toward the possibility of constructing surface water treatment plants

(WTPs), throughout the region, in order to meet future municipal water needs on a sustainable basis. A 16.0 million gallon per day (MGD) plant was proposed to be located just north of Anthony, NM in order to serve the needs of surrounding communities. The proposal includes a transmission line to the Anthony Gap to deliver 2.65 MGD of water to Chaparral. The Anthony WTP was originally recommended to be operational around the year 2005. No efforts are currently being made to meet this time frame and it is unclear when final planning of the plant will begin. The eventual need for the regional WTPs is clear, however, and it is believed that they will be implemented within the planning period of this study.

Due to Chaparral's location, near the New Mexico-Texas state border, another potential supplier of potable water may be the El Paso Water Utilities (EPWU). The EPWU service area extends from the City of El Paso to the state border. Pursuing this option would involve a pipeline linking the EPWU and Chaparral's water distribution systems. However, New Mexico and Texas have litigated over regional water resources in the past. Due to the jurisdictional implications of importing water from Texas, the option of purchasing potable water from EPWU may not be feasible, unless it is implemented as an element of regional and cooperative water master planning.

4.4.3 Aquifer Storage and Recovery (ASR)

Aquifer storage and recovery consists of the placement of surplus water supplies into the aquifer underlying Chaparral. During wet years, excess river water could be injected into the subsurface, stored, and withdrawn when river levels return to normal or low flow conditions. ASR can also be used to store water during times of low demand (autumn and winter months, for example) and withdrawn at a future time when demands increase (summer months).

There are two techniques for transferring excess surface water into the aquifer, as described below.

a. Above Ground Recharge Basins. Using above ground basins would involve placing the excess water into shallow, unlined ponds and allowing the water to infiltrate through the upper soil layer, recharging the underlying aquifer. This method, requires large plots of land for pond construction, encourages water loss due to evaporation, and is largely dependent on the hydrologic properties of the subsurface materials between the pond and the aquifer (these materials should be highly permeable and free from lenses that would impede recharge). Advantages of the basin method are that untreated water can be placed into the ponds, encouraging treatment through natural filtration and attenuation as it seeps down through the vadose zone. Also, a deep water table could cause leaching of salts or mobilization of other contaminants into the target aquifer.

b. Injection Wells. Injection wells use high pressure pumps to inject the water directly into the designated aquifer. Injection wells have the advantage of placing the water directly into the desired storage formation. However, wells can be expensive to construct and operate and chemical composition of the source water can cause plugging of well screens. Furthermore, water for injection directly into the fresh water aquifer requires treatment of water to a quality comparable to the fresh water in the aquifer.

Supply water for recharge would be raw or treated surface water from the Rio Grande. Either of the water sources would require building a transmission pipeline to convey the water to Chaparral.

4.4.4 Desalination of High TDS Water

The southern portion of New Mexico has large reserves of groundwater with high levels of total dissolved solids. In the past, technologies for desalination were not considered economically feasible. However, new and more efficient desalination technologies have now emerged in the market and there has been increased interest in pursuing desalination options. There are numerous desalination efforts currently underway in the Southern New Mexico and El Paso, Texas region. The Tularosa Basin National Desalination Research Facility is less than 100 miles north of Chaparral. There is, also, research being done on new desalting technologies at New Mexico State University (NMSU) and the University of Texas – El Paso (UTEP). The region, therefore, is on the forefront of this technology.

In addition to the research, a number of desalination operations are currently planned or being operated in the region. The City of El Paso has two projects, including a wellhead desalination project and a treatment facility (the JDF) that is currently in the construction phase. The wellhead program includes 11 wells in the Lower Rio Grande Valley and treats a total of 8 MGD. The Joint Desalination Facility (JDF) is designed to deliver 27.5 MGD to the City of El Paso and the U.S. Army Base at Fort Bliss; the plant will be located on Fort Bliss property and is expected to be operational in the fall of 2006. In New Mexico, a 2003 report indicates that the City of Alamogordo will construct a 3.6 MGD desalination plant; this plant is forecasted to increase in capacity to 7.4 MGD by 2030. The facility is designed to grow incrementally so that surrounding communities may join the desalination effort, utilizing the technology to meet their future water needs.

Potentially, the following three options for desalination are available to Chaparral.

- Establishing a small community plant, which would process water locally to meet demands
- Using a regional plant to desalinate water and piping the treated water to the community
- Installing small desalination units at individual wells (wellhead desalination)

In order to determine the feasibility of the three desalination options, a detailed feasibility study (which is beyond the scope of this report) would have to be undertaken. Considering the abundance of brackish water storage in the Hueco Basin Chaparral may find it feasible to participate in a regional desalination facility built by EPWU in the future and deliver the desalinated brackish water to Chaparral via a pipeline. Chaparral may be able to allocate its acquired share of brackish water rights in the Hueco Basin to EPWU for such a regional effort. Sharing of brackish waters of the Hueco Basin for the purpose of regionally desalinating may be jurisdictionally more feasible in the future and could very well become the foundation for a regional cooperative water system planning. Chaparral serves and will continue to serve as a bedroom community for El Paso, thus it appears natural for these communities to cooperate in planning the water supplies for the 40-year period.

4.5 Implementation Constraints

Each of the new source alternatives pose challenges for the community to implement. The foremost constraint relates to the capacity and integrity of the current water distribution system in Chaparral. Additional infrastructure will be necessary to upgrade the distribution system to handle increased demand; this will require technical and financial resources.

Each of the new source alternatives will require wells to be drilled and/or water transmission lines built. Funding of these wells and transmission lines will pose financial burden upon the community. Conveyance of water along jurisdictional boundaries could lead to political, social, or legal challenges, depending on the proposed source. A discussion of these constraints follows in the sub-sections below.

4.5.1 Minor Additions

Developing and implementing a conservation plan poses little challenge to the community of Chaparral. The Office of the State Engineer provides guidelines and a template for developing conservation plans for municipal, as well as industrial, users. Though it is not currently required, it is recommended that each of the three water suppliers draft a water conservation plan. When, in the future, they find it necessary to file a permit request with the OSE this measure will likely be requested.

Agricultural conservation methods require some technical expertise to design and implement. Agencies, such as the USDA-Natural Resources Conservation Service (NRCS), offer services to assist farmers in developing and funding updates to their irrigation methods. These updates are usually expensive, however, (funding assistance is usually on a cost-share basis) and do not necessarily translate into more water being available; often times the excess water is used to supplement the increased yield that the farmer enjoys due to their new methods. Without financial incentives it is unlikely that an agricultural water user would implement water saving techniques to provide water to off-farm users.

In the absence of a community wastewater treatment and disposal system water reuse is not a viable option. When, a community wastewater treatment plant is constructed, water reuse should be implemented.

4.5.2 Purchasing Potable Water from Other Entities

During the 2003 state legislative session a new law was developed in order to create Special Water User Associations (SWUAs); this was done under Section 73-10-48(A), which is amended to the Municipal Water User Association (MWUA) Statues. These SWUAs (including entities such as: state universities, counties, municipalities, and public or member-owned water systems) would be able to acquire and use agricultural water rights for municipal uses. The passing of this statute is seen as a first step in easing the process of converting historic agricultural water rights to municipalities for domestic uses. The SWUA would be required to purchase or lease allotments from historic users in order to offset their domestic demands; also, water supplies can only be used within the boundaries of the irrigation district.

The EBID is currently working on updating its regulations and processes to accommodate this statute. It is anticipated that the new rules will be similar to those for MWUA, which are currently in place. Neither current EBID regulations for MWUAs, nor the new SWUA statute, allow for Rio Grande water to be used outside of the irrigation district boundaries; at this time, Chaparral is not included in these boundaries. The outer limits of EBID are currently being redrawn, however, and discussions with district representatives (Magallanez, 2004) indicated that it would be possible for Chaparral to be drawn into the district, either now or in the future.

The Rio Grande is fully allocated; it is, therefore, necessary to acquire water rights from a current water right holder. If these rights are currently being used for irrigation purposes (as would typically be the case), it may be that only the historic consumptive use portion of this right is available to be transferred for domestic purposes. Also, if the point of diversion, of these rights, is moved a substantial distance up or downstream from the original point of diversion, river gain or losses may be factored into the volume allocated to the new user. It is not clear, at this point, how the transfer of rights from agricultural to domestic use will occur, but these factors could cause a substantial reduction in the volume of the right, causing municipal users to have to purchase large amounts of agricultural water rights; this option may prove to be financially limiting.

Transferring water rights from agricultural to domestic use poses many unknowns at this time. It is expected that as these transfers begin to happen and become more routine, regulations and processes will evolve and many of the current challenges will be addressed. Some of these concerns include the question of whether to purchase or lease water rights. If Chaparral were to acquire SWUA status, they would have the option to lease water from the EBID. These leases are for a 40-year period with the option to buy. If the community chooses to purchase rights, they would have to hold substantial acreage in the irrigation district to offset their water right; at this time, during a full flow year, water users get an average of 3 acre-ft of water per year per acre of land. Therefore, Chaparral would have to own 1,000 acres of land within the district to acquire 3,000 acre-ft of water rights. If Chaparral is obtaining water from the Anthony WTP, it may be possible that the Anthony WTP would be responsible for obtaining the necessary water rights to meet the plant capacity.

As with any of the options that involve importation of water, infrastructure would require substantial commitment of funds. However, regionalization of such infrastructure and sharing of pro-rata costs by the benefiting communities could reduce the burden of funding such infrastructure. Furthermore, acquiring funding from Federal and State sources may be facilitated if such funds are sought as a regional plan that benefits multiple communities. El Paso Water Utilities has investigated water supply options that involve the construction of a water pipeline through the Anthony Gap in order to deliver water to northern parts of the city. There may be an opportunity for collaboration between El Paso and Chaparral in order to construct a pipeline that would serve the interests of both communities; such an arrangement would ease some of the challenges to Chaparral. Also, construction of such a pipeline could be coordinated with Texas DOT and NM DOT so that it is constructed as part of the Northeast Parkway loop connecting to I-10 near Anthony and co-incidentally it follows the alignment commensurate with the desired pipeline.

Technical challenges of importing potable water would be relatively low. If the Anthony WTP is finally considered to be the selected source Chaparral would have to upgrade its currently allotted water share of the 16 MGD plant. As designed, the facility will provide Chaparral with 2.65 MGD of water, which is approximately half of its needed 5.2 MGD. If this option were to be pursued, Chaparral would have to acquire additional water from other users on the system.

As mentioned previously, the EPWU service area extends to the state border just three miles south of Chaparral. The proximity of the two cities and the existing infrastructure of El Paso, make importing potable water from TX an option that must be considered. This alternative would involve a pipeline extending from the northern portion of EPWU's system into Chaparral's distribution system. Negotiations as to the amount of water that could be provided to Chaparral would depend on the current treatment capacity of EPWU. While technically feasible, this option may pose jurisdictional and legal challenges.

4.5.3 Aquifer Storage and Recovery

The option of aquifer storage and recovery (ASR) has many potential obstacles; in order to determine the suitability of the Chaparral area for implementing ASR a feasibility study would have to be undertaken. This study should include groundwater modeling and site-specific exploration in order to address the response of the area aquifer to recharge. Pilot scale studies would be necessary to address the chemical compatibility of the proposed feed water and the existing water supply. In addition, current infrastructure and land availability at the site should be assessed; other concerns, such as costs, regional politics, and existing pollution would be included. Possible water sources for ASR at Chaparral include raw water from the Rio Grande or imported potable water.

As part of the Las Cruces-El Paso Sustainable Water Project, Boyle Engineering evaluated the prospects of implementing ASR in the Lower Rio Grande Region; the study report was released in September of 1995. This report considered four potential ASR sites throughout the region, including one in Northeast El Paso; the site lies just over the state border from Chaparral. Though a detailed site-specific feasibility report would be required if the ASR alternative were selected for Chaparral, the Sustainable Water Project study provides a general idea of the likely success of such an effort.

Boyle reports that the aquifer characteristics, in this portion of the Hueco Bolson, are supportive of ASR techniques. The presence of the depressed water table allows storage space for injected water, as well as positive conditions for recovery (the aquifer has already proven to provide good yield, as is evident by the existence of the cone of depression). The study also found that hydraulic gradients, at the El Paso site, were low enough for migration to not be a major concern. As would be the case in Chaparral, the El Paso study considered water from the Rio Grande as being the source for the ASR; no issues of chemical incompatibility between the Rio Grande and Hueco Bolson waters were found (though pre-treatment may be necessary to discourage precipitate formation in injection wells). The report lists the El Paso site as being receptive to ASR techniques, providing a recovery efficiency of over 90% when injection wells are used and 75% with recharge basins.

There are, however, issues that challenge the likely success of ASR in the community of Chaparral. The main challenge is that, currently, only government entities are allowed to operate an ASR facility under New Mexico state law. Chaparral's unincorporated status makes it unlawful for an ASR operation to be pursued at this time. Also, ASR operations are regulated under the federal Safe Drinking Water Act which requires a permit to discharge water to the subsurface. The applicant must show that injecting water will not degrade the quality of the aquifer. This would, likely, require Chaparral to treat any water that would be injected for ASR purposes. If, however, treated water were imported to the community it would be most logical to directly use that water, not inject it for storage and future recovery.

These challenges make the option of ASR unviable in Chaparral at this time. It will, therefore, not be discussed further in this report. There is, however, one case under which ASR may become a more realistic option for the community. When the proposed wastewater treatment facility is built, there may be an opportunity to store and re-use the treated water through ASR. If the community wants to pursue ASR under this endeavor, the option could be revisited.

4.5.4 Desalination of High TDS Water

There are many technical concerns to be addressed before desalination can be determined to be a viable option for a water supply. There will be questions as to the amount, chemical composition, and location of the source water; the characteristics of the aquifer containing the water must support efficient, cost-effective recovery of these resources. Also, disposal of the brine byproduct is often the most challenging and expensive portion of these projects. In order to determine the likelihood of success for a local desalination effort in Chaparral a detailed feasibility study, evaluating these concerns, would need to be completed. To get a general idea of compatibility, however, we can consider local aquifer properties and reference regional desalination studies in order to draw correlations based on their findings.

As discussed, Chaparral is surrounded by numerous sources of brackish water. The Tularosa Basin fill deposits, in the immediate area of Chaparral, have been shown to have good water production properties; transmissivity values range from 60 to 47,000 ft^2/day (Livingston, 2002). The majority of well tests in the Hueco Bolson have been in the upper 1,000 feet of fill, making it difficult to know the exact properties of deeper formations. Because the majority of the brackish water is in the same fill formation, however, the properties of the overlying fill can be used as an approximation; these transmissivity values range from 1,300 to 37,000 ft^2/day (Meyer, 1976), indicating good productivity.

The chemical composition of groundwater in southwestern New Mexico has been shown to be treatable through desalination. Numerous chemicals found in the water play a role in the most effective treatment method and the cost of treatment (these include chloride, TDS, calcium, sulfate, and sodium). Based on pilot studies, reverse osmosis (RO) was found to be the preferred method of treatment at both the Alamogordo (Tularosa Basin) and El Paso (Hueco Bolson) facilities. TDS concentrations play the largest role in the cost of desalination; as salt levels increase so does the price to remove it. The Alamogordo plant has set a target TDS range of 1,500 to 4,000 mg/L for their source water, which they will reduce to a final TDS of 800 mg/L during treatment. El Paso's target final TDS concentration is less than 900 mg/L; it's source water TDS ranges from 600 to 1,500 mg/L (TDS concentrations are expected to increase, however, as pumping continues at the site and more brackish water migrates into the well field).

Brine byproduct can be disposed of in many methods, each of which has its complications and advantages. Wells can be utilized in order to inject the brine into subsurface formations; the brine can be evaporated through the use of ponds or mechanical means. Land applications, direct discharge to a water body, or passing the product through a wastewater treatment plant are additional options. The Alamogordo plant will primarily use evaporation ponds to dispose of their concentrate; they will also attempt to dispose of some of the concentrate through agricultural land applications. The JDF will use a combination of evaporation and injection. Brine concentrate created through wellhead desalination in the El Paso system is disposed of into the sewer system at each well location. Due to the small amount of brine created from a single well as compared to the wastewater flows of a major metroplex like El Paso, sewer disposal is possible. In a community of Chaparral's size, however, the brine amount would represent a much larger proportion of the community's wastewater flow and this option may not be feasible.

The proximity and likely shared water source (brackish water of the Hueco Bolson) of the JDF and possible Chaparral facility make the findings for the El Paso plant a reasonable prediction of the success of desalination efforts in Chaparral. It, therefore, seems reasonable to assume that local desalination efforts could be successful. Smaller desalination efforts have proven successful in numerous communities and it is anticipated that it could be so in Chaparral. Numerous options are available and should be assessed in the feasibility study.

Using a regional desalination facility may also be an option for Chaparral. The community could lease their Hueco Bolson brackish water rights to the EPWU, allowing them to be withdrawn at a down-gradient point in the aquifer, be treated and returned to the community via a pipeline. This would pose less of a challenge in both technical and infrastructural demands than developing a local system. The main concerns associated with this alternative would involve the infrastructure needed to convey the water, negotiations as to the ability of the existing plant to handle the additional flow (including possible plant expansion), and the political and legal implications of moving the water between New Mexico and Texas.

The JDF is designed to meet the combined needs of El Paso (20 MGD) and Fort Bliss (7.5 MGD) over the planning period. This plant was not designed to handle any additional capacity; treating water for Chaparral at the JDF is, therefore, not an option. If, however, the JDF proves to be a successful endeavor, it is anticipated that the city may pursue additional desalination projects; these projects may afford an opportunity for Chaparral to become a participant. If an opportunity were available, Chaparral and EPWU will have to overcome the jurisdictional implications of transporting water across state borders. If the facility were located on federal property (as the JDF is) state conflicts may be easier to overcome.

The most likely scenario under which Chaparral would pursue wellhead desalination would be in conjunction with the existing water distribution system. Under this scenario the current supply practices of the local water companies would continue. As TDS levels reach unsafe levels at individual wells, a small desalination unit would be placed at the wellhead and water would be diverted through it. The water would be treated to drinking water quality and returned to the distribution system. If the community were to drill new wells in the brackish water aquifer with the intent of augmenting its needed 5.2 MGD of water, one central desalination facility would be the most logical way to treat and distribute the water.

Wellhead desalination would have similar technical challenges to a local desalination effort; requiring a feasibility and pilot study in order to determine the most effective treatment method. With this option, the water is treated right at the point of withdrawal and placed directly into the existing distribution system. This reduces the amount of infrastructure needed (pipelines that would be necessary to convey water to and from a local desalination facility, for example). Also, because the land is already owned and existing wells would be used, the infrastructure and cost associated with drilling new wells or purchasing land to locate a treatment facility would be reduced. Brine disposal from these small desalination units could be difficult. Brine will probably be disposed of in evaporation ponds located adjacent to the wellhead desalination facility or piped to a central brine disposal facility.

4.6 Compatibility with Regional Sustainable Water Planning

The alternatives considered in this report were initially selected due to their anticipated ability to augment Chaparral's future water demands without threatening other water users in the region. The following on-going planning efforts were considered in order to assess the impact of each alternative:

- Tularosa Basin Regional Water Plan
- Lower Rio Grande Regional Water Plan
- Las Cruces-El Paso Regional Sustainable Water Project
- Doña Ana County Regional Water Plan
- Office of the State Engineer Regional Groundwater Requirements

4.6.1 Conservation

Each of the water plans considered indicate the importance of conservation in maintaining sustainable water supplies in the region; the OSE requires conservation to be a part of the permitting process. Water is currently being re-used in Alamogordo and other areas within the region; it has also been studied or proposed for other areas. Each of the conservation related scenarios proposed in this report are therefore, in full agreement with regional activities.

4.6.2 Purchasing Potable Water from Other Entities

Purchasing potable water from the Anthony WTP or other entities within the State of New Mexico is in compliance with regional water planning; this practice is incorporated as a part of the Las Cruces-El Paso Regional Sustainable Water Project. The LRG Regional Water Plan presents the treatment plants as a necessary alternative for the region and it is expected that these plants will be constructed during the 40-year planning period.

Importing water from entities outside of the state could be compatible with regional water planning (though it currently may not be). This option may have jurisdictional and legal challenges, but the geographic location of Chaparral lends to the option of importing water from Texas to be a technically and financially attractive solution. Through regional cooperation, this option may increase in compatibility.

4.6.3 Desalination of Brackish Water

Desalination practices are currently being pursued in both El Paso and Alamogordo. As long as the source of the brackish water originates in New Mexico, there is no anticipated threat to regional water sustainability from this option.

5.0 COSTS AND RATE IMPACTS

5.1 Costs

Order of magnitude costs to provide a comparative picture of each of the considered alternatives were estimated from the most recent and relevant available published resources. These resources contain cost estimates made within the past 5 years. All costs were adjusted to 2003 dollars for comparison. Overall owning and operating cost per acre-ft was calculated based on a 40 year amortization of capital costs at an annual interest rate of 5%.

Each of the options investigated includes additional costs for delivering the new source of water to Chaparral. With the exception of wellhead desalination at existing wells, all water supply options involve constructing transmission pipelines from the source to the point of use. The financial burden of pipeline construction could be shared with another party to reduce the impact on any one community. For instance, EPWU has considered water supply options that involve constructing a pipeline through the Anthony Gap. Combining efforts of El Paso and Chaparral to construct a pipeline through the gap can reduce the financial burden on each community. Also, efforts of several New Mexico water users can be combined in acquiring water from the Salt Basin

Numerous sources of brackish water have been discussed in this report. Utilizing brackish water in the Hueco Bolson would be the most cost effective source, because it would eliminate the need for an extensive transmission line. Due to this fact, all desalination cost estimates will be based on the assumption that the Hueco Bolson will be used as the source of brackish water.

5.1.1 Costs Associated with Conservation

Overall costs associated with developing and implementing conservation plans at the domestic, municipal, and industrial level are minimal; usually, conservation measures actually save the utility variable and future fixed costs. Conversely, once the volume of water sales is decreased, the unit price of the water may well need to be increased to meet existing fixed costs of the water company. Agricultural conservation measures, on the other hand, can be expensive; often times a large investment is required without equivalent benefits to the farmer. Often, major conservation measures do not make financial sense to the water user. In the absence of financial incentive it is unlikely that agricultural users will implement conservation techniques.

It has been determined that neither retirement of water rights nor water reuse is a viable option for the community at this time; however, these options may be considered in the future. It is expected that the financial implications of these options will be taken into account when they are reevaluated.

5.1.2 Costs Associated with Purchasing Potable Water from Other Entities

The 2000 Sustainable Water Project report on the Anthony WTP was used to obtain an approximate cost for purchasing water from this entity. Total capital cost (including plant construction, pipelines, contingencies, and engineering fees) adjusted to 2003 dollars is estimated at $41.1 million. The annual plant operation and maintenance (O&M) cost is estimated at $1.8 million.

These costs only include 4.6 miles of pipeline from NM-478 along O'Hara Road. Therefore, Chaparral will be responsible for funding the remaining pipeline through the Anthony Gap (an additional 5.2 miles is needed to extend the pipe to the western edge of the community). This additional capital cost of the Anthony Gap pipeline was estimated based on prevailing material and installation costs for similar pipelines. A conservative unit cost of $100 per linear foot was used for estimating. Pipeline costs through the Anthony Gap can be reduced if the project is constructed jointly with the planned Northeast Parkway project slated to be built by Texas and New Mexico DOT. Operation and maintenance of the pipeline was estimated at 5% of the overall capital cost over the pipe's 40 year design life.

In addition to the infrastructure costs, there would be costs associated with the purchase or lease of Rio Grande water rights. These costs are currently estimated based on a City of Las Cruces ordinance. The 2003 cost of water rights was set at $3,000 per acre (for a 3 acre-ft per acre per year allowance during a full release). There are also fees that would be paid to the EBID for the management of the water; these fees were $50 per acre during the year of 2003; in addition, each contract holder must pay the administrative fee of $10 per year. Table 13 summarizes the projected total capital, operating, and overall owning and operating costs in 2003 dollars. Costs for water are also included.

Table 13: Summary of Costs for Purchasing Potable Water from Anthony, NM Water and Sewer Sanitation District

Total Capital Cost of 16 MGD Plant (million)	Annual O&M for 16 MGD Design (million)	Annual Owning and Operating Cost (per acre-ft)	Annual Cost of Water (per acre-ft) [1]	Overall Cost (per acre-ft)
$44.1	$1.8	$260	$1,020	$1,280

(Boyle, 2000); (Cohen, 2005); (ADIP, 2005); (EBID, 2004)
[1] Based on a full allocation of 3 acre-ft of water per acre of water right

The EPWU – Public Service Board's website was referenced for general information on water costs associated with importing water from El Paso. The EPWU does not offer wholesale rates for water sales to large users. All users, small and large, are charged the same unit price per hundred cubic feet; fixed monthly charges are based on meter size (a meter size of 8 inches was assumed for this analysis). The cost estimation was based on the assumption that Chaparral would be treated equally to any other large water user within the EPWU system. If 100% of the 2003 water demand were to be purchased by Chaparral it would have cost the community $2.2 million ($964/acre-ft). Additional costs would be incurred for the infrastructure needed to connect the Chaparral water distribution system to that of El Paso; this would include a pipeline of approximately 3 miles and the necessary meters, valves, and other appurtenances. Capital and O&M costs for this 3 mile transmission pipeline were calculated using the same procedure as the 5.2 mile pipeline through the Anthony Gap discussed above. Table 14 summarizes the costs for this option.

Table 14: Summary of Costs for Purchasing Potable Water from EPWU

Capital Cost of Transmission Pipeline (million)	Annual O&M Cost of Transmission Pipeline	Annual Pipeline Owning and Operating Cost (per acre-ft)	Annual Cost of Water from EPWU (per acre-ft)	Overall Cost (per acre-ft)
$1.5	$1,900	$20	$960	$980

(EPWU, 2004); (Cohen, 2005); (ADIP, 2005)

5.1.3 Costs Associated with Desalination of Brackish Water

Cost estimates for the Alamogordo desalination facility provide an order of magnitude picture associated with a small RO treatment plant relying on evaporation ponds for brine disposal (brine disposal practices can have a significant impact on cost and should be taken into consideration). The plant is designed to begin production at 3.6 MGD and phase up to an eventual production of 7.4 MGD. The report presents costs for each of these phase-in periods. In order to estimate the costs for Chaparral to build a 5.2 MGD desalination plant, Alamogordo plant costs for the 4.7 and 5.9 MGD phase-in periods were interpolated.

The Alamogordo facility is designed at a site that is 26 miles north of the city. Because of this, the capital costs for transmission piping, pumping, and storage account for about 40% of the overall capital cost of the project. It is unlikely that Chaparral's plant would be such a large distance outside of the community. The Hueco Bolson freshwater aquifer depth reduces to zero near the eastern edge of the community. At this point, the brackish water aquifer is easily accessible. It is, therefore, assumed that Chaparral's local facility would be located no more than 10 miles from the community edge. In order to adjust the reported costs of the Alamogordo facility to more closely resemble the likely scenario in Chaparral, therefore, capital costs for piping, pumping and storage were reduced by 60%. Table 15 summarizes the anticipated costs for a local desalination facility, utilizing evaporation basins, in Chaparral. At this time, there is no cost associated with acquiring groundwater rights in the Hueco Bolson.

Table 15: Summary of Costs for Local Desalination

Total Capital Cost of 5.2 MGD Facility (million)	Annual O&M Costs of 5.2 MGD Facility (million)	Overall Cost (per acre-ft)
$30.0	$1.1	$500

(Livingston, 2003)

A 2003 New Mexico State University thesis, prepared by R. Foldager, outlines cost estimates for reverse osmosis desalination plants throughout the country; these estimates (adjusted to reflect a 40 year amortization and 5% interest rate) are in general agreement with those of the Alamogordo plant. The report gives an average overall cost of $445–585 per acre-ft for plants ranging in size from 1.0 to 10.0 MGD using evaporation basins for brine disposal. Plants that use injection wells range in price from $570–1740 per acre-ft (brine disposal practices make a significant difference in costs).

If Chaparral were to utilize an existing facility for desalination and then transport the treated water to the community, treatment related capital costs could be reduced. However, Chaparral would still be responsible for the cost of treating their water (including a portion of the capital and O&M costs of the treatment facilities) and the cost of delivering the water to the community from the treatment point. Utilizing a larger plant may reduce the annual owning and operating cost of the treatment facility.

To provide an order of magnitude picture of costs associated with using a regional plant a scenario whereby water is treated at a facility similar to the JDF facility was considered. Table 16 outlines the costs at the El Paso JDF. These cost estimates are based on a conversation with personnel at CDM (the engineering firm that designed the JDF) in late 2004. Costs were quoted on a per acre-foot basis. The overall cost of the plant, transmission, wells, brine disposal, and O&M is estimated to be $467 per acre-ft of final product. Similar to importing potable water from EPWU, a 3 mile transmission pipeline would be necessary for this option. Capital and O&M costs were calculated as outlined above.

Table 16: Cost Estimates for Regional Desalination

Capital Cost of Transmission Pipeline (million)	Annual O&M Cost of Transmission Pipeline (million)	Annual Owning and Operating Cost of Transmission Pipeline (per acre-ft)	Cost for Utilizing Regional Facility (per acre-ft)	Overall Cost (per acre-ft)
1.5	$1.9	$20	$470	$490

(CDM, 2004); (Cohen, 2005); (ADIP, 2005)

In order to obtain a general cost estimate for wellhead desalination, a project in the Lower Valley of El Paso was referenced. The Lower Valley Wellhead Desalination Program involves 11 wells producing 8 MGD of treated water. The capital costs for this project were $8.7 million, which includes the reverse osmosis treatment equipment and site improvements (the project is located on land that was previously owned by the EPWU and used existing wells). Annual O&M costs are estimated at $1.8 million. The El Paso wellhead project discharges its brine into the sewer system and it is treated at the wastewater treatment facility. This does not appear to be an option in Chaparral. Therefore, the cost for brine disposal in evaporative ponds was calculated based on those reported in the Alamogordo desalination facility report and added to the owning and operating costs for this option.

The wellhead desalination option would be an add-in to current water system operations. The brackish water would be withdrawn (as the freshwater is now), fed through the reverse osmosis treatment, and released into the existing distribution system. The costs of operating the current water distribution system, therefore, must be added onto the cost for wellhead treatment in order to estimate the total overall cost of operating a wellhead desalination operation. Table 17 outlines the costs associated with both the wellhead treatment and cost for current water system operations.

Table 17: Cost Estimates for Wellhead Desalination

Owning and Operating Cost for Desalination (per acre-ft)	Cost for Current Operations (per acre-ft)	Overall Cost (per acre-ft)
$840	$210	$1,050

(EPWU, 2004)

5.2 Rates

The annual owning and operating cost estimates above, combined with water company data for the year 2003, allow an analysis of the estimated rate impacts of each option. Rates are provided for comparison only; they are intended as a rough estimate of the expected range of rates customers may be expected to pay if certain water augmentation option was implemented.

5.2.1 Current Practices

As was outlined earlier in this report, Chaparral is currently served by three privately owned water companies. The New Mexico Public Regulation Commission (PRC) requires all utility providers to file annual reports outlining their costs, sales, and revenues for the year. The 2003 PRC Annual Reports were obtained for each of the three water companies.

In order to estimate average costs per unit, sales, and revenues for the water companies of Chaparral, a weighted average of each value was calculated. Table 18 summarizes the general information obtained from the 2003 Annual Reports. Under the current operating structure the average annual customer bill is approximately $340.

Table 18: Summary of Water Company Sales Information for 2003

Company	# of Customers	Gross Water Sales (Thousand Gallons)	Gross Revenues	Average Yearly Bill per Customer
Lake Section	2,816	497,900	$938,700	$333
CBG	368	57,400	$138,900	$378
Desertaire	23	7.20	$7,200	$313
Weighted Average				*$340*

5.2.2 Transmission, Distribution, and Operation Expenses

Each of the augmentation alternatives will incur similar costs to those currently experienced for company overhead, operations and maintenance of the transmission and distribution system. In order to estimate these costs the 2003 PRC Annual Report for Lake Section Water Company was used. The Lake Section report was the only report that had sufficient detail to do this analysis.

Costs associated with the maintenance of the distribution system and meters, as well as those for salaries, overhead, taxes, depreciation, and amortization were summed to generate an estimated cost to operate a water company in Chaparral. These costs will continue to accrue in the future irrespective of the augmentation alternative selected. Analysis of these recurring costs results in annual cost of $435 per acre-ft or $240 per customer. This figure was added to the rate analysis of each alternative for consistency.

5.2.3 Rate Impacts of Alternatives

The estimated rates, shown in Table 19, are based on the estimated per acre costs reported in Section 5.1 and are considered a general guide to the price impacts that can be expected with each option. Cost per customer figures are based on the cost per acre-ft and the average annual use per customer, as reported in the 2003 PRC Annual Reports. According the 2003 PRC Annual Reports, the average profit for the water companies was 4.8% of total revenue. In order to compare the estimated and current rates, this profit margin was included in the analysis.

Table 19: Estimated Annual Rate Impacts of Each Alternative

	Overall Cost (per acre-ft) [1]	Cost to Implement (per acre-ft) [2]	Yearly Rate (per customer) [3]
Conservation	Minimal	Minimal	----
Current Practices	----	----	$340
Local Desalination Facility	$500	$980	$530
Wellhead Desalination	$1,050	$1,560	$840
Utilizing Regional Desalination Facility	$490	$960	$520
Importing Potable Water from El Paso, TX	$980	$1,480	$800
Importing Potable Water from Anthony, NM	$1,280	$1,800	$970

[1] As outlined in Section 5.1
[2] Includes the O&M cost of a water company in Chaparral ($435/acre-ft) and a 4.8% profit
[3] Based on an average use of 0.54 acre-ft/customer/year

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Feasibility and Ranking of Alternatives

Table 20 contains a weighted feasibility matrix for each of the proposed alternatives. The alternatives are ranked based on the total weighted score. Each category (technical, cost, social, etc.) was given a weight in order of importance ranging from 1 to 3. The cost category, for example, is given an importance ranking of 3, whereas the social category is ranked at 1. This does not imply that social acceptance is unimportant, it simply makes social acceptance (which is also invariably dependent on the cost) carrying less weight in decision making relative to cost. Each option was assigned a score (ranging from 1 to 5) on the desirability of the option within each category. The total score is calculated by multiplying the category score by the category weight and adding the products. Ranking of options is based on total weighted score. The primary purpose of this matrix is to provide a basis for objective decision making. Alternatives were considered without regard to financial incentives (grants, loans, etc.) that may be available for a certain technology; availability of such funding may alter the rankings.

Table 20: Feasibility Matrix
(1 = Not Desirable; 5 = Highly Desirable)

	Technical (3)	Cost (3)	Social (1)	Jurisdictional /Legal (2)	Total Score	Rank
Conservation	5	5	3	5	43	1
Import Potable Water (El Paso, TX)	4	2	3	1	23	5
Import Potable Water (Anthony , NM)	3	1	3	3	21	6
Local Desalination Facility	4	4	4	4	36	2
Utilizing Regional Desalination Facility	4	4	3	1	29	4
Wellhead Desalination	4	2	5	5	33	3

6.2 CONCLUSIONS

The following conclusions can be drawn from the analysis of water supply needs and options for the community of Chaparral:

1. Chaparral is anticipated to grow as a bedroom community for El Paso and its population over the planning period will near 50,000.
2. Currently Chaparral is served by private water companies. This privately owned and operated system should not restrict planning for the future water supplies and seeking alternative sources of water supply.

3. The current practice of pumping freshwater from the Hueco Bolson appears to be adequate for the first approximately 10 years of this study period. It is projected, however, that by 2012 freshwater depletion and intrusion of brackish water will limit Chaparral's ability to continue pumping freshwater from the bolson indefinitely. If alternative sources of freshwater are not sought, Chaparral's ability to grow will be seriously hampered.
4. Chaparral is located in an area where abundant brackish water is available for use. Water rights for this brackish water are currently available. Technology to treat and use this brackish water as a domestic water supply is now readily available and being used in the region. This technology is now becoming economically feasible.
5. Obtaining treated potable water from the proposed Anthony Water Treatment Plant, treating Rio Grande water, is a jurisdictionally feasible alternative for augmenting Chaparral's future water supply.
6. The location of Chaparral with respect to EPWU service area is unique. Therefore, supply from EPWU on a joint venture or cooperative basis is a viable alternative to provided jurisdictional issues can be resolved.
7. Transporting either treated or raw Rio Grande water for ASR does not offer promise as a feasible alternative to improve fresh groundwater storage for Chaparral.
8. Limited agricultural use in the Chaparral area provides few opportunities to conserve agricultural use and divert this water for domestic use.
9. Seeking brackish water rights in the Hueco Bolson, extracting this water from the shallow lenses of the aquifer east of the community appear to be an attractive alternative. Locating a local desalination facility that is phased to meet the growing demands is economically the most attractive alternative.
10. Wellhead desalination is not an option for augmenting Chaparral's water supply. The practice of wellhead desalination will encourage over-pumping in the Hueco Bolson freshwater aquifer, causing water level drawdowns and brackish water intrusions.
11. Any additions to Chaparral's water supply system will be costly and customer rates will increase substantially. The community should pursue all possible sources of grants and funding for community development and improvement.

6.3 RECOMMENDATIONS

The following recommendations are offered for consideration:

1. Chaparral must start actively seeking alternative sources of water to meet its projected demands, simple conservation measures will be inadequate over the 40-year planning period.
2. Chaparral must begin the process of seeking brackish water rights in the Hueco Bolson while this basin is open and rights readily available.
3. Desalination of brackish water in a centralized local facility has been demonstrated to be the most desirable option based on preliminary analysis presented in this study. A more detailed study of this alternative should be undertaken to further validate its feasibility.

4. Joint venture and cooperative ventures with EPWU should be actively pursued both as a short and long term solution to Chaparral's water supply needs. In this regard, efforts should be undertaken to promote such cooperative ventures and resolve legal and jurisdictional issues that seem to hinder some options.
5. Regular periodic monitoring of TDS levels in all existing public water supply wells in Chaparral should be undertaken. This data base will help in identifying potential salt water intrusion into the freshwater of Hueco Bolson.
6. Metering of water at existing wells should be considered, since this will aid in water conservation and better predictability of pumping data in the Chaparral area.
7. A local groundwater modeling effort should be undertaken to quantify the effects of Chaparral's withdrawals from the Hueco Bolson aquifer.
8. A community wastewater system should be a priority for Chaparral. Once the public system is in place, beneficial re-use of treated water should be considered to enhance recharge and improve storage.

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