REGIONAL WATER SUPPLY PLAN

CITY OF PLAINVIEW

IN CONJUNCTION WITH THE

TEXAS WATER DEVELOPMENT BOARD

1994

FREESE • NICHOLS

CITY OF PLAINVIEW

REGIONAL WATER SUPPLY PLAN

PARTIALLY FUNDED BY A GRANT FROM THE

TEXAS WATER DEVELOPMENT BOARD

FREESE AND NICHOLS, INC.

MAY 1994

STATE OF TEXAS
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EXECUTIVE SUMMARY

This report describes a regional water supply study conducted for the City of Plainview by Freese and Nichols, Inc. The study covers parts of northern Hale and southern Swisher Counties. The Texas Water Development Board provided partial funding for the study through a regional planning grant.

The estimated 1990 population of the study area was 24,643, of whom 21,700 lived in the City of Plainview. Area water suppliers include Plainview, the Town of Kress, Seth Ward Water Supply Corporation, Pleasant Hills Water Company, and Ebeling Water Supply Corporation. There are also about 600 people on private water supplies in the study area. The population is projected to increase by 50 percent, to 36,876, by the year 2040.

The 1990 municipal water use for the study area was about 1,565 million gallons (4.3 MGD), of which about 95 percent was supplied by Plainview. The projected year 2040 normal year water use is 2,021 million gallons (5.5 MGD), and the projected 2040 drought year water use is 2,325 million gallons. By the year 2040, it is assumed that Plainview will provide all of the study area municipal water use as a regional supplier.

The Ogallala Aquifer is the source of most of the municipal water used in the study area. It provides about 60 percent of the water used by Plainview and all the water used by the other area suppliers (with the exception of Seth Ward Water Supply Corporation, which buys water from Plainview). In the last 24 years, Ogallala water levels have dropped an average of 67 feet in the study area outside Plainview and an average of 42 feet inside the City. (The aquifer water levels are dropping faster outside the City because groundwater is used more intensively, especially for irrigated agriculture.) The estimated amount of recoverable groundwater inside the Plainview city limits is about 44,000 million gallons. At current rates of groundwater use, this supply would last Plainview 40 to 50 years.

The City of Plainview also uses water from the Canadian River Municipal Water Authority (CRMWA), delivered by pipeline from Lake Meredith to Plainview's 4.2 MGD water treatment plant. The City's annual allotment of CRMWA water has varied from 867 million gallons (2.4 MGD) to 1,115 million gallons (3.1 MGD) and is usually 990 million gallons (2.7 MGD) or more. Because of the need to blend CRMWA water with groundwater to maintain acceptable levels of dissolved solids, the City has never used its full allocation of CRMWA water. In the last 10 years, Plainview has used an average of only 60 percent of its CRMWA allocations, with an additional 13 percent sold to others as raw water and 27 percent left unused. At this time, any water not supplied from

CRMWA is pumped from the essentially non-renewable groundwater reserves in the City, thus depleting those reserves.

The CRMWA is considering the development of a groundwater supply to supplement its Lake Meredith water and improve water quality. This project would increase the amount of water available to Plainview and other member cities, reduce the levels of dissolved solids in the water, and increase the unit cost of CRMWA supplies.

The regional water supply study by Freese and Nichols included investigations of regional water transmission facilities, Plainview's water treatment plant, and the feasibility of using reclaimed wastewater from Plainview's wastewater treatment plant. These investigations led to the following conclusions:

- A 10-inch pipeline and associated facilities needed to supply the Town of Kress with potable water from Plainview would cost about $1.4 million at 1993 prices.

- A 6-inch pipeline from Plainview to supply Ebeling Water Supply Corporation and Pleasant Hills Water Company would cost about $540,000 at 1993 prices.

- The City of Plainview's solids contact type water treatment plant has a rated capacity of 4.2 MGD. The plant meets the current Texas Surface Water Treatment Rule requirements for disinfection at its rated flow rate.

- The water treatment plant is currently operating at a maximum rate of about 2 MGD, and it can meet current turbidity requirements at that rate of flow. At higher flow rates, treated water turbidities may exceed allowable levels.

- The City of Plainview should undertake improvements to the plant to allow operation at higher rates than 2 MGD. Initial improvements include wind covers for the clarifiers, diverting the settled portion of the backwash water to the sludge drying beds, and checking and reconditioning the valves and piping used for parallel operation of the clarifiers. If these improvements do not allow operation at the plant's full rated capacity of 4.2 MGD, the City should investigate using dual media in the filters and/or expanding the filters.

- A major wastewater reuse program for Plainview would not be cost effective, but a limited program to supply water for tree irrigation at the City landfill merits further analysis. (The City is considering planting trees around the perimeter of its landfill to serve as a windbreak and a visual screen. These trees could be irrigated by reclaimed wastewater.)

The recommended approach to long-term water supply for the study area depends on whether the CRMWA develops a groundwater supply to supplement surface water from Lake Meredith. Freese and Nichols worked with City of Plainview staff to select the most promising water supply alternatives for detailed analysis and developed recommended plans with and without the additional CRMWA supply. It is clear that any water supply plan which provides water through 2040 and leaves Plainview with in-city groundwater reserves as of 2040 will increase the City's short term water supply costs.

If CRMWA does not develop additional water supplies to supplement Lake Meredith, the best alternative for Plainview would be to develop a new groundwater well field covering approximately 10 square miles outside of the City. Beginning in 2001, this groundwater field would supply about 40 percent of the City's water needs, with another 40 percent from CRMWA water and 20 percent from in-city groundwater. This plan would significantly increase water supply costs over the current approach, but it would give Plainview a viable water supply to 2040 and beyond.

If CRMWA does develop additional water supplies to supplement Lake Meredith, the best alternative for Plainview would be to take advantage of the improved quality of the CRMWA water and increase its use of CRMWA supplies. In this scenario, Plainview would raise its use of CRMWA water to about 70 percent of its needs beginning in 2001, with the remaining 30 percent coming from in-city groundwater. This approach would also significantly increase Plainview's short-term water supply costs but would give the City a viable long-term water supply plan.

Either of the recommended plans would provide a viable water supply for Plainview. Based on the information developed for this study, there is no clear indication that Plainview should favor or oppose the new CRMWA supply. However, it is in Plainview's interest that CRMWA make a decision on the new supply soon. If CRMWA decides not to pursue a new supply, Plainview should move quickly to purchase the water rights required for a new groundwater well field and discontinue irrigated agriculture in the area where the well field will be developed. Undue delay in acquiring the water rights would lead to continued depletion of groundwater supplies by irrigated agriculture.

Although it is important to move quickly to acquire the needed groundwater rights, the construction of facilities and the use of the new groundwater field is less urgent. However, Plainview should not delay beyond 2010 before beginning to use the new groundwater field. This is important so that Plainview can preserve in-city groundwater as the most economical way to meet its future peak demands.

Freese and Nichols has the following additional recommendations for Plainview:

- In order to preserve in-city groundwater reserves for future peaking needs, Plainview should use as much CRMWA water as possible for base supply, thus decreasing the use of in-city groundwater. In order to maximize its use of CRMWA water, the City should:

  - make improvements at its water treatment plant as soon as possible to increase the maximum treatment rate above 2 MGD
  - operate the treatment plant at higher rates whenever high demand makes this possible
  - monitor the blending of groundwater and surface water carefully, using as much surface water as is consistent with maintaining acceptable water quality.

- The City of Plainview is the logical regional water supplier for the study area. The City provided about 95 percent of the 1990 water use and is the only study area water supplier with access to CRMWA water supplies.

- Plainview's current practice of using groundwater for about 60 percent of its water needs and treated CRMWA water for the remaining 40 percent will not provide a sustainable long-term water supply for the City. Based on projected water needs and estimated supplies, Plainview would exhaust in-city groundwater reserves by about 2035 with this approach. Since groundwater outside the City is currently being depleted even more rapidly than the in-city reserves, Plainview probably would face significant problems in seeking new supplies once the in-city reserves are gone.

CITY OF PLAINVIEW

REGIONAL WATER SUPPLY PLAN

MAY 1994

1. INTRODUCTION

In October of 1991, the City of Plainview authorized Freese and Nichols, Inc., to develop a regional water supply study for the 50-year period through the year 2040. Detailed analysis began in April of 1992, after Plainview obtained a regional planning grant from the Texas Water Development Board partially funding the study. The purpose of the study is to investigate regional water requirements, assess surface and groundwater resources, and develop a long-term water supply plan.

Figure 1.1 is a map of the study area, which includes part of northern Hale County and southern Swisher County in the Texas Panhandle. Water suppliers in the study area include the City of Plainview, the Town of Kress, Seth Ward Water Supply Corporation, Westridge Water Company (now taken over by Plainview), Ebeling Water Supply Corporation, and Pleasant Hills Water Company.

The scope of work for this study included the following major elements:

- Task A - Water Supply Study
  - projections of population and water use
  - analysis of ways to increase the use of surface water
  - investigation of the feasibility and cost of constructing a pipeline to deliver

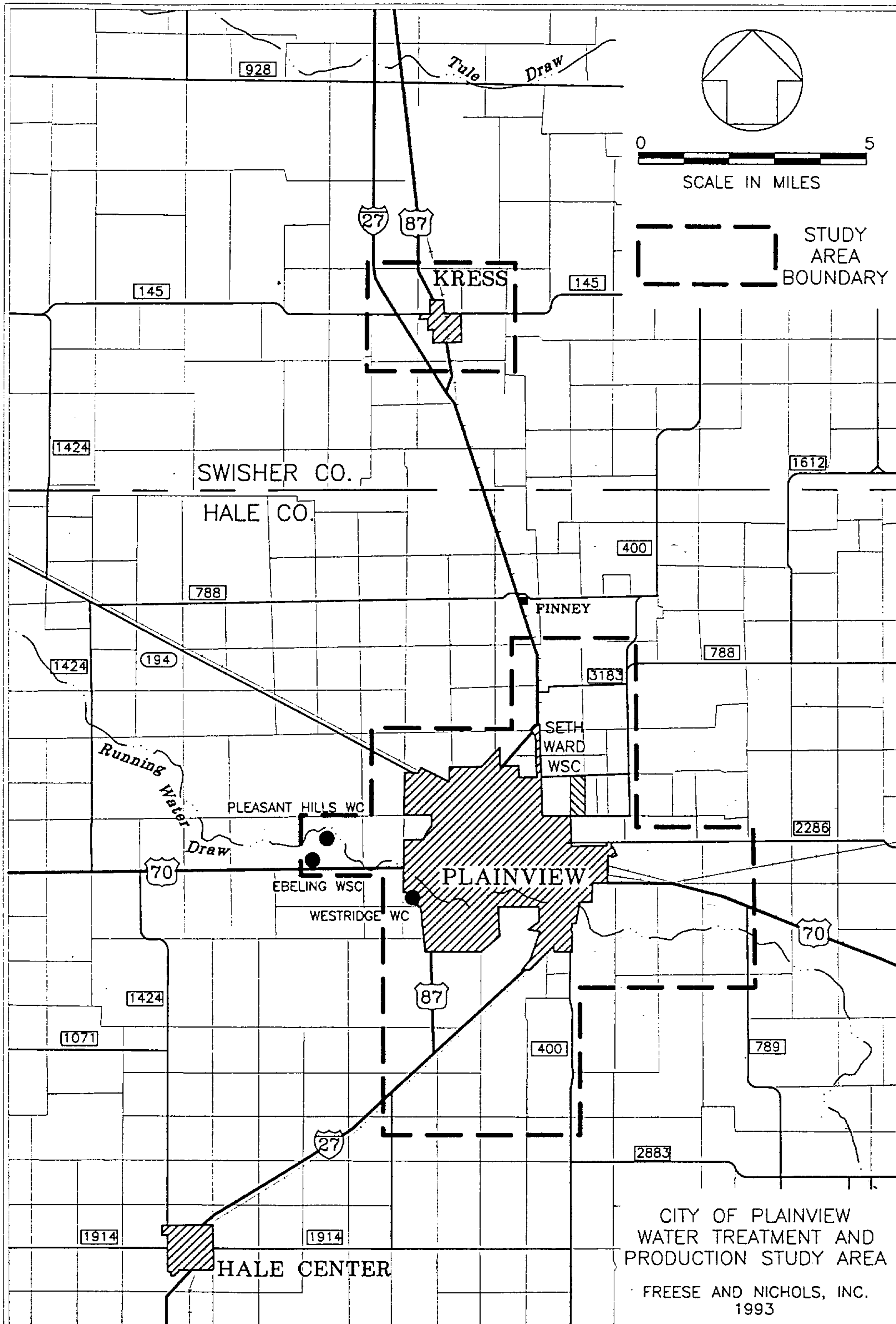
928
Tule Draw
SCALE IN MILES
0
5
STUDY AREA BOUNDARY
27
87
KRESS
145
145
1424
SWISHER CO.
HALE CO.
1612
400
788
PINNEY
788
1424
194
3183
SETH WARD WSC
Running Water Draw
PLEASANT HILLS WC
2286
70
EBELING WSC
PLAINVIEW
WESTRIDGE WC
70
87
1424
1071
400
789
27
2883
1914
1914
HALE CENTER
CITY OF PLAINVIEW
WATER TREATMENT AND
PRODUCTION STUDY AREA
FREESE AND NICHOLS, INC.
1993
FREESE AND NICHOLS, INC.

FIGURE 1.1

potable water from Plainview's water treatment plant to Kress

- analysis of groundwater availability in the region

- development and analysis of potential water supply plans

- creation of a development plan and schedule for the preferred alternative for additional water supply

- Task B - Water Conservation Plan

  - preparation of a water conservation and drought contingency plan for the planning area in accordance with Texas Water Development Board regulations

- Task C - Wastewater Reuse Feasibility Study

  - inventory of potential areas where reclaimed water may be appropriately substituted for fresh water

  - inventory of potential uses of reclaimed water

  - market analysis for reclaimed water

  - preliminary cost-benefit analysis for the treatment and use of reclaimed water

- Task D - Water Treatment and Production Study

  - disinfection evaluation for Plainview's water treatment plant

  - filter performance and turbidity evaluation of Plainview's water treatment plant

  - distribution system analysis to investigate ways of delivering more water from Plainview's water treatment plant

- Task E - Coordination Meetings, Management, and Quality Reviews

- Task F - Preparation of Draft and Final Reports

This report describes the methodology, findings, and results of the Plainview regional water supply study. Section 2 presents the population and water use projections for the study area. Section 3 gives an analysis of the existing water supply sources in the vicinity of Plainview, including surface water and groundwater supplies. (The groundwater analysis is a summary of work by William F. Guyton Associates, which served as a subconsultant to Freese and Nichols (1). Their report is included as Appendix B.) Section 4 covers the water transmission facilities needed for regional supply, concentrating on a pipeline from Plainview to Kress. Section 5 describes the analyses of the performance of the City's water treatment plant. Section 6 presents the results of the wastewater reuse feasibility study. Section 7 describes the screening of additional water supply alternatives for the study area, and Section 8 presents a detailed life cycle cost analysis of the most promising alternatives. Section 9 gives a long-range development plan and schedule for the recommended alternative for additional water supply. Section 10 includes the conclusions and recommendations of this study.

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(1) Numbers in parentheses match references listed in Appendix A.

2. POPULATION AND MUNICIPAL WATER USE PROJECTIONS

Population and municipal water use projections were developed for the study area, which is shown in Figure 1.1. Currently active municipal water suppliers in this area include the City of Plainview, the Town of Kress, Seth Ward Water Supply Corporation, Ebeling Water Supply Corporation, and the Pleasant Hills Water Company. Westridge Water Company also supplied water in the area until Plainview annexed its service area in 1992.

Projected Population

Prior to 1980, most of the cities in Hale and Swisher Counties had a history of generally steady population growth. From 1980 through 1990, the area experienced a high out-migration rate, which resulted in decreased population in the 1990 Census. Table 2.1 shows available historical population data for the City of Plainview, the Town of Kress, and other parts of the study area. Seth Ward's population was not determined by the Census prior to 1990. The population for the remaining area is based on Texas Water Development Board (TWDB) municipal survey records for Westridge Water Company (annexed by Plainview in 1992), Ebeling Water Supply Corporation, and Pleasant Hills Water Company and on estimates for the area not served by those suppliers. Figure 2.1 shows population data for Plainview from 1910 through 1990.

Estimating future population requires consideration of several components, including fertility rates, mortality rates and migration rates. According to the Texas State Data

Table 2.1

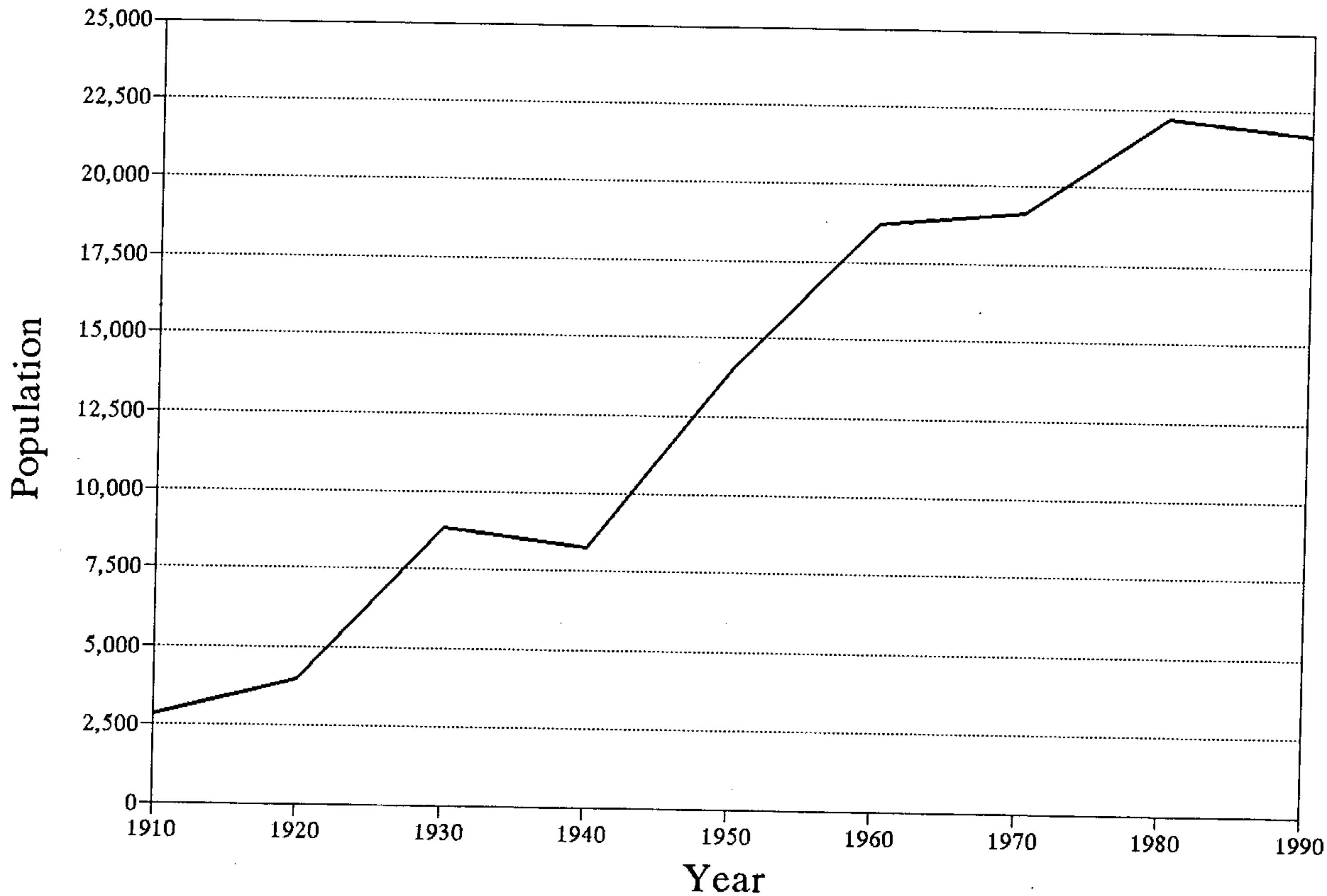
Historical Population Data for the Study Area

Year	Plainview	Kress	Seth Ward	Remaining Area	Total
1910	2,829				
1920	3,989				
1930	8,834				
1940	8,263				
1950	14,044				
1960	18,735	438			
1970	19,096	578			
1980	22,187	783			
1990	21,700	739	1,402	802	24,643

Center (2), migration is the most difficult of these components to project. For this study, Freese and Nichols compared population projections for the study area derived from several sources:

- Texas Water Development Board (TWDB) projections dated October 1989 (3).
- Texas Water Development Board (Draft) projections dated April 1992 (4).
- South Plains Association of Governments projections, by county (5).
- Texas State Data Center (TSDC) of Texas Agricultural Experiment Station at Texas A & M University projections, by county (2).
- City of Plainview Comprehensive Plan (6).
- City of Kress Comprehensive Water Supply Plan (7).

Figure 2.1
City of Plainview Historical Population



The TWDB's draft April 1992 population projections for Hale and Swisher Counties reflect the decrease in the counties' populations between 1980 and 1990. The TWDB projections are based on the assumption that future out-migration from the counties will equal that of the 1980s, which causes very slow population growth for the next few decades. Figure 2.2 shows TWDB population projections for the City of Plainview, based on the 1989 low and high series projections and the 1992 draft low and high series projections. The figure also shows the population projection from the City's Comprehensive Plan (6). The South Plains Association of Governments is currently using the TWDB 1991 high series population projections, which have been replaced by the TWDB draft projections dated April 1992.

The Texas State Data Center projected the future population for Hale and Swisher Counties based on three different scenarios:

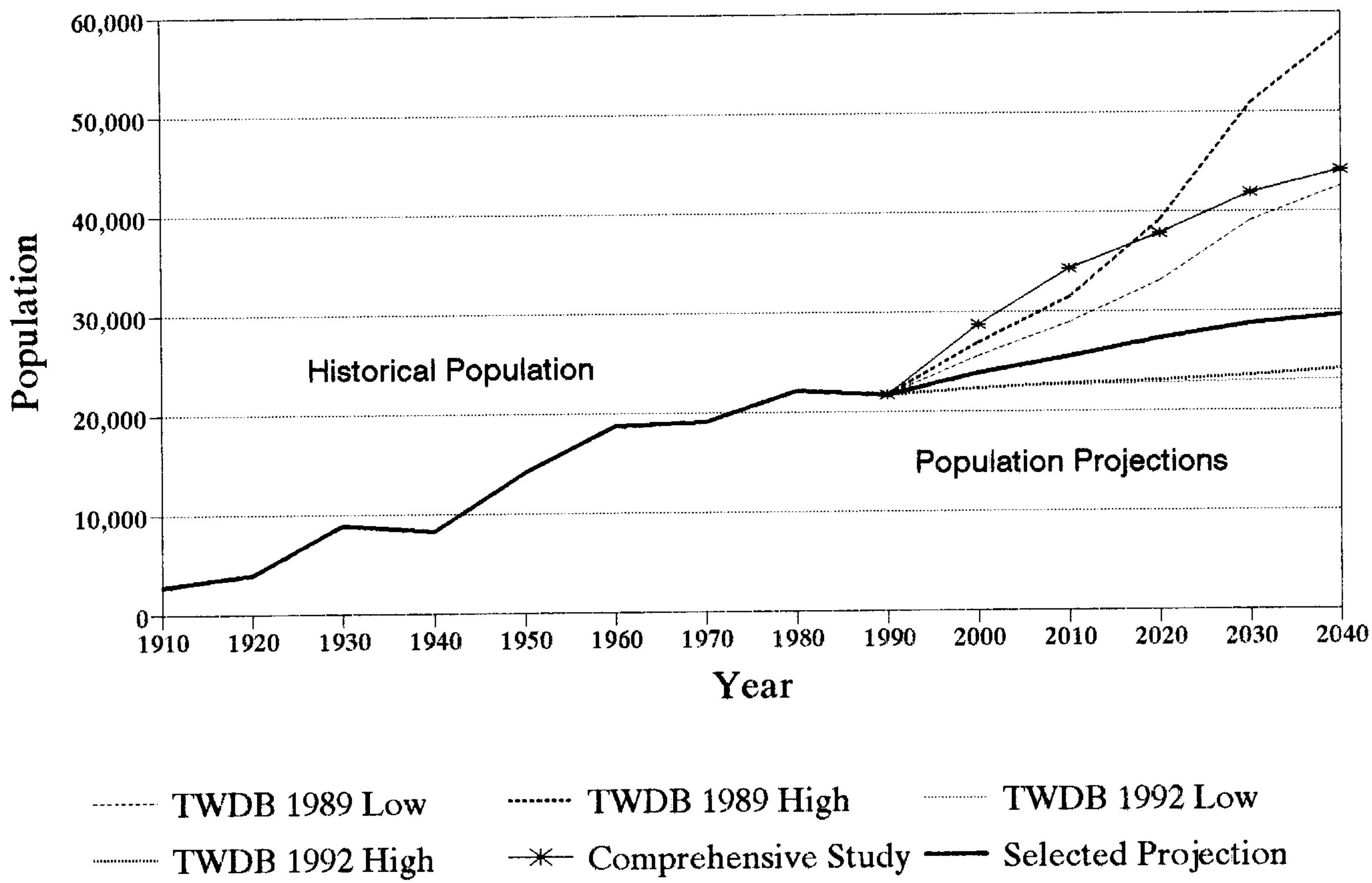
- Scenario (0.0) assumes that in-migration and out-migration are equal (i.e. net migration is zero), which gives the highest population projection for the counties.

- Scenario (1.0) assumes that future net migration rates will be the same as those of the 1980s. This assumption, influenced by the out-migration during the 1980-90 decade, produces the lowest population projection for Hale and Swisher Counties. The resulting projections are very close to the TWDB's draft 1992 high series population projections.

- Scenario (0.5) is an approximate average of the (0.0) and (1.0) scenarios, assuming rates of net out-migration one-half of those in the 1980s. The Texas State Data Center describes this as "the most likely scenario of population growth for most counties, at least for the immediate future."

Since preparation of the TWDB and TSDC projections, there have been two significant developments which might affect future population growth in the study area.

Figure 2.2
Plainview Population Projections



First, Plainview has recently annexed the Westridge subdivision, which was supplied by the Westridge Water Company. In this study, the Westridge area population is included in Plainview's projections for 2000 through 2040. In addition, the City of Plainview has been selected for a 500-bed substance abuse felony punishment unit. The prison will employ 170 people and house up to 500 inmates initially, and its average daily water demand is expected to be 75,800 gallons. The facility will be located about 3 miles east of town, south of U.S. Highway 70. Although its location is outside of Plainview's city limits, the prison will be supplied with potable water from the City. This facility is expected to be expanded eventually to a 2,250-bed unit. For this study, the prison is assumed to be a 500-unit facility with 170 employees as of the year 2000. The capacity and employment are assumed to increase linearly to 2,250 beds and 500 employees in the year 2040. Prison occupancy is assumed to be 80 percent of capacity.

Some of the employees for the prison will be hired locally, and some will move to the study area. The new employment will also have a secondary impact on the local population by its stimulus to the economy. The estimated effect of the prison on the local population is based on the following assumptions:

- The population of the region will increase by 50 percent of the number of prison employees and dependents.
- There will be an average of 2 dependents per employee.
- The assumed distribution of the increased population of employees and dependents is 50 percent in Plainview, 25 percent in Seth Ward, 10 percent in the other service areas, and 15 percent outside of the study area.

- The population will increase by the number of inmates, which is assumed to be 80 percent of the capacity.

The population projection for the City of Plainview in this study uses the TWDB 1992 high series population projection as a base line. An acceleration factor is applied to the growth line, using a ratio of the TSDC (0.0) scenario to the TWDB 1992 high series projection for Hale County. The impacts of the Westridge area annexation and the new prison are then added to the accelerated growth rate to obtain the adopted population projection shown in Table 2.2 and Figure 2.2.

Using the TSDC (0.0) scenario is equivalent to assuming no net out-migration from Plainview. This assumption reflects Plainview's success in attracting new jobs in the recent past. Plainview now serves as a regional employment center, attracting workers from as far as Lubbock. One reason that Plainview has not experienced population growth with these new jobs is the shortage of affordable housing (8). Steps are now being taken to make Farmers Home Administration rural housing loans available in Plainview, which should provide the needed stimulus to improving housing opportunities and increase the in-city population.

The population projection for the Town of Kress uses the TWDB 1992 high series population projection trend for Swisher County (other) as a base line. This trend has been accelerated using a ratio of the TSDC (0.5) scenario to the TWDB 1992 high series population projection for Swisher County. This accelerated trend is then used to project Kress' population, using the 1990 Census as a starting base.

Table 2.2

Population Projections in the Study Area

Year	Plainview	Kress	Seth Ward	Prison Inmates	Remaining Area	Total
1990	21,700	739	1,402	0	802	24,643
2000	23,762	776	1,833	400	922	27,693
2010	25,406	797	2,182	750	1,095	30,230
2020	27,218	830	2,513	1,100	1,259	32,920
2030	28,711	845	2,881	1,450	1,443	35,330
2040	29,410	845	3,213	1,800	1,608	36,876

Note: The population projection for Plainview (2000-2040) includes the Westridge area.

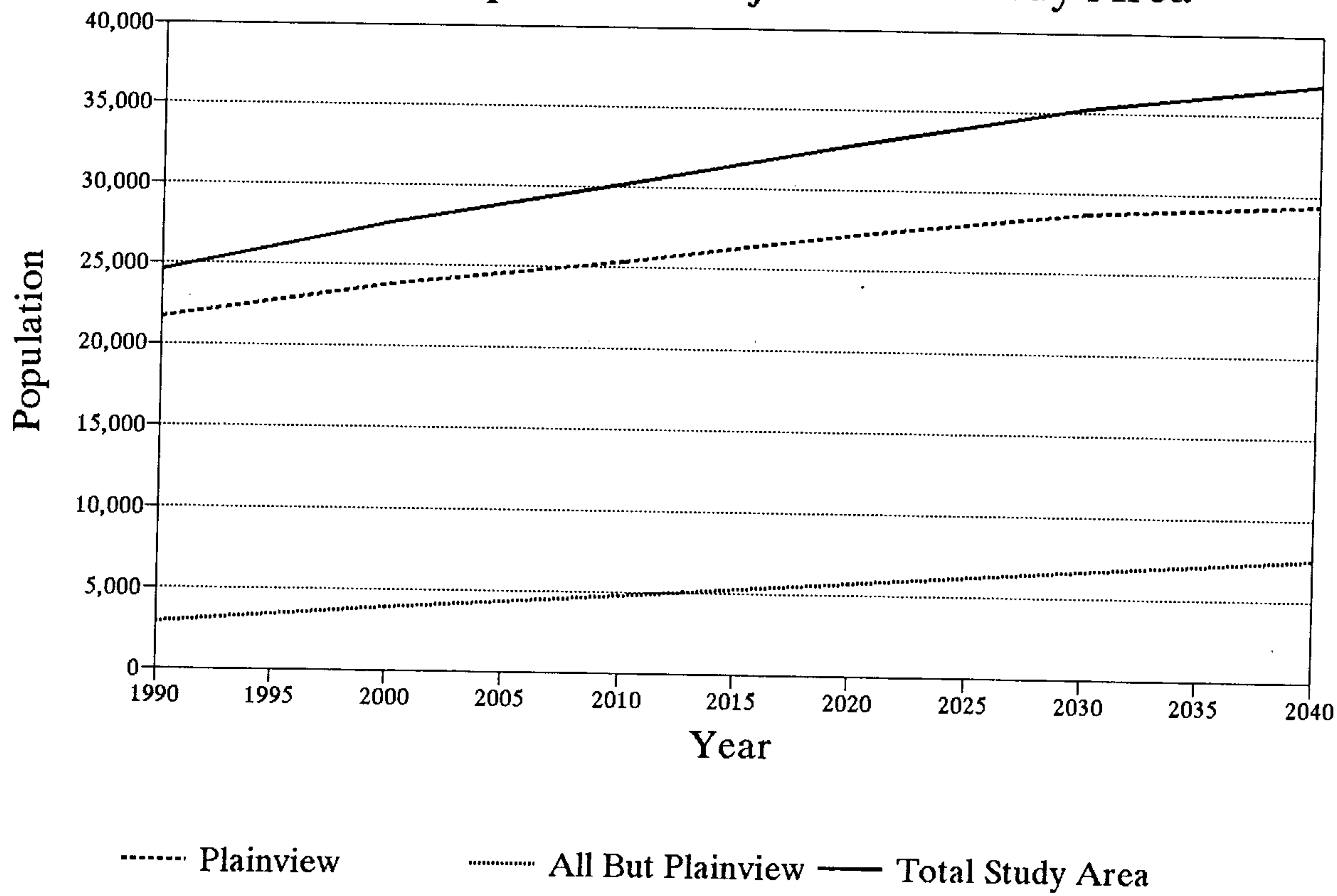
Population projections for the remaining areas in the study are based on the TWDB 1992 trend for Hale County (other), adjusted to assume no net migration. The 1990 other population is estimated to be 802. (According to TWDB records, Pleasant Hills Water Company serves 65 people, Ebeling Water Supply Corporation serves 45 people, and Westridge Water Company serves 92 people. The study area population not served by any of the water suppliers is estimated as 600 people, based on available information.) The impact of the new prison facility is added to the base population projections. Table 2.2 and Figure 2.3 summarize the total population projections for the study area.

Projected Municipal Water Use

Current water use in the study area includes significant irrigated agriculture, self-

Figure 2.3

Total Population Projection in Study Area



supplied industrial use, domestic use, and municipal use for Plainview, Kress, and the other area water suppliers. This study focuses on meeting municipal and domestic water needs. It is likely that irrigation users and self-supplied industrial users will continue to obtain their own water from the Ogallala Aquifer.

TWDB records give historical municipal water use data for the study area. Records for Plainview and Kress extend for many years, but records for the smaller suppliers are only available for recent years. Table 2.3 gives the 1990 water use for the area suppliers and the percentage of the total municipal use in the study area for each. The table shows that Plainview supplies over 93 percent of the area's municipal water use. Table 2.4 gives historical water use data for the City of Plainview. Figure 2.4 shows Plainview's historical total water use, and Figure 2.5 shows Plainview's average daily per capita water use. A statistical analysis of Plainview's historical per capita use shows an increase of about 2 gallons per capita per day per decade.

Water use for Kress has varied from 27 million gallons to 45 million gallons in recent years, with a decrease in the average daily per capita use over the past 20 years. This decrease is probably attributable to inability to supply the demand fully, and it is not assumed to indicate an actual decrease in per capita water needs. Kress' average water use for the period of 1971 to 1980, before the decrease began, was about 146 gallons per capita per day.

Seth Ward Water Supply Corporation water use data for 1990 and 1991 were

Table 2.3

1990 Municipal Water Use in the Study Area
by Supplier

(Million Gallons)

Supplier	1990 Water Use	Percent of Total
Plainview	1,460	93.3%
Kress	39	2.5%
Seth Water WSC	24	1.5%
Westridge WC	10	0.6%
Pleasant Hills WC	3	0.2%
Ebeling WSC	2	0.2%
Other (individual wells)	27	1.7%
	1,565	100.0%

Note: The Westridge Water Company use is based on an assumed 300 gallons per capita per day.

Table 2.4

City of Plainview Historical Water Use

Year	Plainview Water Use			Population	Per Capita Use
	MG per Year	Peak Day (MGD)	Ratio of Peak Day to Average		(GPCD)
1960	1,253	9.35	2.73	18,735	183
1961	1,145	7.90	2.52	18,771	167
1962	1,315	8.78	2.44	18,807	192
1963	1,439	10.30	2.61	18,843	209
1964	1,550	10.85	2.55	18,879	225
1965	1,575	10.38	2.40	18,916	228
1966	1,325	10.03	2.76	18,952	192
1967	1,224	8.15	2.43	18,988	177
1968	1,076	8.25	2.80	19,024	155
1969	1,102	8.88	2.94	19,060	158
1970	1,325	9.20	2.53	19,096	190
1971	1,258	11.15	3.23	19,396	178
1972	1,197	10.20	3.11	19,695	167
1973	1,270	9.48	2.72	19,995	174
1974	1,340	11.53	3.14	20,295	181
1975	1,235	8.85	2.62	20,594	164
1976	1,355	9.08	2.45	20,894	178
1977	1,276	10.93	3.12	21,210	165
1978	1,331	10.80	2.96	21,531	169
1979	1,255	8.38	2.44	21,856	157
1980	1,468	10.05	2.50	22,187	181
1981	1,372	10.58	2.81	22,288	169
1982	1,392	8.70	2.28	22,286	171
1983	1,556	10.80	2.53	22,449	190
1984	1,452	9.20	2.31	22,615	176
1985	1,388	8.10	2.13	22,577	168
1986	1,419	10.20	2.62	22,540	172
1987	1,517	9.40	2.26	22,440	185
1988	1,396	7.70	2.02	22,340	171
1989	1,480	9.00	2.22	22,020	184
1990	1,460	9.20	2.30	21,700	184
Average:			2.60		

Figure 2.4
City of Plainview Historical Water Use

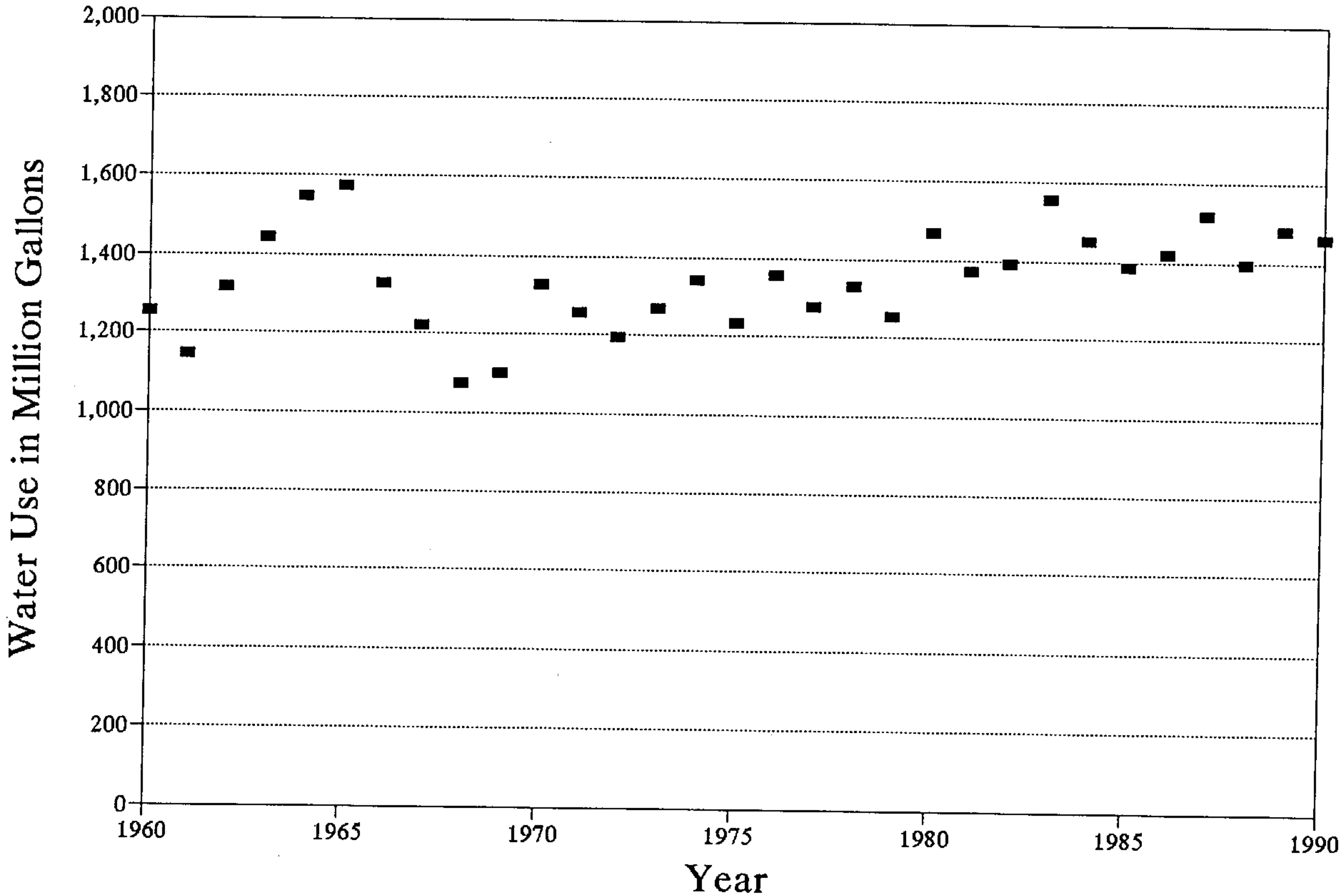
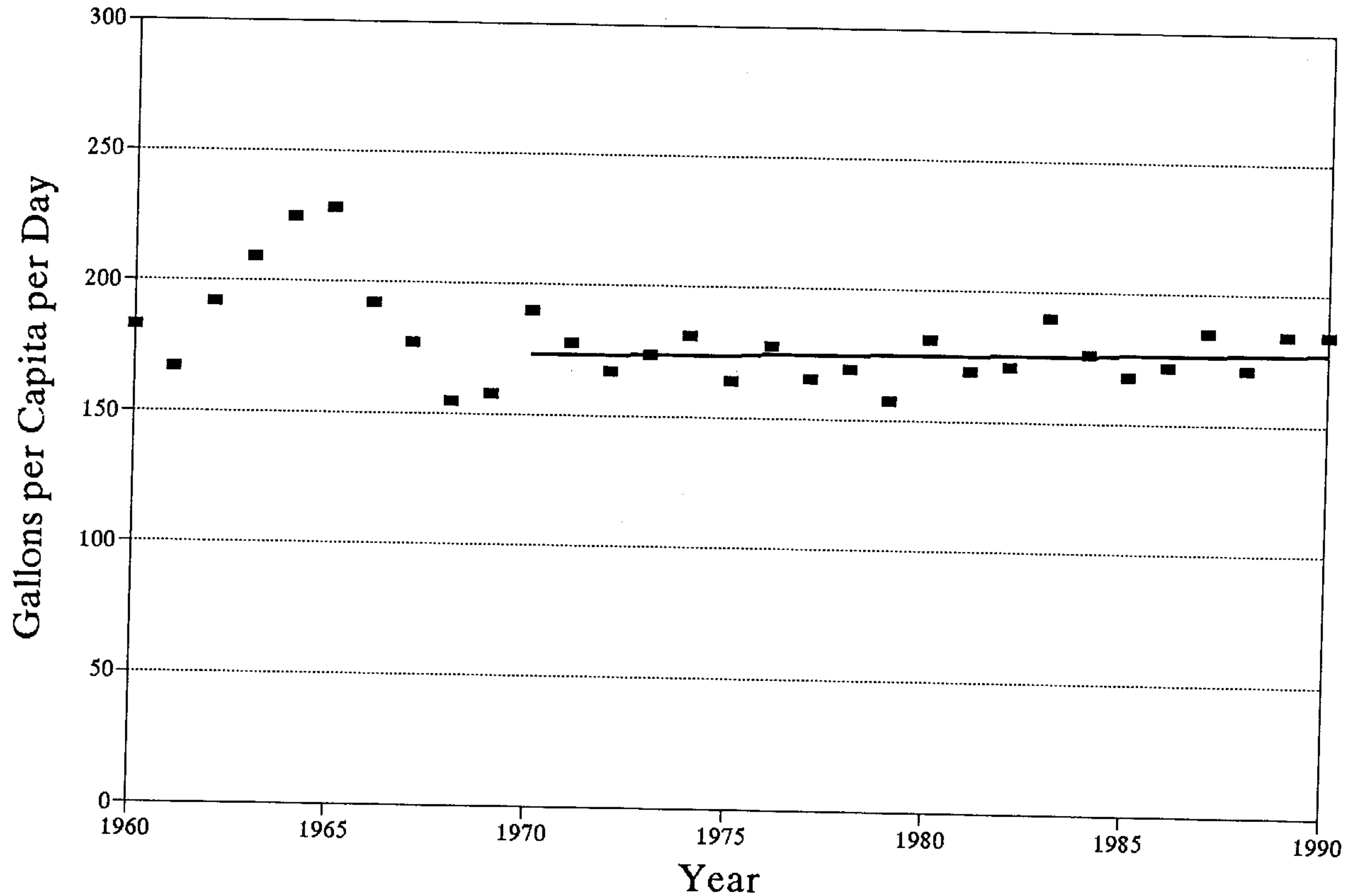


Figure 2.5
Plainview Average Daily Per Capita Use



obtained from Plainview's treated water sales to the Corporation. The water supply corporation has 240 connections in the area to which Plainview supplied water in 1990 and 1991. It also has another 90 connections to the east, in an area not then served. The portion of Seth Ward served by the water supply corporation in 1990 and 1991 used about 70 gallons per capita per day, and this is expected to increase to 90 gallons per capita per day over time. It is assumed that Seth Ward Water Supply Corporation will expand its service area to serve all of Seth Ward by the year 2000.

The Westridge area to the west of Plainview has approximately 40 connections. According to TWDB records, the average annual water use of the Westridge area for 1990 and 1991 was about 1,500,000 gallons. This figure is questionable because the actual water consumption of that area appears to be much higher than that, and the TWDB records showed annual water use for the Westridge area of about 15,000,000 gallons prior to 1983. In this study, the current average water use for the Westridge Water Company service area is assumed to be 300 gallons per capita per day.

According to TWDB records, the average water use for Ebeling Water Supply Corporation and Pleasant Hills Water Company is about 120 gallons per capita per day. It is assumed that the remainder of the study area (not currently served by a supplier) has a municipal water use of 120 gallons per capita per day.

The state of Texas is placing an increasing emphasis on water conservation, as evidenced by legislation requiring water-conserving plumbing and by programs of the Texas Natural Resources Conservation Commission and the TWDB. This regional water supply and treatment study includes the preparation of a water conservation and drought contingency plan for the City of Plainview and surrounding potential service area. The purpose of the water conservation and drought contingency plan for the City of Plainview is to establish short-term and long-term goals for conserving water and to determine the procedures and steps necessary to achieve these goals. Over the next several decades, it is assumed that conservation will result in a 10 percent decrease in per capita municipal water use for Plainview, Kress, and the newly-annexed Westridge area. It is assumed that conservation programs will not decrease the already low per capita water use in the Seth Ward area and the remaining study area. Table 2.5 summarizes the average daily per capita water use projections used for this study. The full text of the conservation and drought contingency plan developed for Plainview is included as Appendix B.

The projections of population and average per capita water use discussed above form the basis for projections of normal year water use for the study area. Table 2.6 gives projected normal year water use without conservation, assuming that the per capita demand for Plainview (including the Westridge area) and Kress remains at 1990 levels. Historical data for Plainview show that drought year demands can be as much as 15 percent higher than normal year demands, and Table 2.7 gives projected drought year demands without conservation. Tables 2.8 and 2.9 give projected normal and drought year demands with a ten percent reduction in per capita demand due to conservation measures.

Figure 2.6 shows Plainview's projected water use from previous studies, including TWDB 1989 and 1992 projections and the City's 1989 comprehensive plan (6). Figure 2.7

Table 2.5

Average per Capita Water Use Projections

(Gallons per Capita per Day)

Year	Plainview	Kress	Seth Ward	Westridge	Remaining Area
1990	177	146	70	300	120
2000	173	143	80	294	120
2010	170	140	90	288	120
2020	166	138	90	282	120
2030	163	135	90	276	120
2040	159	132	90	270	120

Table 2.6

Normal Year Water Use Projections without Conservation Practices

(Million Gallons per Year)

Year	Plainview	Kress	Seth Ward	Remaining Area	Total
2000	1,568	41	54	40	1,703
2010	1,691	43	72	48	1,854
2020	1,824	44	83	55	2,006
2030	1,937	45	95	63	2,140
2040	1,998	45	106	70	2,219

Table 2.7

Drought Year Water Use Projections without Conservation Practices

(Million Gallons per Year)

Year	Plainview	Kress	Seth Ward	Remaining Area	Total
2000	1,803	47	62	46	1,958
2010	1,945	49	83	55	2,132
2020	2,098	51	95	63	2,307
2030	2,228	52	109	72	2,461
2040	2,298	52	122	81	2,553

Table 2.8

Normal Year Water Use Projections with Conservation Practices

(Million Gallons per Year)

Year	Plainview	Kress	Seth Ward	Remaining Area	Total
2000	1,533	41	54	40	1,668
2010	1,625	41	72	48	1,786
2020	1,714	42	83	55	1,894
2030	1,789	42	95	63	1,989
2040	1,804	41	106	70	2,021

Table 2.9

Drought Year Water Use Projections with Conservation Practices

(Million Gallons per Year)

Year	Plainview	Kress	Seth Ward	Remaining Area	Total
2000	1,763	47	62	46	1,918
2010	1,869	47	83	55	2,054
2020	1,971	48	95	63	2,177
2030	2,057	48	109	72	2,286
2040	2,075	47	122	81	2,325

shows Plainview's water use as projected for this study. Figure 2.8 shows the projected water use for the whole study area.

Peak-Day Use Projections

Peak-day use projections for the City of Plainview are based on the City's historical ratio of peak-day use to average-day use, shown in Table 2.4. The peak-day to average-day use ratio, averaged over the past 30 years, is 2.60. Peak-day use for the other service areas is calculated based on the Texas Natural Resources Conservation Commission requirement of a minimum of 0.6 gallons per minute per connection. The number of connections is derived from projected populations, using historical ratios of number of people per connection for each supplier. These ratios are 4.2 people per connection for Seth Ward, 2.6 people per connection for Kress, and 2.5 people per connection for the

Figure 2.6 - City of Plainview
Projected Water Use from Previous Studies

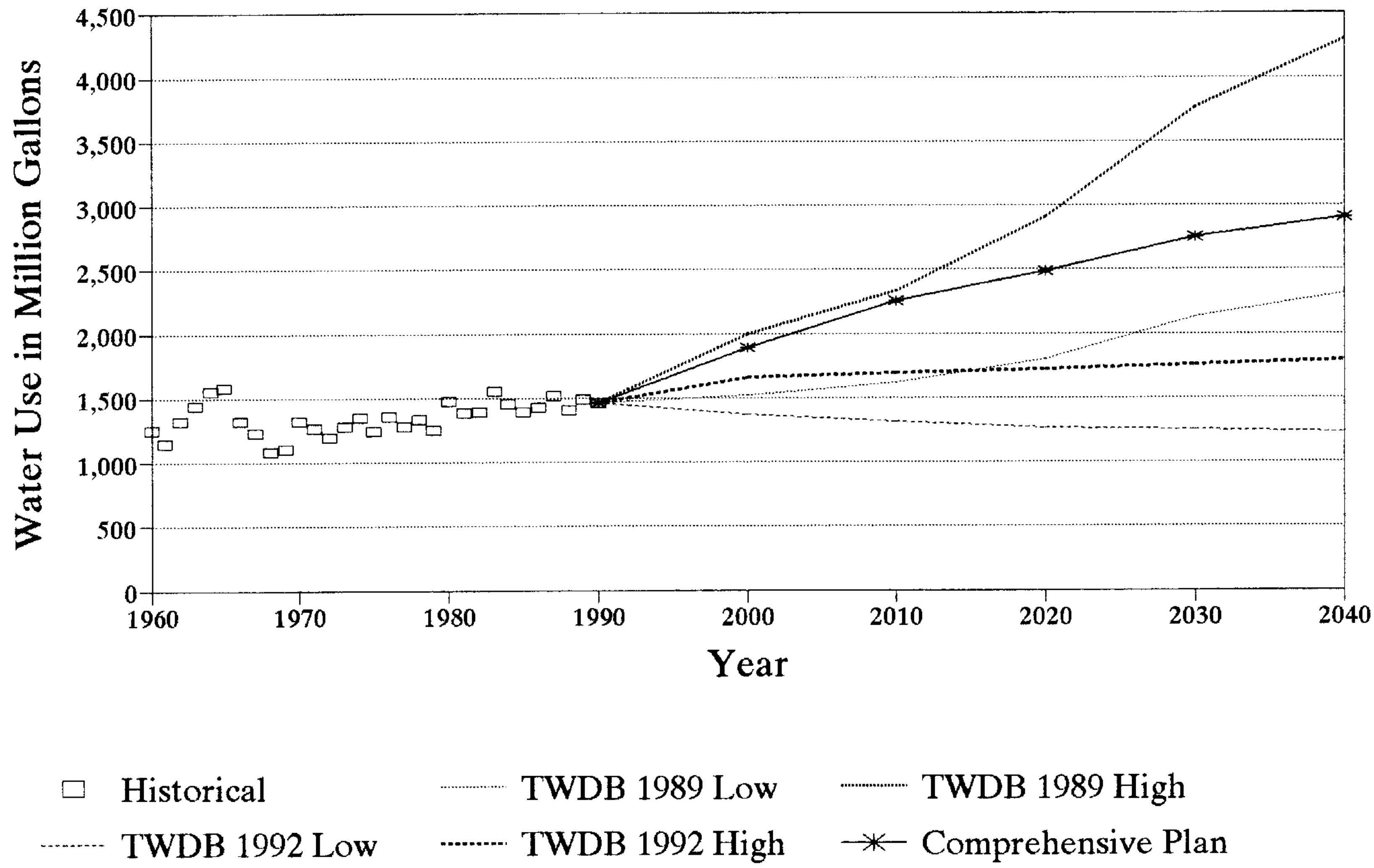


Figure 2.7 - City of Plainview
Projected Water Use Selected for Study

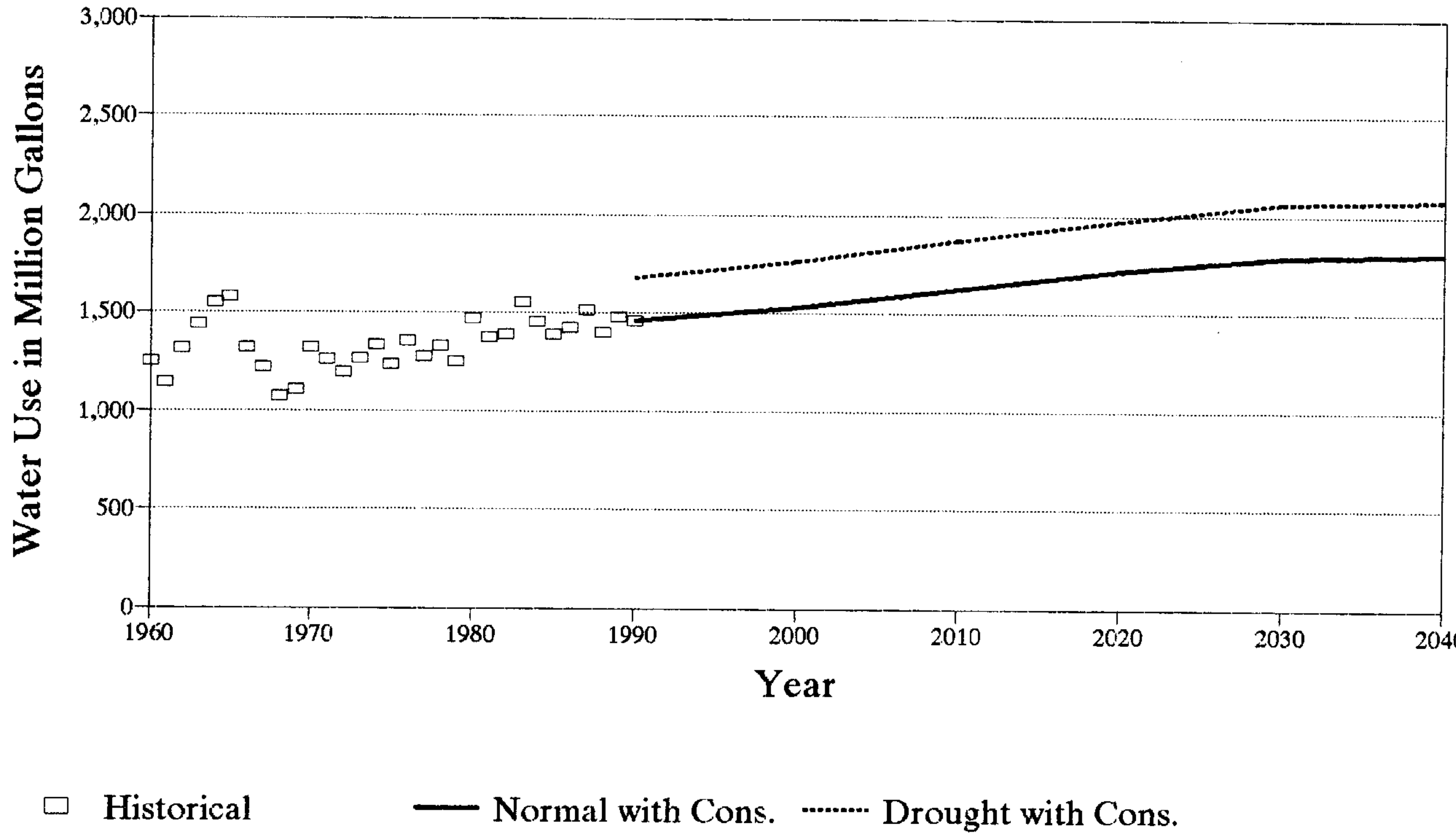


Figure 2.8 - Total Area
Projected Water Use Selected for Study

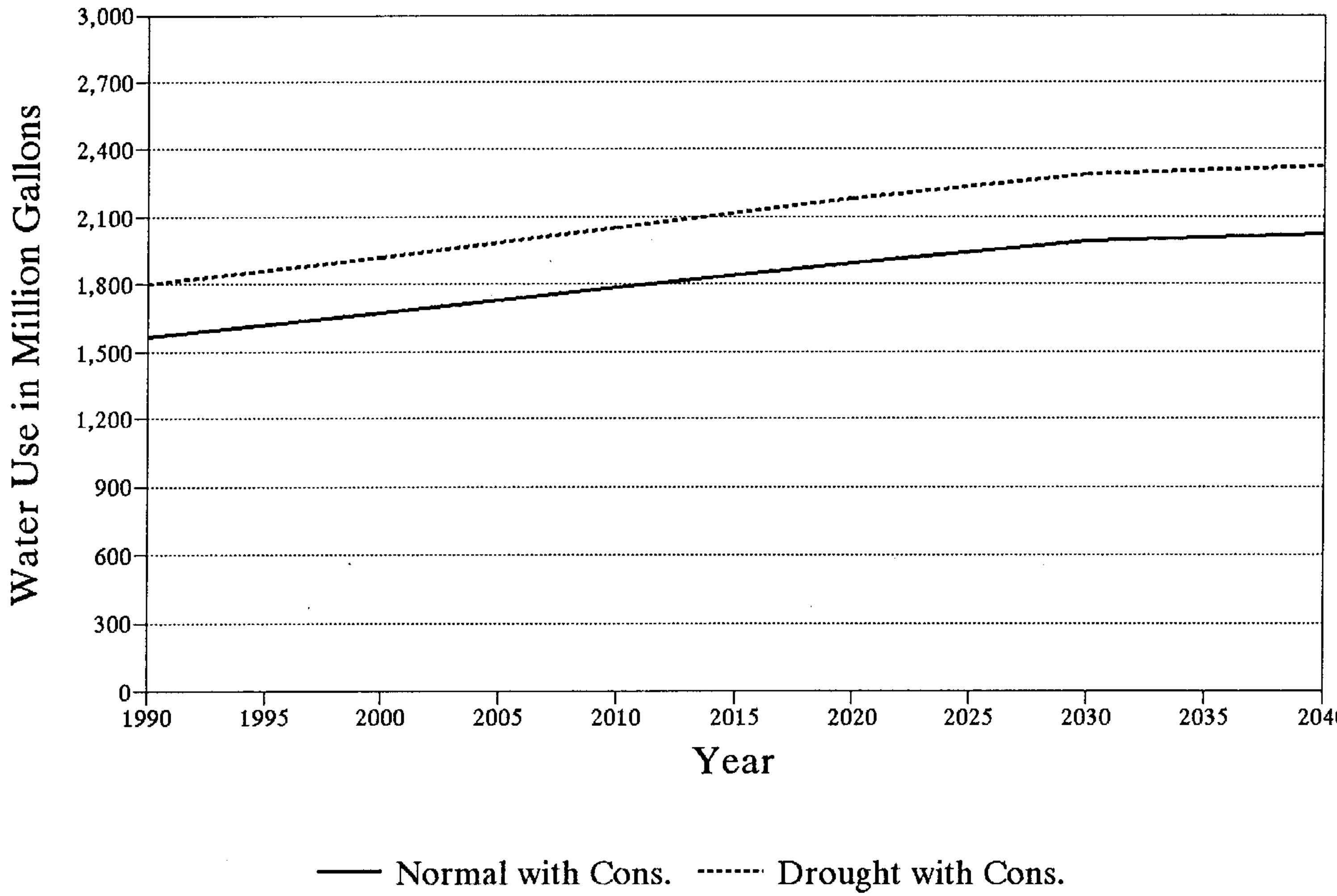


Table 2.10

Peak-Day Use Projections in the Study Area

(Million Gallons per Day)

Year	Plainview	Kress	Seth Ward	Remaining Area	Total
2000	10.92	0.26	0.38	0.32	11.88
2010	11.58	0.27	0.45	0.38	12.68
2020	12.21	0.28	0.52	0.44	13.45
2030	12.74	0.28	0.59	0.50	14.11
2040	12.85	0.28	0.66	0.56	14.35

remaining area. Table 2.10 lists the peak-day use projections in the study area.

Water to Be Supplied by Plainview as the Regional Supplier

The primary supplier of municipal and domestic water in the study area is the City of Plainview, which supplies in-city demands and provides a portion of Seth Ward Water Supply Corporation water use. The Town of Kress, the Seth Ward Water Supply Corporation, and other users in the study area (Ebeling Water Supply Corporation, Pleasant Hills Water Company, and private individuals) have smaller, independent water supplies. Over time, it seems likely that Plainview will increase its role as the area's primary municipal supplier, as the area of the city increases and as other supplies become less economical. Based on discussions with Plainview staff, the following assumptions for outside supply are adopted for the purposes of this study:

- Irrigation and major industries will continue to have supplies independent of the City of Plainview system.

- The water use of the Town of Kress will be supplied by Plainview beginning by the year 2000.

- In 1990, all of Seth Ward Water Supply Corporation's water use was supplied by Plainview. The water supply corporation has since drilled its own well to supply a portion of its needs. For this study, we will assume that Seth Ward Water Supply Corporation will provide half of its own water use until 2000. It is assumed that all of Seth Ward's water use will be supplied by Plainview after 2010, following a gradual transition from 2000 through 2010.

- The water use of the remaining study area will be supplied by Plainview as of 2040, with a gradual transition from 2000 through 2040.

Table 2.11 gives the total projected normal year municipal and domestic needs of the study area, the amount of outside supply, and the amount to be supplied by Plainview. Table 2.12 gives the same information for a drought year. Table 2.13 gives the projected peak day water supply required from Plainview. Table 2.14 gives the year-by-year projection of normal year, drought year, and peak day water supplies from Plainview.

Table 2.11

Projected Normal Year Supply Required from Plainview

(Million Gallons per Year)

Year	Study Area Municipal and Domestic Water Use	Outside Supplies	Supply by Plainview
1990	1,565	81	1,484
2000	1,668	67	1,601
2010	1,786	36	1,750
2020	1,894	28	1,866
2030	1,989	16	1,973
2040	2,021	0	2,021

Table 2.12

Projected Drought Year Supply Required from Plainview

(Million Gallons per Year)

Year	Study Area Municipal and Domestic Water Use	Outside Supplies	Supply by Plainview
1990	1,565	81	1,484
2000	1,918	77	1,841
2010	2,054	41	2,013
2020	2,177	32	2,145
2030	2,286	18	2,268
2040	2,325	0	2,325

Table 2.13

Projected Peak Day Supply Required from Plainview

(Million Gallons per Day)

Year	Study Area Municipal and Domestic Water Use	Outside Supplies	Supply by Plainview
2000	11.9	0.5	11.4
2010	12.7	0.3	12.4
2020	13.5	0.2	13.3
2030	14.1	0.1	14.0
2040	14.4	0.0	14.4

Table 2.14

Year-by-Year Projected Water Supply Required from Plainview

(Million Gallons)

Year	Projected Normal Year Plainview Supply	Projected Drought Year Plainview Supply	Projected Peak Day Plainview Supply
1994	1,531	1,761	10.8
1995	1,543	1,774	10.9
1996	1,554	1,787	11.0
1997	1,566	1,801	11.1
1998	1,578	1,815	11.2
1999	1,589	1,827	11.3
2000	1,601	1,841	11.4
2001	1,616	1,858	11.5
2002	1,631	1,876	11.6
2003	1,646	1,893	11.7
2004	1,661	1,910	11.8
2005	1,676	1,927	11.9
2006	1,690	1,944	12.0
2007	1,705	1,961	12.1
2008	1,720	1,979	12.2
2009	1,735	1,996	12.3
2010	1,750	2,013	12.4
2011	1,762	2,026	12.5
2012	1,773	2,039	12.6
2013	1,785	2,053	12.7
2014	1,796	2,066	12.8
2015	1,808	2,079	12.9
2016	1,820	2,092	12.9
2017	1,831	2,105	13.0
2018	1,843	2,119	13.1
2019	1,854	2,132	13.2
2020	1,866	2,145	13.3

Table 2.14, Continued

Year	Projected Normal Year Plainview Supply	Projected Drought Year Plainview Supply	Projected Peak Day Plainview Supply
2021	1,877	2,157	13.4
2022	1,887	2,170	13.4
2023	1,898	2,182	13.5
2024	1,909	2,194	13.6
2025	1,920	2,207	13.7
2026	1,930	2,220	13.7
2027	1,941	2,232	13.8
2028	1,952	2,244	13.9
2029	1,962	2,256	13.9
2030	1,973	2,268	14.0
2031	1,978	2,274	14.0
2032	1,983	2,280	14.1
2033	1,987	2,285	14.1
2034	1,992	2,291	14.2
2035	1,997	2,297	14.2
2036	2,002	2,302	14.2
2037	2,007	2,308	14.3
2038	2,011	2,313	14.3
2039	2,016	2,318	14.4
2040	2,021	2,325	14.4
Total	85,173		

3. EXISTING WATER SUPPLY

The two existing sources of water supply in the study area are groundwater from the Ogallala Aquifer and surface water from Lake Meredith, which is delivered by the Canadian River Municipal Water Authority (CRMWA). The City of Plainview obtains about 60 percent of its supply from the Ogallala and 40 percent from CRMWA. All other municipal suppliers in the study area (except Seth Ward Water Supply Corporation, which purchases some water from Plainview) get their water from the Ogallala, as do self-supplied irrigation and industrial water users.

The Ogallala Aquifer

Ground Water Availability in the Vicinity of Plainview, Texas is a report on the ground water analysis conducted by Guyton Associates, as part of this study. The Guyton report includes a thorough discussion of the Ogallala Aquifer and groundwater availability in the study area (1).

The Ogallala Aquifer outcrops at the land surface along the banks of Running Water Draw, which passes through the study area. It is an unconfined aquifer, of Tertiary geologic age, and is comprised of layers and lenses of silt, sand, clay, rock and caliche. The aquifer is underlain by Lower Cretaceous strata composed of beds of limestone and dolomite. The total thickness of the aquifer ranges from about 250 feet north of Plainview at the Hale County line to about 400 feet in the southeast part of the study area. In the southern part of the study area, where the Lower Cretaceous strata occur, the thickness of the Ogallala Aquifer decreases rapidly to only 100 feet.

The area considered for the groundwater analysis extends about 10 miles west, 12 miles east, 9 miles north, and 9 miles south from the center of Plainview. Pumpage of groundwater from the Ogallala Aquifer in the study area is for municipal, domestic, livestock, industrial and irrigation uses. In 1989, the total pumpage in the study area was about 70,638 million gallons. The combined municipal pumpage by the City of Plainview, Hale Center and Kress was about 1,083 million gallons in 1989, which was about 1.5 percent of the total groundwater pumpage for that year. Pumpage for domestic and livestock use in 1989 is estimated at about 652 million gallons (0.9 percent of the total pumpage); pumpage for industrial use is estimated at about 443 million gallons (0.6 percent of the total pumpage); and pumpage for irrigation is estimated by TWDB as about 68,460 million gallons (97 percent of total pumpage).

Plainview has 19 wells that draw from the Ogallala Aquifer for municipal water supply. Four of the wells are currently abandoned, and 15 wells are operable. The depths of the wells range from 280 to 367 feet. The pumping rates of the wells range from about 340 to 1,100 gallons per minute (GPM) and average about 600 to 650 GPM. Figure 3.1 shows the location of Plainview's municipal wells and surface water treatment plant.

The pumping rates of some of Plainview's wells have decreased over the past several years, based on data collected and reviewed during this study. As part of the study, well performance and pump performance tests were made on 12 of the City's wells to identify the changes in pumping rates and their possible causes. The results of these tests are

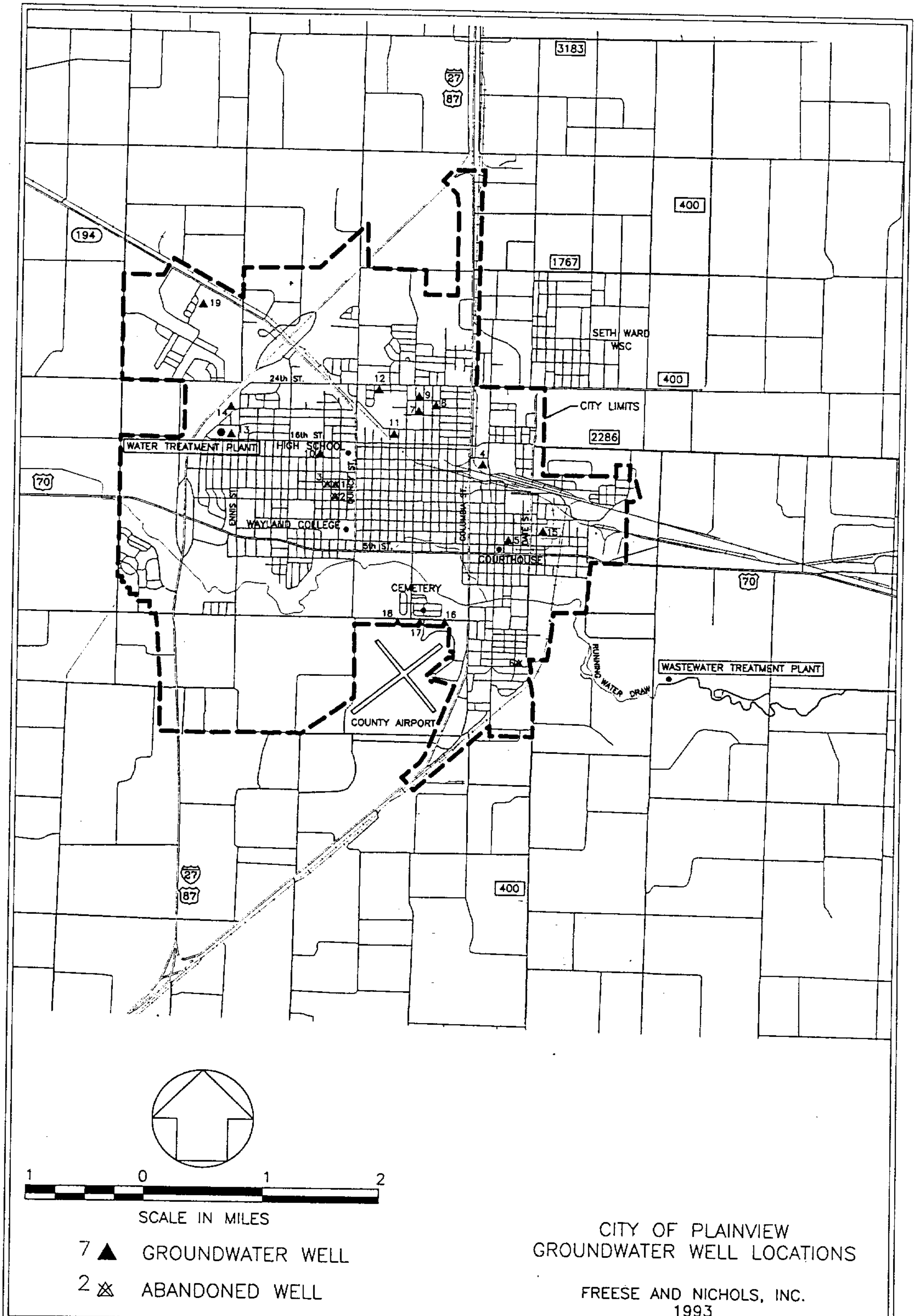

3183
27
87
400
194
1767
SETH WARD
WSC
400
24th ST.
CITY LIMITS
2286
16th ST.
WATER TREATMENT PLANT
HIGH SCHOOL
70
ENNIS ST.
QUINCY ST.
COLUMBIA ST.
DALE ST.
WAYLAND COLLEGE
5th ST.
COURTHOUSE
70
CEMETERY
RUNNING WATER DRAW
WASTEWATER TREATMENT PLANT
COUNTY AIRPORT
27
87
400
1 0 1 2
SCALE IN MILES
7 ▲ GROUNDWATER WELL
2 ⨂ ABANDONED WELL
CITY OF PLAINVIEW
GROUNDWATER WELL LOCATIONS
FREESE AND NICHOLS, INC.
1993
FREESE AND NICHOLS, INC.

FIGURE 3.1

presented in the Guyton Associates report (1).

Groundwater pumpage records for the City of Plainview are available beginning in 1955. The annual pumpage of groundwater for municipal uses was 1,010 million gallons in 1955 and reached a maximum of about 1,575 million gallons in 1965. In 1969, Plainview began obtaining and treating surface water from the CRMWA, which reduced the City's use of groundwater. Table 3.1 gives the historical groundwater and surface water use for Plainview from 1969 through 1991. Annual groundwater use in that period has ranged from 519 million gallons in 1972 to 1,046 million gallons in 1990. Groundwater use since 1969 has averaged 724 million gallons per year.

The Town of Kress currently obtains its water supply from three groundwater wells. Two of these wells are located near town, and the third is located north of Finney in Hale County, a few miles south of Kress. The wells have recently suffered a significant decrease in production capacity, and are now operating at about 25 percent of their rated output (7). Each of the wells near town is now producing approximately 150-200 gallons per minute (0.22-0.29 MGD), and the well near Finney is producing approximately 200 gallons per minute (0.29 MGD). TWDB data imply that about two-thirds of Kress' supply in recent years has come from the well near Finney. The annual groundwater use for Kress has ranged from 27 to 45 million gallons during the past few years. Westridge Water Company, Pleasant Hills Water Company, and Ebeling Water Supply Corporation all obtain water from small wells in the Ogallala Aquifer.

Table 3.1

City of Plainview Groundwater and Surface Water Production

Year	Groundwater Production (MG)	Groundwater Production (% of Total)	Surface Water Production (MG)	Surface Water Production (% of Total)	Total Water Production (MG)	In-City Water Use (MG)
1969	723	65.6%	379	34.4%	1,102	1,102
1970	695	52.5%	630	47.6%	1,325	1,325
1971	620	49.3%	637	50.7%	1,257	1,257
1972	519	43.4%	678	56.6%	1,197	1,197
1973	813	64.1%	456	35.9%	1,269	1,269
1974	648	48.4%	692	51.6%	1,340	1,340
1975	579	46.9%	655	53.1%	1,234	1,234
1976	728	53.7%	627	46.3%	1,355	1,355
1977	784	61.5%	491	38.5%	1,275	1,275
1978	873	65.6%	458	34.4%	1,331	1,331
1979	565	45.0%	690	55.0%	1,255	1,255
1980	710	48.4%	758	51.6%	1,468	1,468
1981	709	51.1%	677	48.9%	1,386	1,372
1982	799	56.8%	609	43.3%	1,408	1,392
1983	910	58.1%	657	41.9%	1,567	1,556
1984	781	53.7%	673	46.3%	1,454	1,452
1985	680	49.0%	709	51.0%	1,389	1,388
1986	817	57.5%	603	42.5%	1,420	1,419
1987	792	52.2%	726	47.8%	1,518	1,517
1988	728	52.1%	668	47.9%	1,396	1,396
1989	935	62.7%	556	37.3%	1,491	1,480
1990	1,046	70.5%	438	29.5%	1,484	1,460
1991	914	64.1%	512	35.9%	1,426	1,402
Averages:						
1969-1988	724	53.1%	624	46.9%	1,348	1,345
1982-1991	840	57.7%	615	42.3%	1,455	1,446

Availability of Groundwater

Water levels in Ogallala wells in the study area have declined about 120 to 150 feet since the mid 1940s. From January 1968 through December 1991 or February 1992, the average water level decline in available observation wells outside of Plainview was about 67 feet. For the same period, the average water level decline within Plainview's city limits was about 42 feet. The smaller rate of decline in the Plainview wells is believed to be the result of a lower overall pumpage per square mile in and near the City.

Groundwater analyses performed in the study area show that about 61,900 million gallons of water are estimated to be in storage in the aquifer beneath Plainview. It is estimated that about two-thirds to three-fourths of the 61,900 million gallons in storage can be withdrawn by wells. Thus, about 41,400 to 46,400 million gallons of water are available from the Ogallala Aquifer within the city limits. If the City continues to use water in the aquifer at the current rate of about 980 million gallons per year, the recoverable water in storage would provide a supply for about 42 to 47 years. If Plainview were to use water at a greater rate, the supply would last for a shorter period.

Surface Water from the Canadian River Municipal Water Authority

The Canadian River Municipal Water Authority (CRMWA) is a political subdivision of the State of Texas, created by special act of the State Legislature. The primary purpose of the Authority is to provide a source of municipal and industrial water for its eleven member cities: Amarillo, Borger, Brownfield, Lamesa, Levelland, Lubbock, O'Donnell, Pampa, Plainview, Slaton, and Tahoka.

To accomplish this purpose, CRMWA contracted with the U.S. Bureau of Reclamation to construct the facilities of the Canadian River Project, consisting of Sanford Dam, which impounds Lake Meredith on the Canadian River near Borger, and a 322-mile aqueduct system to carry raw water from Lake Meredith to the member cities. Each city pays a share of the cost of constructing project facilities and the cost of operation and maintenance. CRMWA began delivering water to its member cities in 1968 and has operated the project facilities continuously since that time.

CRMWA has contracted with Plainview to provide 1,238 million gallons per year of untreated water during a year of normal supply. The latest available data from the CRMWA indicate that Plainview's share of the safe yield of the system is about 70 percent of the 1,238 million gallons per year allocation, or about 867 million gallons per year. The City can usually obtain 80 percent of its allocation, or about 990 million gallons per year. Plainview uses an 18-inch pipeline to bring untreated CRMWA water to its water treatment plant. The current CRMWA supply system is capable of delivering water to Plainview at a maximum rate of about 4.2 MGD, and this is also the rated capacity of the water treatment plant.

Plainview sells part of its raw water allocation from the CRMWA to Foxley Cattle Co./Cactus Feeders in Swisher County. The contract for this sale requires Foxley Cattle Co./Cactus Feeders to take a minimum of 200,000 gallons per day and allows them as much as 500,000 gallons per day. This supply can be discontinued by the City at any time.

Table 3.2 summarizes Plainview's surface water use, its raw water sales to Cactus Feeders and the remaining un-used allocations from CRMWA for the period from 1969 to 1991. Figure 3.2 illustrates this information graphically. The average annual use of surface water for the City of Plainview between 1969 and 1988 was about 624 million gallons. In 1989, 1990 and 1991, the use of surface water was 556, 438 and 512 million gallons.

Plainview's Use of Groundwater and Surface Water

Plainview combines groundwater from its wells 13 and 14 with treated surface water from the Canadian River Municipal Water Authority at its water treatment plant. The primary reason for this blending is to decrease high levels of dissolved salts in the CRMWA water, which lead to undesirable taste. It is estimated that at least 50 to 60 percent of the groundwater that is pumped by Plainview comes from wells 13 and 14. The other Plainview wells are used principally to provide water during periods of high demand and to serve areas of the City that are farther from the water treatment plant.

Figure 3.3 shows Plainview's historical use of groundwater and surface water, which is also presented in Table 3.1. The ratio of surface water use to total water use in Plainview averaged 46.9 percent for the period from 1969 to 1988. The portion of total use supplied by surface water was less in recent years: 37.3 percent in 1989, 29.5 percent in 1990, and 35.9 percent in 1991. Figure 3.4 shows the history of surface water use as a percent of total water use for Plainview.

Table 3.2

Plainview Surface Water Use from CRMWA

(Million Gallons per Year)

Year	Total Water Supply from CRMWA	Raw Water Sales	In-City Use	CRMWA Allocation	Unused Allocations
1969	379		379	722	343
1970	630		630	722	92
1971	637		637	832	195
1972	678		678	896	218
1973	456		456	947	491
1974	692		692	1,037	345
1975	655		655	867	212
1976	627		627	867	240
1977	492	1	491	867	375
1978	605	147	458	867	262
1979	901	211	690	1,115	214
1980	940	182	758	1,115	175
1981	842	165	677	991	149
1982	809	200	609	991	182
1983	798	141	657	991	193
1984	810	137	673	1,115	305
1985	831	122	709	1,115	284
1986	703	100	603	991	288
1987	846	120	726	991	145
1988	802	134	668	991	189
1989	714	158	556	991	277
1990	573	135	438	991	418
1991	613	101	512	991	378

Figure 3.2
Plainview Surface Water Use from CRMWA

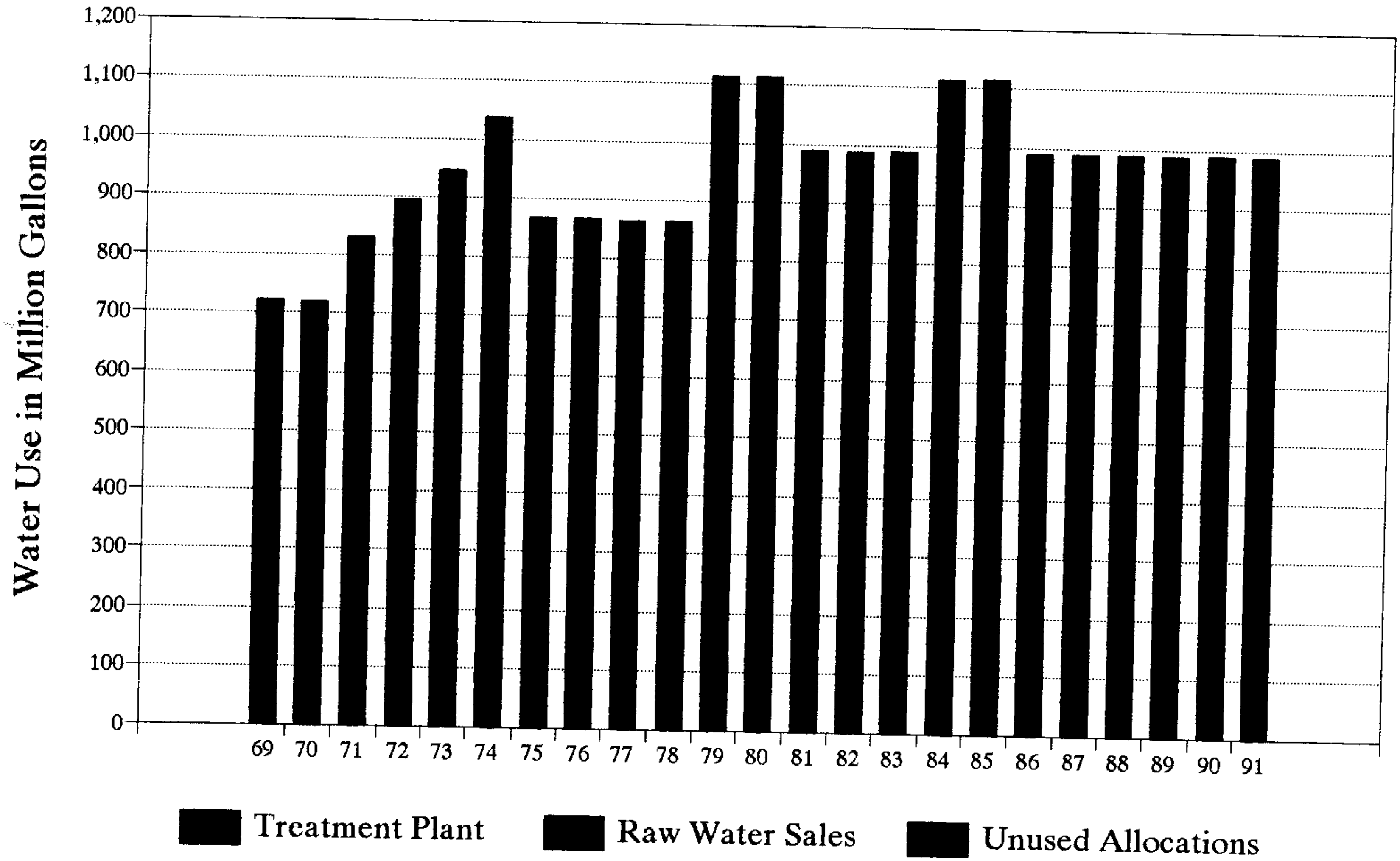


Figure 3.3
Historical Plainview Water Use

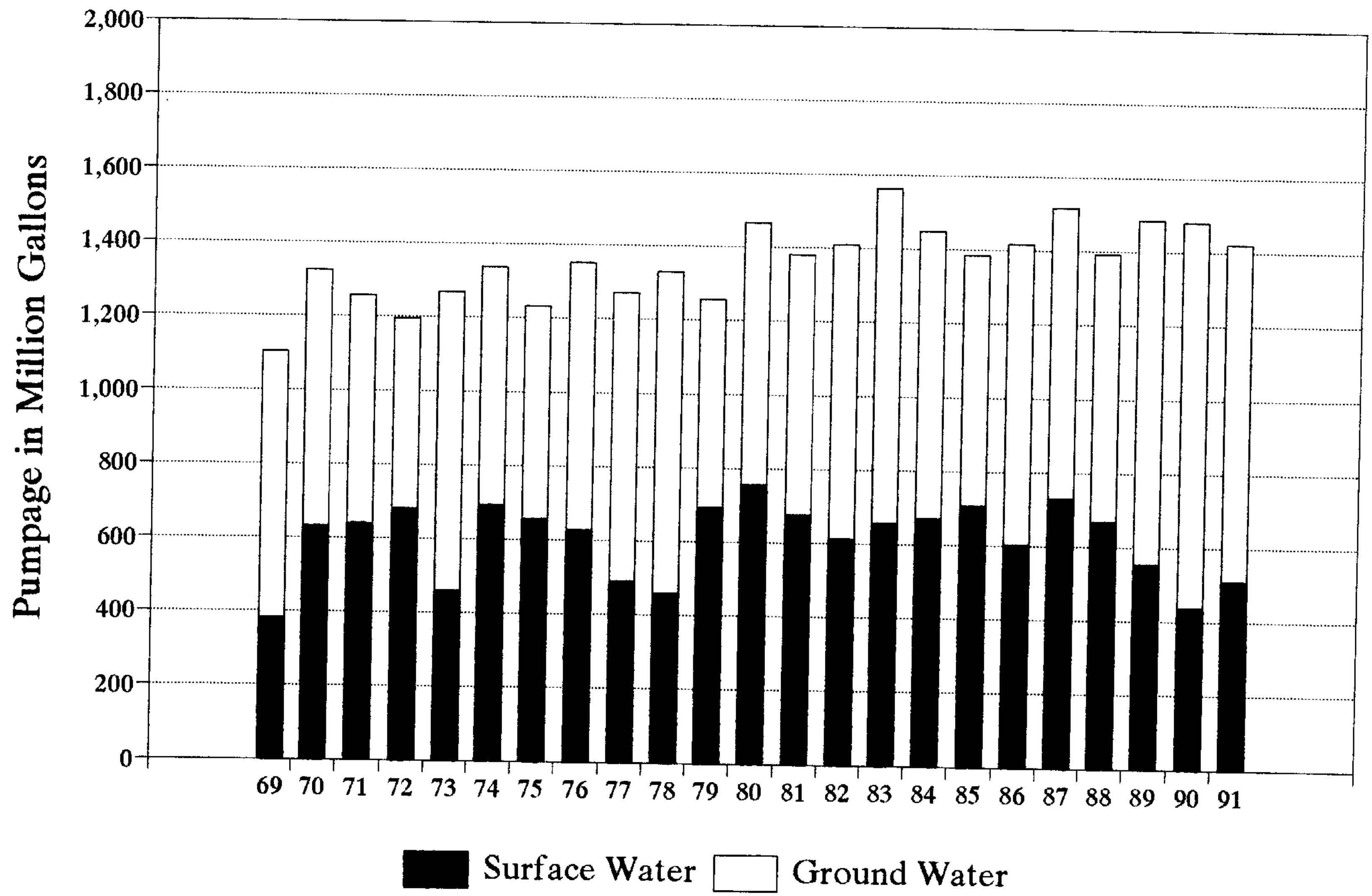
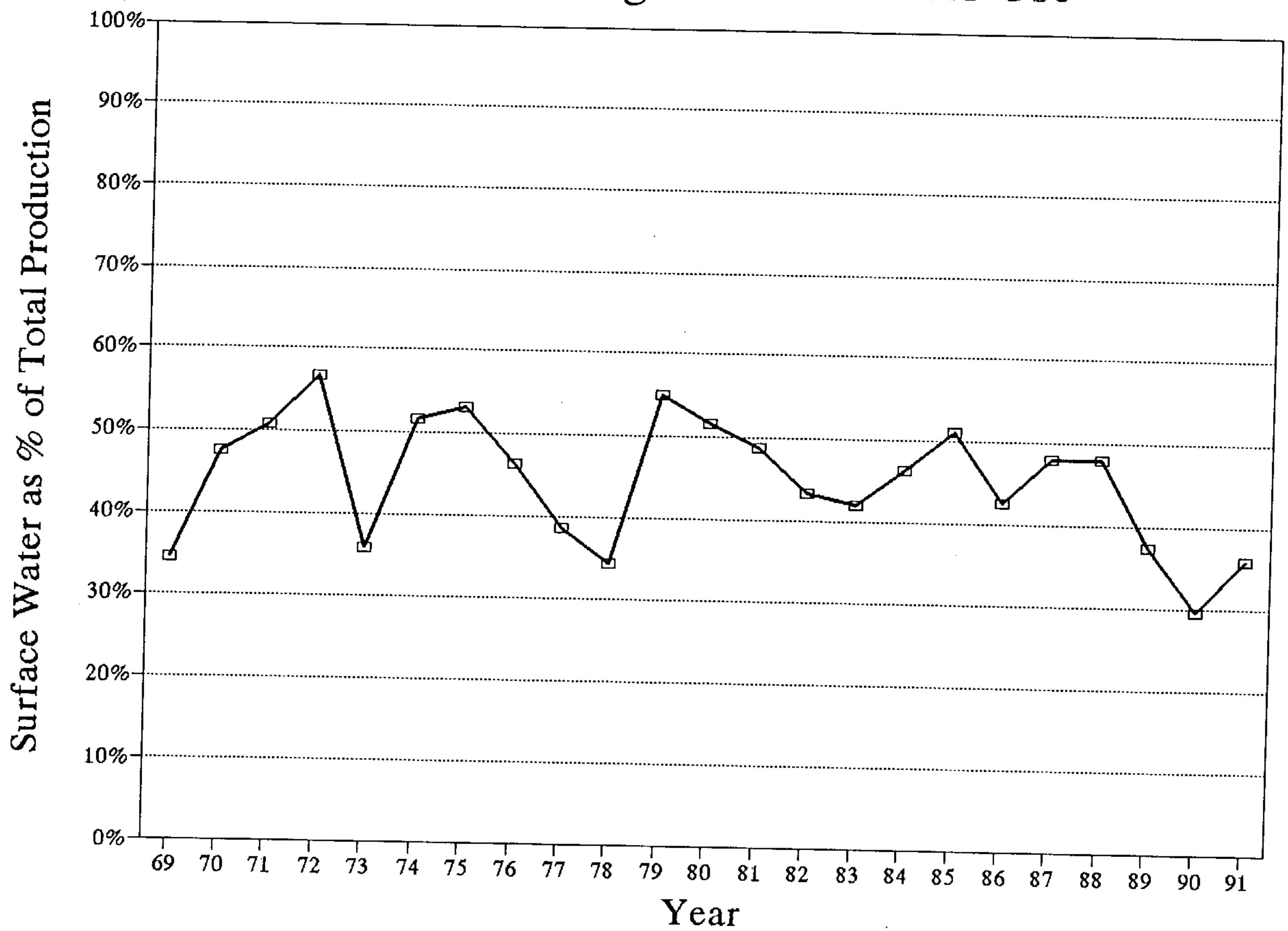


Figure 3.4 - Plainview's Surface Water Use As a Percentage of Total Water Use



Figures 3.5, 3.6, 3.7, and 3.8 show the daily use of ground and surface water for the years 1988 through 1991. One reason that surface water use has declined in recent years is that the level of dissolved solids in the CRMWA water has been increasing. To maintain acceptable quality in the blended water, Plainview has increased the percentage of groundwater in the blend. Plainview water treatment plant personnel also indicate that lower summertime demands have made it difficult to use as much CRMWA water as in the past.

The decline in Plainview's use of CRMWA water in recent years is troubling. CRMWA water is the only renewable supply in the study area. As the use of CRMWA water decreases, the mining of essentially non-renewable Ogallala water increases. In the long term, it is important for Plainview to preserve some in-city groundwater supplies to meet future peak needs. The City should make every effort to increase its on-going use of CRMWA water to the extent possible, preserving in-city groundwater for future needs.

Availability of CRMWA Surface Water

Plainview is the only water supplier in the study area which can purchase and treat surface water from the CRMWA. Other suppliers can get surface water only by purchasing treated water from Plainview. Because of the high dissolved solids level and the need to blend the surface water with groundwater, Plainview has never been able to use its full allotment from CRMWA. The CRMWA is currently working on two projects which might increase the availability of surface water to Plainview and other CRMWA

Figure 3.6
Plainview Daily Water Use - 1989

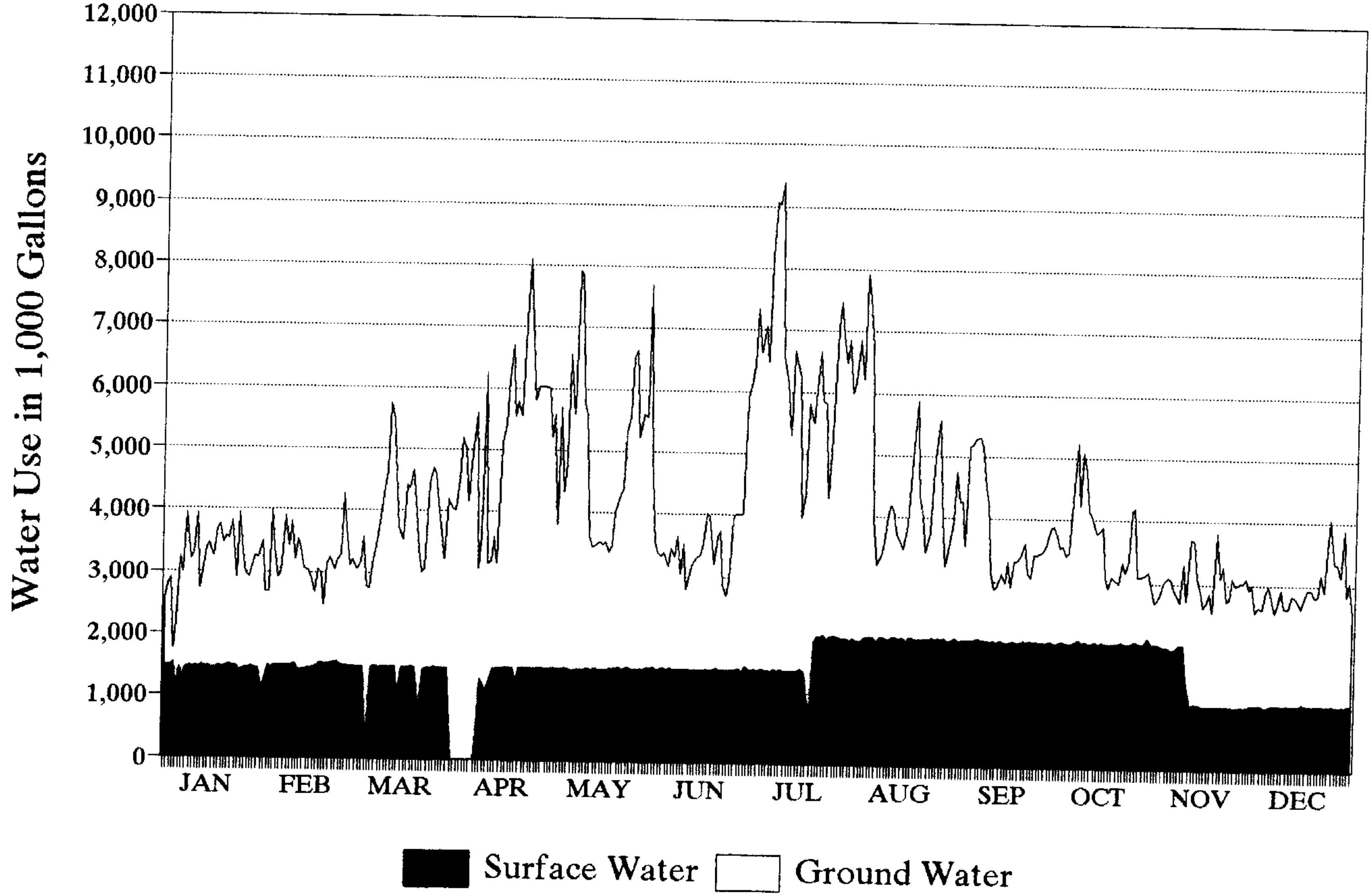


Figure 3.7
Plainview Daily Water Use - 1990

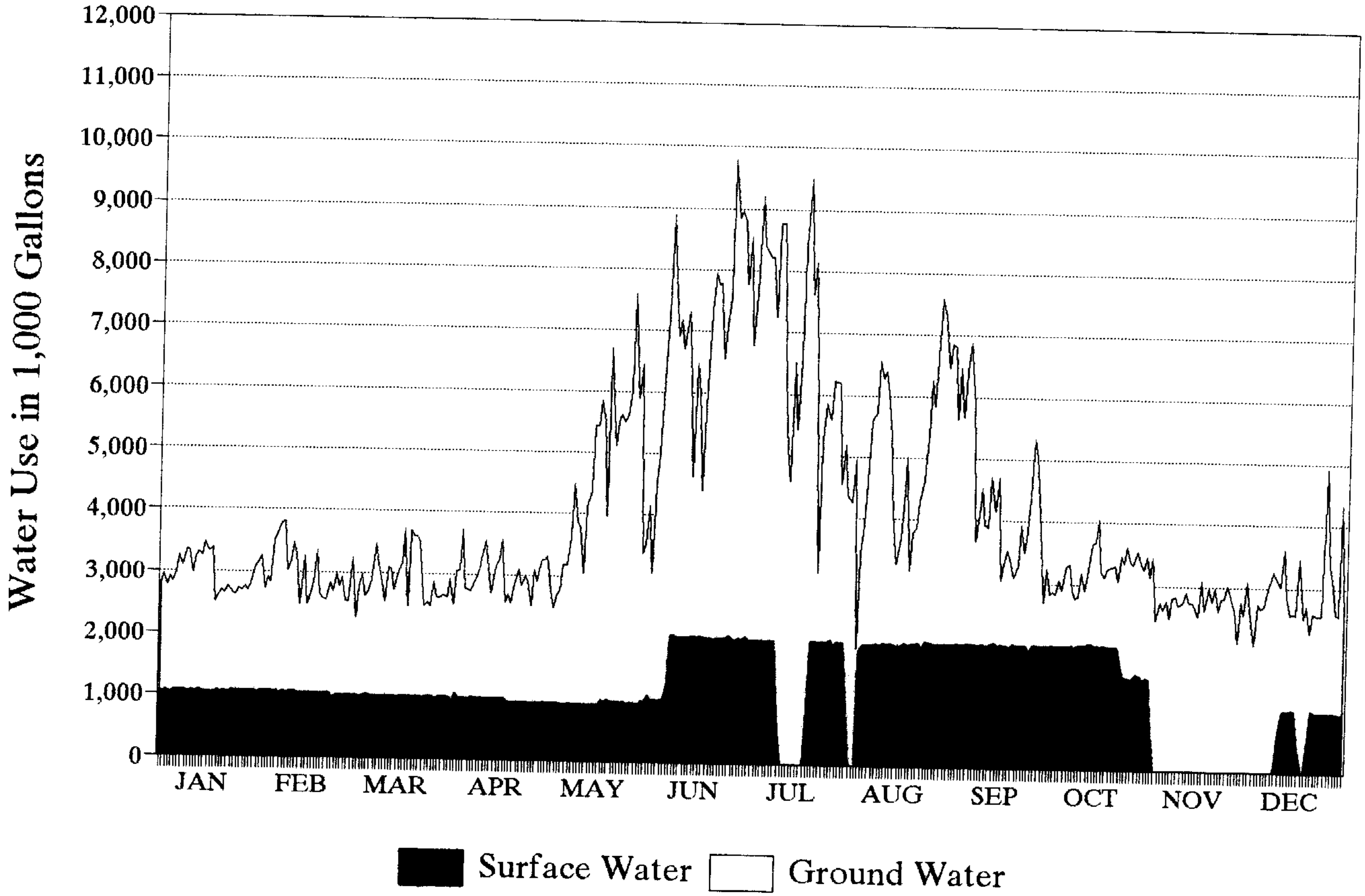
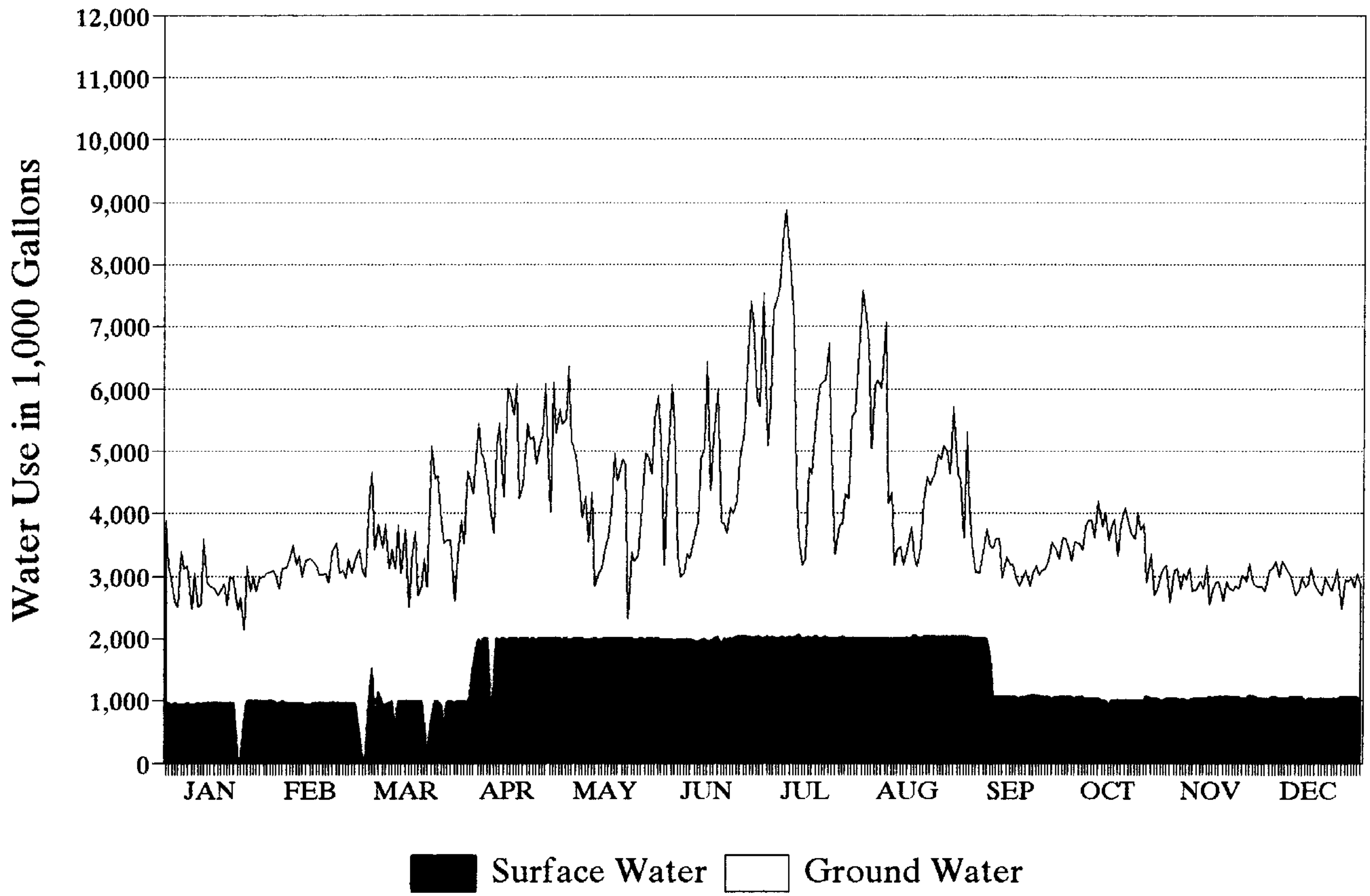


Figure 3.8
Plainview Daily Water Use - 1991



member cities. The federal government has been studying the possibility of diverting highly saline low flows from the Canadian River upstream from Lake Meredith, thus reducing the inflow of salts and the level of dissolved solids in the lake. CRMWA is also investigating development of a groundwater well field to supplement Lake Meredith diversions with higher quality groundwater. Based on the draft report on the preliminary investigation of the potential groundwater well field (9), CRMWA development of this alternative would have the following effects on Plainview:

- CRMWA water (which would be a blend of Lake Meredith water and less saline groundwater) would be usable with little or no blending after conventional treatment. This would give Plainview the option of using more CRMWA water and less local groundwater.
- The amount of CRMWA water available to Plainview would increase.
- The unit cost of water from CRMWA would increase to cover the cost of the new project.

CRMWA is planning to continue its investigations of development of the proposed groundwater well field.

4. WATER TRANSMISSION FOR REGIONAL SUPPLY

Plainview is the obvious candidate to serve as a regional water supplier for the study area. The City is by far the largest municipal water supplier in the area, with over 93 percent of the municipal water use, and it has access to surface water from CRMWA as well as groundwater. Plainview currently supplies a portion of the water for Seth Ward Water Supply Corporation by a direct connection from the City's water distribution system. The other water suppliers in the study area are not as close to Plainview as the Seth Ward Water Supply Corporation, and it would be necessary to build potable water transmission facilities if Plainview is to provide water for these suppliers in the future.

Pipeline to Kress

Development of potable water transmission facilities to the Town of Kress is the most immediate concern, for the following reasons:

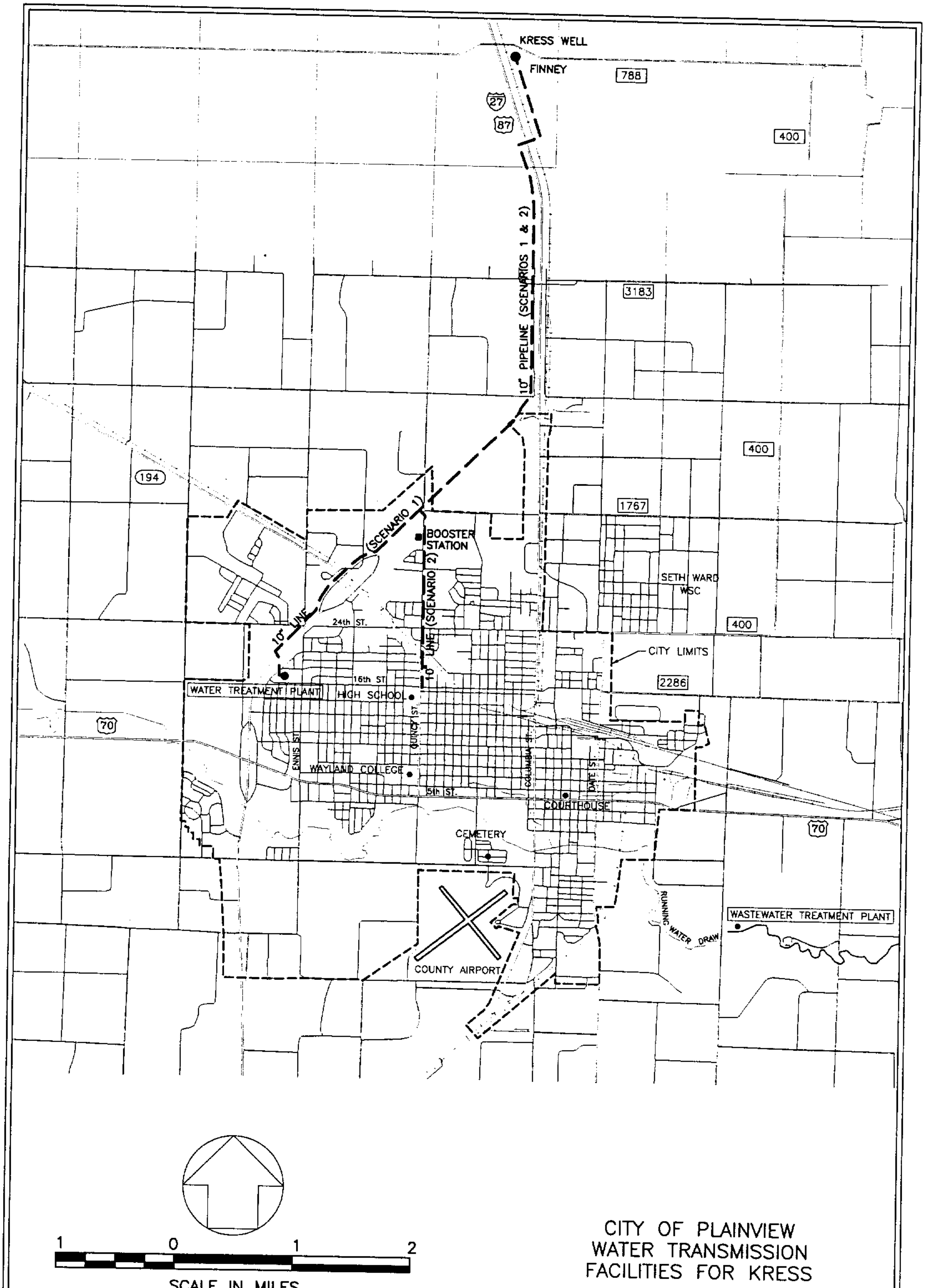
- Kress has the greatest water use of the other study area suppliers.
- Kress' current supply sources appear to be somewhat undependable, and the Town has expressed interest in a supply from Plainview.
- Kress is some distance from Plainview, which would make the transmission facilities relatively expensive.

In addition to the three groundwater wells discussed in Section 3, the Town of Kress has two storage tanks: a 200,000 gallon ground storage tank on the south side of town, which serves as a terminal storage tank for the water pumped from the well near Finney, and a 50,000 gallon elevated storage tank near the center of town (10).

For this study, it is assumed that treated water from Plainview's water treatment plant would be delivered to meet the peak-day needs of the Town of Kress. As discussed in Section 2, the year 2040 peak-day demand for the Town of Kress is projected to be 0.28 MGD. Delivery of water to Kress would require a pump station in Plainview and a pipeline from Plainview's water treatment plant to Kress' existing water supply pipeline from the well north of Finney. (The existing pipeline from Finney would convey the water to the ground storage tank on the south side of Kress.)

One approach to supplying Kress would be to build a 10" pipeline from the Plainview water treatment plant north along Interstate Highway 27 to Finney. Figure 4.1 shows the southern part of this pipeline as Alternative 1. The system would require a 0.3 MGD booster station with two 12 horsepower pumps at the treatment plant. Water would be transferred to Kress at the water treatment plant boundary. The total length of the transmission line from the water treatment plant to the well location north of Finney would be approximately 6.6 miles. This approach avoids construction in developed areas in Plainview. The estimated total capital cost of the required facilities, including engineering, surveying and contingencies, would be approximately $1,406,000, as shown in Table 4.1.

An alternative approach for supplying treated water to Kress could be built in conjunction with potential improvements to Plainview's water distribution system. If improvements are made so that more water can be delivered from the water treatment plant to the central part of Plainview, it would be possible to develop a slightly shorter



CITY OF PLAINVIEW
WATER TRANSMISSION
FACILITIES FOR KRESS

FREESE AND NICHOLS, INC.
1993

FREESE AND NICHOLS, INC.

FIGURE 4.1

Table 4.1

Cost Estimate for Water Transmission Facilities to Kress

Alternative 1

Item	Quantity	Units	Unit Price	Total Price
Mobilization	-	LS	-	$ 48,500
10" PVC Line	35,000	LF	$ 18.00	630,000
Bore and Open Cut Crossings:				
Ft. Worth and Denver Railroad	50	LF	140.00	7,000
Atchison, Topeka and Santa Fe Railroad	50	LF	140.00	7,000
Interstate Highway 27 (2 crossings)	312	LF	140.00	43,700
U.S. Highway 194	116	LF	140.00	16,200
F.M. 3183	75	LF	140.00	10,500
F.M. 788	75	LF	140.00	10,500
County Roads (7 crossings)	350	LF	40.00	14,000
Trench Safety	35,000	LF	2.00	70,000
Line/Tank Disinfection Setup	-	LS	-	5,000
Air Release/Vacuum Valve Structure	12	EA	3,000	36,000
Blow and Drain Valves	2	EA	3,000	6,000
Booster Station	-	LS	-	114,400
Subtotal 1				$1,018,800
Engineering and Survey @ 20%				203,800
Subtotal 2				$1,222,600
Contingencies @ 15%				183,400
TOTAL				$1,406,000

transmission line to Kress. In this case, a 10" pipeline would run from Sixteenth and Quincy north to Finney. Figure 4.1 shows this pipeline as Alternative 2. The total length of the 10" pipeline from Sixteenth and Quincy to the well location north of Finney would be approximately 6.2 miles, saving 0.4 miles of pipeline. With this approach, the first mile of the line would be in developed areas in Plainview, while the rest would be in open areas. As with the first alternative, there would be a 0.3 MGD booster station with two 12 horsepower pumps in Plainview. Water would be transferred to Kress at this booster station. Operation and maintenance on the pipeline and booster station would be the responsibility of Plainview, and Kress would reimburse the City for the expenses. The estimated total capital cost of the facilities for the second alternative, including engineering, surveying and contingencies, would be approximately $1,512,000, as shown in Table 4.2. This does not include the cost of the water distribution system improvements in Plainview.

Alternative 1, with the pipeline from the water treatment plant to the Kress pipeline north of Finney, would cost about $106,000 less than the second alternative. Since Alternative 1 would keep the Kress supply separate from Plainview's internal distribution system and would not require any improvements to that system, it is the recommended alternative. Kress may have to modify the existing pump on its groundwater well near Finney to match the head in the proposed transmission line. The need for such modifications would be investigated as part of the detailed design of the transmission line.

Table 4.2

Cost Estimate for Water Transmission Facilities to Kress

Alternative 2

Item	Quantity	Units	Unit Price	Total Price
Mobilization	-	LS	-	$ 52,200
10" PVC Line (in town)	7,500	LF	$ 28.00	210,000
10" PVC Line (open areas)	25,000	LF	18.00	450,000
Bore and Open Cut Crossings:				
Ft. Worth and Denver Railroad	50	LF	140.00	7,000
Atchison, Topeka and Santa Fe Railroad	50	LF	140.00	7,000
Interstate Highway 27 (2 crossings)	312	LF	140.00	43,700
F.M. 3183	75	LF	140.00	10,500
F.M. 788	75	LF	140.00	10,500
County Roads (3 crossings)	150	LF	40.00	6,000
Pavement Replacement 32:	2,220	SY	28.00	62,200
Trench Safety	35,000	LF	2.00	65,000
Traffic Control	-	LS	-	10,000
Line/Tank Disinfection Setup	-	LS	-	5,000
Air Release/Vacuum Valve Structure	12	EA	3,000	36,000
Blow and Drain Valves	2	EA	3,000	6,000
Booster Station	-	LS	-	114,400
Subtotal				$1,095,500
Engineering and Survey @ 20%				219,100
Subtotal				$1,314,600
Contingencies @ 15%				197,200
TOTAL				$1,511,800

Treated Water Transmission Facilities for Other Suppliers

Seth Ward Water Supply Corporation can be supplied directly from Plainview's water distribution system, and the facilities needed to supply Kress are outlined above. The other two water suppliers in the area, Ebeling Water Supply Corporation and Pleasant Hills Water Company, are closer to Plainview than Kress and are close to one another. If it becomes desirable to supply these entities with water from Plainview, a 6-inch pipeline could be run west from the City to their service areas to deliver a peak-day flow of 0.1 MGD. The capital cost of this transmission facility, including a 2.8-mile pipeline and a booster station at the Plainview water treatment plant, would be approximately $540,000.

Cost of Regional Treated Water Supplies

The cost to other suppliers for treated water from Plainview's water system should be based on Plainview's actual cost of service. Elements of cost would include:

- Payment of any debt service costs incurred by Plainview for facilities constructed to deliver water to other suppliers.
- Payment of operation and maintenance costs incurred by Plainview for facilities constructed to deliver water to other suppliers.
- Payment of a share of Plainview's debt service costs for the Canadian River Municipal Water Authority facilities, based on the contract peak delivery rate to other suppliers.
- Payment of a pro rata share of charges to Plainview for operation and maintenance of the CRMWA facilities, based on annual water use by other suppliers.
- Payment for debt service costs for Plainview's water treatment plant, based on the

contract peak delivery rate to other suppliers.

- Payment of a pro rata share of operation and maintenance costs for Plainview's water treatment plant, based on annual water use by other suppliers.

- Payment of a pro rata share of administration costs for water utility, based on annual water use by other suppliers.

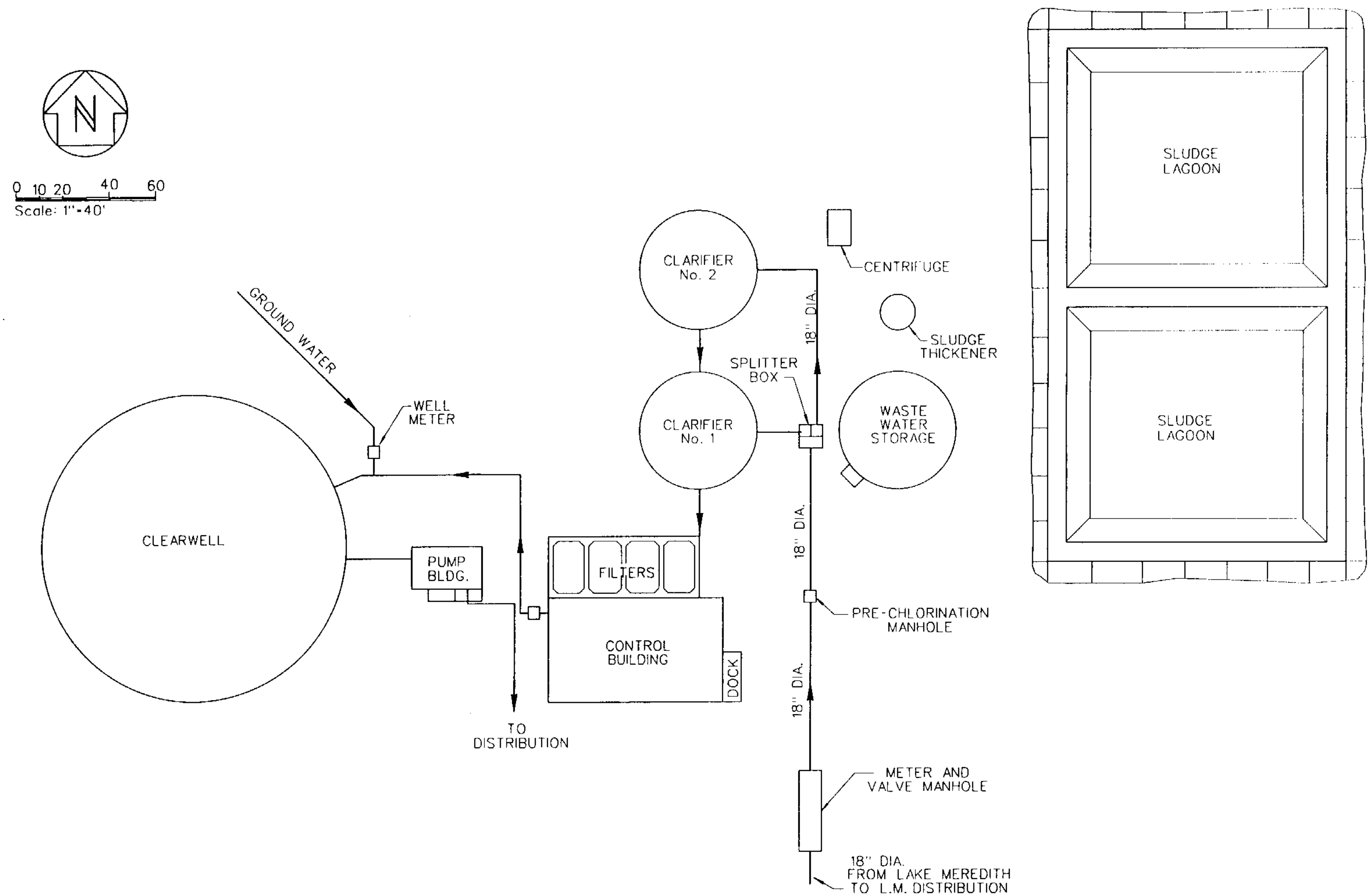
5. WATER TREATMENT PLANT

Plainview's surface water treatment plant is the largest single source of water supply in the study area. This section describes the evaluation of that plant for compliance with current Safe Drinking Water Act standards and requirements.

Water Treatment Plant Description

Plainview's 4.2 million gallons per day (MGD) solids contact type water treatment plant treats raw water from Lake Meredith, delivered to Plainview by the Canadian River Municipal Water Authority. The City blends treated surface water with groundwater in the plant's clearwell. This blending avoids problems with taste by reducing the relatively high dissolved solids levels in the surface water. Figure 5.1 and the following paragraphs describe the existing water treatment plant.

As shown in Figure 5.1, the existing treatment process includes solids contact clarification, filtration, disinfection and clearwell storage. Raw water enters the plant through an 18 inch diameter pipe, flows through a raw water meter and is pre-chlorinated using free chlorine. The flow continues through a splitter box to either of the two solids contact clarifiers. The clarifiers can be operated in series, parallel, or individually. Currently, they are operated singly, with operation in series only when additional contact time is required to handle taste and odor episodes. From the clarifiers, the water flows by gravity to four mono-media filters, containing approximately 27 inches of sand media. After filtration, treated water is combined with approximately equal amounts of



FREESE AND NICHOLS, INC.
CONSULTING ENGINEERS
FORT WORTH, TEXAS

CITY OF PLAINVIEW
WATER TREATMENT
PLANT LAYOUT

FIGURE 5

groundwater in the 2 million gallon clearwell.

Safe Drinking Water Act Disinfection Requirements

In Texas, the Texas Natural Resources Conservation Commission (TNRCC) administers the requirements of the SDWA through the Texas Surface Water Treatment Rule (TSWTR). The TSWTR sets standards for disinfection based on a "CT" (Concentration of disinfectant and Time) evaluation of a water treatment plant. The TSWTR requires that the combination of treatment and disinfection achieve at least a 99.9% (3-log) inactivation/removal of *Giardia lamblia* cysts and at least a 99.99% (4-log) inactivation/removal of viruses. For conventional treatment, the rule requires at least a 0.5-log inactivation of *Giardia* and a 2.0-log inactivation of viruses through disinfection contact time. (The remaining required inactivation is assumed to occur through other treatment processes.)

Surface Water Treatment Rule Disinfection Evaluation for Plainview

The original scope of services for the regional water supply and treatment plan was to conduct a tracer study (a field version of the CT analysis) for Plainview's water treatment plant. Information gathered during the initial water treatment plant site visit suggested that the tracer study would not be required, and Freese and Nichols recommended that the calculated method would be used to determine CT compliance. This change to the scope seemed desirable for the following reasons:

- The Texas Natural Resource Conservation Commission allows the use of the calculated method for determining CT compliance for certain plants whose disinfection strategy is based on free chlorine, such as Plainview.

- Preliminary calculations using conservative hydraulic assumptions showed that Plainview's water treatment plant complies with the CT requirements in its current operation.

- Any physical modifications to the plant would require a CT compliance study (probably a full tracer study). Preliminary indications are that certain physical improvements may be necessary to improve operations at the Plainview surface water treatment plant. If such improvements are made, Plainview would have to redemonstrate its compliance. Therefore, Plainview should demonstrate its current compliance with the CT requirements by the least expensive of the available methods, the calculated method.

Appendix C is a copy of the calculated CT compliance evaluation for Plainview. The Texas Water Commission (predecessor to the TNRCC) accepted this evaluation as demonstrating Plainview's compliance with current requirements. Since the existing disinfection strategy meets both the virus and *Giardia* CT requirements, no modifications to the treatment plant are currently required. To meet the CT requirements, plant operators must maintain a free chlorine residual of at least 1.0 mg/l from the point of free chlorine application up to and including the clearwell.

<u>Turbidity and Filter Performance</u>

TSWTR turbidity requirements became effective July 1, 1993, requiring that a system's filtered water must have a turbidity less than or equal to 0.5 NTU in at least 95 percent of the measurements taken each month, with no sample exceeding 5 NTU. The turbidity performance of a treatment plant depends on the chemical settling and filtration processes.

Table 5.1 shows turbidity analysis for Plainview's water treatment plant for the period from January 1990 through June 1993. Discussions with plant staff at the end of November confirmed that the turbidity removal since June 1993 is consistent with the levels recorded since August of 1992. With the plant operating at a capacity of approximately 2 MGD, it is shown to consistently achieve the turbidity removal requirements.

At higher flow rates, the plant may not be able to consistently meet the current turbidity requirements. Turbidity can be especially difficult to control during the spring when high winds are often a problem. High winds can cause the sludge blanket in the clarifier to wash out, which overloads the filters and increases the turbidity of the filtered water. Plainview can operate the plant to meet turbidity regulations during these periods by either reducing the flow through the plant and/or carefully timing filter backwash operations. Return of all the filter backwash water to the head of the plant, as is current practice, tends to cause the effluent quality to deteriorate when the plant is operating at a high flow rate.

It is important that Plainview use as much CRMWA water as possible in order to preserve in-city groundwater for long-term needs. In order to operate the water treatment plant at flow rates above 2 MGD and achieve the required turbidity levels, the City will need to make some improvements to the plant. We recommend that Plainview make the following improvements in the near future:

- Provide wind baffles or covers for the solids contact clarifiers to reduce the affect

Table 5.1

Historical pH and Turbidity Data, 1990-1993

Month/Year	Maximum pH		Treated Water Turbidity (NTU)					
	Raw Water	Treated Water	Average	Maximum	Minimum	Total# Samples	#Samples ≤0.5 NTU	%Samples ≤0.5 NTU[a]
January, 1990	8.8	7.9	0.58	0.88	0.47	31	2	3.2%
February	8.7	7.9	0.59	0.89	0.47	28	2	7.1%
March	8.9	7.8	0.59	0.93	0.49	31	1	3.2%
April	8.9	7.8	0.55	0.72	0.39	19	1	5.3%
May	8.7	7.8	0.43	0.62	0.29	31	26	80.6%
June	8.9	7.8	0.68	0.99	0.27	30	6	20.0%
July	8.5	7.4	0.72	0.95	0.35	31	7	22.6%
August	8.6	7.7	0.51	0.76	0.36	31	23	61.3%
September	8.7	7.6	0.41	0.71	0.10	30	24	73.3%
October	8.4	7.4	0.74	1.00	0.42	31	1	3.2%
November	8.3	7.8	0.24	0.78	0.12	30	27	90.0%
December	9.2	7.8	0.33	0.91	0.10	31	24	77.4%
January, 1991	8.9	7.7	0.45	0.94	0.10	31	21	67.7%
February	8.9	7.6	0.34	0.78	0.16	28	22	78.6%
March	8.7	7.7	0.27	0.70	0.10	31	28	90.3%
April	8.6	7.6	0.30	0.82	0.09	30	27	90.0%
May	8.9	7.5	0.37	0.75	0.10	31	24	77.4%
June	8.7	7.5	0.31	0.55	0.02	30	27	90.0%
July	8.7	7.8	0.25	0.53	0.09	31	29	93.5%
August	8.8	7.6	0.25	0.75	0.02	31	29	90.3%
September	8.6	7.4	0.35	0.84	0.02	30	23	73.3%
October	8.4	7.4	0.23	0.58	0.04	31	30	90.3%
November	8.9	7.3	0.26	0.98	0.06	30	29	93.3%
December	8.8	7.3	0.34	0.97	0.06	31	26	83.9%

Table 5.1, Continued

Month/Year	Maximum pH		Treated Water Turbidity (NTU)					
	Raw Water	Treated Water	Average	Maximum	Minimum	Total# Samples	#Samples ≤0.5 NTU	%Samples ≤0.5 NTU[a]
January, 1992	8.9	7.1	0.36	0.69	0.11	31	30	96.8%
February	8.5	7.0	0.28	0.96	0.09	28	27	96.4%
March	8.4	8.3	0.31	0.44	0.13	31	31	100.0%
April	8.6	7.2	0.28	0.68	0.03	30	30	100.0%
May	8.6	7.2	0.29	0.88	0.06	31	29	93.5%
June	8.6	7.2	0.22	0.43	0.01	30	30	100.0%
July	8.8	7.1	0.33	0.86	0.03	31	27	87.1%
August	8.6	7.9	0.23	0.39	0.07	31	31	100.0%
September	8.6	7.3	0.24	0.48	0.05	30	30	100.0%
October	8.6	7.1	0.28	0.48	0.10	31	31	100.0%
November	8.8	7.6	0.30	0.49	0.14	30	30	100.0%
December	8.5	7.0	0.26	0.50	0.05	31	31	100.0%
January, 1993	8.5	7.0	0.28	0.49	0.06	31	31	100.0%
February	8.7	7.1	0.31	0.46	0.14	28	28	100.0%
March	8.5	7.1	0.15	0.44	0.02	31	31	100.0%
April	8.9	7.9	0.12	0.29	0.04	30	30	100.0%
May	8.5	7.0	0.11	0.34	0.02	31	31	100.0%
June	8.4	7.0	0.10	0.22	0.04	30	30	100.0%
Maximum	9.2[b]	7.9		1.00				

Notes: a. After July 1, 1993, 95% of turbidity samples must be ≤0.5 NTU.
b. One daily sample recorded pH >9.0 during two year period (December 1990).

of wind on the sludge blanket.

- Modify the backwash return water operations to return only the clearer water from the top of the washwater basin. (Improvements are scheduled for the first quarter of 1994 to make this modification.)

In order to treat the full rated capacity of 4.2 MGD, it is necessary to operate the two clarifiers in parallel. Plant staff should verify the operability of the valves and piping required for parallel operation and upgrade the equipment if necessary. If these modifications do not allow the plant to operate at 4.2 MGD, the next steps would be to replace the filter media with dual media and possibly to expand the filters.

6. WASTEWATER REUSE FEASIBILITY STUDY

One possible source of additional water supply for the Plainview area would be the reuse of treated wastewater. In addition to providing water supply, wastewater reuse offers the benefit of reducing the amount of treated wastewater discharged into the environment. The Texas Natural Resources Conservation Commission (TNRCC) now requires wastewater reuse feasibility studies as a condition of municipal wastewater discharge permitting. Appendix D is a wastewater reuse feasibility study for Plainview.

Scope of the Wastewater Reuse Feasibility Study

The wastewater reuse feasibility study for Plainview includes the following elements:

- Water supply and demand assessment for the area served
- Inventory/screening of potential reclaimed wastewater users
- Inventory of potential uses and analysis of the market for reclaimed wastewater
- Preliminary cost-benefit analysis for the treatment and use of reclaimed wastewater.

Water Supply and Demand Assessment

As discussed in Section 2, Plainview's total water use in 1991 was 1,484 million gallons, including sales to the Seth Ward Water Supply Corporation. About 132 million gallons of that total, or 9 percent, went to the 23 customers with an annual consumption of over 1 million gallons. In addition, there are four major self-supplied industrial or commercial users near the City, with a total water use of 215 million gallons per year. Plainview's average discharge of treated wastewater effluent from 1988 to 1991 was about

765 million gallons, or about 52 percent of the 1991 municipal water use. The currently permitted average day discharge from the plant is 2.23 MGD, which would be 814 million gallons in a year.

Inventory/Screening of Potential Reclaimed Water Users

Table 6.1 lists potential users of reclaimed wastewater in and near Plainview. Reclaimed wastewater is not considered for potable water supply because of health concerns, the high cost of treating wastewater effluent to potable standards and the availability of alternative supplies. Irrigated agriculture is not considered to be a likely candidate for reclaimed water due to the availability of relatively inexpensive groundwater from the Ogallala Aquifer. The potential reclaimed water users listed in Table 6.1 include 7 municipal users, 2 commercial users, and 2 industries. The total potential reuse is about 95.5 million gallons per year.

The City landfill is a particularly promising candidate for wastewater reuse. Plainview is proposing to plant trees around the landfill perimeter to serve as a visual barrier and a windblock. Irrigation for these trees would require a substantial amount of water, and the use of reclaimed wastewater would be economical because the landfill is very near the wastewater treatment plant.

Inventory of Potential Uses/Analysis of Market Conditions

Table 6.2 identifies the type of use for the potential users of reclaimed wastewater identified in Table 6.1. The majority of the estimated potential use for reclaimed water

Table 6.1

Potential Reclaimed Water Users

Customer Type	Customer	Estimated Annual Use (gallons)
Municipal	City Cemetery[a]	negligible
	Running Water Draw Regional Park	5,132,000
	Broadway Park	2,000,000
	Givens St. Park	2,000,000
	Frisco Park	1,000,000
	Other City Parks	1,750,000
	Wastewater Treatment Plant[b]	28,500,000
	City Landfill[c]	30,628,000
Commercial	Walmart Distribution Center	1,882,000
	Country Club	1,707,000
Industrial	Excel	15,635,000
	Zipp Industries (Occidental)	5,256,000
TOTAL		95,490,000

Notes:
a. The quantity of water consumed is negligible.
b. The wastewater treatment plant already uses effluent for non-potable purposes. This consumption is not metered, but is estimated at 3.5% of the permitted discharge.
c. The landfill is not a current water consumer. However, the proposed addition of trees makes the landfill a potential candidate for reuse.

Table 6.2

Type of Use for Potential Reclaimed Wastewater Customers

Type of Use	Customer	Estimated Annual Use (gallons)
Restricted Access Landscape Irrigation	City Cemetery	negligible
	City Landfill	30,628,000
	Walmart Distribution Center	1,882,000
	Country Club	1,707,000
Restricted Access Landscape Irrigation/ Process	Wastewater Treatment Plant	28,500,000
Process	Excel	15,635,000
	Zipp Industries	5,256,000
Subtotal		83,608,000
Unrestricted Access Landscape Irrigation	Running Water Draw Regional Park	5,132,000
	Broadway Park	2,000,000
	Givens Street Park	2,000,000
	Frisco Park	1,000,000
	Other City Parks	1,750,000
Subtotal		11,882,000
TOTAL		95,490,000

would be for landscape irrigation of areas with restricted access or for industrial process water. Landscape irrigation for areas with unrestricted access, such as City parks, requires a higher degree of treatment than these uses.

Preliminary Cost/Benefit Analysis

Preliminary cost-benefit analyses for various alternative scenarios for the use of reclaimed wastewater indicate that a major wastewater reuse project is not cost-effective for Plainview. For systems delivering water to several users, the estimated unit cost of reclaimed wastewater would vary from $6.68 per thousand gallons to $59.33 per thousand gallons. The current cost of potable water from the City is $0.90 per thousand gallons. The only alternative which appears to be promising is the reuse of reclaimed wastewater at the City landfill for tree irrigation. The estimated unit costs for this limited system range from $1.17 to $1.53 per thousand gallons, depending on the design assumptions. If the City decides to plant trees around the landfill, this potential use of reclaimed wastewater should be investigated further.

7. ALTERNATIVES FOR ADDITIONAL WATER SUPPLY

As discussed in Section 2, the normal-year municipal water demand for the study area is expected to increase from approximately 1,565 million gallons in 1990 to 2,021 million gallons by 2040. The year 2040 drought-year demand is projected to be 2,325 million gallons, and the peak day demand is projected to be 14.4 million gallons. By the year 2040, it is assumed that Plainview will be supplying all municipal water use in the study area as a regional water supplier. Figure 7.1 shows the projected normal-year, drought-year, and peak day demands to be supplied by Plainview, as given in Table 2.14.

Requirements for Long Range Water Supply

The long range water supply plan for Plainview must satisfy the following requirements:

- Provide the total amount of water needed from Plainview over the study period. According to the demand projections shown in Figure 7.1 and Table 2.14, the projected total amount of water to be supplied by Plainview over the 47 years from 1994 through 2040 is 85,173 million gallons.

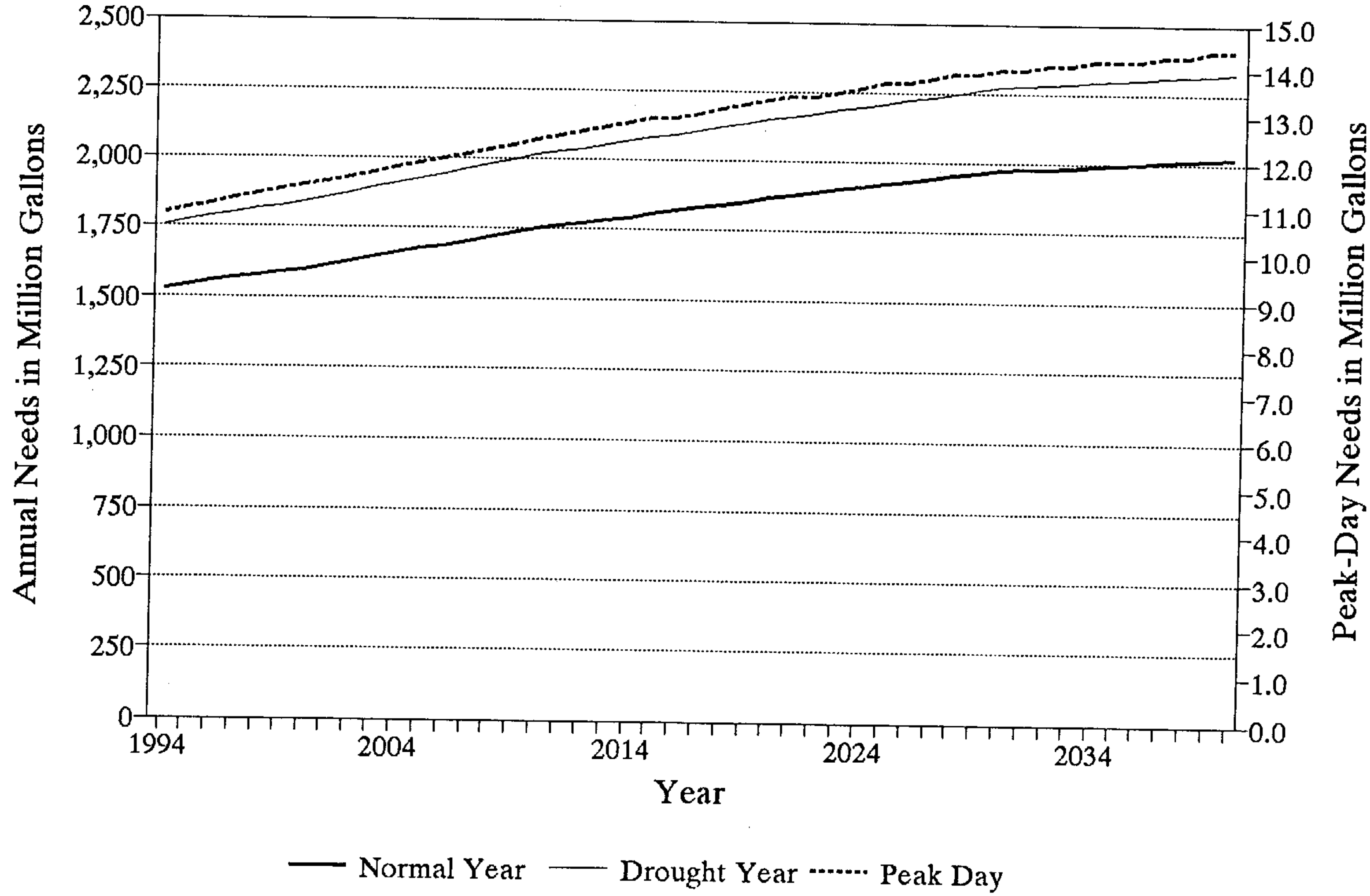
- Be capable of providing the drought year supply needed from Plainview in each year should a drought occur. By 2040, the potential drought year demand is expected to reach 2,325 million gallons.

- Be capable of supplying the peak day supply needed from Plainview in each year. The peak day supply needed from Plainview is projected to reach 14.4 million gallons by 2040.

- Provide potable water for Plainview and its customers at a reasonable unit cost.

It is also important for Plainview to preserve water supply sources near the City to meet future peak demands. If it becomes necessary to meet peak demands from distant

Figure 7.1
Projected Plainview Water Requirements



sources, the capacity (and thus the cost) of water transmission facilities will increase greatly. Maintaining a nearby source for peaking makes it possible to use more distant sources for base supplies, with much smaller (and less expensive) water transmission facilities.

Alternatives for Long Range Water Supply

Based on the analyses conducted for this study and on discussions with City of Plainview staff, the following long range water supply alternatives were considered for Plainview:

- Continue the current practice of supplying about 40 percent of the water use from surface water and 60 percent from groundwater wells within the City of Plainview.
- Make distribution system improvements and increase the amount of surface water used.
- Purchase additional groundwater rights immediately outside of the City to allow the development of additional supplies.
- Develop one or more groundwater well fields outside of the city to provide additional supplies.
- Assuming that the Canadian River Municipal Water Authority develops additional supplies and improves the water quality from that source, increase the use of CRMWA water.
- Install desalination equipment at the water treatment plant to allow increased use of surface water supplies.
- Supply a part of the municipal water needs for the study area from reclaimed wastewater.

Freese and Nichols conducted a preliminary screening of these alternatives based on available information. The results of that screening are summarized below:

Continue the current practice. In recent years, the City of Plainview has supplied approximately 60 percent of its water use from groundwater. If this practice were to continue for the next 47 years, the projected supply from groundwater would be 60 percent of 85,173 million gallons, or 51,104 million gallons. According to the Guyton Associates report *Ground-Water Availability in the Vicinity of Plainview, Texas* (1), there are about 41,400 to 46,600 million gallons of recoverable groundwater within Plainview's current city boundaries. As an approximation, continued reliance on groundwater within the city limits for the next 47 years, without increasing the portion of water use supplied by surface water, would completely exhaust the recoverable groundwater supplies within the Plainview city limits. This is likely to be the least expensive alternative for Plainview in the short term, but it will leave the City with no in-city supplies for the future.

Make distribution system improvements. Plainview's use of surface water is limited by water quality (which requires blending with lower-salinity groundwater) and by distribution system limitations. The distribution system limitations make it difficult to supply parts of Plainview from the water treatment plant, which is on the west side of the City. It seems likely that water distribution system improvements could increase the amount of surface water used, perhaps from an average of 40 percent of total use to an average of 50 percent. (Water quality considerations would probably make it difficult to provide more than 50 percent of the water use from surface water.) If CRMWA develops additional supplies and improves the quality of its supplies, the use of surface water can be increased without distribution system improvements.

Purchase additional groundwater rights immediately outside of the City. This alternative would provide additional groundwater reserves without changing the basic water supply system of a centralized surface water supply with groundwater from multiple sources. In general, land is more expensive near the City, and the acquisition of groundwater rights could be difficult.

Develop new groundwater well fields. This alternative is likely to be expensive in the short term, but it would allow the City to provide for future supplies and to preserve groundwater within the City for peaking.

If CRMWA develops additional supplies, increase use of surface water. As is discussed in Section 3, the CRMWA is studying the possibility of developing a groundwater well field and blending groundwater with Lake Meredith water. This project would improve the quality of the CRMWA supply (by lowering dissolved solids) and increase the amount of water available to Plainview and other customers. This alternative is not entirely within the control of the City of Plainview, since other CRMWA member cities will participate in the decision on developing additional supplies. If the CRMWA does develop additional supplies and improve its water quality, Plainview would be able to increase its use of CRMWA water and preserve local groundwater supplies for peaking. However, the resulting increased unit cost of CRMWA water and the cost of surface water treatment will probably make this increased use of CRMWA water an expensive alternative.

Install desalination equipment. Preliminary investigations indicate that this alternative will be prohibitively expensive because of the high capital and operating costs of such facilities.

Use reclaimed wastewater. As is discussed in Section 6 and Appendix D, this alternative does not appear to be cost-effective for Plainview, with the possible exception of limited local irrigation supplies near the wastewater treatment plant.

Water Supply Scenarios Selected for Further Analysis

The preferred water supply scenario for Plainview may depend on whether or not CRMWA develops additional water supplies. It is necessary for Plainview to develop two water supply plans, one assuming that CRMWA does not develop additional supplies and another assuming that CRMWA does develop additional supplies.

For the assumption that CRMWA does not develop additional supplies, Freese and Nichols and Plainview selected the following scenarios for detailed analysis:

- **Scenario A-1.** Continue the current practice of using 60 percent groundwater and 40 percent surface water as long as possible.
- **Scenario A-2.** Make distribution system improvements to allow increased use of the available CRMWA supply and use in-city groundwater to provide the balance of the requirements.
- **Scenario A-3.** Develop new groundwater well fields adequate to meet projected future growth and continue to use CRMWA water at the current rate.

For the assumption that CRMWA does develop additional supplies, Freese and Nichols and Plainview selected the following scenarios for detailed analysis:

- **Scenario B-1.** Continue the current practice of using 60 percent groundwater and 40 percent surface water as long as possible.

- **Scenario B-2.** Increase the use of surface water to meet as much of the projected water needs as possible and use groundwater to provide the balance of the needs.

- **Scenario B-3.** Continue to use CRMWA water at the current rate and develop new groundwater well fields in order to preserve a portion of in-city supplies for peaking.

Scenarios A-1 and B-1 both call for Plainview to continue the current practice of using 60 percent groundwater and 40 percent surface water as long as possible. As discussed above, this approach would probable exhaust the in-city groundwater supply before 2040. As a result, these alternatives are probably not actually viable. They are included in the detailed analysis because they will provide a baseline and allow the City to compare the cost of other alternatives to the projected future costs of its current approach. Section 8 discusses the detailed life cycle cost analyses of these recommendations, and Appendix E includes the full life cycle cost analyses.

8. DETAILED ANALYSIS OF SELECTED SCENARIOS

Appendix E presents a detailed life cycle cost analysis for the six alternatives selected in Section 7. This section describes the results of that analysis and presents the recommended water supply plans for Plainview.

Assumptions in the Analysis

Table 8.1 gives some basic assumptions used in the detailed analysis of the water supply plans. Based on recent experience, the general inflation rate is set at 4 percent per year. The inflation rate for Canadian River Municipal Water Authority (CRMWA) general operation and maintenance expenses is 7.6 percent per year through the year 2000, based on the trend of recent CRMWA expenditures. After the year 2000, inflation for these costs is the general inflation rate of 4 percent per year. Data provided by Plainview and CRMWA are the source of the current CRMWA and Plainview water production costs. The Guyton Associates groundwater report (1) provides the estimate of 44,000 million gallons of recoverable in-city groundwater as of 1993. The debt service of 25 equal annual payments with 7 percent per year interest is a conservative assumption for possible market conditions at the time of future capital expenditures. The discount rate of 4 percent per year provides the basis for determining the present worth of future expenditures.

Appendix E includes the detailed life cycle cost analysis for each of the six scenarios. This section describes the basic approach for each scenario and presents a summary of

Table 8.1

Assumptions in the Life Cycle Cost Analyses

Inflation	
CRMWA General Operation and Maintenance	7.6 percent per year, 1993-2000 4 percent per year after 2000
CRMWA Pumping, Energy, and Chemicals	4 percent per year
Other Costs	4 percent per year
Current CRMWA Costs	
1993 Debt Service for Plainview	$101,820
1993 General Operation and Maintenance	7.66¢ per thousand gallons
1993 Pumping, Energy, and Chemicals	12¢ per thousand gallons
Current Plainview Water Production Costs	
1993 General Operation and Maintenance	$32,600 per year
1993 Groundwater Pumping	5.6¢ per thousand gallons
1993 Groundwater Production (other than pumping)	8.1¢ per thousand gallons
1993 Surface Water Treatment	32.9¢ per thousand gallons
Other Assumptions	
In-City Recoverable Groundwater in 1993	44,000 million gallons
Debt Service	25 equal annual payments at 7 percent interest
Discount Rate for Present Worth	4 percent per year

the results of those analyses. Scenarios A-1 through A-3 address Plainview's projected needs assuming that there is no new supply from CRMWA, while scenarios B-1 through B-3 are appropriate if the CRMWA develops its proposed new supplemental groundwater supply.

All of the life cycle cost analyses consider the cost of producing potable water in Plainview. They do not include the cost of delivering the water to retail customers or to other area water suppliers. These costs should be very nearly the same for all alternatives, and they should not affect the choice among the alternatives.

Appendix E shows projected future unit costs of potable water including the effect of inflation. These projected costs are changed to present worth unit costs by applying a 4 percent discount factor. In effect, this removes the impact of inflation, so that present worth costs are essentially projected future costs at 1993 prices. This section uses the present worth unit prices, with the effect of inflation removed.

Scenario A-1: No New CRMWA Supply; Continue Current Practice

The City of Plainview currently uses treated CRMWA surface water to supply about 40 percent of its needs and uses groundwater pumped by wells in the City for the remaining 60 percent. Scenario A-1 shows the impact of continuing this approach to meet projected demands through 2040. The only capital investment projected for this scenario is the construction of new groundwater wells as the in-city groundwater supplies are depleted.

Table 8.2 gives a summary of the life cycle cost analysis from 1994 through 2040 for Scenario A-1. This approach is quite economical, at least for the short term, with present worth costs projected to remain near current levels. (That is, the cost of potable water production will increase at approximately the general inflation rate.) However, the analysis shows that this approach will exhaust in-city groundwater supplies before the year 2040. Since the groundwater outside the City is currently being depleted even more rapidly than the in-city reserves, Plainview would probably face significant problems in attempting to find additional water supplies when the in-city groundwater is gone. In addition, depleting the in-city groundwater supplies eliminates the local source of water to meet peak demands. Once the local supplies are gone, Plainview will have to construct long-distance transmission facilities large enough to meet its peak needs.

Scenario A-2: No New CRMWA Supply; Make Distribution System Improvements

Plainview's use of CRMWA surface water is limited by the need to blend the treated surface water with groundwater to limit the level of dissolved solids and by the difficulty of distributing water to the entire City from the water treatment plant on the west side of town. Appendix F describes distribution system analyses conducted by Freese and Nichols and gives recommended distribution system improvements which would make it possible to increase the use of treated surface water. For the analysis of this scenario, we assume that the proposed distribution system improvements would increase the use of surface water to 50 percent. The need for blending to improve water quality makes it

Table 8.2

Summary of Results of Life Cycle Cost Analysis for Scenario A-1
No New CRMWA Supply; Continue Current Practice

1994-2040 Capital Investment in 1993 Dollars	$1,884,000
Present Worth Unit Cost of Potable Water	
Average, 1994-2040	37.6¢ per thousand gallons
Highest Year (2039)	38.8¢ per thousand gallons
Sources of Water Supply: 1994-2040	
In-City Groundwater	51,108 MG (60.0%)
CRMWA	34,065 MG (40.0%)
In-City Groundwater Remaining in 2040	-7,108 MG (depleted in 2035)

unlikely that Plainview would choose to use more than 50 percent surface water with the present CRMWA water quality. (The use of surface water is limited to the reliable supply available from CRMWA, which is 990 million gallons per year. From 2032 on, this restriction keeps the surface water supply at less than half of the total water use.) The rest of the supply needed for this scenario would come from in-city groundwater. This scenario would require capital investment for the proposed distribution system improvements and for the construction of groundwater wells as the in-city groundwater supplies are depleted.

Table 8.3 gives a summary of the life cycle cost analysis from 1994 through 2040 for this alternative. With this approach, the recoverable in-city groundwater reserves are

Table 8.3

Summary of Results of Life Cycle Cost Analysis for Scenario A-2
No New CRMWA Supply; Make Distribution System Improvements

1994-2040 Capital Investment in 1993 Dollars	$2,377,800
Present Worth Unit Cost of Potable Water	
Average, 1994-2040	42.1¢ per thousand gallons
Highest Year (1996)	46.8¢ per thousand gallons
Sources of Water Supply: 1994-2040	
In-City Groundwater	42,985 MG (50.5%)
CRMWA	42,188 MG (49.5%)
In-City Groundwater Remaining in 2040	1,015 MG

projected to last through 2040 but to be essentially depleted at that time. (The remaining in-city reserve of 1,015 million gallons is less than one year's use of groundwater.) The construction of the distribution improvements and the increased use of more expensive surface water would cause an increase in the unit cost of potable water of about 9 cents per thousand gallons in the near future, and the supply remains somewhat more expensive than the current approach. Scenario A-2 suffers from the same disadvantages of depleting in-city groundwater as does Scenario A-1, although these disadvantages are delayed by a few years.

Scenario A-3: No New CRMWA Supply; Develop New Groundwater Well Field

The development of a new groundwater well field would enable Plainview to extend the life of the in-city groundwater reserves. This scenario would require significant capital investment to purchase water rights for a well field and to construct groundwater wells and transmission facilities. We assume that the new well field would provide 40 percent of Plainview's water needs, with treated CRMWA water continuing to supply 40 percent and in-city groundwater providing the remaining 20 percent. The scenario includes the following steps in the development of the groundwater well field:

- Plainview purchases the water rights to a 10 square mile area in 1995. Based on the Guyton Associates report, 10 square miles would have about 33,000 million gallons of recoverable groundwater reserves.
- Plainview constructs a 5 mile water transmission pipeline, four wells and associated collection facilities in the year 2000 and begins to use water from the well field in 2001.
- The transmission facility brings well field groundwater to the water treatment plant for blending with treated CRMWA water.
- Plainview adds additional wells and collection facilities in 2015, 2025, and 2035.

Table 8.4 gives a summary of the life cycle cost analysis from 1994 through 2040 for this scenario. This approach leaves recoverable in-city groundwater reserves in 2040 of 22,573 million gallons - over 50 years of use at the 2040 in-city use rate. The capital costs associated with developing the groundwater well field would cause the unit cost of potable water to increase by about 27 cents per thousand gallons over the next few years, not considering the impact of inflation.

Table 8.4

Summary of Results of Life Cycle Cost Analysis for Scenario A-3
No New CRMWA Supply; Develop New Groundwater Well Field

1994-2040 Capital Investment in 1993 Dollars	$9,475,000
Present Worth Unit Cost of Potable Water	
Average, 1994-2040	49.2¢ per thousand gallons
Highest Year (2001)	69.5¢ per thousand gallons
Sources of Water Supply: 1994-2040	
In-City Groundwater	21,427 MG (25.2%)
CRMWA	34,065 MG (40.0%)
Well Field Groundwater	29,681 MG (34.8%)
In-City Groundwater Remaining in 2040	22,573 MG

Recommended Scenario if CRMWA Does Not Develop a New Supply

Table 8.5 summarizes the results of the life cycle cost analyses for the three scenarios considered assuming that CRMWA does not develop a new groundwater supply to supplement Lake Meredith. Figure 8.1 shows the projected present worth unit costs for the three scenarios from 1994 through 2040. Figure 8.2 is a comparison of the sources of supply for the three scenarios, and Figure 8.3 shows the estimated recoverable reserves of in-city groundwater as of the year 2040. Figure 8.1 shows that the present worth unit cost of water supply rises substantially over the next few years in Scenario A-3, as Plainview develops the new well field facilities. The present worth unit costs for Scenario A-3 then decline toward the unit costs for the other scenarios.

Table 8.5

Comparison of Results of Life Cycle Cost Analyses for Scenarios With No New CRMWA Supply

	Scenario A-1	Scenario A-2	Scenario A-3
1994-2040 Capital Investment in 1993 Dollars	$1,884,000	$2,377,800	$9,475,000
Average Present Worth Unit Cost of Potable Water in Cents per Thousand Gallons, 1994-2040	37.6¢	42.1¢	49.2¢
Highest Year Present Worth Unit Cost of Water			
-Year	2039	1996	2001
-Present Worth Unit Cost in Cents per Thousand Gallons	38.8¢	46.8¢	69.5¢
Sources of Water Supply			
-In-City Groundwater in Million Gallons	51,108(60.0%)	42,985(50.5%)	21,427(25.2%)
-CRMWA in Million Gallons	34,065(40.0%)	42,188(49.5%)	34,065(40.0%)
-Well Field Groundwater in Million Gallons	0	0	29,681(34.8%)
In-City Groundwater Remaining in 2040 in Million Gallons	-7,108 (depleted in 2035)	1,015	22,573

Figure 8.1 - Projected Present Worth Unit Costs If CRMWA Does Not Develop Additional Supply

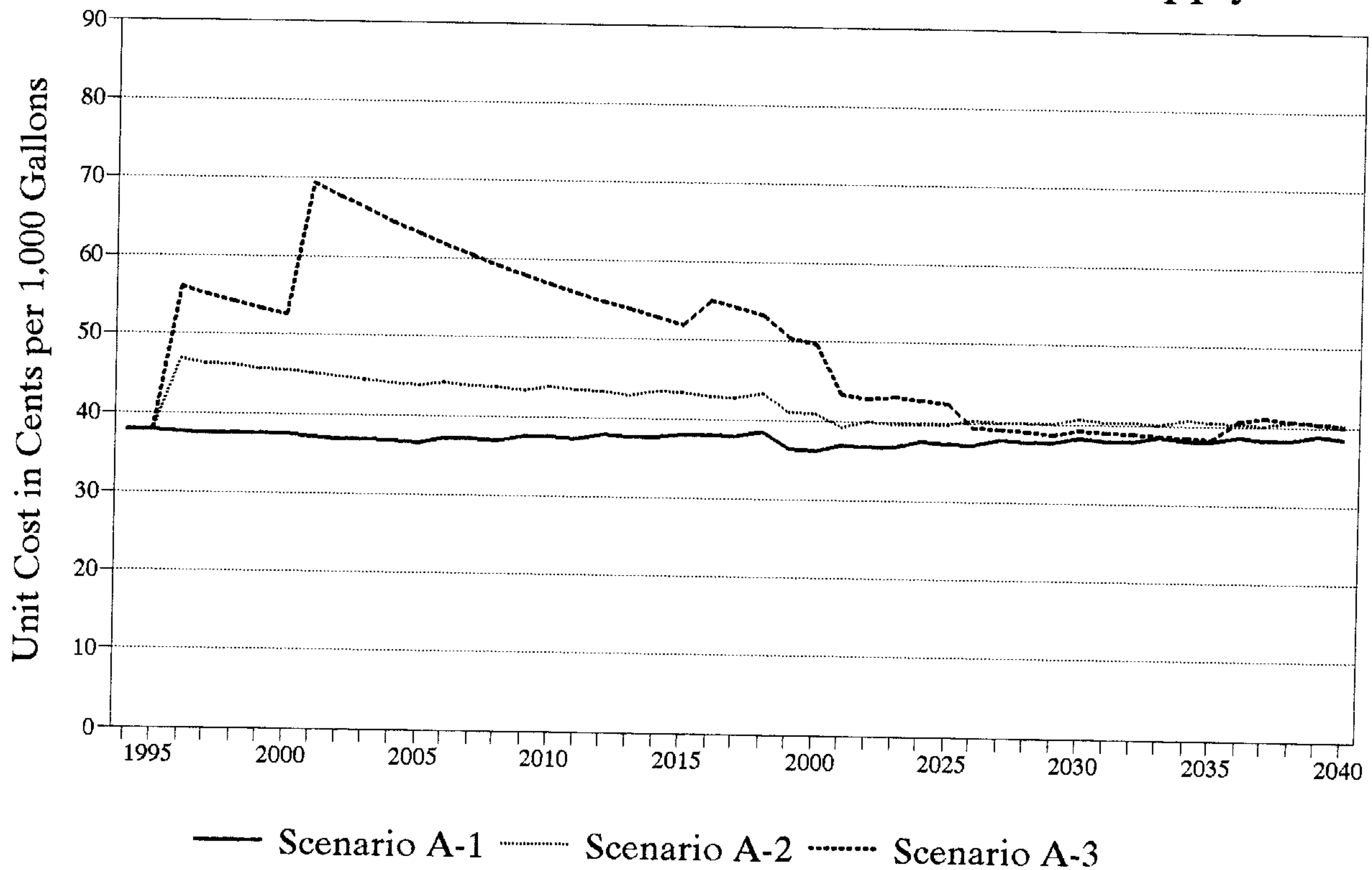


Figure 8.2 - Comparison of Sources of Supply If CRMWA Does Not Develop Additional Supply

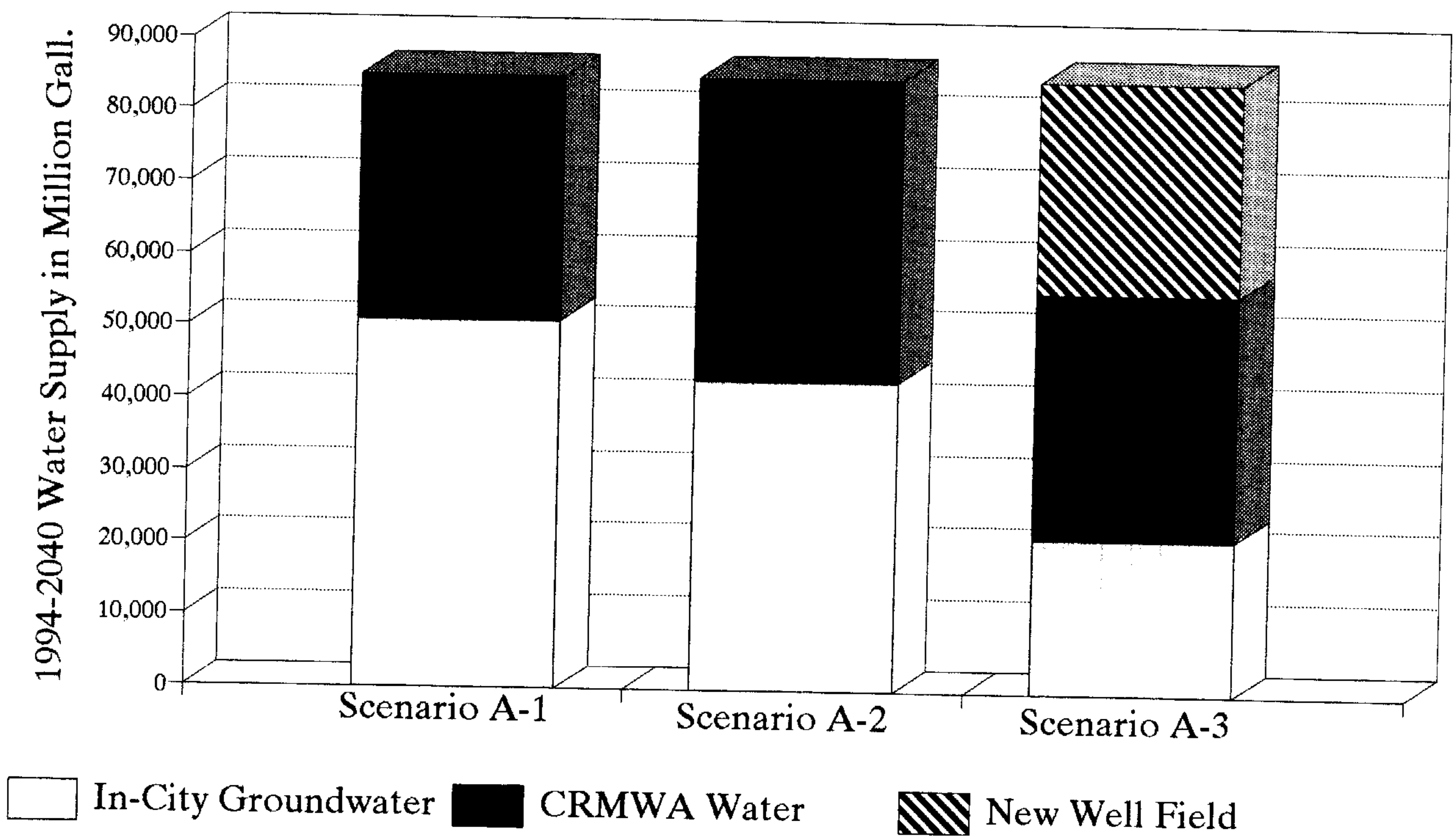
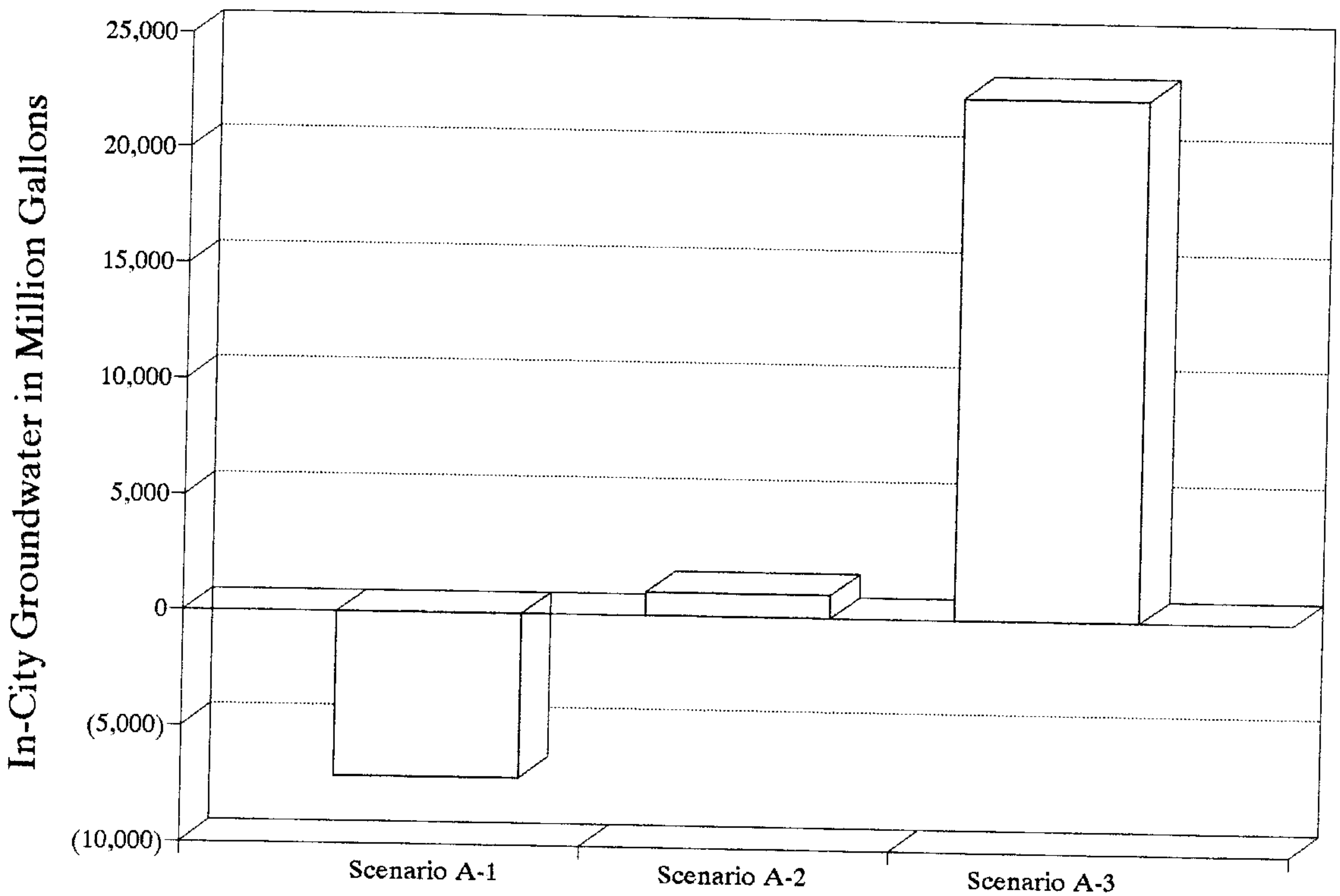


Figure 8.3 - In-City Groundwater Reserves as of 2040
If CRMWA Does Not Develop Additional Supply



If CRMWA does not develop a new groundwater supply to supplement Lake Meredith, we recommend Scenario A-3, development of a new groundwater well field, as the best alternative for Plainview. Although this is the most expensive of the alternatives considered in detail, it provides a reliable supply through 2040 and leaves a significant reserve of in-city groundwater to serve Plainview's future needs beyond 2040. Although Scenarios A-1 and A-2 are less expensive in the short term, they would lead to significant problems toward the end of the study period, as Plainview depletes its local groundwater supplies.

Scenario B-1: New CRMWA Supply; Continue Current Practice

The only difference between this scenario and Scenario A-1 is the cost of the water supply from CRMWA. If CRMWA develops a new supply, the City of Plainview could continue to use treated CRMWA water to supply about 40 percent of its needs and to use groundwater pumped from in-city wells for the remaining 60 percent. The cost of CRMWA water would increase to cover the cost of the new supply developed by CRMWA. Table 8.6 gives a summary of the life cycle cost analysis from 1994 through 2040 for this scenario. As with Scenario A-1, the analysis shows that this approach would exhaust in-city groundwater supplies by about the year 2035. This would present Plainview with the challenge of finding a new source of supply at that time, with no nearby sources likely to be available.

Table 8.6

Summary of Results of Life Cycle Cost Analysis for Scenario B-1
New CRMWA Supply; Continue Current Practice

1994-2040 Capital Investment in 1993 Dollars	$3,992,000
Present Worth Unit Cost of Potable Water	
Average, 1994-2040	42.9¢ per thousand gallons
Highest Year (2001)	50.5¢ per thousand gallons
Sources of Water Supply: 1994-2040	
In-City Groundwater	51,108 MG (60.0%)
CRMWA	34,065 MG (40.0%)
In-City Groundwater Remaining in 2040	-7,108 MG (depleted in 2035)

Scenario B-2: New CRMWA Supply; Increase Use of CRMWA Water

If CRMWA were to develop a new source of water supply with improved quality, Plainview would not have to blend treated CRMWA water with groundwater to control the level of dissolved solids. As a result, the City could increase its use of CRMWA water and decrease reliance on local groundwater. For the analysis of this scenario, we assume that Plainview would use 70 percent treated CRMWA water and 30 percent in-city groundwater. This scenario would result in significantly greater costs for CRMWA debt service and operation, as well as higher treatment costs due to the increased use of CRMWA water. It would also allow Plainview to make greater use of the CRMWA supplies available. By the year 2040, Plainview's water treatment plant would be operating at an average rate of about 3.9 MGD, very near its rated capacity. Table 8.7 gives a summary of the life cycle cost analysis from 1994 through 2040 for this alternative. The table shows that the supply would be fairly costly and that there would be 15,157 million gallons of in-city groundwater left in 2040 (about 25 years supply at the 2040 use rate).

Scenario B-3: New CRMWA Supply; Develop New Groundwater Well Field

Even if CRMWA develops a new supply to supplement Lake Meredith water and improve its quality, Plainview would have the option of developing its own groundwater well field rather than increasing its use of CRMWA supplies. For this scenario, we assume that the new well field would provide 40 percent of Plainview's water needs, with treated CRMWA water continuing to supply 40 percent and in-city groundwater providing the remaining 20 percent. This approach would require the same significant capital investment for the groundwater well field as Scenario A-3, as well as increased costs for CRMWA water. Table 8.8 gives a summary of the life cycle cost analysis from 1994 through 2040 for this scenario. This approach leaves recoverable in-city groundwater reserves in 2040 of 22,573 million gallons - over 50 years of use at the 2040 in-city use rate. The capital costs associated with developing the groundwater well field and the increased costs from CRMWA would cause this to be a relatively expensive scenario.

Recommended Scenario if CRMWA Develops a New Supply

Table 8.9 summarizes the results of the life cycle cost analyses for the three scenarios considered assuming that CRMWA develops a new groundwater supply to

Table 8.7

Summary of Results of Life Cycle Cost Analysis for Scenario B-2
New CRMWA Supply; Increase Use of CRMWA Water

1994-2040 Capital Investment in 1993 Dollars	$3,050,000
Present Worth Unit Cost of Potable Water	
Average, 1994-2040	53.0¢ per thousand gallons
Highest Year (2001)	64.4¢ per thousand gallons
Sources of Water Supply: 1994-2040	
In-City Groundwater	28,843 MG (33.9%)
CRMWA	56,330 MG (66.1%)
In-City Groundwater Remaining in 2040	15,157 MG

supplement the Lake Meredith supply. Figure 8.4 shows the projected present worth unit costs for the three scenarios from 1994 through 2040. Figure 8.5 is a comparison of the sources of supply for the three scenarios, and Figure 8.6 shows the estimated recoverable reserves of in-city groundwater as of the year 2040. Figure 8.4 shows that the present worth unit cost of water supply rises substantially over the next few years with Scenarios B-2 and B-3.

If CRMWA develops a new groundwater supply to supplement Lake Meredith, we recommend Scenario B-2, increasing the use of CRMWA water, as the best alternative for Plainview. This is an expensive alternative, but it provides a reliable supply through 2040 and leaves a significant reserve of in-city groundwater to serve Plainview's future

Table 8.8

Summary of Results of Life Cycle Cost Analysis for Scenario B-3
New CRMWA Supply; Develop New Well Field

1994-2040 Capital Investment in 1993 Dollars	$11,583,000
Present Worth Unit Cost of Potable Water	
Average, 1994-2040	54.5¢ per thousand gallons
Highest Year (2001)	82.8¢ per thousand gallons
Sources of Water Supply: 1994-2040	
In-City Groundwater	21,427 MG (25.2%)
CRMWA	34,065 MG (40.0%)
Well Field Groundwater	29,681 MG (34.8%)
In-City Groundwater Remaining in 2040	22,573 MG

needs beyond 2040. Although Scenario B-1 is less expensive in the short term, it would lead to significant problems toward the end of the study period, as Plainview depletes its local groundwater supplies.

Comparison of the Recommended Plans with and without a New CRMWA Supply

Table 8.10 and Figures 8.7, 8.8, and 8.9 are a comparison of the recommended water supply plans with and without development of a new water supply by the CRMWA. Scenario A-3, the recommended water supply plan without development of a new CRMWA supply, offers the following advantages:

- The average present worth unit cost of water would be less than with a new

Table 8.9

Comparison of Results of Life Cycle Cost Analyses for Scenarios With New CRMWA Supply

	Scenario B-1	Scenario B-2	Scenario B-3
1994-2040 Capital Investment in 1993 Dollars	$3,992,000	$3,050,000	$11,583,000
Average Present Worth Unit Cost of Potable Water in Cents per Thousand Gallons, 1994-2040	42.9¢	53.0¢	54.5¢
Highest Year Present Worth Unit Cost of Water			
-Year	2001	2001	2001
-Present Worth Unit Cost in Cents per Thousand Gallons	50.5¢	64.4¢	82.8¢
Sources of Water Supply			
-In-City Groundwater in Million Gallons	51,108(60.0%)	28,843(33.9%)	21,427(25.2%)
-CRMWA in Million Gallons	34,065(40.0%)	56,330(66.1%)	34,065(40.0%)
-Well Field Groundwater in Million Gallons	0	0	29,681(34.8%)
In-City Groundwater Remaining in 2040 in Million Gallons	-7,108 (depleted in 2035)	15,157	22,573

Figure 8.4 - Projected Present Worth Unit Costs
If CRMWA Develops Additional Supply

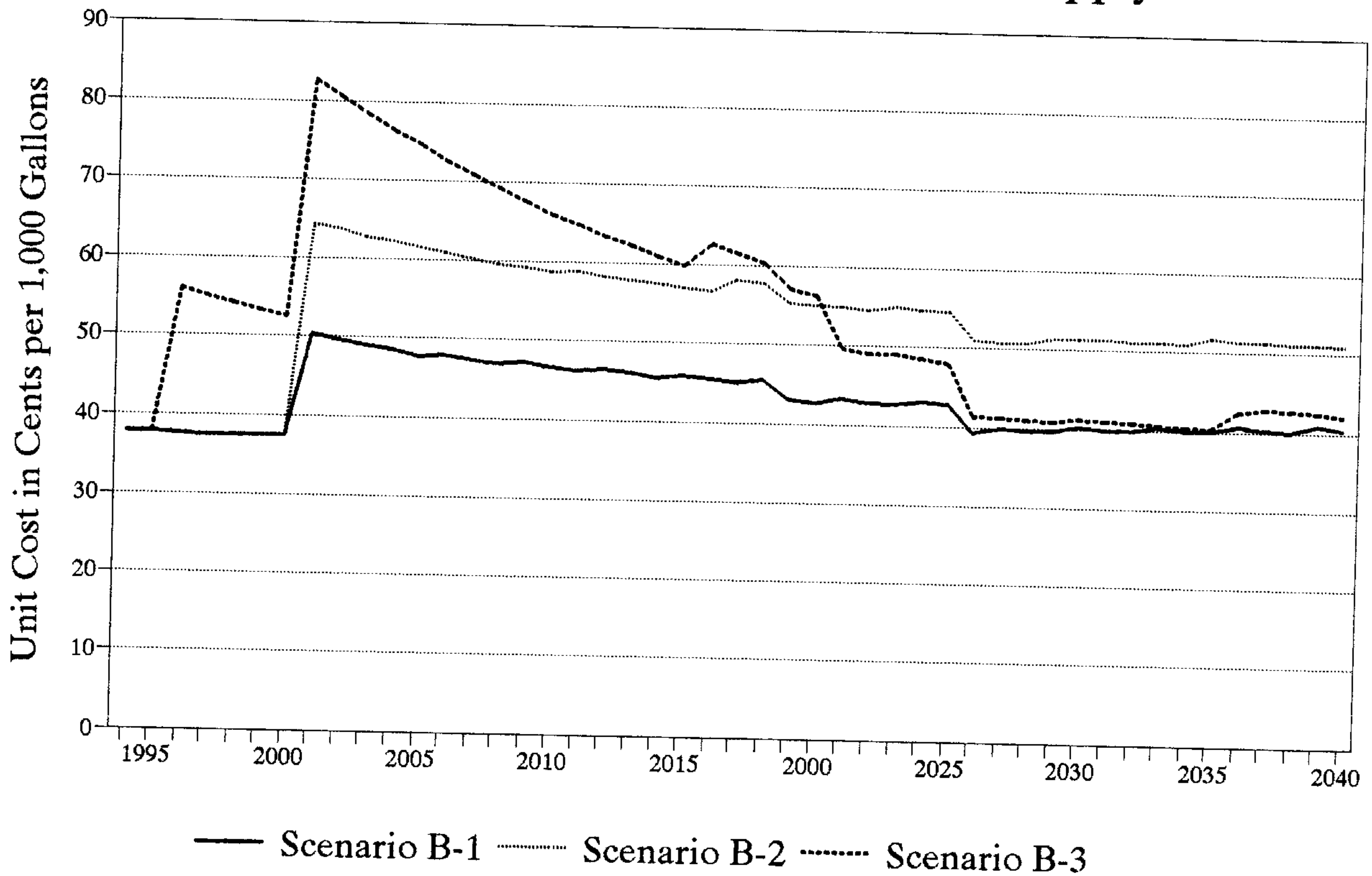


Figure 8.5 - Comparison of Sources of Supply If CRMWA Develops Additional Sypply

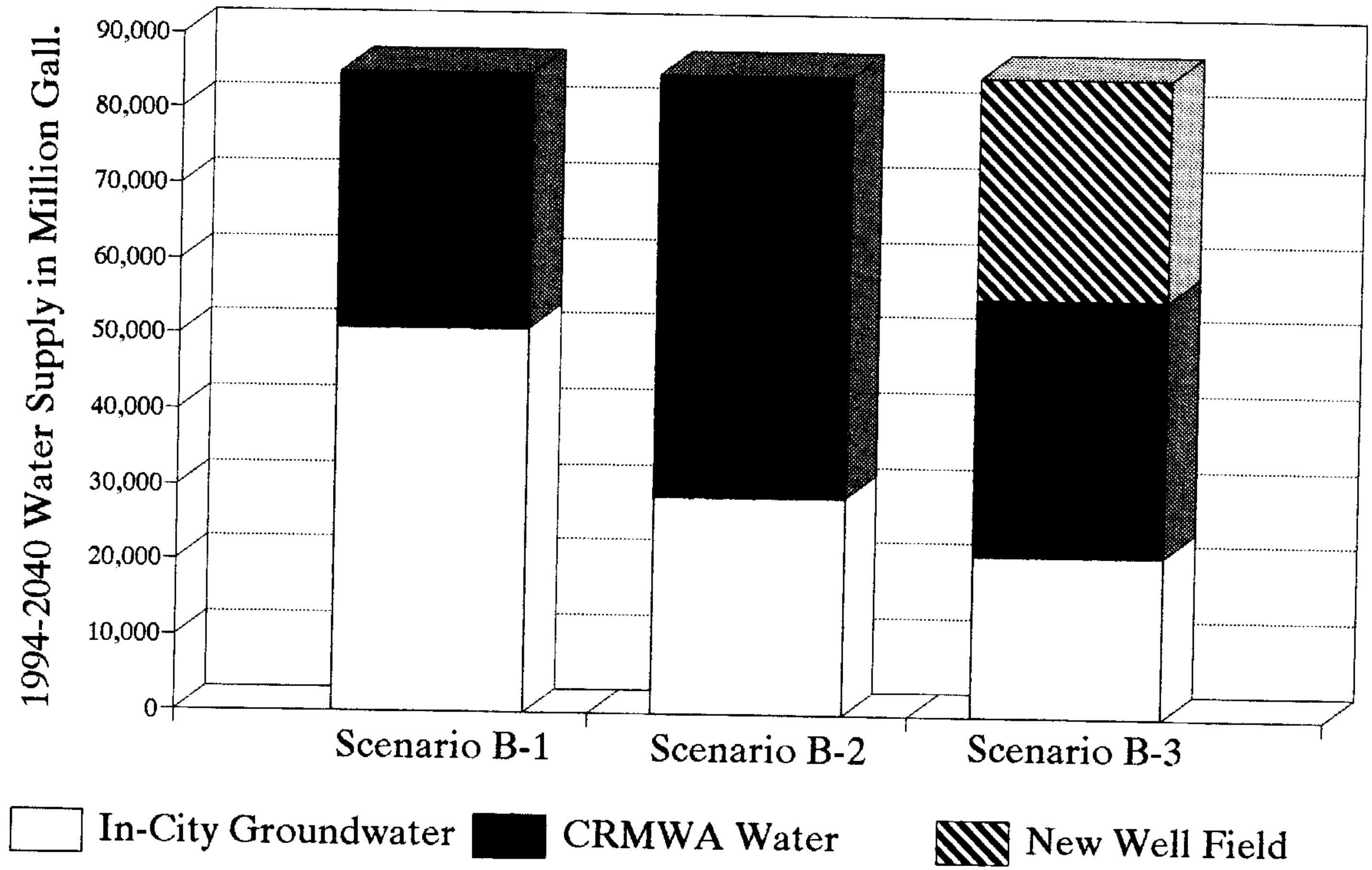
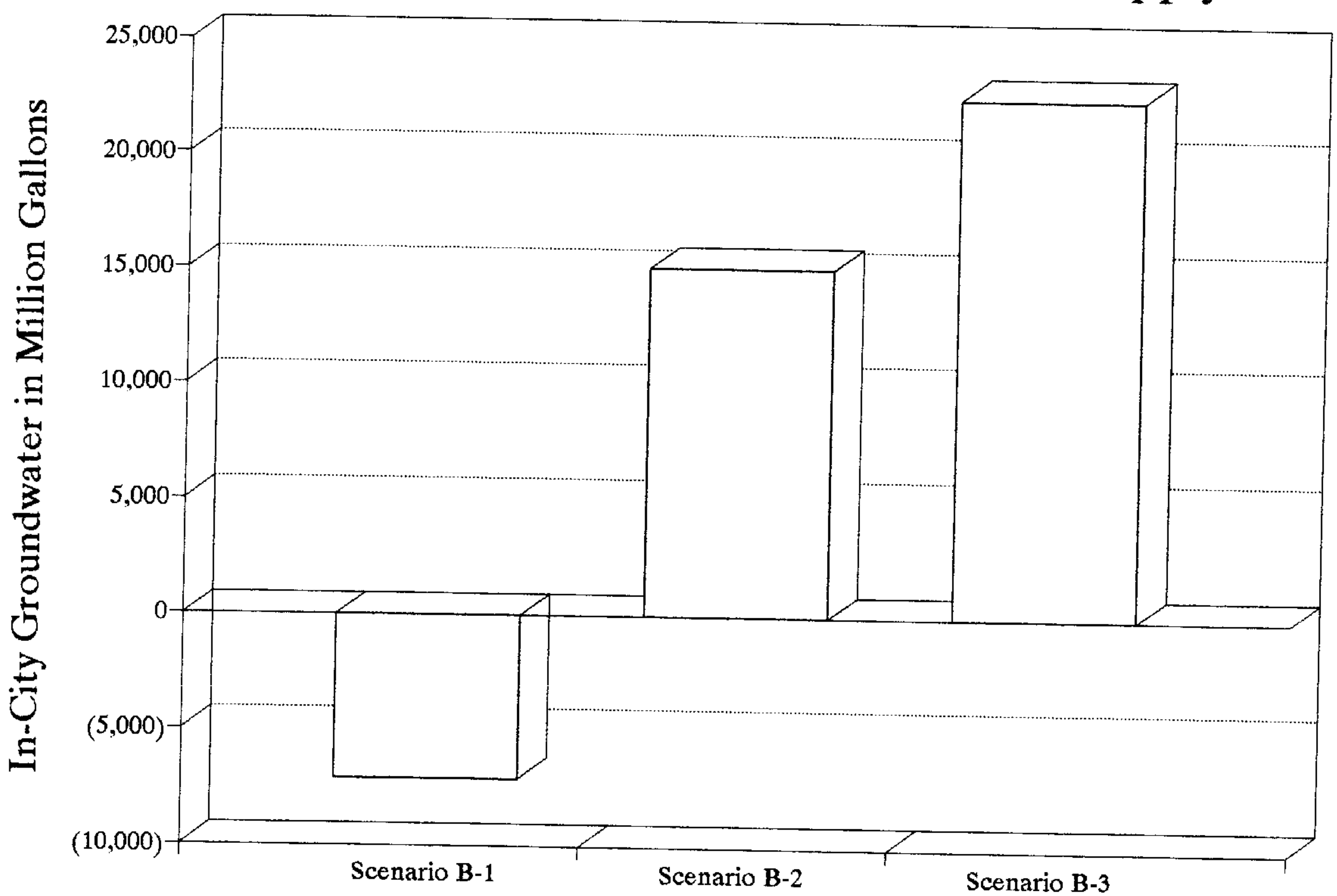


Figure 8.6 - In-City Groundwater Reserves as of 2040 If CRMWA Develops Additional Supply



CRMWA supply.

- Plainview would maintain control of most of its water supply.
- There would be more in-city groundwater remaining in 2040.

Scenario B-2, the recommended water supply plan with development of a new CRMWA supply, offers the following advantages:

- The cost increases would be more gradual than without a new CRMWA supply, and the peak cost would be less.
- Plainview would make more complete use of the CRMWA facilities and supplies in which it has invested over the years.
- Plainview would not be required to remove local farmland from irrigated agriculture for a groundwater well field.
- Plainview would not be required to build and operate a new groundwater well field.
- The capital investment would be less than without a new CRMWA supply.

Either of the recommended scenarios would be a viable water supply plan for Plainview. As a member of the CRMWA, Plainview can influence the authority's decision on the proposed additional groundwater supply to supplement Lake Meredith water. Based on the information developed for this study, there is no clear indication that Plainview should favor or oppose the new CRMWA supply. Plainview can supply its own needs regardless of the decision on the supplemental supply. However, it is in Plainview's interest that a decision on the supply be made quickly. Irrigated agriculture is continuing to deplete the Ogallala Aquifer near the City. If Plainview is going to develop its own new groundwater well field, the City should proceed to purchase the water rights for the

Table 8.10

Comparison of Recommended Scenarios
With and Without CRMWA Development of a New Supply

	Scenario A-3 (Recommended without)	Scenario B-2 (Recommended with)
1994-2040 Capital Investment in 1993 Dollars	$9,475,000	$3,050,000
1994-2040 Average Present Worth Unit Cost in cents per Thousand Gallons	49.2¢	53.0¢
Highest Year Present Worth Unit Cost		
-Year	2001	2001
-Present Worth Unit Cost in cents per Thousand Gallons	69.5¢	64.4¢
Sources of Water Supply in Million Gallons		
-In-City Groundwater	21,427(25.2%)	28,843(33.9%)
-CRMWA	34,065(40.0%)	56,330(66.1%)
-Well Field Groundwater	29,681(34.8%)	0
In-City Groundwater Remaining in 2040 in Million Gallons	22,573	15,157

well field and discontinue irrigated agriculture as soon as possible in the area where the well field will be developed.

Figure 8.7 - Projected Present Worth Unit Costs for the Recommended Water Supply Plans

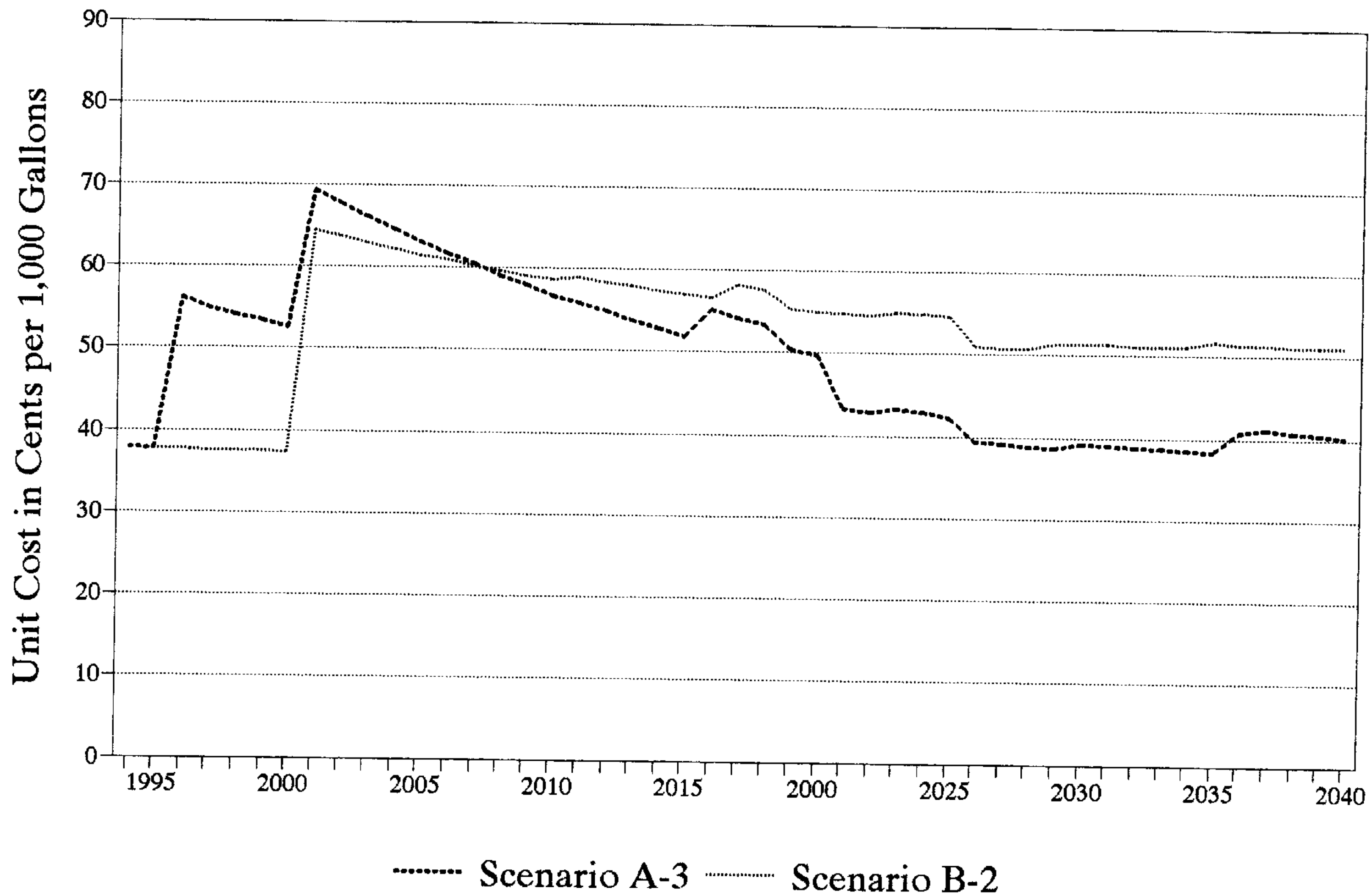


Figure 8.8 - Comparison of Sources of Supply for the Recommended Water Supply Plans

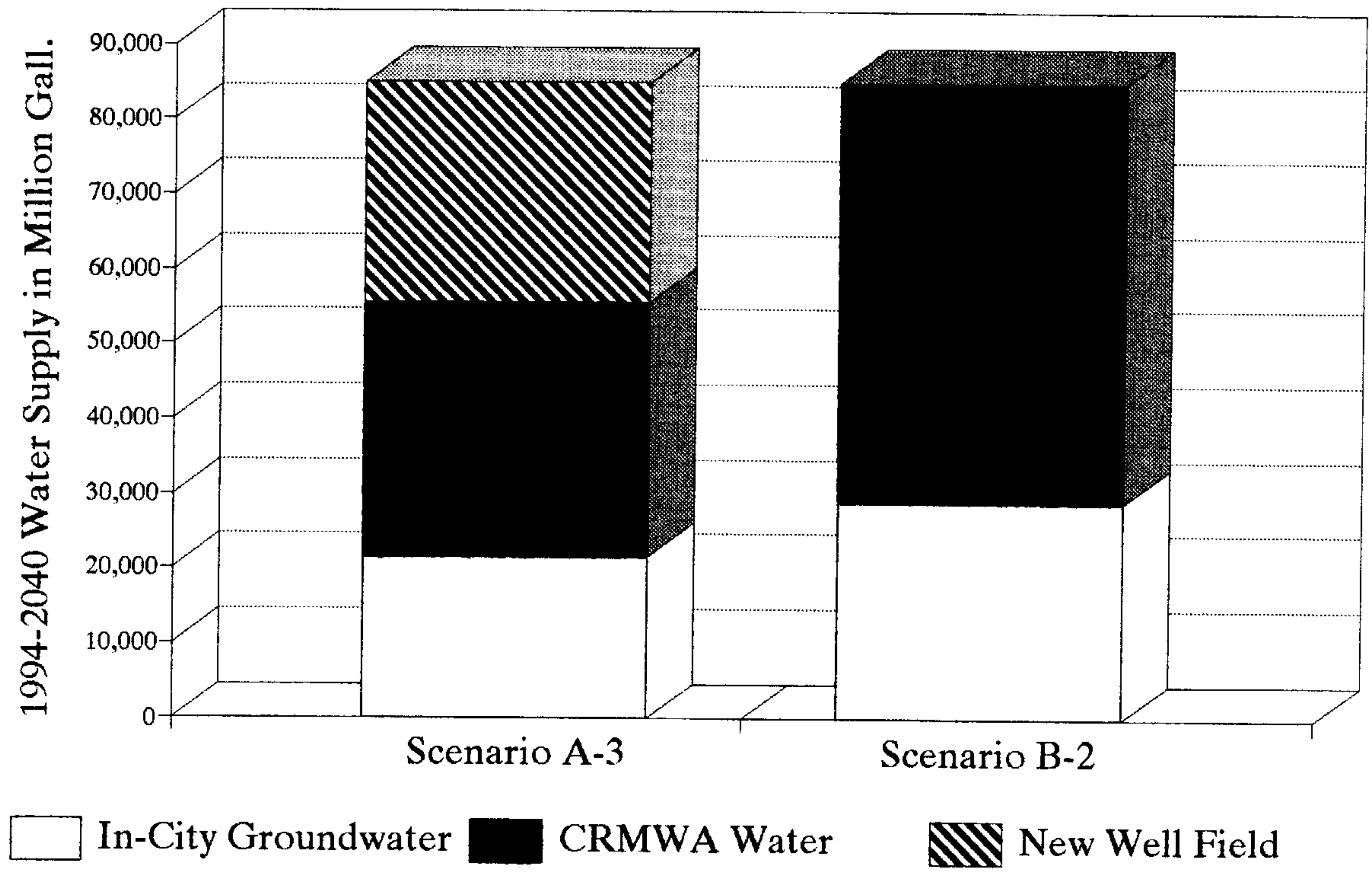
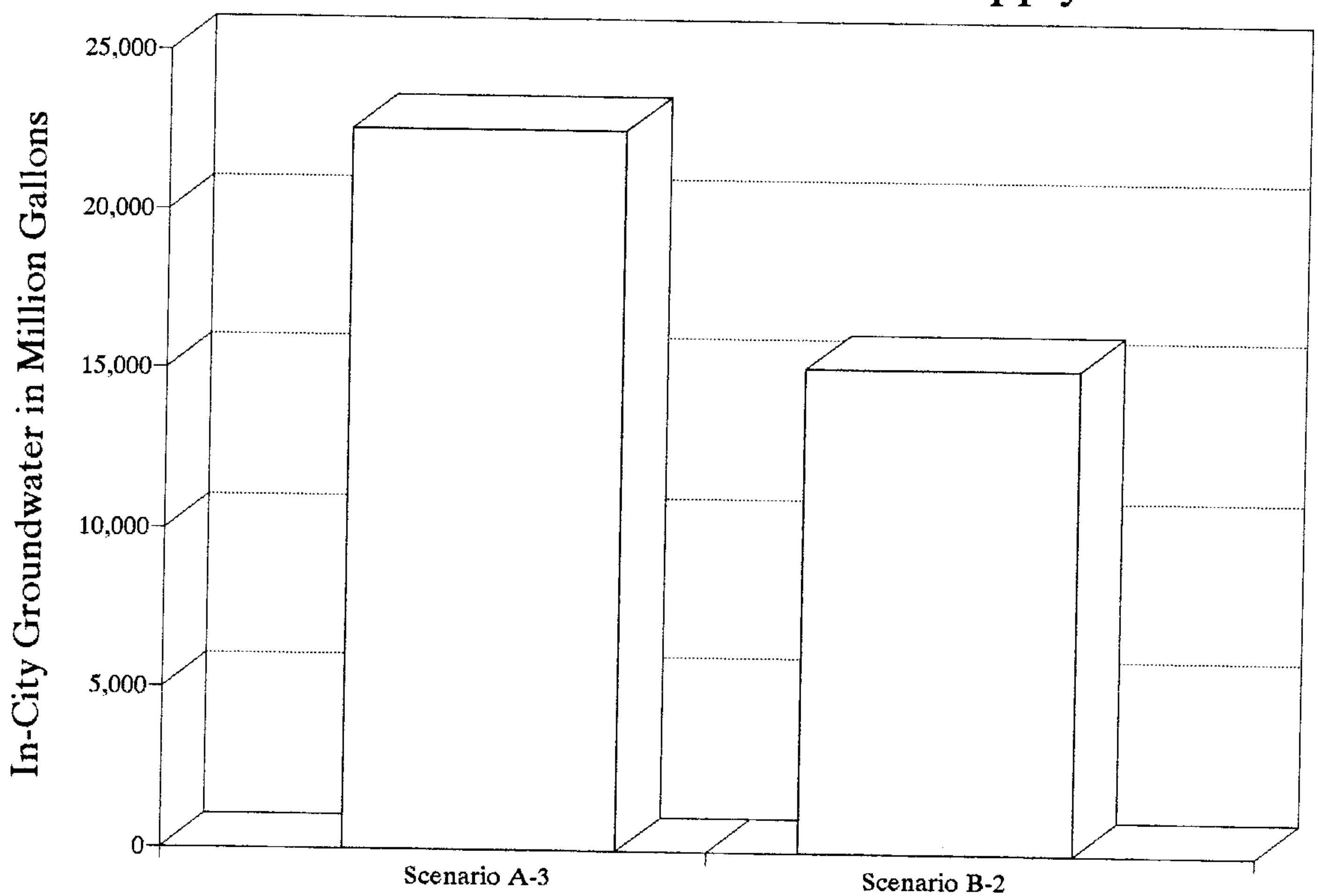


Figure 8.9 - In-City Groundwater Reserves as of 2040 for the Recommended Water Supply Plans



9. DEVELOPMENT PLANS AND SCHEDULES FOR RECOMMENDED WATER SUPPLY SCENARIOS

Section 8 presents two recommended water supply scenarios for Plainview. Scenario B-2 applies if CRMWA develops an additional water supply to supplement Lake Meredith and improve water quality, and Scenario A-3 applies if CRMWA does not develop an additional water supply. CRMWA is currently investigating the development of this additional supply, and the decision on whether or not to proceed will probably be made in the next few years.

Implementation of Scenario B-2, Assuming CRMWA Develops Additional Supply

If CRMWA proceeds to develop an additional supply to supplement Lake Meredith, the recommended water supply plan for Plainview is to increase its use of CRMWA water and decrease the rate of use of in-city groundwater supplies (Scenario B-2). The recommended plan would be to use about 70 percent CRMWA water and 30 percent in-city groundwater (contrasted with the current use of about 40 percent CRMWA water and 60 percent in-city groundwater). Almost all of the planning and development required for this scenario would be carried out by the CRMWA. Plainview would need to increase its use of CRMWA water when the new supply is implemented and would be required to pay increased water supply costs due to greater CRMWA unit costs, increased purchases from CRMWA, and increased volume of water treated. These short-term costs would provide long-term benefits by preserving in-city groundwater reserves to meet future needs.

Implementation of Scenario A-3, Assuming CRMWA Does Not Develop Additional Supply

If CRMWA does not develop an additional supply to supplement Lake Meredith, Plainview should implement Scenario A-3, development of a groundwater well field outside of the City. Because groundwater levels outside of Plainview are declining due to irrigation use, Plainview should proceed as quickly as possible to secure groundwater rights. Table 9.1 outlines a possible timetable for the implementation of this alternative. Some points to remember in implementing Scenario A-3 are given below:

- Scenario A-3 should be implemented only if CRMWA does not develop a supply to supplement Lake Meredith. (If CRMWA does develop such a supply, increasing the use of CRMWA water seems to be a better alternative for Plainview.)

- Because of the on-going depletion of groundwater in the Plainview area by irrigated agriculture, it is desirable to purchase the required water rights for the groundwater well field and discontinue irrigation of that land as soon as possible.

- It is advisable to wait for a CRMWA decision on the development of additional supply before proceeding with the development of Scenario A-3. If CRMWA decides not to develop the supply, Plainview should be prepared to move quickly to acquire the needed water rights.

- To the extent practical, the water rights needed for Scenario A-3 should be purchased in a contiguous block. This will diminish the depletion of the supplies by outside pumping and make the development of collection and transmission facilities significantly more economical.

- The analyses by Guyton Associates provide more specific guidance on the acquisition of groundwater rights in the vicinity of Plainview.

- Although it is important to move quickly to acquire the needed groundwater rights, the construction of facilities and the use of water from the groundwater field is less urgent. If Plainview were to delay the use of the field for five to ten years beyond the time suggested in Table 9.1, the primary negative impact would be a relatively small decrease in the in-city groundwater reserves available in 2040. The benefit

Table 9.1

Timetable for Implementation of Scenario A-3
Development of a Groundwater Well Field

Approximate Date	Action
1994	CRMWA decision not to develop supplemental supply.
1994	Plainview to begin exploring acquisition of groundwater rights.
1994	Review of data, sampling, test holes for groundwater rights.
1995	Acquisition of groundwater rights.
1998	Design of transmission facilities and first four wells with associated collection facilities.
2000	Construction of transmission facilities and first four wells with associated collection facilities.
2001	Operation of well field.
2015	Construction of additional wells with associated collection facilities.
2025	Construction of additional wells with associated collection facilities.
2035	Construction of additional wells with associated collection facilities.

would be a delay in the increased cost of water supply for Plainview caused by developing and using the groundwater field.

- We would not recommend delaying beyond 2010 before beginning to use the groundwater field. It is important that Plainview preserve in-city groundwater as the most economical way to meet peaking demands, and undue delay in using the groundwater well field will result in depletion of in-city groundwater reserves.

10. SUMMARY AND RECOMMENDATIONS

Summary of Population and Water Use Projections

a. The study area, which is shown in Figure 1.1, has an estimated 1990 population of 24,643. The City of Plainview is the largest community in the study area, with a 1990 census population of 21,700.

b. The projected 2040 study area population is 36,876, a 50 percent increase from the 1990 population.

c. The 1990 municipal water use for the study area was 1,565 million gallons. The City of Plainview used 1,460 million gallons (93.3 percent) and supplied an additional 24 million gallons (1.5 percent) to the Seth Ward Water Supply Corporation. Other area water suppliers include the Town of Kress, the Westridge Water Company (now taken over by Plainview), Pleasant Hills Water Company, and Ebeling Water Supply Corporation.

d. The projected 2040 normal year municipal water use for the study area is 2,021 million gallons, a 29 percent increase from the 1990 level. This assumes a 10 percent reduction from current levels of per capita municipal use due to water conservation. In a drought year, the projected municipal water use is 2,325 million gallons. The projected 2040 peak day water use is 14.4 million gallons.

e. The City of Plainview will probably supply an increasing portion of study area municipal water use as a regional supplier. By 2040, it is projected that Plainview will supply all of the study area municipal water use. (In 1990, Plainview supplied

94.8 percent of the study area municipal water use.)

Summary of Existing Water Supply

f. The Ogallala Aquifer is the source of most of the water used in the study area. The Ogallala provides about 60 percent of the municipal water supply for the City of Plainview, which has 15 active groundwater wells. The Seth Ward Water Supply Corporation purchases water from Plainview and has recently constructed a well in the Ogallala. The other municipal water suppliers in the study area obtain all of their water from the aquifer.

g. Water levels in the Ogallala Aquifer have declined about 120 to 150 feet since the mid-1940s. From the beginning of 1968 through the beginning of 1992 (24 years), Ogallala water levels declined an average of 67 feet in the study area outside Plainview and an average of 42 feet inside the City. (The rate of decline is lower in Plainview because of lower overall pumpage per square mile in and near the City.)

h. There are about 44,000 million gallons of recoverable groundwater reserves in the Ogallala Aquifer within the Plainview city limits.

i. The City of Plainview also uses water from the Canadian River Municipal Water Authority (CRMWA), of which it is a member. CRMWA water is delivered by pipeline from Lake Meredith, on the Canadian River, to Plainview's 4.2 MGD water treatment plant.

j. The City of Plainview is entitled to 1,238 million gallons from the CRMWA during a year of normal supply. The allocation from CRMWA can be as low as 867 million gallons (70 percent), but the City can usually obtain 990 million gallons (80 percent) or more. Because of the need to blend CRMWA water with groundwater to maintain acceptable levels of dissolved solids, the City has never used its full allocation of CRMWA water.

k. The CRMWA is considering the development of a groundwater supply to supplement Lake Meredith and improve the quality of the CRMWA water. This project would increase the amount of water available to Plainview and other member cities, reduce the levels of dissolved solids in the water, and increase the cost of CRMWA supplies.

Summary of Water Transmission for Regional Supply

l. Constructing a 10-inch pipeline and associated facilities to supply the Town of Kress with potable water from Plainview would cost about $1,406,000. A 6-inch pipeline from Plainview to supply Ebeling Water Supply Corporation and Pleasant Hills Water Company would cost about $540,000.

Summary of Water Treatment Plant Analyses

m. The City of Plainview's 4.2 MGD solids contact type water treatment plant treats CRMWA water for the City. The plant meets the current Texas Surface Water Treatment Rule requirements for disinfection. It is currently operating at a maximum rate of about 2 MGD and meets turbidity requirements at that rate of flow.

n. In order to allow the plant to operate at higher flow rates than 2 MGD, the City should undertake the following improvements:

- Protect the solids contact clarifiers from wind by baffles or covers.
- Modify the backwash return water operations to take the settled portion of the backwash water to the sludge drying beds.
- Check the valves and piping which allow parallel operation of the clarifiers and upgrade as necessary.

If these improvements do not allow operation of the water treatment plant at its rated capacity of 4.2 MGD, Plainview should investigate filter media replacement and/or filter expansion.

Summary of Wastewater Reuse Feasibility Study

o. The regional water supply study included a wastewater reuse feasibility study to explore reclaimed wastewater as a possible source of additional water supply for Plainview. Although a major wastewater reuse program for Plainview would not be cost effective, a limited program to supply water for tree irrigation at the City landfill merits further analysis.

Summary of Alternatives for Regional Water Supply

p. Potential alternatives for long range water supply for Plainview include the following:

- Continue the current practice of supplying about 40 percent of the water use from surface water and 60 percent from groundwater wells within the City of Plainview.

- Make distribution system improvements and increase the amount of surface water used.

- Purchase additional groundwater rights immediately outside of the City to allow the development of additional supplies.

- Develop one or more groundwater well fields outside of the City to provide additional supplies.

- Assuming that the Canadian River Municipal Water Authority develops additional supplies and improves its water quality, increase the use of CRMWA water.

- Install desalination equipment at the water treatment plant to allow increased use of surface water supplies.

- Supply a part of the municipal water needs for the study area from reclaimed wastewater.

q. The recommended approach to long-term water supply for Plainview will depend on whether the CRMWA develops a groundwater supply to supplement surface water from Lake Meredith. For this study, three scenarios were investigated assuming that CRMWA does not develop such a supplemental supply, and three scenarios were investigated assuming that CRMWA does develop the supply.

<u>Recommendations</u>

a. In order to preserve in-city groundwater reserves for future peaking needs, Plainview should use as much CRMWA water as possible for base supply, thus decreasing the use of in-city groundwater.

b. In order to maximize its use of CRMWA water, the City should take the following actions:

- Make water treatment plant improvements as soon as possible to increase the maximum treatment rate above 2 MGD.
- Operate the water treatment plant at rates above 2 MGD when high summertime demands make this practical.
- Monitor the blending of surface water and groundwater carefully, keeping the groundwater use as low as possible (and the surface water use as high as possible) while maintaining acceptable water quality.

c. The City of Plainview is the logical regional water supplier for the study area. The City provided about 95 percent of the 1990 water use and is the only water supplier in the study area with access to CRMWA water supplies.

d. Plainview's current practice of using groundwater for about 60 percent of the water needs and treated CRMWA water for the remaining 40 percent will not provide a viable long-term water supply. Based on projected water needs and estimated supplies, Plainview would exhaust in-city groundwater reserves by about 2035 with this approach. Since groundwater outside the City is currently being depleted even more rapidly than the in-city reserves, Plainview probably would face significant problems in seeking new supplies once the in-city reserves are gone.

e. If CRMWA does not develop additional water supplies to supplement Lake Meredith, the best alternative for Plainview would be to develop a groundwater well field on approximately 10 square miles of land outside of the City. Beginning in 2001, this groundwater field would supply about 40 percent of the City's water needs, with 40 percent from CRMWA water and 20 percent from in-city groundwater. This plan would significantly increase water supply costs over the current approach, but would give Plainview a viable water supply to 2040 and beyond.

f. If CRMWA does develop additional water supplies to supplement Lake Meredith, the best alternative for Plainview would be to take advantage of the improved quality of the CRMWA water and dramatically increase its use of CRMWA supplies. In this scenario, Plainview would increase its use of CRMWA water to about 70 percent of its needs beginning in 2001, with the remaining 30 percent coming from in-city groundwater. This approach would also significantly increase Plainview's short-term water supply costs but give the City a viable long-term water supply plan.

g. Either of the recommended scenarios would provide a viable water supply for Plainview. Based on the information developed for this study, there is no clear indication that Plainview should favor or oppose the new CRMWA supply. However, it is in Plainview's interest that CRMWA make a decision on the new supply quickly.

h. If CRMWA decides not to pursue a new supply, Plainview should move quickly to purchase the water rights required for a groundwater well field and discontinue irrigated agriculture in the area where the well field will be developed. Undue delay in acquiring the water rights will lead to continued depletion of groundwater supplies by irrigated agriculture.

i. Although it is important to move quickly to acquire the needed groundwater rights, the construction of facilities and the use of the groundwater field is less urgent. However, Plainview should not delay beyond 2010 before beginning to use the groundwater field. This is important so that Plainview can preserve in-city groundwater as the most economical way to meet its future peak demands.

APPENDIX A

LIST OF REFERENCES

APPENDIX A

LIST OF REFERENCES

(1) Guyton Associates: "Ground Water Availability in the Vicinity of Plainview, Texas," 1993.

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(3) Texas Water Development Board: "Projections of Population and Municipal Water Demands," October 1989.

(4) Texas Water Development Board: "Projections of Population and Municipal Water Demands (Draft)," April 1992.

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(7) Oller Engineering, Inc.: "City of Kress, Texas, Comprehensive Water Supply Plan," June 1991.

(8) The Steve Rogers Company: " Housing Study, Plainview, Texas," February 1991.

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(10) Richard Oller: June 11, 1992, telephone memorandum with Richard Oller of Oller Engineering, Inc., "Subject: Water System in Kress."

(11) Parkhill, Smith and Cooper, Inc.: "City of Plainview, Texas, Comprehensive Plan 1976 - 2000," June 1976.

APPENDIX B

WATER CONSERVATION AND DROUGHT CONTINGENCY PLAN

FOR THE CITY OF PLAINVIEW

WATER CONSERVATION

AND

DROUGHT CONTINGENCY PLAN

FOR THE CITY OF PLAINVIEW

MAY 1994

STATE OF TEXAS
THOMAS C. GOOCH
50668
REGISTERED
PROFESSIONAL ENGINEER

5/26/94

Thomas C. Gooch, P.E.

Haitham M. Awwad

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1. INTRODUCTION

The City of Plainview is located in the Panhandle of Texas, in Hale County in the Brazos River Basin. In October 1991, Plainview authorized Freese and Nichols, Inc., to carry out a regional water supply study for the City and the surrounding potential service area. This study is partially funded by a grant from the Texas Water Development Board. Its overall purpose is to investigate the water requirements and surface and groundwater resources of the area and to develop a long term water supply plan. The adoption of a water conservation plan is required for any project funded by the Texas Water Development Board. Section 15.001 8(A) and (B) of Vernon's Texas Code Annotated state that "Conservation" means:

(A) the development of water resources; and

(B) those practices, techniques and technologies that will reduce the consumption of water, improve the efficiency in the use of water, or increase the recycling and reuse of water so that a water supply is made available for future or alternative uses."

The purpose of the water conservation and drought contingency plan for the City of Plainview is to establish short-term and long-term goals for conserving water, and to determine the procedures and steps necessary to achieve these goals.

2. SYSTEM EVALUATION

Existing Water Supplies

The City of Plainview has a service area of roughly 13 square miles. According to the 1990 Census, the population of Plainview is 21,700. The City obtains its water supplies from groundwater and surface water. Groundwater in Plainview is pumped from the Ogallala Aquifer at depths around 300 feet. The aquifer is 200 feet thick, unconfined, and is recharged only from local precipitation. Currently, the City has 15 wells in operation, with a total rated pumping capacity of 14.3 million gallons per day (MGD). Based on an 18-hour daily operation schedule, the potential production of the wells is about 10.7 MGD.

Plainview's surface water supply is provided by the Canadian River Municipal Water Authority (CRMWA) from Lake Meredith. The City of Plainview has contracted with CRMWA for 1,238 million gallons of untreated water during a year of normal supply. This is equivalent to 3.4 million gallons per day. Purchases of surface water from CRMWA started in 1969. Untreated water is transported from the CRMWA aqueduct system through an 18-inch line to a 2 million gallon ground storage tank at Plainview's water treatment plant. The maximum delivery rate to Plainview from the CRMWA system is 4.15 MGD. The maximum capacity of the water treatment plant is 4.2 MGD.

The City's water distribution system consists mostly of 6" and 8" lines fed from 12" and 14" mains. In 1991, there were 7,597 connections to the system in Plainview: 6,761 residential, 760 commercial and 76 industrial. New connections have been added at an average rate of approximately 36 per year, averaged over the past 20 years. Plainview has five ground storage facilities with a total capacity of 5 million gallons. All of the ground storage tanks are located in conjunction with the City's water wells. The City also has five elevated storage tanks, providing a total storage capacity of 1.75 million gallons. A fairly even distribution of storage locations exists throughout the core of the City.

Historical and Projected Water Use

The City of Plainview's average annual water use from the Ogallala Aquifer and the Canadian River for the years 1990 and 1991 was 1,572,859,800 gallons per year (131,071,600 gallons per month). This figure includes the City's sales of raw water to Cactus Feeders, Inc., and its supply of treated water to Seth Ward WSC. The City's average annual water demand for the same period, excluding the sales to Cactus Feeders, Inc., and Seth Ward WSC, was 1,430,956,300 gallons per year (119,246,300 gallons per month). The ratio of the average daily summer use to the average annual daily use for the years 1990 and 1991 was 1.42:1.

The City of Plainview sells raw water to a cattle feed lot at Foxley Co./Cactus Feeders, Inc., in Swisher County with a minimum use of 200,000 gallons per day to be diverted from the CRMWA aqueduct. This diversion can be discontinued at any time if the need arises. The average annual raw water sales to Cactus Feeders, for 1990 and 1991, was 117,912,500 gallons per year (9,826,000 gallons per month). In 1989, the City of Plainview began providing the Seth Ward WSC with treated water for commercial and residential uses. The Seth Ward WSC service area is approximately 0.5 square miles. The

Seth Ward area (only part of which is served by Plainview) has a population of 1,402 according to the 1990 Census. The Corporation is supplied by two main lines from Plainview to a delivery point near the northeast city limits of Plainview. Seth Ward WSC has 240 connections in the area that Plainview has agreed to serve, and another 90 connections to the east of the area not yet served. Seth Ward is expected to grow at a faster rate than the City itself. Seth Ward's average annual water demand for years 1990 and 1991 was 23,991,000 gallons per year (1,999,300 gallons per month).

Plainview recently annexed the Westridge area to the west of the City, which has approximately 40 connections. Prior to he annexation, the area was supplied by the Westridge Water Company. According to TWDB records, the average annual water demand of the Westridge area for the past two years has been around 1,500,000 gallons. This figure is highly questionable because the actual water consumption of that area appears to be much higher than that, and the TWDB records showed annual water demands for the Westridge area 10 times as much as the above figure prior to 1983.

The City of Plainview was recently selected for a 500-bed substance abuse felony punishment unit. The facility will employ 170 people, and its average annual water demand is expected to be 27,500,000 gallons. This new prison facility is expected to ultimately be expanded to 1,000-bed or 2,250-bed unit.

Freese and Nichols, Inc., has analyzed population and water demand projections derived from different sources for Plainview, its surrounding areas and potential water customers. The study selected the most probable population and water demand projections for the study area, after including the impacts of the new prison and the Westridge area annexation.

Table B-1 gives the population and water demand projections for the City of Plainview. Table B-2 shows the Seth Ward WSC population and water demand projections through the year 2040, as selected by the study. Plainview's twenty largest customers are listed in Table B-3. Table B-4 shows the 1990 monthly water sales by category.

Wastewater Information

The City of Plainview owns and operates the Plainview municipal wastewater treatment plant, near the southeast city limits. The facility has an operating capacity of 3.3 MGD, with the capability of handling peak flows up to 6.6 MGD. Virtually all developed areas within the existing corporate limits are served by city sewer.

Financial Information

The City of Plainview has a non-declining rate structure for water sales, and is moving toward adopting an ascending block rate. All connections to the supply system are metered, with new meters having been installed in most of the City. The City currently charges $8.25/month as a service charge plus $0.90 per 1,000 gallons for water sales. The City also charges $0.44 per 1,000 gallons for sewer service. Seth Ward currently charges $15.00 for up to 3,000 gallons and $1.75 per 1,000 gallons for use above 3,000 gallons. Plainview's average annual revenue derived from water sales for the years 1990 and 1991 was $1,657,100.

Table B-1

City of Plainview Projected Population and Water Demands

Year	Population	Annual Demands With Conservation (1,000 Gal)	(MGD)	Annual Demands Without Conservation (1,000 Gal)	(MGD)
1990	21,700	1,460,000	4.00	1,460,000	4.00
2000	23,762	1,533,300	4.20	1,568,100	4.30
2010	25,406	1,625,300	4.45	1,690,500	4.64
2020	27,218	1,714,100	4.70	1,823,800	5.00
2030	28,711	1,789,100	4.90	1,936,500	5.31
2040	29,410	1,803,800	4.94	1,997,900	5.47

Table B-2

Seth Ward WSC Projected Population and Water Demands

Year	Population	Annual Demands (1,000 Gal)	(MGD)
1990	1,402	23,670	0.06
2000	1,833	53,500	0.15
2010	2,182	71,700	0.20
2020	2,513	82,600	0.23
2030	2,881	94,600	0.26
2040	3,213	105,500	0.29

Table B-3

City of Plainview High-Volume Water Users
(Water Consumption April 1991 - March 1992)

Account Name	Service Address	Consumption (gallons/year)
PLV Ice DBA Host Ice	411 W. 3rd	16,673,000
Seth Ward WSC	24th & N. Date Meter A	13,500,000
Seth Ward WSC	24th & N. Date Meter B	9,707,000
City of Plainview	3500 W. 16th (WTP)	9,076,000
Westar Property Mngmnt.	4201 Dimmitt Rd.	8,518,000
Central Plains Hosp.	2601 Dimmitt Rd.	7,929,000
Housing Authority	1707 N. Date Mid-West	7,198,000
Housing Authority	1707 N. Date (South)	6,429,000
Heritage Home	2510 W. 24th	6,321,000
Park RWD Regional Park	3400 Kirchwood	5,132,000
Furr's Cafeteria #176	3605 Olton Rd. (Furrs)	4,740,000
Plains Village	2601 Joliet	3,633,000
Plainview Schools	1413 Quincy High School	3,510,000
Barrington Apartments	2704 W. 24th	3,422,000
Coca Cola Bottling Co.	105 I-27	3,346,000
Kettle Restaurant	700 N. I-27	3,308,000
Congress Inn	3600 Olton Rd.	3,220,000
Edgemere Apartments	3602 W. 26th	3,079,000
Rogers, Vernon	800 N. Date	2,767,000
Housing Authority	1707 N. Date	2,677,000
Total for all Users		124,185,000

Table B-4

City of Plainview 1990 Monthly Water Sales by Category
(Values in 1,000 Gallons)

Month	Residential	Industrial/ Commercial	Cactus Feeders, Inc.	Total
Jan	49,729	14,673	16,141	80,543
Feb	51,255	15,810	13,487	80,552
Mar	51,010	14,599	13,320	78,929
Apr	58,266	17,872	10,588	86,726
May	66,156	18,764	10,290	95,210
Jun	118,921	26,297	12,303	157,521
Jul	176,960	33,952	13,772	224,684
Aug	98,660	24,907	8,761	132,328
Sep	109,896	25,843	9,036	144,775
Oct	65,718	18,827	9,391	93,936
Nov	64,111	20,314	7,524	91,949
Dec	53,708	16,880	10,553	81,141
Total	964,390	248,738	135,166	1,348,294

Note: The residential and commercial water sales include Plainview's sales of treated water to Seth Ward WSC.

3. WATER CONSERVATION PLAN

The potential methods of water conservation for municipalities are listed in Section 363.85(b) of the Texas Water Development Board Rules relating to "Financial Programs". They are as follows:

a. Education and information programs.

b. Plumbing codes or ordinances for water conserving devices in new construction.

c. Retrofit programs to improve water-use efficiency in existing buildings.

d. Conservation-oriented water rate structure.

e. Universal metering and meter repair and replacement.

f. Water conserving landscaping.

g. Leak detection and repair.

h. Water recycling and reuse.

i. Implementation and enforcement.

Each of these potential conservation methods was considered in the development of a conservation plan for Plainview.

Education and Information Programs

The City of Plainview will inform the City users of various recommended methods for implementing a reduction in water consumption. Currently, water conservation literature is being distributed at the City Hall, and the City staff gives talks to schools on water conservation practices. The City will distribute additional resource materials which are available from the Texas Water Development Board and other agencies which develop pertinent information or data. The first year program will consist of the following activities:

a. A "Fact Sheet" explaining the Plainview's conservation plan will be developed and distributed to water customers at the outset of the Plan.

b. An article will be placed in the local newspaper, coordinated with the distribution of the "Fact Sheet".

c. Each new customer will be advised of the City's conservation program, and will be provided with a "New Customer Information Packet" which contains "Homeowners Guide," the "Fact Sheet", and copies of the articles published in local papers during the year.

d. A newspaper article will be published advising water customers that the Homeowners Guide is available at the Administration Offices.

e. The brochure, "Water ... Half-A-Hundred Ways to Save It," will be made available to water customers.

f. A news article will be published elaborating on brochure items and certain methods for saving water.

g. One of two brochures, "How to Save Water Outside the Home," or "How to Save Water Inside the Home," will be distributed to water customers.

The long-term education and information program will consist of five activities each year after the first year:

a. New brochures emphasizing new or innovative means for conserving water will be made available at the Administration Offices.

b. A statement will be printed on the water bill advising water customers that the brochures are available at the Administration Offices.

c. A newspaper article targeting one particular household water using utility or item (dishwasher, shower, toilet, laundry, ... etc.) will be published with methods for conserving water.

d. A brochure will be made available which correlates weather predictions to outside household use, car washing, lawn watering, and time of the day.

e. Homeowners Guide will be distributed to customers.

Attachment B-2 is a listing of water conservation literature that is available from the TWDB and other sources. Attachment B-3 includes an example of public information suggestions, which has been reproduced in part from the Texas Water Development Board Bulletin, titled "Water ... Half-A-Hundred Ways to Save It."

Plumbing Codes

The Texas Natural Resource Conservation Commission (TNRCC) requires that cities and utilities with a population of 5,000 or more, and do not have a plumbing code, adopt a water saving plumbing code for new construction and for replacement of plumbing fixtures in existing structures. The City of Plainview has adopted the 1988 edition of the Uniform Plumbing Code. The city limits residential meters (including sprinkler systems) to one inch or smaller, which tends to discourage excess water use and encourage conservation.

Water Conservation Retrofit Program

Title V of the Health and Safety Code, Subsection E, Chapter 421 requires that businesses stock and sell only plumbing fixtures which conform to water saving performance standards. This will ensure that plumbing fixtures installed during new construction and remodeling will be of the conservation oriented type. The City of Plainview will advise customers regarding retrofit devices (such as low-flow shower heads, toilet dams, faucet aerators, etc.) that reduce water use by replacing or modifying existing fixtures.

Conservation Oriented Water Rate Structure

The City of Plainview currently has a non-declining rate structure for water sales, which encourages water conservation. The City is moving toward adopting an ascending block rate structure, which will further discourage the wasteful use of large quantities of water. The City is now relating sewer charges to water consumption, with a 20,000 gallon ceiling, and that also encourages water conservation.

Universal Metering and Meter Repair and Replacement

All connections to the water supply system in Plainview are metered with new meters having been recently installed in most of the City. The City is testing and replacing meters on an on-going basis, concentrating on the largest meters first. Meter readers classify the apparent conditions of all City meters, and repairs are initiated in areas with poor classification. Universal metering will continue after adoption of this plan.

Plainview's production meters are located at the four booster pump stations at the City's groundwater storage tanks, at the water treatment plant, and on two groundwater wells that pump directly into the distribution system. The City uses these meters to estimate and report its groundwater production. These meters will be tested and calibrated and will be retested annually.

Service meters larger than two inches (2") will be tested every two years. Service meters two inches (2") and smaller will be tested at least every ten years. Plainview is also planning to install a service meter to measure water used for backwash at the water treatment plant.

Water Conserving Landscaping

Educational material will include information relating to low water use landscaping. The City reviews and approves subdivision plans. At the time building permits are acquired, developers will be provided with literature pertaining to low water demand landscaping items. Nurseries and local businesses will also be provided with this literature.

Leak Detection and Repair

The current billing cycles make it difficult for the City of Plainview to accurately determine the amount of unaccounted-for water losses in the system. The City will implement a system using a 12-month moving total of water treated and pumped versus water sold in order to assess this amount more accurately. The average unaccounted-for water for the year 1991 was 16.6% of the annual water production. Losses of this size are not uncommon in municipal water systems. Plainview has almost immediate response to reports of water leaks, which minimizes water waste. The City has recently repaired the large meter at the Wal-Mart distribution center, which was found to be inaccurate. The City is also conducting audits to identify connections which bypass city meters and correct those which are found.

The City of Plainview will continue to monitor monthly consumption. Classification of meter condition provides a reliable and effective leak detection program. The City is also aware that assistance in leak detecting surveys can be obtained from the Texas Water Development Board Staff.

Recycling and Reuse

The City of Plainview has authorized Freese and Nichols, Inc. to conduct a Wastewater Reuse Feasibility Study. The study is included as Appendix D to this regional water supply study. The study includes an inventory of potential areas and specific uses of reclaimed water. The study also includes a market analysis, including identification of quantity, quality, selling price and infrastructure requirements necessary for marketing the reclaimed water. The City will investigate other reuse and recycling programs where legally possible and economically feasible.

The City of Plainview currently recycles all water used for filter backwash at the water treatment plant. This amount is estimated at about 41,000 to 45,000 gallons per day. Water reclamation at the wastewater treatment plant is being considered by the City. External reuse at the plant site, including grass irrigation, ranges between 250,000 and 500,000 gallons per year. The wastewater treatment plant does not have internal (chlorine contact makeup water) recycling because ultra-violet disinfection is used rather than chlorination.

Implementation and Enforcement

The City of Plainview, through its staff, will implement the Water Conservation Plan in accordance with the Council's adoption of the Plan, plumbing codes, and revisions thereof as set out in this Plan. Plainview also maintains the authority to inspect any and all connections by Seth Ward WSC customers to the water distribution system located past the delivery point of the Corporation's water system.

Contract with Other Political Subdivisions

Any political subdivision and/or wholesale customer applying for new or renewed water contracts from the City of Plainview must have (1) an approved Texas Water Development Board Water Conservation and Drought Contingency Plan in effect, or (2) must officially adopt applicable provisions of the City of Plainview Water Conservation and Drought Contingency Plan.

Annual Reporting

The City, through adoption of this plan and as required by Section 363.181(b) Title 31 of the Texas Administrative Code (TAC), published June 24, 1986, commits to report to the Executive Director of the Texas Water Development Board annually. The report to the Director will contain information describing:

a. Progress in Conservation Plan implementation.

b. Public response to plan implementation and operation.

c. Quantitative effectiveness with reference to:

- system reduction and
- reduction in customer or per capita use

d. List of public information released during the year.

4. DROUGHT CONTINGENCY PLAN

Threshold Conditions

The Texas Water Development Board suggests four levels or "trigger conditions" for determining the degree of urgency for initiation of Drought Contingency Plan. These four levels of drought condition relate to the City of Plainview, and are as follows:

a. Mild drought, and occurs when: (a) The average daily water consumption reaches 90% of the production capacity, and has been that high for a period of three days. (b) Weather conditions indicate that high use is likely to continue.

b. Moderate drought conditions are reached when: (a) The average daily water consumption reaches 100% of the rated production capacity for a three day period. (b) Weather conditions indicate mild drought will exist for five days or more. (c) A mechanical failure of pumping equipment which will require more than 24 hours to repair occurs when a mild drought is in progress.

c. Severe drought classification is reached when: (a) Average daily water consumption reaches 110% of production capacity for a 24 hour period, (b) Average daily water consumption will not enable storage levels to be maintained, (c) System demand exceeds available high service pump capacity, or (d) a mechanical failure of pumping equipment which will require more than 12 hours to repair occurs when a moderate drought is in progress.

d. An Emergency Condition is declared when: (a) the CRMWA system fails, and the surface water cannot be delivered to the City, (b) the water system is contaminated either accidently or intentionally, or (c) the water system fails from acts of God (tornadoes, hurricanes, etc.) or man. An emergency condition is treated like a severe drought.

Drought Contingency Measures

The Water Conservation and Drought Contingency Ordinance adopted and included as part of this plan enables the Mayor to initiate action that will effectively implement the Plan. The following steps are recommended.

Step I

Step I curtailment shall be initiated upon existence of mild drought conditions and will include the following actions:

a. Develop Information Center and designate information person.

b. Advise public of condition and publicize availability of information from the Information Center.

c. Encourage voluntary reduction of water use.

d. Contact commercial and industrial users and explain necessity for initiation of strict conservation methods.

e. Implement system oversight and make adjustments as required to meet changing conditions.

Step II

Step II curtailment shall be initiated by the Mayor on his identifying moderate drought conditions. The listed actions are compulsory on users and are intended to prohibit non-essential water use. ("Non-essential Water Use" is defined as washing house windows, sidings, eaves, and roof with hose, and without the use of a bucket; washing driveways, streets, curbs and gutters; washing vehicles without cutoff valve and bucket; unattended sprinkling of landscape shrubs and grass; draining and filling swimming pools; and flushing water system.)

a. Outdoor residential use of water will be permitted on alternate days. Even number houses will use water for outdoor residential uses on even days of the month and odd number houses on odd days of the month. Outdoor residential uses consist of washing vehicles, boats, trailers, landscape sprinkler systems and irrigation, recreational use of sprinklers, outside showers (in parks) and water slides.

b. The Mayor will monitor system function and establish hours for outside water use, depending upon system performance.

c. The Information Center and publicity elements shall keep the public advised of curtailment status.

d. Commercial and industrial users will be visited to ensure that conservation measures have been initiated.

Step III

Step III curtailment shall be initiated upon existence of a severe drought or emergency condition as determined by the Mayor. The Mayor will ban the use of water for:

a. Vehicle washing, window washing, outside watering (lawn, shrubs, faucet dripping, garden, etc);

b. Public water uses which are not essential for health, safety and sanitary purposes. These non-essential uses include: street washing, watering of parks, fire hydrant flushing, filling swimming pools, watering athletic fields and courses, and dust control sprinkling.

c. Commercial uses not listed will be controlled to the extent dictated by the Mayor.

Businesses requiring water as a basic function of the business, such as nurseries, commercial car wash, laundromats, high pressure water cleaning, etc., will obtain written permission from the Mayor for intended water use.

The System Priority for water service shall be made based on the following priority list.

a. Hospitals

b. Residential

c. Schools

d. Industrial

e. Commercial

f. Recreational

Information and Education

The public will be made aware of conservation and drought conditions by information and data transfer through the City's program. During periods of drought curtailment, Step I conditions will establish an information center, an information person, and utilize the most effective methods developed for information dissemination on a daily basis.

Close observation of the first year information program should develop the most effective ways to communicate with customers. Posting notices, newspaper articles, radio coverage and direct mail to customers will be used during the first year activities.

Initiation Procedures

Initiation procedures for drought response are described in this Plan. Each condition will be met with corresponding action by the Mayor. The City will affect curtailment, give notice, publicize and follow-up with implementation of curtailment.

Termination Notification

Termination of each drought condition will begin when conditions have improved to the extent that an upgraded condition can be declared by the Mayor. This process will be employed until full service can be provided. System priority will be considered in returning to upgraded condition. Termination will be initiated by the Mayor by giving notice, etc., as was given to enact drought curtailment.

Modification, Deletion and Amendment

The Mayor can add, delete, and amend rules, regulations and implementation as needed/desired, and shall advise the City Council of such amendments at its regular or called meeting.

Means of Implementation

Adoption of this Plan and Drought Contingency Ordinance will enable the City to implement and carry out enforcement of enacted ordinances to make the Plan effective and workable.

ATTACHMENT B-1

LIST OF REFERENCES

ATTACHMENT B-1

LIST OF REFERENCES

(1) Parkhill, Smith and Cooper, Inc.: "City of Plainview, Texas, Comprehensive Plan 1976 - 2000," June 1976.

(2) Hunter Associates, Inc.: "Comprehensive Plan, 1989 - 2010, for the City of Plainview, Texas," October 1989.

ATTACHMENT B-2

LISTING OF WATER CONSERVATION LITERATURE

TEXAS WATER DEVELOPMENT BOARD
WATER CONSERVATION LITERATURE

TITLE	PUBLISHED BY	DESCRIPTION	LENGTH
Water...Half-A-Hundred Ways To Save It*	TWDB	Pamphlet	8 pages
Water Saving Ideas For Business and Industry*	TWDB	Pamphlet	8 pages
How to Save Water Outside The Home	TWDB	Pamphlet	8 pages
How to Save Water Inside The Home*	TWDB	Pamphlet	8 pages
A Homeowner's Guide to Water Use and Water Conservation*	TWDB	Booklet	22 pages
Drip Irrigation*	TWDB	Pamphlet	6 pages
Lawn Watering Guide*	TWDB	3 1/2" x 5" Plastic Card	2 sides
Toilet Tank Leak Detector Tablets*	TWDB	2 Tablets	-
Municipal and Commercial Water Conservation Services	TWDB	Pamphlet with Tear-out	8 pages
Guidelines for Municipal Water Conservation and Drought Contingency Planning and Program Development	TWDB	Loose-leaf	36 pages
How to Xeriscape	NXC	Pamphlet	10 pages
Texas Sesquicentennial Native Plant Landscape (located in Austin)	TDA/TWDB	Pamphlet	8 pages
Guide for Locating and Reducing Unaccounted for Water Through the Use of the Water Audit and Leak Detection	TWDB	Guidebook	30 pages

TITLE	PUBLISHED BY	DESCRIPTION	LENGTH
Guide for Designing Conservation Water Rate Structures	TWDB	Guidebook	30 pages
Model Water Ordinances	TWDB	Guidebook	30 pages
Texas Water Resources and Conservation	TWDB	Paper	38 pages
Efficient Use of Water in the Garden and Landscape (B-1496)	TAEX	Booklet	20 pages
Xeriscape [2]	City of Austin	Booklet	20 pages
Water Pressure Reducing Valves [2]	Watts Regulator	Booklet	21 pages
Texas Native Tree and Plant Directory, 1986 [2]	TDA	Book	161 pages
Sources of Leak Detection Equipment and Services [2]	TWDB	List	2 pages
Sources of Water Saving Devices [2]	TWDB	List	21 pages
The Cost of Conventional Water Supply Development and Treatment [2]	TWDB	Paper	9 pages
Potential for Utilization of Brackish Groundwater [2]	TWDB	Paper	21 pages
Guidelines for Water Reuse EPA-600/ 8-80-036 [2]	EPA	Book	105 pages
Guidelines for Municipal Water Conservation and Drought Contingency Planning and Program Development [2]	TWDB	Loose-Leaf	36 pages

TITLE	PUBLISHED BY	DESCRIPTION	LENGTH
Water Conservation and Drought Contingency Plan Development Procedures [2]	TWDB	Loose-Leaf	58 pages
Municipal Water Conservation Workshop Notebook	TWDB	Notebook	6 sections

[2] These items are available either in single copies or in the Municipal Water Conservation Notebook. However, the Board is not able to give out the Notebook, but can loan a copy for a period of two weeks.

* Order in 1000 Lots.

Abbreviations:

AWWA	American Water Works Association
EPA	Environmental Protection Agency
HPUWCD #1	High Plains Underground Water Conservation District No. 1
NXC	National Xeriscape Council, Inc.
SCS	USDA - Soil Conservation Service
TAEX	Texas Agricultural Extension Service
TDA	Texas Department of Agriculture
TWDB	Texas Water Development Board

ATTACHMENT B-3

PUBLIC INFORMATION SUGGESTIONS

This section has been reproduced, in part, from
Texas Water Development Board Bulletin, titled
"Water...Half-A-Hundred Ways to Save It."

POSSIBLE SAVINGS WITH WATER CONSERVATION

For approximately $10.00 to $15.00 the average homeowner can install two low flow showerheads, place dams or bottles in the toilet tanks, put low-flow aerators on the faucets, and repair dripping faucets and leaking toilets. This could save from 10,000 to 25,000 gallons/year for a family of four, and would pay for itself, in less than a year. Even more water could be saved if good outdoor water conservation is practiced for lawns and gardens.

CONSERVATION TIPS

A. In The Bathroom:

1. Take a shower instead of filling the tub and taking a bath. Showers usually use less water than tub baths.

2. Install a low-flow shower head which restricts the quantity of flow at 60 psi to no more than 3.0 gallons per minute.

3. Take short showers and install a cutoff valve or turn the water off while soaping and back on again only to rinse.

4. Do not use hot water when cold will do. Water and energy can be saved by washing hands with soap and cold water; hot water should only be added when hands are especially dirty.

5. Reduce the level of water being used in a bath tub by one or two inches if a shower is not available.

6. Turn water off when brushing teeth until it is time to rinse.

7. Do not let the water run when washing hands. Instead, hands should be wet, and water should be turned off while soaping and scrubbing and turned on again to rinse. A cutoff valve may also be installed on the faucet.

8. Shampoo hair in the shower. Shampooing in the shower takes only a little more water than is used to shampoo hair during a bath and much less than shampooing and bathing separately.

9. Hold hot water in the basin when shaving instead of letting the faucet continue to run.

10. Test toilets for leaks. To test for a leak, a few drops of food coloring can be added to the water in the tank. The toilet should not be flushed. The customer can then watch to see if the coloring appears in the bowl within a few minutes. If it does, the fixture needs adjustment or repair.

11. Use a toilet tank displacement device. A one-gallon plastic milk bottle can be filled with stones or with water, recapped, and placed in the toilet tank. This will reduce the amount of water in the tank, but still provide enough for flushing. (Bricks which some people use for this purpose are not recommended, since they crumble eventually and could damage the working mechanism, necessitating a call to the plumber). Displacement devices should never be used with new low-volume flush toilets.

12. Install faucet aerators to reduce water consumption.

13. Never use the toilet to dispose of cleansing tissues, cigarette butts, or other trash. This can waste a great deal of water and also places an unnecessary load on the sewage treatment plant or septic tank.

14. Install a new low-volume flush toilet that uses 3.5 gallons or less per flush when building a new home or remodeling a bathroom.

B. In the Kitchen:

1. Use a pan of water (or place a stopper in the sink) for rinsing pots and pans and cooking implements when cooking, rather than turning on the water faucet each time a rinse is needed.

2. Never run the dishwasher without a full load. In addition to saving water, expensive detergent will last longer and a significant energy saving will appear on the utility bill.

3. Use the sink disposal sparingly, and never use it for just a few scraps.

4. Keep a container of drinking water in the refrigerator. Running water from the top until it is cool is wasteful. Better still, both water and energy can be saved by keeping cold water in a picnic jug on a kitchen counter to avoid opening the refrigerator door frequently.

5. Use a small pan of cold water when cleaning vegetables rather than letting the faucet run.

6. Use only a little water in the pot and put a lid on it for cooking most food. Not only does this method save water, but food is more nutritious since vitamins and minerals are not poured down the drain with the extra cooking water.

7. Use a pan of water for rinsing when hand washing dishes rather than running the faucet.

8. Always keep water conservation in mind, and think of other ways to save in the kitchen. Small kitchen savings from not making too much coffee or letting ice cubes melt in a sink can add up in a year's time.

C. <u>In the Laundry</u>:

1. Wash only a full load when using an automatic washing machine (32 to 59 gallons are required per load).

2. Use the lowest water level setting on the washing machine for light loads whenever possible.

3. Use cold water as often as possible to save energy and to conserve the hot water for uses which cold water cannot serve. (This is also better for clothing made of today's synthetic fabrics.)

D. <u>For Appliances and Plumbing</u>:

1. Check water requirements of various models and brands when considering purchasing any new appliance that uses water. Some use less water than others.

2. Check all water line connections and faucets for leaks. If the cost of water is $1.00 per 1,000 gallons, one could be paying a large bill for water that simply goes down the drain because of leakage. A slow drip can waste as much as 170 gallons of water EACH DAY, or 5,000 gallons per month, and can add as much as $5.00 per month to the water bill.

3. Learn to replace faucet washers so that drips can be corrected promptly. It is easy to do, costs very little, and can represent a substantial amount saved in plumbing and water bills.

4. Check for water leakage that the customer may be entirely unaware of, such as a leak between the water meter and the house. To check, all indoor and outdoor faucets should be turned off, and the water meter should be checked. If it continues to run or turn, a leak probably exists and needs to be located.

5. Insulate all hot water pipes to avoid the delays (and wasted water) experienced while waiting for the water to "run hot."

6. Be sure the hot water heater thermostat is not set too high. Extremely hot settings waste water and energy because the water often has to be cooled with cold water before it can be used.

7. Use a moisture meter to determine when house plants need water. More plants die from over-watering than from being on the dry side.

E. Out-of-Door Use:

1. Water lawns early in the morning during the hotter summer months. Much of the water used on the lawn can simply evaporate between the sprinkler and the grass.

2. Use a sprinkler that produces large drops of water, rather than a fine mist, to avoid evaporation.

3. Turn soaker hoses so the holes are on the bottom to avoid evaporation.

4. Water slowly for better absorption, and never water in high winds.

5. Forget about watering the streets or walks or driveways. They will never grow a thing.

6. Condition the soil with compost before planting grass or flower beds so that water will soak in, rather than run off.

7. Fertilize lawns at least twice a year for root stimulation. Grass with a good root system makes better use of less water.

8. Learn to know when grass needs watering. If it has turned a dull grey-green or if footprints remain visible, it is time to water.

9. Do not water too frequently. Too much water can overload the soil so that air cannot get to roots and can encourage plant diseases.

10. Do not over-water. Soil can absorb so much moisture and the rest simply runs off. A timer will help, and either a kitchen timer or an alarm clock will do. An inch and one-half of water applied once a week will keep most Texas grasses alive and healthy.

11. Operate automatic sprinkler systems only when the demand on the town's water supply is lowest. Set the system to operate between 4:00 a.m. and 6:00 a.m.

12. Do not scalp lawns when mowing during hot weather. Taller grass holds moisture better. Rather, grass should be cut fairly often, so that only 1/2 to 3/4 inch is trimmed off. A better looking lawn will result.

13. Use a watering can or hand water with the hose in small areas of the lawn that need more frequent watering (those near walks or driveways, or in especially hot, sunny spots).

14. Learn what types of grass, shrubbery, and plants do best in the area and in which parts of the lawn, and then plant accordingly. If one has a heavily shaded yard, no amount of water will make roses bloom. In especially dry sections of the state, attractive arrangements of plants that are adapted to arid or semi-arid climates should be chosen.

15. Consider decorating areas of the lawn with rocks, gravel, wood chips, or other materials now available that require no water at all.

16. Do not "sweep" walks and driveways with the hose. Use a broom or rake instead.

17. Use a bucket of soapy water and use the hose only for rinsing when washing the car.

ATTACHMENT B-4

WATER CONSERVATION/DROUGHT

CONTINGENCY PLAN ORDINANCE

STATE OF TEXAS

COUNTY OF HALE

I, ____________________, City Secretary of Plainview, Texas, do hereby notify that the attached is a true and correct copy of an ordinance passed and approved in a meeting of the City Council held on the ________ day of ______________, as same is recorded in the minutes of the City Council in Plainview, Texas, and as same is on file in the records of City of Plainview.

WITNESS my hand and seal of said City, this day of 1992.

____

Karen McBeth, City Secretary

ORDINANCE NO. ______

AN ORDINANCE ADOPTING A CITY OF PLAINVIEW WATER CONSERVATION AND DROUGHT CONTINGENCY PLAN; PENALTIES CLAUSE; CUMULATIVENESS CLAUSE; SEVERABILITY CLAUSE; CONFLICTS CLAUSE; AND EFFECTIVE DATE

WHEREAS, the City Council of the City of Plainview, Texas, has determined there is an urgent need in the best public interest of the City of Plainview to adopt a Water Conservation Plan and Drought Contingency Plan; and

WHEREAS, the City Council further determines that such public need is of an emergency nature; and

WHEREAS, the City Council finds and declares that a sufficient written notice of the date, hour, place and subject of this meeting of the City Council was posted at a designated place convenient to the public at the City Hall for the time required by law preceding this meeting and that such place of posting was readily accessible at all times to the general public; and

WHEREAS, the City Council of the City of Plainview now desires to evidence its approval of the Water Conservation/Drought Contingency Plan and adopt such plan as an official policy of the City;

NOW, THEREFORE, BE IT ORDAINED by the City Council of the City of Plainview, Texas:

Section I

The City Council hereby approves and adopts as the City of Plainview Water Conservation Plan, the Water Conservation/Drought Contingency Plan attached hereto to as Exhibit A and incorporated herein. The City commits to implement the program according to the procedures set forth in the adopted plan.

Section II

The City shall report to the Texas Water Development Board annually on the implementation and effectiveness of the plan in accordance with the outline set forth in the Plan.

Section III

In regards to implementation and enforcement of the Water Conservation and Drought Contingency Plan, the Mayor of the City of Plainview is designated as the official responsible for implementation and enforcement, and the following guidelines are adopted:

1. Mild Drought

   (a) Average daily water consumption reaches 90% of the production capacity and has been that high for a period of three days.

   (b) Weather conditions indicate that high use is likely to continue.

2. Moderate Drought

   (a) The average daily water consumption reaches 100% of the rated production capacity for a three day period.

   (b) Weather conditions indicate mild drought will exist five days or more.

   (c) A mechanical failure of pumping equipment which will require more than 24 hours to repair occurs when a mild drought is in progress.

3. Severe Drought

   (a) Average daily water consumption reaches 110% of production capacity for a 24 hour period.

   (b) Average daily water consumption will not enable storage levels to be maintained.

   (c) System demand exceeds available high service pump capacity.

   (d) A mechanical failure of pumping equipment which will require more than 12 hours to repair occurs when a moderate drought is in progress.

4. Emergency Condition

   (a) The CRMWA system fails, and the surface water cannot be delivered to the City.

   (b) Water system is contaminated either accidently or intentionally.

   (c) Water system fails from acts of God (tornados, hurricanes, etc.) or man. An emergency condition is treated like a severe drought.

In the event severe classification conditions persist (Item 3 above) for an extended period of time or an emergency condition is identified (Item 4 above), the City may ration water usage and/or terminate service to selected users of the system in accordance with following sequence:

   (1) Recreational Users

   (2) Commercial Users

   (3) School Users

   (4) Residential Users

   (5) Hospitals, Public Health and Safety Facilities

<u>Section IV</u>

Users of City water except for the City, that do not comply with Section III of this Ordinance shall be subject to a penalty and fine of not less than $10.00 per day, nor more than $200.00 per day for each day of non-compliance and/or disconnection or discontinuance of water services to such users by the City.

<u>Section V</u>

Provisions of this ordinance are cumulative and nothing herein shall prevent, alter, or diminish the applicability or enforcement of other ordinances restricting, regulating or governing the subject matter herein.

Section VI

If any section, subsection, sentence, clause, phrase, or portion of this ordinance is for any reason held invalid or unconstitutional by any court of competent jurisdiction, such portion shall be deemed a separate, distinct, and independent provision and such holding shall not affect the validity of the remaining portions hereof.

Section VII

All ordinances or portion of any ordinance in conflict herewith are hereby amended to conform with the provisions hereof.

Section VIII

This ordinance shall be of full force and effect upon its passage and publication as required by law.

PASSED AND APPROVED, this ______ day of _____________, 1992.

____
E.V. Ridlehuber, Mayor

ATTEST:

____
Karen McBeth, City Secretary

APPROVED AS TO CONTENT:

____
William R. Hogge
Director of Public Works

APPROVED AS TO FORM:

____
Wally Hatch
City Attorney

RESOLUTION NO. _________

A RESOLUTION OF THE CITY OF PLAINVIEW AUTHORIZING THE MAYOR TO IMPLEMENT THE PROVISION OF THE WATER CONSERVATION AND DROUGHT CONTINGENCY PLAN AND NOTIFY CUSTOMERS OF REQUIREMENTS.

WHEREAS, the City Council of the City of Plainview, Texas, saw an emergency need to adopt a Water Conservation and Drought Contingency Plan for the City and adopted same by Ordinance No. _______ on ____________________________; and

WHEREAS, the Mayor of the City of Plainview should be authorized to implement said Plan and notify customers of the minimum requirements;

NOW, THEREFORE, BE IT RESOLVED by the City Council of the City of Plainview, Texas, that:

The Mayor of the City of Plainview is hereby empowered to implement the provisions of the Plan.

BE IT FURTHER RESOLVED that:

The Mayor of the City of Plainview shall take the necessary steps to put this Plan into effect by notifying and requesting the customers of the City to meet the minimum requirements of this Plan

PASSED AND APPROVED this _____ day of _________________, 1992.

____
E. V. Ridlehuber, Mayor

ATTEST:

____
Karen McBeth, City Secretary

APPENDIX C

POTABLE WATER SYSTEM

SURFACE WATER TREATMENT RULE

DISINFECTION EVALUATION

CITY OF PLAINVIEW, TEXAS

POTABLE WATER SYSTEM
SURFACE WATER TREATMENT RULE
DISINFECTION EVALUATION

OCTOBER 1992

FREESE AND NICHOLS, INC.

PLN91214

STATE OF TEXAS
RAYMOND R. LONGORIA
54681
REGISTERED
PROFESSIONAL ENGINEER

Raymond R. Longoria

30 OCT 92

Raymond R. Longoria, P.E., D.E.E.
Randal D. Romack

1. INTRODUCTION

SAFE DRINKING WATER ACT DISINFECTION REQUIREMENTS

The Texas Department of Health (TDH) adopted new rules and regulations in compliance with the requirements of the 1986 Safe Drinking Water Act (SDWA) on October 13, 1990. These new rules were incorporated into the Texas Administrative Code on January 1, 1991, as the Texas Surface Water Treatment Rule (TSWTR). The primary effective date for full enforcement of these rules is July 1, 1993. Since adoption of the TSWTR, the regulatory group responsible for administering the rule has been shifted from the TDH to the Texas Water Commission (TWC).

The Texas Surface Water Treatment Rule requires that the combination of treatment and disinfection achieve at least a 99.9% (3-log) inactivation/removal of Giardia lamblia cysts and at least a 99.99% (4-log) inactivation/removal of viruses. For conventional treatment the rule requires at least a 0.5-log inactivation of Giardia and a 2.0-log inactivation of viruses through disinfection "contact" time. Contact is defined as the detention time at which 90% of the water passing through a basin or tank is retained and is identified as "T_{10}". The T_{10} values, which are hydraulic characteristics specific to each plant, are combined with the plant's disinfectant residual concentrations ("C"). The resulting CT value must meet or exceed the required CT value tabulated by the U.S. Environmental Protection Agency (EPA) for various pHs, temperatures, and disinfectant concentrations.

The CT requirement is a departure from the approach of establishing a Maximum Contaminant Level (MCL) for a given parameter, and testing to determine whether that parameter's concentration in the finished water exceeds the MCL. Instead, the CT requirement is based on treatment technique through the plant. It is important to remember that the SWTR CT requirements are in parallel to the TWC disinfectant residual requirements, which apply at the tap. It is possible to meet either, both, or neither of the requirements, depending on the disinfectant decay rate in the system.

PROJECT SCOPE

The City of Plainview retained Freese and Nichols to:

1) evaluate the existing water treatment plant and drinking water distribution system to determine its compliance with the SDWA disinfection requirements, and
2) recommend system modifications, if necessary, so that the existing treatment plant will comply with the SDWA disinfection requirements.

Information gathered during the initial water treatment plant site visit suggested that the field version of SDWA CT compliance study would not be required. It was recommended that the calculated method be used as opposed to the field version for the following reasons:

- TWC allows the use of the calculated version for certain plants whose disinfection strategy is based on free chlorine, such as Plainview. Preliminary calculations suggested Plainview could show compliance using the calculated version, saving the time and expense of the field version.

- Preliminary indications are that certain physical improvements are going to be necessary at the Plainview SWTP to improve operations which will require a tracer study to be performed upon completion of the work. Little would be gained from performing the full tracer study at this time.

Subsequently, the scope was modified to include the calculated version of the tracer study for determining CT compliance.

2. TREATMENT PLANT AND DISTRIBUTION SYSTEM DESCRIPTION

The City of Plainview water supply system includes the use of both groundwater and surface water. The raw surface water is purchased from the Canadian River Municipal Water Authority (CRMWA) and is delivered through a pipeline from the CRMWA's reservoir.

A 4.2 MGD solids contact type water treatment plant treats the raw water which subsequently is combined with groundwater. Figure 2.1 and the following sections describe the existing water treatment plant. The plant was originally designed but never used for lime-softening. Groundwater is also mixed with treated surface water to increase the water quality.

TREATMENT SYSTEM

The existing treatment process, as shown in Figure 2.1, includes solids contact clarification, filtration, and clearwell storage. Raw water enters the plant through an 18 inch diameter pipe where it flows through a raw water meter and is pre-chlorinated using free chlorine. Water continues to a splitter box where the flow can split to either of two solids contact clarifiers. The clarifiers are normally operated in series but can be operated using only one clarifier to control taste and odor problems. Water flows by gravity to four (4) mono-media filters. After filtration, treated water is combined to approximately 50% groundwater before clearwell storage.

Table 2-1 gives the dimensions, volumes, and theoretical retention times for each disinfection zone. This table reflects minimum working water depth of 12 feet in the clearwell.

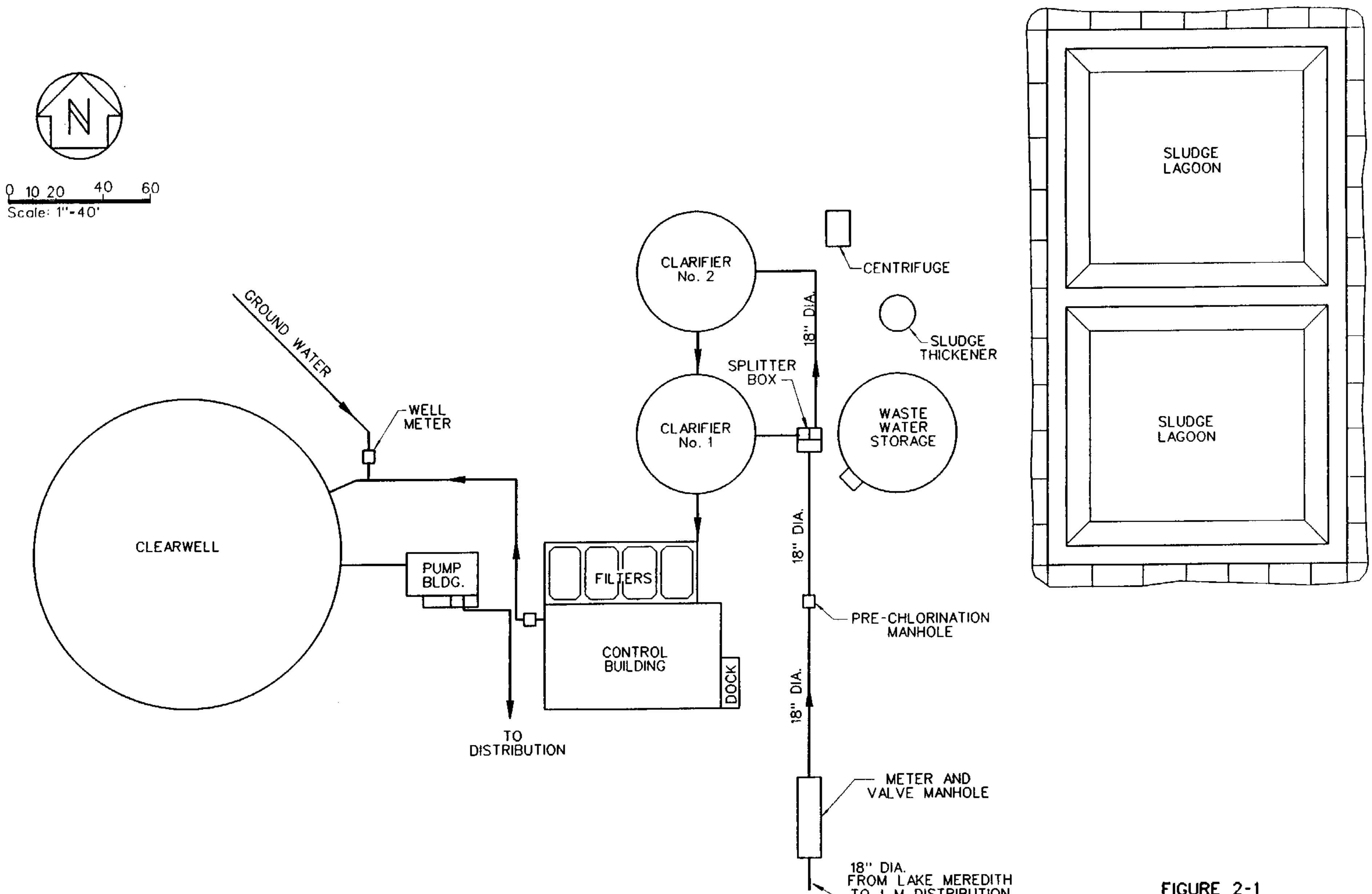


FIGURE 2-1

FREESE AND NICHOLS, INC. CONSULTING ENGINEERS FORT WORTH, TEXAS	CITY OF PLAINVIEW GENERAL LAYOUT

TABLE 2–1

FREESE AND NICHOLS, INC. — **WTP Tracer Hydraulics Spreadsheet**

FACILITY: City of Plainview WTP
PROJECT: PLN 91214
PHASE: Final Report — **DATE:** October 1992

FLOWRATE: 4.2 MGD (100% of Design Capacity)

PROCESS UNIT	NO. UNITS	DIMENSIONS (ft) L	W	SWD	TOTAL VOLUME cu ft	1000 gal	HRT (hr:min:sec) Unit	Cumul
Raw Water Line	1	60.0	1.5 << I.D.		106	0.8	00:00:16	00:00:16
Splitter Box	1	8.0	6.0	14.0	672	5.0	00:01:43	00:02:00
Clarifier	1	56.0 << I.D.		16.0	39,408	294.8	01:41:04	01:43:04
Filters (above media)	3	27.0	13.5	3.0	3,281	24.5	00:08:25	01:51:28

FLOWRATE: 8.1 MGD * (100% of Design Capacity)

PROCESS UNIT	NO. UNITS	DIMENSIONS (ft) L	W	SWD	TOTAL VOLUME cu ft	1000 gal	HRT (hr:min:sec) Unit	Cumul
Clearwell**	1	130.0 << I.D.		12.0	159,279	1,191.4	03:31:48	03:31:48

* Includes 3.9 MGD groundwater in addition to 4.2 MGD surface water.
** Minimum working water depth = 12 feet.

3. CURRENT SYSTEM CT VALUES AND COMPLIANCE

CT REQUIREMENTS

The City of Plainview Surface Water Treatment Plant uses free chlorine as the sole disinfectant. Required CT values, for Giardia disinfection and for virus disinfection, are tabulated in the EPA disinfection Guidance Manual as a function of water temperature, pH, and residual concentration. According to plant records, the minimum water temperature measured during the last several years was roughly 5° C; therefore, the 5° C tables are appropriate for calculating CT compliance.

Monthly monitored raw water pH and treated water pH data for the period January, 1990 through December, 1991 are summarized in Table 3-1. Raw water pH monitored daily exceeded 9.0 only once and treated water pH did not exceed 8.0 during this period.

For water with a critical temperature of 5°C and a critical pH of 9.0 in the raw water line and a critical pH of 8.0 in the clarifiers, filters, and clearwell, the EPA tables provide the following CT requirements for disinfection using free chlorine:

Viruses	4 min-mg/l
Giardia	52 min-mg/l (at 1.0 mg/l residual, pH = 9.0)
Giardia	36 min-mg/l (at 1.0 mg/l residual, pH = 8.0)

CURRENT CT COMPLIANCE

Table 3-2 summarizes calculations for the system's existing chlorination strategy. The free chlorine residual was measured at several locations throughout the plant. Typically, free chlorine residual is 2.0 to 2.5 mg/l at the splitter box and 1.0 to 2.0 in the clarifiers, filter effluent, and clearwell. Consequently, Table 3-2 reflects more conservative values in each disinfection zone. With 1.0 mg/l free chlorine residual each zone provides 37.7 min-mg/l of CT. This represents 104.1% of the Giardia CT requirement and 945.5% of the virus CT requirement. A conservative baffling ratio of 0.2 was assumed for the clarifier and approved by the State in a telephone conversation. The totals in the right column of Table 3-2 indicate the existing disinfection strategy meets both the virus and Giardia CT requirements.

TABLE 3–1

CITY OF PLAINVIEW
WATER TREATMENT PLANT

Month/Year	Raw Water pH max	Treated Water pH max
January – 1990	8.8	7.9
February	8.7	7.9
March	8.9	7.8
April	8.9	7.8
May	8.7	7.8
June	8.9	7.8
July	8.5	7.4
August	8.6	7.7
September	8.7	7.6
October	8.4	7.4
November	8.3	7.8
December	9.2	7.8
January – 1991	8.9	7.7
February	8.9	7.6
March	8.7	7.7
April	8.6	7.6
May	8.9	7.5
June	8.7	7.5
July	8.7	7.8
August	8.8	7.6
September	8.6	7.4
October	8.4	7.4
November	8.9	7.3
December	8.8	7.3
Maximum	9.2*	7.9

*One daily sample recorded pH > 9.0 during two year period

TABLE 3–2

FACILITY: City of Plainview, Texas WTP
OPTION: Current Chlorination Strategy

DESIGN FLOWRATE (MGD): 4.2
CRITICAL TEMPERATURE (°C) 5.0

DISINFECTION ZONE:		1 Raw Water Line	2 Splitter Box	3 Clarifier (1)	4 Filters (3)	5 Clearwell	6	Total for Plant
Design Conditions								
Flowrate	MGD	4.2	4.2	4.2	4.2	8.1 *B*		
Volume	MG	0.0008 *A*	0.0050	0.2948	0.0245	1.1914 *C*		
HRT	minutes	0.27	1.71	101.06	8.41	211.81		
Baffling Ratio	– – –	1.0	0.5	0.2	0.7	0.05		
T–10	minutes	0.27	0.86	20.21	5.89	10.59		
Free–Cl	mg/l	1.0	1.0	1.0	1.0	1.0		
CT Values								
Free–Cl	min*mg/l	0.3	0.9	20.2	5.9	10.6		
pH	– – –	9.0	9.0	8.0	8.0	8.0		
Giardia								
CT – Requirement	min*mg/l	52	52	36	36	36		
% of Required	%	0.5	1.6	56.1	16.4	29.4		104.1
Viruses								
CT – Requirement	min*mg/l	4	4	4	4	4		
% of Required	%	6.8	21.4	505.3	147.2	264.8		945.5

A Plug–flow hydraulics through pipe
Pipe Diameter 18.0 in
Length of Pipe 60.0 ft

B Includes 3.9 MGD Groundwater.
C Minimum working water depth = 12 feet.

Rev: 10/28/92 – RDR

4. PROPOSED SYSTEM MODIFICATIONS

The existing disinfection strategy meets both the virus and Giardia CT requirements; therefore, no modifications are required. To meet the CT requirements, however, a free chlorine residual of at least 1.0 mg/l must be maintained in the raw water line from the point of free chlorine application up to and including the clearwell.

APPENDIX D

WASTEWATER REUSE

FEASIBILITY STUDY

CITY OF PLAINVIEW, TEXAS

WASTEWATER REUSE FEASIBILITY STUDY

MAY 1994

FREESE AND NICHOLS, INC.

STATE OF TEXAS
RAYMOND R. LONGORIA
54661
REGISTERED
PROFESSIONAL ENGINEER

23 MAY 94

Raymond R. Longoria, P.E.,D.E.E.

APPENDIX D

WASTEWATER REUSE FEASIBILITY STUDY

The objective of this study is to investigate the possibility of substituting reclaimed water from the Plainview wastewater treatment plant for potable water and/or fresh water within the Plainview service area where such substitution would be appropriate and cost effective pursuant to the requirements presented in Texas Natural Resource Conservation Commission Regulation 31, Chapters 305 and 310.

Scope of Work

The scope of work for the wastewater reuse feasibility study is as follows:

1. A water supply and demand assessment for the area served.
2. An inventory of potential areas where reclaimed water may be appropriately substituted for potable water and/or fresh water.
3. An inventory of potential uses of reclaimed water.
4. An analysis of the markets for reclaimed water and the conditions necessary to serve the market (eg. quantity, quality, sell price, distribution system).
5. A preliminary cost-benefit analysis for the treatment and use of reclaimed water compared with the continued use of potable water and/or fresh water, water supply augmentation, water conservation, and/or cost of treatment and disposal of treated wastewater.

Assessment of Service Area Water Supply and Demand

The Plainview wastewater treatment plant (WWTP) is located within the City of

Plainview and Hale County approximately 1.5 miles east of Hale County Airport. An inventory was performed of the water consumption for the Plainview service area. Table D-1 gives a list of the major water users in the Plainview area, excluding irrigated agriculture.

The estimated total combined annual groundwater and surface water demand for the Plainview service area is about 1,500 MG. The average annual wastewater effluent discharge from the Plainview WWTP from 1988 to 1991 was approximately 765 MG, which is approximately 51 percent of the current area water demand. The historical flows and wastewater quality characteristics for Plainview are summarized in Attachment D-1. Based on the current permitted annual average day discharge value of 2.23 mgd, the ultimate potential annual effluent supply would be 814 MG, or about 54 percent of current area water demand.

Inventory/Screening of Potential Reclaimed Water Users

Local municipal water billing records were reviewed to identify regular large volume consumers of water for non-potable purposes. Table D-2 lists the significant Plainview water system customers who are potential candidates for reclaimed water use. Of the existing water customers, one municipal customer and one commercial customer are potential candidates. The municipal use is associated with the parks, and the commercial use is the Walmart Distribution Center.

No industrial water customers emerged as likely candidates for reclaimed water use. However, there are two self-supplied industries in the region that are potential candidates for reuse. Reuse by these industries would not benefit the Plainview water system directly

Table D-1

Largest Water Consumers for the Plainview Water Supply System

Customer	Use	Consumption (Gallons/Year)
Seth Ward Water Supply	Municipal	23,207,000
PLV Ice DBA Host Ice	Industrial	16,673,000
Housing Authority	Municipal	16,304,000
Westar Property Management	Municipal	8,518,000
Central Plains Reg. Hospital	Industrial	7,929,000
Heritage Home	Municipal	6,321,000
Park RWD Regional Park	Municipal	5,132,000
Furrs Cafeteria 176	Commercial	4,740,000
City OF Plainview	Municipal	4,076,000
Plains Village	Municipal	3,663,000
Plainview Schools	Industrial	3,510,000
Barrington Apartments	Commercial	3,422,000
Coca Cola Bottling Comp	Industrial	3,346,000
Kettle Restaurant	Commercial	3,308,000
Congress Inn	Commercial	3,220,000
Edgemere Apartments	Commercial	3,079,000
Holiday Inn	Commercial	2,810,000
Rogers, Vernon	Commercial	2,767,000
Conestoga	Commercial	2,636,000
Broadway Park	Municipal	2,000,000
Givens St. Park	Municipal	2,000,000
WalMart Distribution Center	Commercial	1,882,000
Frisco Park	Municipal	1,000,000
Total		131,543,000

Private Wells

Customer	Use	Consumption (Gallons/Year)
Azteca	Industrial	192,423,000
Excel	Industrial	15,635,000
Zipp Industries (Occidental)	Industrial	5,256,000
Country Club	Commercial	1,707,000
Total		215,021,000

Table D-2

Potential Reclaimed Water Users

Type	Customer	Estimated Total Annual Use (Gallons/Year)
Municipal	City Cemetery[a]	
	Running Water Draw Regional Park	5,132,000
	Broadway Park	2,000,000
	Givens St. Park	2,000,000
	Frisco Park	1,000,000
	Other City Parks	1,750,000
	Wastewater Treatment Plant[b]	28,500,000
	City Landfill[c]	30,628,000
Commercial	Walmart Distribution Center	1,882,000
	Country Club	1,707,000
Industrial	Excel	15,635,000
	Zipp Ind. (Occidental)	5,256,000
	TOTAL	95,490,000

Notes:

a. The quantity of water consumed is negligible.

b. Already uses effluent for non-potable purposes. This consumption is not metered, but is estimated at 3.5% of the permitted discharge.

c. Not a current water consumer. However, the proposed addition of trees makes the landfill a potential candidate for reuse.

but would decrease the use of groundwater in the region. Azteca, another self-supplied industry in the area, is a large volume water consumer, but will not be considered as a potential candidate because nearly all of its consumption requires potable water. Additionally, one commercial user, the Country Club, irrigates from a private well. Substitution of reuse water in the application could reduce the reliance on groundwater as well.

The City of Plainview has identified another potential application for reuse in which reclaimed water would be used to irrigate trees surrounding the City's new landfill. The City has proposed to plant various species of trees around the perimeter of the landfill in order to provide a visual barrier and a windblock. The landfill is located directly north of the wastewater treatment plant and has high potential for reuse due to its close proximity and relatively high potential water consumption.

The estimated irrigation requirements for the City landfill are based on the Hale County's Agricultural Extension Service recommendation of 1 inch of irrigation per week for most types of vegetation in this area. Actual irrigation requirements vary with the species of plant, but because of the unknown type and quantity of trees, the irrigation demand is based on 1 inch per week. There are approximately 1,890,000 ft^2 (43.4 acres) of land surrounding the landfill which could be utilized for trees. Assuming that irrigation will only occur 6 months per year, the total annual consumption would be 30,628,000 gallons per year.

The current permitted maximum annual effluent discharge quantity for the Plainview treatment plant is 814 MG. The potential annual reclaimed water usage given in Table D-2 represents approximately twelve percent of the total permitted effluent production. The potential reclaimed water use represents approximately six and one half percent of the Plainview service area's total water demand. The demand represents the quantity supplied by the City and excludes consumption from privately-owned wells.

<u>Inventory/Identification of Potential Reclaimed Water Uses</u>

Non-potable water uses identified for the Plainview service area and classified according to those categories recognized in TAC Section 31, Chapters 310 of the TNRCC Rules and Regulations for reclaimed water reuse are shown in Table D-3.

The significant individual service area water users identified in Section 4 for each type of reclaimed water use shown above are described below.

Type 1: Irrigation of Crop and Pastureland

None

Table D-3

Typical Wastewater Reuse Categories

Type	Use Description	Reclaimed Water Demand Mo/Yr	Reclaimed Water Demand % of Est. Total
1	Irrigation of Crops and Pasture Land	-	0
2	Irrigation Restricted Landscaped Areas (Medians/Golf Courses)	6	70
3	Irrigation of Unrestricted Landscaped Areas (Shopping Center Areas/Office Parks/School Grounds)	6	11
4	Commercial Processes	-	0
5	Industrial Process	12	19

Type 2: Restricted Landscape Irrigation

- Walmart Distribution Center — Turf Irrigation
- City Cemetery — Turf Irrigation
- Country Club — Turf Irrigation
- Wastewater Treatment Plant — Turf Irrigation/Process Water/Washdown
- City Landfill — Tree Irrigation

Type 3: Unrestricted Landscape Irrigation

- Running Water Draw Park — Turf Irrigation
- Broadway Park — Turf Irrigation

- Givens St. Park — Turf Irrigation
- Frisco Park — Turf Irrigation
- Other City Parks — Turf Irrigation

Type 4: Commercial Processes

None

Type 5: Industrial Processes

- Excel — Washdown/Process water
- Zipp Industries — Process Water

Analysis of Market Conditions For Reclaimed Water

Quality. All respondents indicated that they could accept the water quality standards stipulated in TAC Section 31, Chapter 310 of the TNRCC Rules and Regulations. Therefore, the following criteria and maximum values apply to the viable uses of reclaimed water identified in the Plainview service area:

1.	Irrigation of Food Crops	
	- BOD_5 (System other than pond system)	10 mg/l
	- BOD_5 (Pond system)	30 mg/l
	- Turbidity	3 NTU
	- Fecal Coliform (Not to exceed)	75 CFU/100 ml
2.	Irrigation of Fodder, Fiber and Seed Crops	
	- BOD_5	30 mg/l
3.	Irrigation of Pastures of Animals Milked for Human Consumption	
	- BOD_5 (Other than pond system)	20 mg/l
	- BOD_5 (Pond System	30 mg/l
	- Fecal Coliform (Not to exceed)	800 CFU/100 ml
4.	Irrigation of Landscaped Areas	
	• For Unrestricted Landscaped Areas	
	- BOD_5	5 mg/l
	- Turbidity	3 NTU
	- Fecal Coliform (Not to exceed)	75 CFU/100 ml

- For Restricted Landscaped Areas

- BOD_5 (Other than pond system)	20 mg/l
(Pond system)	30 mg/l
- Fecal Coliform (Not to exceed)	800 CFU/100 ml

5. A Landscaped Impoundment, Restricted Recreational Improvement, or Ornamental Fountain.

- BOD_5	10 mg/l
- Turbidity	3 NTU
- Fecal Coliform (Not to exceed)	75 CFU/100 ml

6. Commercial and Industrial Use of Reclaimed Water

- BOD_5 (System other than pond system)	20 mg/l
- BOD_5 (Pond system)	30 mg/l
- Fecal Coliform (Not to exceed)	200 CFU/100 ml

Treatment/Distribution Systems. For the purpose of performing the required preliminary cost-benefit analysis, preliminary conceptual designs for each feasible type of reuse have been developed to serve each interested reclaimed wastewater customer or group of customers. They are as follows:

- Conceptual Design A: Restricted Landscape Irrigation / Industrial
  - New Effluent Pumping Station at Plainview Plant Site
  - New Effluent Force Main to Destination
  - New Ground Storage Tank
  - Existing Irrigation Pumps Distributed System
- Conceptual Design B: Unrestricted Landscape Irrigation
  - Tertiary Treatment
  - New Effluent Pumping Station at Plainview Plant Site
  - New Effluent Force Main to Destination
  - New Ground Storage Tank

- Existing Irrigation Pumps Distributed System

The potential reuse customers have been grouped into the appropriate Treatment/Distribution categories and are presented in Table D-4.

The Plainview WWTP currently uses effluent for non-potable water service, eliminating the need for an additional distribution system to be added.

Table D-4

Treatment/Distribution Categories For Potential Reuse Customers

Potential Customer	Treatment/ Distribution Category	Quantity (Gallons/Year)
Country Club	A	1,707,000
Excel	A	15,635,000
Zipp Industries	A	5,256,000
Walmart Distribution Center	A	100,000
City Landfill	A	30,628,000
Running Water Draw Park	B	5,132,000
Broadway Park	B	2,000,000
Givens St. Park	B	2,000,000
Frisco Park	B	1,000,000
Other City Parks	B	1,750,000

Estimated Costs: Two major scenarios will be included in the cost analysis. One scenario will consider the reuse candidates that are remotely located, and thus will include a considerable pipeline cost. A separate scenario will involve only the City landfill, which is adjacent to the treatment plant. The landfill's close proximity and relatively high water consumption make it a particularly suitable candidate for water reuse, thereby warranting consideration independently of the other candidates.

Scenario 1: Widespread Reuse

Scenario 1 includes four alternatives, whose estimated costs are compared in Table D-5. Two alternatives are associated with each of Treatment/Distribution category A and B. Category A is turf irrigation for restricted areas and for the industrial uses and requires no treatment upgrade but does require a non-potable water distribution system. Category B is for unrestricted turf irrigation and includes a treatment plant upgrade. This quality water also could be used for the restricted turf irrigation and industrial uses. The alternatives are shown in Figures D-1 and D-2.

The alternatives within each category include one that provides service to the two industries and one that does not. Since the water being used by the industries is groundwater at a relatively low cost, cost estimates were developed for an alternative which excludes their participation. This identifies an estimated cost for each category if the industries elect not to participate. The estimated construction costs use EPA's *Innovative and Alternative Technology Assessment Manual* updated using the *Engineering News-Record* Construction Cost Index. The operation and maintenance costs are based on a power cost of $0.065/KWH. The net present worth (NPW) cost for each alternative is calculated using an interest rate of 8% and an NPW period of 20 years. The NPW cost is converted into a cost per 1,000 gallons of reuse supply water.

For comparison purposes, the cost for potable water through the Plainview water supply system is $0.90/1,000 gallons. All of the four alternatives for widespread reuse are significantly more expensive than the cost of potable water and the cost of groundwater to the Country Club and the candidate industries. This is attributed to the relatively low

Table D-5

Distribution System Options

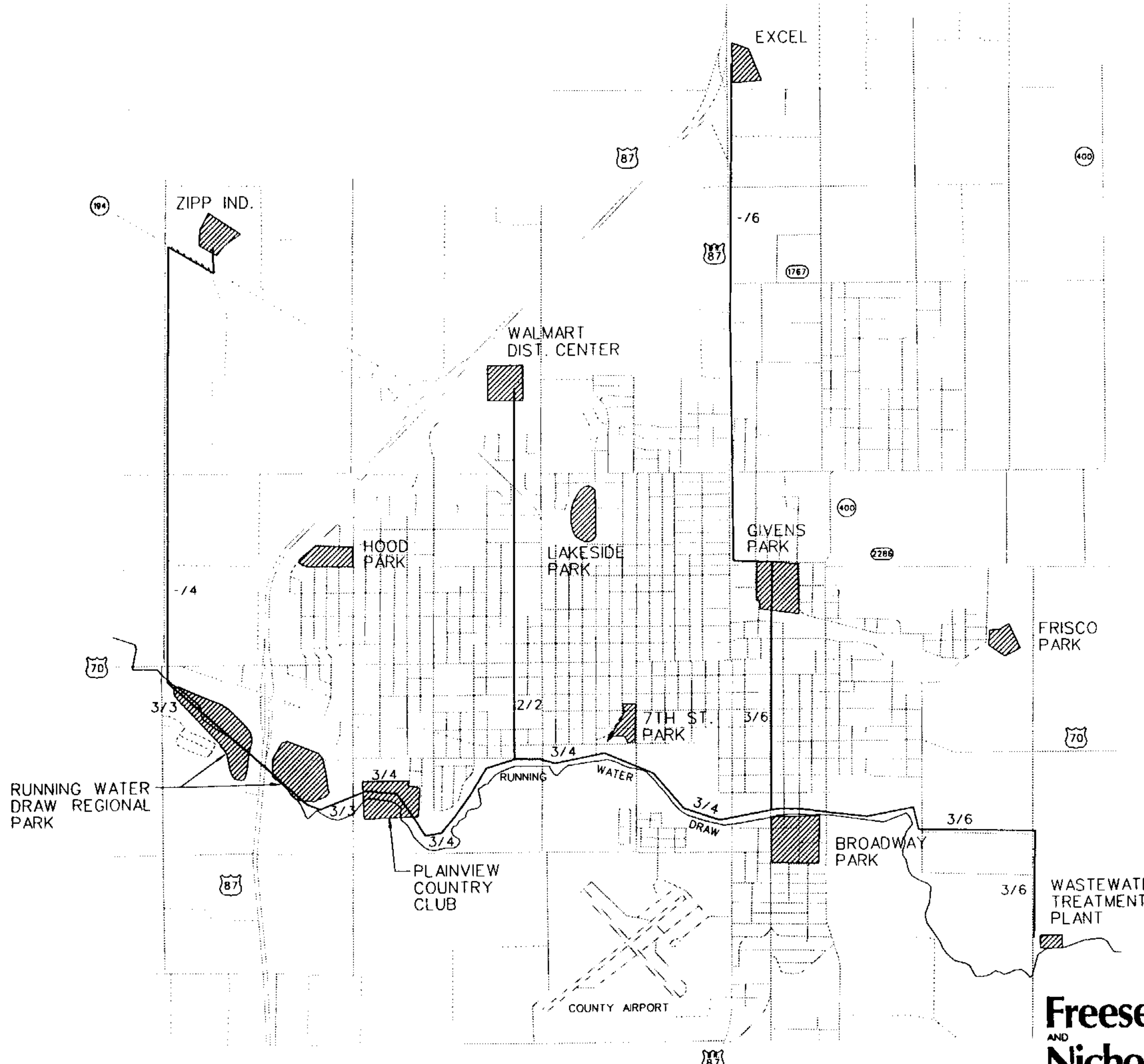
Alternative	Quantity (MG/Y)	Distribution Category	Construction Cost	O & M Cost (Per Year)	Total Cost Per 1,000 GAL.
A1	1.80	A (Rest. Turf Irr. - No. Ind.)	$ 775,546	$ 27,760	$ 59.33
A2	22.70	A (Rest. Turf Irr. - Inc.)	$1,208,370	$ 28,616	$ 6.68
B1	13.68	B (Unrest. Turf Irr. - No Ind.)	$1,698,806	$ 38,912	$ 15.59
B2	34.60	B (Unrest. Turf Irr. - Ind.)	$2,772,087	$ 60,686	$ 9.92

demand for non-potable water (approximately 5% of the total demand) and the cost associated with the treatment and distribution improvements to supply the reuse water.

Based on the costs presented in Table D-5, it does not appear that any of these reuse alternatives is feasible for Plainview or the groundwater users to implement.

Scenario 2: Landfill Irrigation

Several distribution options were considered for implementing reuse at the City landfill. Options 1 and 2 provide simultaneous irrigation of the entire land area for 8 hours per day, 4 and 7 days per week, respectively. These options are shown in Figure D-3. Option 3 consists of a system in which only half of the land area would be watered at any one time. Irrigation for each half would occur on alternate days, 8 hours per day. In options 4 and 5, the flow would be split as it enters the landfill irrigation area, half flowing in each direction. Irrigation



LEGEND

3/6 PIPE SIZE IN INCHES WITH NO INDUSTRIAL/PIPE SIZE IN INCHES WITH INDUSTRIAL

PROPOSED REUSE FACILITY

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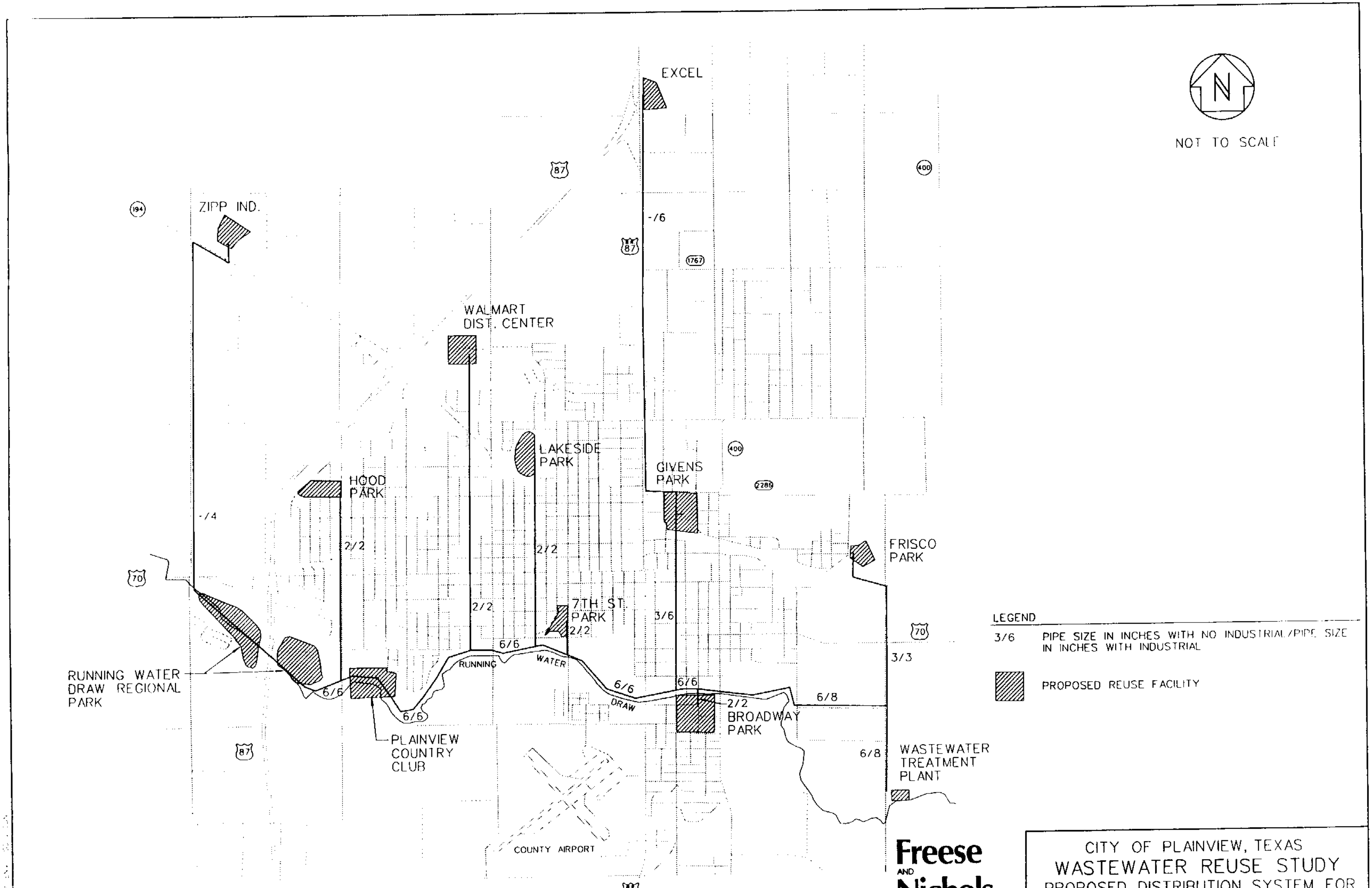
CONSULTING ENGINEERS

CITY OF PLAINVIEW, TEXAS
WASTEWATER REUSE STUDY
PROPOSED DISTRIBUTION SYSTEM FOR RESTRICTED LANDSCAPED AREAS

FIGURE D-1

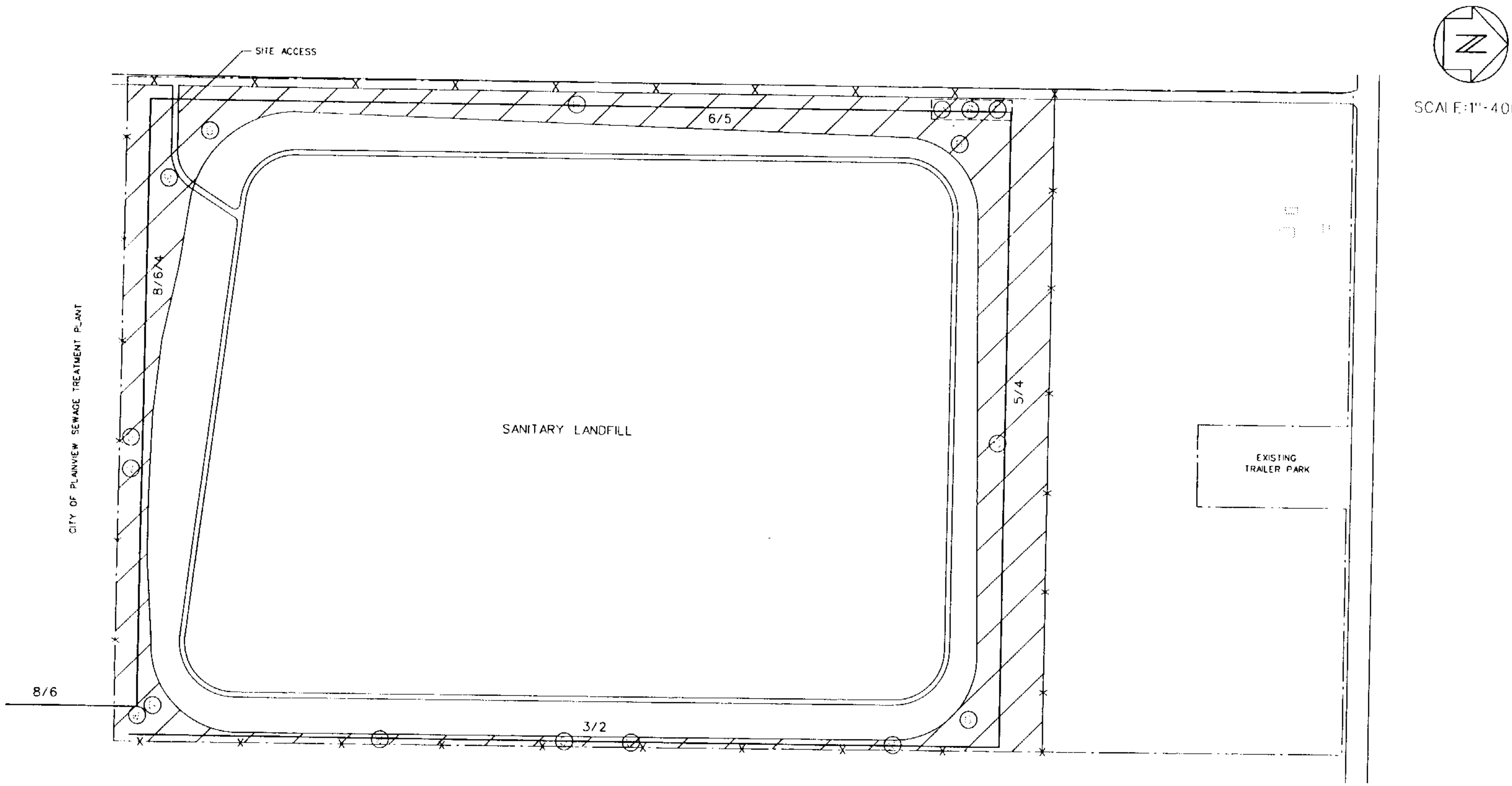


Freese and Nichols, Inc.
CONSULTING ENGINEERS

CITY OF PLAINVIEW, TEXAS
WASTEWATER REUSE STUDY
PROPOSED DISTRIBUTION SYSTEM FOR UNRESTRICTED LANDSCAPED AREAS

FIGURE D-2

ORIGINAL BASE MAP OBTAINED FROM HAMM ENGINEERING.



LEGEND

8/3 — PIPE DIAMETER FOR OPTION 1 / PIPE DIAMETER FOR OPTION 2

PROPOSED REUSE AREA

GROUNDWATER MONITORING WELL CLUSTER (GWMWC)

GROUNDWATER MONITORING WELL (DOWN GRADIENT)

METHANE GAS MONITORING WELL

—x— FENCE

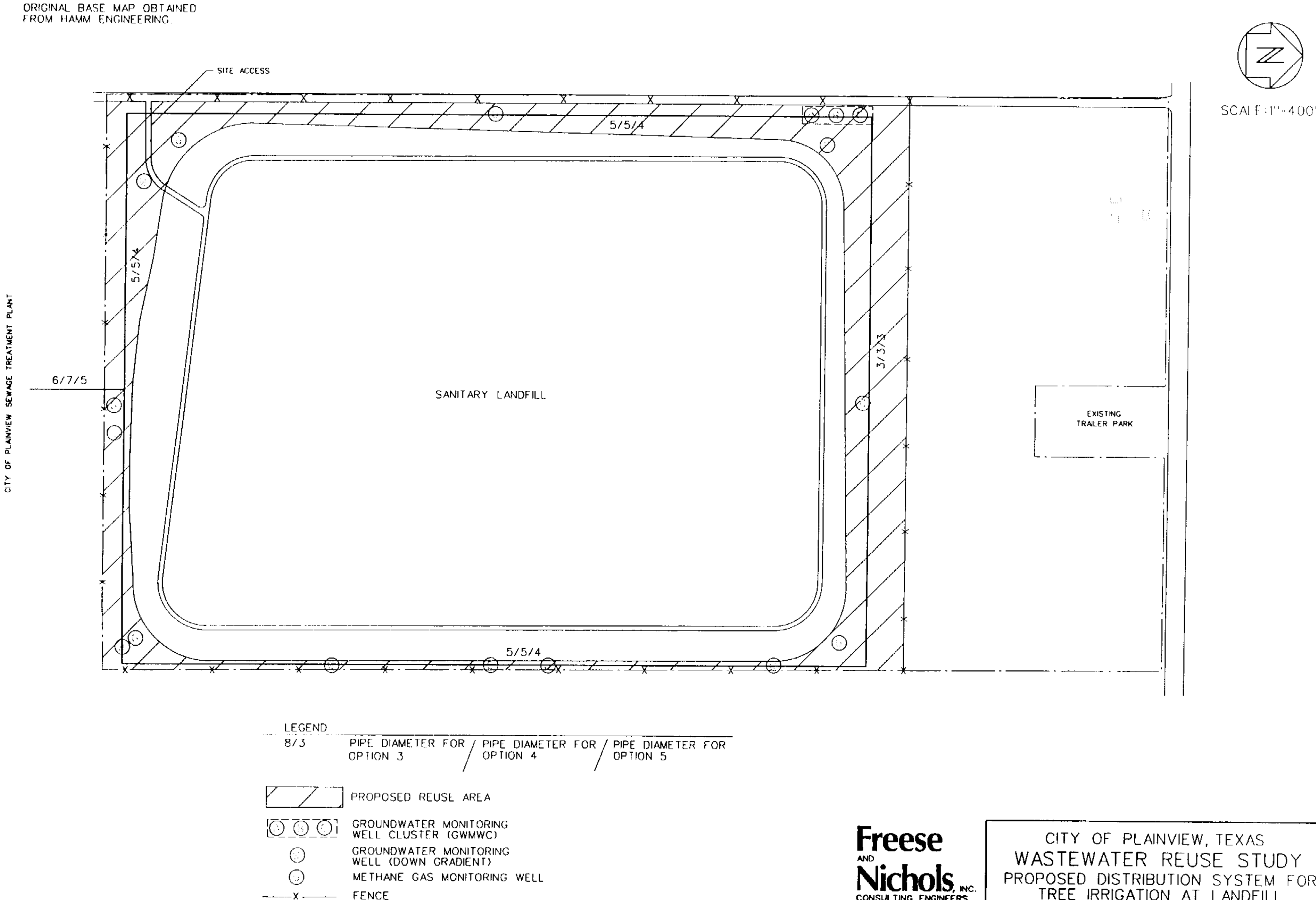
Freese and Nichols, Inc.
CONSULTING ENGINEERS

CITY OF PLAINVIEW, TEXAS
WASTEWATER REUSE STUDY
PROPOSED DISTRIBUTION SYSTEM FOR TREE IRRIGATION AT LANDFILL

FIGURE D-would occur 8 hours per day, 4 and 7 days per week, respectively. Options 3, 4 and 5 are shown in Figure D-4. Costs are based on the same assumptions and procedures as described in Scenario 1. The costs associated with implementing options 1 thru 5 are shown in Table D-6. These costs do not include the cost of an irrigation system, which would be required whether irrigation water is reclaimed wastewater or City potable water.

The construction costs shown are relatively low in that only a pumping facility and a short run of reuse water transmission pipeline will be required. The irrgation system capital costs are not shown because they would be a requirement regardless of the source of the irrigation water. The O&M costs are roughly distributed half and half between the manpower cost for running and maintaining the system (excluding the irrigation system) and the power costs for pumping. The pumping costs are based on a flow rate of 30.628 million gallons per year, a pumping head of 150 feet and power costs of $0.065/KwH.

The total cost per 1000 gallons for these options is significantly less than the cost for widespread irrigation but greater than the present cost of potable water through the Plainview water supply system. However, it should be noted that the present cost of potable water does not include the cost of tying into the City's existing potable water supply and constructing a new pipeline to serve the landfill, nor the benefits associated with reducing the use of potable water for non-potable applications. The costs for Option 2 is comparable to the current potable water costs. Considering the benefit of reducing the use of potable water for this type of application and that current and pending Safe Drinking Water Act regulations likely will increase the cost of producing potable water, it is recommended that the City pursue Option 2 of the tree irrigation at the landfill scenario.



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CITY OF PLAINVIEW, TEXAS
WASTEWATER REUSE STUDY
PROPOSED DISTRIBUTION SYSTEM FOR
TREE IRRIGATION AT LANDFILL

FIGURE D-4

MSVHOWELL
N:\PLN91214\ENV\FIGD-4.DGN

Table D-6

Tree Irrigation at Landfill
Excludes Cost of Force Main

Alternative[a]	Reuse Quantity (MG/Y)	Construction Cost	O & M Cost (Per Year)	Cost Per 1,000 Gallons
OPTION 1	30.628	$122,250	$34,325	$1.53
OPTION 2	30.628	$103,950	$25,288	$1.17
OPTION 3	30.628	$120,870	$25,288	$1.23
OPTION 4	30.628	$122,250	$32,700	$1.47
OPTION 5	30.628	$110,070	$25,288	$1.19

Notes:
a. An interest rate of 8% over T = 20 years was assumed.
b. A flow of 1,178,010 gallons/wk for 6 months/yr was used to obtain the reuse quantity.

Permits

Use of wastewater effluent for reuse requires a permit only if the reuse water ultimately is discharged to waters in the state, if the user intends to treat the effluent additionally for a more restrictive use, or if the user intends to transfer the reclaimed water to another user (TAC Chapter 310.5.a.-e.)

The effluent reuse scenarios in which the City sells or transfers the effluent to the local industries would require a permit under TAC Chapter 310.5.e. The effluent reuse scenarios in which effluent irrigates City lands (including tree irrigation at the landfill) will not require a wastewater reuse permit or require a major permit amendment to the existing discharge permit. However, the Texas Natural Resource Conservation Commission (TNRCC) will need to be notified that the effluent is to be used in whole or part for irrigation of city property.

The plans and specifications for improvements in support of the reuse system will need to be submitted to the TNRCC for review and approval in accordance with TAC Chapter 310.6.i.

If the tree irrigation at the landfill scenario is pursued, it also will require notification and approval by the TNRCC with respect to the landfill permit. The major concern will involve the potential impact of the effluent on the leachate monitoring plan. The effluent could possibly trigger the next level of monitoring requirements at the landfill. The effluent should be tested for the same parameters required at the landfill to better gauge the potential impact.

ATTACHMENT D-1

HISTORICAL WASTEWATER FLOWS - QUALITY CHARACTERISTICS

YEAR	MONTH	FLOW GPD	BOD_5 MG/L	TSS MG/L	
1988	JAN	2,118,612	18.0	16	
	FEB	2,041,000	7.4	14	
	MAR	1,931,261	9.2	14	
	APR	2,054,186	8.2	11	Avg Flow = 2,336,368
	MAY	2,347,706	7.4	9	Max Flow = 2,721,129
	JUNE	2,420,500	7.9	9	Avg BOD = 9.6
					Max BOD = 18
	JULY	2,721,129	9.9	8	Avg TSS = 10.3
					Max TSS = 16
	AUG	2,526,548	6.9	7	
	SEPT	2,656,820	9.6	11	
	OCT	2,436,690	11.5	8	
	NOV	2,401,967	8.1	8	
	DEC	2,380,000	12.1	9	
1989	JAN	2,370,323	14.2	13	
	FEB	2,293,000	12.1	14	
	MAR	2,145,452	8.9	14	
	APR	2,161,000	8.6	12	
	MAY	2,270,548	8.2	10	
	JUNE	2,468,000	7.7	7	Avg Flow = 2,167,865
	JULY	2,177,000	11.9	6	Max Flow = 2,468,000
	AUG	2,111,000	7.0	9.00	Avg BOD = 10.97
					Max BOD = 16.08
	SEPT	2,160,933	16.08	14.33	Avg TSS = 11.3
					Max TSS = 14.33
	OCT	2,046,129	10.0	11.7	
	NOV	1,910,000	11	12	
	DEC	1,901,000	16	12	
1990	JAN	1,875,645	30	16	
	FEB	1,913,214	22	12	
	MAR	1,858,000	20	11.6	
	APR	1,865,000	21	11	
	MAY	1,919,000	26	10.3	
	JUNE	1,839,000	15	9	Avg Flow = 1,881,714
	JULY	1,916,000	18	8	Max Flow = 1,979,000
	AUG	1,979,000	15	13	Avg BOD = 18
					Max BOD = 30
	SEPT	1,954,000			Avg TSS = 11.1
					Max TSS = 16
	OCT	1,934,000	11	10	
	NOV	1,2815,000	13	10	
	DEC	1,785,000	7	11	

YEAR	MONTH	FLOW GPD	BOD_5 MG/L	TSS MG/L
1991	JAN	1,717,000	8	9
	FEB	1,931,250	7	8
	MAR	1,888,000	9	6
	APR	1,912,000	15	8
	MAY	2,041,000	14	9
	JUNE	2,016,000	8	9
	JULY	2,136,000	11	4
	AUG	2,136,000	4	5
	SEPT	2,175,800	5	5
	OCT	2,032,000	1	5
	NOV	1,993,967	7	6
	DEC	1,989,000	5	13
AVG.		**2,095,821**	**11.7**	**10**

Avg Flow = 1,991,335
Max Flow = 2,175,800
Avg BOD = 8.7 Max BOD = 15
Avg TSS = 7.3 Max TSS = 13

APPENDIX E

LIFE CYCLE COST ANALYSES

OF ADDITIONAL WATER SUPPLY SCENARIOS

APPENDIX E

LIFE CYCLE COST ANALYSES

OF ADDITIONAL WATER SUPPLY SCENARIOS

The preferred water supply scenario for Plainview will depend on whether or not the Canadian River Municipal Water Authority (CRMWA) develops additional water supplies. This appendix includes life cycle cost analyses for three scenarios, which are applicable if CRMWA does not develop additional groundwater supplies from Roberts County to supplement Lake Meredith (A-1, A-2 and A-3), as well as three scenarios which are appropriate if CRMWA does develop additional supplies (B-1, B-2, and B-3).

Scenario A-1

Assuming that CRMWA does not develop additional water supply, Scenario A-1 is for Plainview to continue the current practice of using 60 percent groundwater and 40 percent surface water as long as possible. Table E-1 is the projected life cycle cost of potable water for the City of Plainview under this scenario, for the period from 1994 to 2040. The text below explains the columns in Table E-1.

Annual Water Use: The projected annual water use for Plainview, for all scenarios, is taken from Table 2.14. The projected total supply required from Plainview for the period from 1994 through 2040 is approximately 85,173 million gallons (MG).

Sources of Supply: The projected annual water use was distributed for this scenario assuming 60 percent groundwater and 40 percent CRMWA water. The projected total

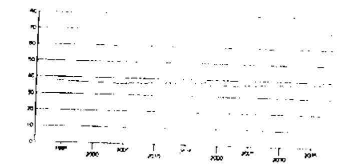
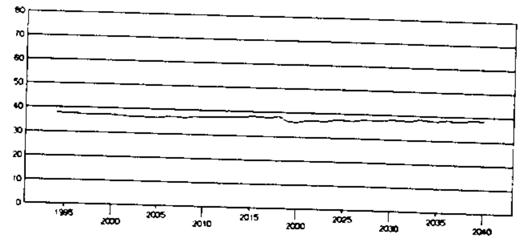


Table E-1
Projected Costs of Water to the City of Plainview: 1994 – 2040
Assuming CRMWA Does Not Develop a New Supply Source
Scenario A-1: Continue Current Practice of Using 60 Percent Groundwater and 40 Percent Surface Water

Year	Annual Water Use (MG)	Sources of Supply: GW (MG)	Sources of Supply: CRMWA (MG)	Recoverable GW in City (MG) (a)	Water Production Costs: Capital Cost	Debt Service	General O & M	Groundwater O & M: Pumping	Groundwater O & M: Other	Surface Water O&M	Total Production	Canadian River Municipal Water Authority Water Cost: Debt Service Reservoir/ Aqueduct	GOM Reservoir/ Aqueduct	Pumping, Energy & Chemicals	Total CRMWA	Annual Grand Total	Unit Cost in Cents per 1,000 Gal.	Pres. V Unit C in Cent 1,000 C
1994	1,531	919	612	43,081		0	33,900	54,500	77,400	209,400	375,200	101,800	50,500	76,400	228,700	603,900	39.4	37
[illegible]	[illegible]	[illegible]	617	[illegible]		0	35,300	58,100	81,100	219,800	394,100	101,800	54,800	80,100	236,700	630,800	40.9	37
1996	1,554	932	622	41,223		0	36,700	61,900	84,900	230,200	413,700	101,800	59,400	84,000	245,200	658,900	42.4	37
1997	1,566	940	626	40,283		0	38,100	66,000	89,100	240,900	434,100	101,800	64,300	87,900	254,000	688,100	43.9	37
1998	1,578	947	631	39,336		0	39,700	70,300	93,300	252,600	455,900	101,800	69,700	92,100	263,600	719,500	45.6	37
1999	1,589	953	636	38,383		0	41,200	75,200	97,700	264,800	478,900	101,800	75,600	96,600	274,000	752,900	47.4	37
2000	[illegible]	[illegible]	640	37,422		0	42,900	80,100	102,400	277,100	502,500	101,800	81,900	101,100	284,800	787,300	49.2	37
2001	1,616	970	646	36,452		0	44,600	85,500	107,500	290,900	528,500	101,800	86,000	106,100	293,900	822,400	50.9	37.
2002	1,631	979	652	35,473		0	46,400	91,100	112,900	305,300	555,700	101,800	90,300	111,400	303,500	859,200	52.7	37
2003	1,646	988	658	34,485		0	48,300	97,600	118,500	320,400	584,800	101,800	94,800	116,900	313,500	898,300	54.6	36.
2004	1,661	997	664	33,488		0	50,200	104,000	124,300	336,300	614,800	101,800	99,500	122,700	324,000	938,800	56.5	36.
[illegible]	[illegible]	[illegible]	670	32,482	251,400	0	52,200	110,700	130,500	352,900	646,300	101,800	104,400	128,700	334,900	981,200	58.5	36.
2006	1,690	1,014	676	31,468		21,600	54,300	118,300	136,800	370,300	701,300	101,800	109,500	135,100	346,400	1,047,700	62.0	37.
2007	1,705	1,023	682	30,445		21,600	56,500	125,900	143,500	388,600	736,100	101,800	114,900	141,700	358,400	1,094,500	64.2	37.
2008	1,720	1,032	688	29,413	282,700	21,600	58,700	134,000	150,500	407,600	772,400	101,800	120,500	148,700	371,000	1,143,400	66.5	36.
2009	1,735	1,041	694	28,372		45,900	61,100	143,200	157,900	427,700	835,800	101,800	126,400	156,000	384,200	1,220,000	70.3	37.5
2010	1,750	1,050	700	27,322		45,900	63,500	152,300	165,700	448,600	876,000	101,800	132,600	163,600	398,000	1,274,000	72.8	37.4
2011	1,762	1,057	705	26,265	318,100	45,900	66,000	162,300	173,400	469,900	917,500	101,800	138,900	171,400	412,100	1,329,600	75.5	37.3
2012	1,773	1,064	709	25,201		73,200	68,700	172,100	181,600	491,400	987,000	101,800	145,300	179,300	426,400	1,413,400	79.7	37.8
2013	1,785	1,071	714	24,130		73,200	71,400	183,400	190,100	514,700	1,032,800	101,800	152,200	187,700	441,700	1,474,500	82.6	37.7
2014	1,796	1,078	718	23,052	357,800	73,200	74,300	195,200	199,000	538,300	1,080,000	101,800	159,200	196,300	457,300	1,537,300	85.6	37.6
[illegible]	[illegible]	[illegible]	723	21,967		103,900	77,300	206,900	208,300	563,700	1,160,100	101,800	166,700	205,600	474,100	1,634,200	90.4	38.1
2016	1,820	1,092	728	20,875		103,900	80,300	220,200	218,000	590,300	1,212,700	101,800	174,600	215,300	491,700	1,704,400	93.6	38.0
2017	1,831	1,099	732	19,776	402,400	103,900	83,600	233,300	228,200	617,300	1,266,300	101,800	182,600	225,200	509,600	1,775,900	97.0	37.8
2018	1,843	1,106	737	18,670		138,400	86,900	248,200	238,800	646,400	1,358,700	101,800	191,200	235,800	528,800	1,887,500	102.4	38.4
2019	1,854	1,112	742	17,558		138,400	90,400	263,600	249,700	676,800	1,418,900	0	200,200	246,900	447,100	1,866,000	100.6	36.3
2020	[illegible]	[illegible]	746	[illegible]	452,700	138,400	94,000	279,400	261,600	707,700	1,481,100	0	209,300	258,100	467,400	1,948,500	104.4	38.2
2021	1,877	1,126	751	15,312		177,200	97,800	296,700	273,500	740,900	1,586,100	0	219,100	270,200	489,300	2,075,400	110.6	36.9
2022	1,887	1,132	755	14,180		177,200	101,700	314,900	286,000	774,700	1,654,500	0	229,100	282,500	511,600	2,166,100	114.8	36.8
2023	1,898	1,139	759	13,041	509,200	177,200	105,700	334,500	299,200	809,900	1,726,500	0	239,500	295,400	534,900	2,261,400	119.1	36.7
2024	1,909	1,145	764	11,896		220,900	110,000	354,900	312,800	847,900	1,846,500	0	250,700	309,200	559,900	2,406,400	126.1	37.4
[illegible]	1,920	[illegible]	768	10,744		220,900	114,400	375,400	327,300	886,400	1,924,400	0	262,100	323,300	585,400	2,509,800	130.7	37.3
2026	1,930	1,158	772	9,586	572,800	220,900	118,900	398,100	342,200	926,600	2,006,700	0	274,000	338,000	612,000	2,618,700	135.7	37.2
2027	1,941	1,165	776	8,421		270,000	123,700	422,500	358,100	968,700	2,143,000	0	286,400	353,300	639,700	2,782,700	143.4	37.8
2028	1,952	1,171	781	7,250		270,000	128,600	447,800	374,300	1,013,900	2,234,600	0	299,800	369,800	669,600	2,904,200	148.8	37.7
2029	1,962	1,177	785	6,073	644,300	270,000	133,800	474,600	391,300	1,059,900	2,329,600	0	313,400	386,600	700,000	3,029,600	154.4	37.6
[illegible]	[illegible]	[illegible]	789	[illegible]		325,300	139,100	503,500	409,300	1,107,900	2,484,900	0	327,600	404,100	731,700	3,216,600	163.0	38.2
2031	1,978	1,187	791	3,702		303,700	144,700	531,800	426,800	1,155,200	2,562,200	0	341,600	421,300	762,900	3,325,100	168.1	37.9
2032	1,983	1,190	793	2,512	724,800	303,700	150,500	561,800	445,000	1,204,400	2,665,400	0	356,200	439,300	795,500	3,460,900	174.5	37.8
2033	1,987	1,192	795	1,320		365,900	156,500	593,000	463,500	1,255,700	2,834,600	0	371,400	458,000	829,400	3,664,000	184.4	38.4
2034	1,992	1,195	797	125		341,600	162,800	626,300	483,300	1,309,200	2,923,200	0	387,200	477,500	864,700	3,787,900	190.2	38.1
[illegible]	[illegible]	[illegible]	799	(1,073)	[illegible]	341,600	169,300	661,300	503,900	1,365,000	3,041,100	0	403,700	497,900	901,600	3,942,700	197.4	38.0
2036	2,002	1,201	801	(2,274)		411,600	176,100	698,200	525,400	1,423,200	3,234,500	0	420,900	519,100	940,000	4,174,500	208.5	38.6
2037	2,007	1,204	803	(3,478)		384,300	183,100	737,000	547,700	1,483,800	3,335,900	0	438,800	541,200	980,000	4,315,900	215.0	38.3
2038	2,011	1,207	804	(4,685)	917,100	384,300	190,400	777,800	571,100	1,545,100	3,468,700	0	456,900	563,600	1,020,500	4,489,200	223.2	38.2
2039	2,016	1,210	806	(5,895)		463,000	198,000	820,800	595,400	1,610,900	3,688,100	0	476,400	587,600	1,064,000	4,752,100	235.7	38.8
[illegible]	[illegible]	[illegible]	808	[illegible]		432,300	[illegible]	[illegible]	620,700	[illegible]	[illegible]	0	[illegible]	[illegible]	1,109,300	4,913,800	243.1	38.5
Totals:	85,173	51,108	34,065														Average:	37.6

(a) Remaining groundwater in storage is based on an estimated 44,000 million gallons recoverable supply.

(b) Discount rate @ 4 percent per year, to 1993 dollars.



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Year	Annual Water Use (MG)	GW (MG)	Pumping, CEnergy & Chemicals	Total CRMWA	Annual Grand Total	Unit Cost in Cents per 1,000 Gal.	Pres. Worth Unit Cost in Cents per 1,000 Gal. (b)
		Sources of Suer Authority Water Cost					
1994	1,531	919	76,400	228,700	603,900	39.4	37.9
1995	1,543	926	80,100	236,700	630,800	40.9	37.8
1996	1,554	932	84,000	245,200	658,900	42.4	37.7
1997	1,566	940	87,900	254,000	688,100	43.9	37.5
1998	1,578	947	92,100	263,600	719,500	45.6	37.5
1999	1,589	953	96,600	274,000	752,900	47.4	37.5
2000	1,601	961	101,100	284,800	787,300	49.2	37.4
2001	1,616	970	106,100	293,900	822,400	50.9	37.2
2002	1,631	979	111,400	303,500	859,200	52.7	37.0
2003	1,646	988	116,900	313,500	898,300	54.6	36.9
2004	1,661	997	122,700	324,000	938,800	56.5	36.7
2005	1,676	1,006	128,700	334,900	981,200	58.5	36.5
2006	1,690	1,014	135,100	346,400	1,047,700	62.0	37.2
2007	1,705	1,023	141,700	358,400	1,094,500	64.2	37.1
2008	1,720	1,032	148,700	371,000	1,143,400	66.5	36.9
2009	1,735	1,041	156,000	384,200	1,220,000	70.3	37.5
2010	1,750	1,050	163,600	398,000	1,274,000	72.8	37.4
2011	1,762	1,057	171,400	412,100	1,329,600	75.5	37.3
2012	1,773	1,064	179,300	426,400	1,413,400	79.7	37.8
2013	1,785	1,071	187,700	441,700	1,474,500	82.6	37.7
2014	1,796	1,078	196,300	457,300	1,537,300	85.6	37.6
2015	1,808	1,085	205,600	474,100	1,634,200	90.4	38.1
2016	1,820	1,092	215,300	491,700	1,704,400	93.6	38.0
2017	1,831	1,099	225,200	509,600	1,775,900	97.0	37.8
2018	1,843	1,106	235,800	528,800	1,887,500	102.4	38.4
2019	1,854	1,112	246,900	447,100	1,866,000	100.6	36.3
2020	1,866	1,120	258,100	467,400	1,948,500	104.4	36.2
2021	1,877	1,126	270,200	489,300	2,075,400	110.6	36.9
2022	1,887	1,132	282,500	511,600	2,166,100	114.8	36.8
2023	1,898	1,139	295,400	534,900	2,261,400	119.1	36.7
2024	1,909	1,145	309,200	559,900	2,406,400	126.1	37.4
2025	1,920	1,152	323,300	585,400	2,509,800	130.7	37.3
2026	1,930	1,158	338,000	612,000	2,618,700	135.7	37.2
2027	1,941	1,165	353,300	639,700	2,782,700	143.4	37.8
2028	1,952	1,171	369,800	669,600	2,904,200	148.8	37.7
2029	1,962	1,177	386,600	700,000	3,029,600	154.4	37.6
2030	1,973	1,184	404,100	731,700	3,216,600	163.0	38.2
2031	1,978	1,187	421,300	762,900	3,325,100	168.1	37.9
2032	1,983	1,190	439,300	795,500	3,460,900	174.5	37.8
2033	1,987	1,192	458,000	829,400	3,664,000	184.4	38.4
2034	1,992	1,195	477,500	864,700	3,787,900	190.2	38.1
2035	1,997	1,198	497,900	901,600	3,942,700	197.4	38.0
2036	2,002	1,201	519,100	940,000	4,174,500	208.5	38.6
2037	2,007	1,204	541,200	980,000	4,315,900	215.0	38.3
2038	2,011	1,207	563,600	1,020,500	4,489,200	223.2	38.2
2039	2,016	1,210	587,600	1,064,000	4,752,100	235.7	38.8
2040	2,021	1,213	612,600	$1,109,300	$4,913,800	243.1	38.5
Totals:	85,173	51,108					
						Average:	37.6

(a) Remaining groundwater in st

(b) Discount rate @ 4 percent pe

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groundwater supply through 2040 for this scenario would be 51,108 MG, with a CRMWA water supply 34,065 MG.

Recoverable In-City Groundwater: According to the *Ground-Water Availability in the Vicinity of Plainview, Texas*, by Guyton Associates (1), there are about 41,000 to 46,000 million gallons of recoverable groundwater within Plainview's current city boundaries. As an approximation, if the recoverable groundwater is about 44,000 million gallons, Table E-1 shows that the current production rate would completely exhaust the recoverable groundwater supplies within Plainview's City limits by the year 2035.

Capital Cost: The estimated saturated thickness of the Ogallala aquifer in Plainview ranges from 110 to 170 feet. During the period from 1968 to 1991 or 1992, the typical water level decline in the Plainview wells was about 42 feet (an average of 1.8 feet per year). If the groundwater depletion rate were to remain at this level, the City would need to add more wells in order to maintain the current production rate. It should be noted that the average static water level decline in the area outside Plainview has been about 2.8 feet per year, and thus, the future rate of saturated thickness decline could be greater outside than in the City. Plainview has 15 operating wells with a combined pumping rate of about 9,000 to 10,000 gallons per minute (GPM) or an average rate per well of about 600 to 660 gpm. If the saturated thickness of the aquifer were to decrease to 50 feet and the production of the wells decreased to about 300 to 400 GPM, then 23 to 33 wells would be needed for Plainview to maintain a combined pumping rate of 9,000 to 10,000 GPM, assuming that the existing 15 wells continue to operate satisfactorily.

Based on this analysis, it is estimated that for the next 10 to 12 years Plainview could compensate for the drop in water level by lowering the well pumps. However, starting in the year 2005, it is assumed that Plainview would need to begin adding about one new groundwater well every 3 years. The estimated 1993 cost of installing a production well, including test hole boring, electric log, sieve analysis, water sampling and analysis, and easement and engineering at 30 percent, would be about $157,000. The capital costs of additional production wells needed during the planning period through the year 2040 are summarized in Table E-2. The total capital investment for the period from 1994 through 2040 would be about $1,884,000, in 1993 dollars.

It should be noted here that Plainview has 4 wells that are 30 years or more old. If a well develops a problem that can not be economically repaired, the City should consider abandoning that well and constructing a new one at or near the abandoned well site. These abandonment and new well construction costs were not included in this analysis.

Debt Service: Annual debt service payments on the capital costs were calculated assuming 25 equal payments and 7 percent per year interest rate.

General O & M: The general O & M cost, assumed non-volume dependent, is taken from the City's Fiscal Year 1992-93 budget to be about $32,600. This is assumed to increase by 4 percent per year during the planning period.

Groundwater O & M - Pumping: The groundwater unit cost for pumping is estimated from the Fiscal Year 1992-93 budget to be approximately 5.6 cents per

Table E-2

Capital Costs of Regional Water Supply to Plainview: 1994-2040
Assuming CRMWA Does Not Develop a New Supply Source
Scenario A-1: Continue Current Practice of Using
60 Percent Groundwater and 40 Percent Surface Water

Year	Type of Improvement	Capital Cost of Improvement: 1993 Cost	Capital Cost of Improvement: Cost with Inflation
2005	New in-city groundwater well	$ 157,000	$251,400
2008	New in-city groundwater well	157,000	282,700
2011	New in-city groundwater well	157,000	318,100
2014	New in-city groundwater well	157,000	357,800
2017	New in-city groundwater well	157,000	402,400
2020	New in-city groundwater well	157,000	452,700
2023	New in-city groundwater well	157,000	509,200
2026	New in-city groundwater well	157,000	572,800
2029	New in-city groundwater well	157,000	644,300
2032	New in-city groundwater well	157,000	724,800
2035	New in-city groundwater well	157,000	815,300
2038	New in-city groundwater well	157,000	917,100
Total		$1,884,000	

thousand gallons. This unit cost is assumed to increase by 4 percent per year with inflation. The unit cost for pumping in this analysis also increases as a function of pumping head increase, associated with the expected drop in static water levels.

Groundwater O & M - Other: The unit cost associated with groundwater production (other than pumping) is estimated from the City budget at approximately 8.1 cents per thousand gallons for Fiscal Year 1992-93. This unit cost is assumed to increase by 4 percent per year throughout the planning period.

Surface Water O & M: The unit cost of treated water, associated with surface water production, is estimated from the City Fiscal Year 1992-93 budget at approximately 32.9 cents per thousand gallons. This unit cost is assumed to increase by 4 percent per year throughout the planning period.

Total Production: The total production cost is the summation of the annual debt service payments, general O & M, groundwater production cost and surface water production cost.

CRMWA - Debt Service Reservoir/Aqueduct: The annual debt service payments were taken from the latest payment schedule as prepared for Plainview by the CRMWA, dated June 1987.

CRMWA - GOM Reservoir/Aqueduct: The general operation and maintenance unit cost of CRMWA water was estimated at approximately 7.66 cents per thousand gallons for the year 1993. The CRMWA general operation and maintenance costs have been analyzed for the period from 1979 to 1992. During the period from 1984 to 1992, this cost has been found to increase at an average rate of 7.6 percent per year. In this study, the unit cost of GOM reservoir/aqueduct is assumed to increase by 7.6 percent per year for the period from 1993 to 2000. From 2001 on, the rate of increase is set at 4 percent per year, matching the assumed inflation rate.

CRMWA - Pumping, Energy and Chemicals: The pumping, energy and chemicals (PE&C) unit costs to Plainview have ranged between 14.6 and 11.3 cents per thousand gallons for the period from Fiscal Year 1983-84 to Fiscal Year 1989-90. According to *Overview of Conjunctive Management Alternatives for the Canadian River Municipal Water Authority*, by Parkhill, Smith and Cooper, Inc., and Lee Wilson and Associates, Inc.(9), the 1992-93 estimate of this cost for Plainview is about 12.0 cents per thousand gallons. In this study, this unit cost is assumed to increase by 4 percent per year throughout the planning period.

Total CRMWA: The projected total CRMWA water cost through the year 2040 is the summation of the debt service cost, the general operation and maintenance cost and the pumping, energy and chemicals cost to Plainview for CRMWA water.

Annual Grand Total: The projected annual grand total cost of Plainview potable water is the summation of the production cost and CRMWA water cost.

Unit Cost: The unit cost of water is taken as the annual grand total divided by the projected annual water use.

Present Worth Unit Cost: The projected present worth unit cost of Plainview potable water is calculated assuming a 4 percent per year discount rate. The average

1994-2040 present worth unit cost would be about 37.6 cents per thousand gallons, and the highest unit cost would about 38.8 cents per thousand gallons, in the year 2039.

<u>Scenario A-2</u>

Assuming that CRMWA does not develop additional water supply, Scenario A-2 is for Plainview to make distribution system improvements to allow increased use of the available CRMWA supply and use in-city groundwater to provide the balance of the requirements. Table E-3 is the projected life cycle cost of potable water for the City of Plainview under this scenario, for the period from 1994 to 2040.

Sources of Supply: In this scenario, the annual water use projected for the years 1994 and 1995 is assumed to remain at 60 percent groundwater and 40 percent CRMWA water. As the City makes distribution system improvements in the year 1995, the supply ratio is assumed to become 50 percent groundwater and 50 percent CRMWA water, starting in the year 1996. The use of surface water is limited to the reliable supply available from the CRMWA, which is 990 MG (about 80 percent of Plainview's allocation). From the year 2032 on, this restriction keeps the surface water supply at slightly less than half of the total water use, and the rest of the supply needed for this scenario would come from in-city groundwater. The projected total groundwater supply and CRMWA water supply for this scenario would be approximately 42,985 MG and 42,188 MG, respectively, through the year 2040.

Table E-3
Projected Costs of Water to the City of Plainview: 1994 – 2040
Assuming CRMWA Does Not Develop a New Supply Source
Scenario A-2: Make Distribution System Improvements

Year	Annual Water Use (MG)	Sources of Supply: GW (MG)	Sources of Supply: CRMWA (MG)	Recoverable GW in City (MG) (a)	Capital Cost	Debt Service	Water Production Costs: General O & M	Water Production Costs: Groundwater O & M: Pumping	Water Production Costs: Groundwater O & M: Other	Surface Water O&M	Total Production	Canadian River Municipal Water Authority Water Cost: Debt Service Reservoir/ Aqueduct	GOM Reservoir/ Aqueduct	Pumping, Energy & Chemicals	Total CRMWA	Annual Grand Total	Unit Cost in Cents per 1,000 Gal.	Pres. Worth Unit Cost in Cents per 1,000 Gal. (b)
1994	1,531	919	612	43,081		0	33,900	54,500	77,400	209,400	375,200	101,800	50,500	76,400	228,700	603,900	39.4	37.9
1995	1,543	926	617	42,155	1,043,500	0	35,300	58,100	81,100	219,600	394,100	101,800	54,800	80,100	236,700	630,800	40.9	37.8
1996	1,554	777	777	41,378		89,500	36,700	51,600	70,800	287,600	536,200	101,800	74,300	104,900	281,000	817,200	52.6	46.8
1997	1,566	783	783	40,595		89,500	38,100	54,700	74,200	301,400	557,900	101,800	80,600	109,900	292,300	850,200	54.3	46.4
1998	1,578	789	789	39,806		89,500	39,700	58,300	77,800	315,800	581,100	101,800	87,400	115,200	304,400	885,500	56.1	46.1
1999	1,589	794	795	39,012		89,500	41,200	62,000	81,400	331,000	605,100	101,800	94,800	120,700	317,300	922,400	58.0	45.8
2000	1,601	800	801	38,212		89,500	42,900	65,700	85,300	346,800	630,200	101,800	102,800	126,500	331,100	961,300	60.0	45.6
2001	1,616	808	808	37,404		89,500	44,600	70,100	89,600	363,800	657,600	101,800	107,800	132,700	342,300	999,900	61.9	45.2
2002	1,631	815	816	36,589		89,500	46,400	74,700	94,000	382,100	686,700	101,800	113,200	139,400	354,400	1,041,100	63.8	44.8
2003	1,646	823	823	35,766		89,500	48,300	79,300	98,700	400,800	716,600	101,800	118,700	146,200	366,700	1,083,300	65.8	44.5
2004	1,661	830	831	34,936		89,500	50,200	84,400	103,500	420,900	748,500	101,800	124,600	153,500	379,900	1,128,400	67.9	44.1
2005	1,676	838	838	34,098	251,400	89,500	52,200	90,000	108,700	441,400	781,800	101,800	130,700	161,000	393,500	1,175,300	70.1	43.8
2006	1,690	845	845	33,253		111,100	54,300	95,800	114,000	462,900	838,100	101,800	137,100	168,800	407,700	1,245,800	73.7	44.3
2007	1,705	852	853	32,401		111,100	56,500	101,400	119,500	486,000	874,500	101,800	143,900	177,300	423,000	1,297,500	76.1	43.9
2008	1,720	860	860	31,541		111,100	58,700	108,000	125,500	509,600	912,900	101,800	150,900	185,900	438,600	1,351,500	78.6	43.6
2009	1,735	867	868	30,674	294,100	111,100	61,100	114,900	131,500	534,900	953,500	101,800	158,400	195,100	455,300	1,408,800	81.2	43.4
2010	1,750	875	875	29,799		136,300	63,500	122,300	138,100	560,800	1,021,000	101,800	166,100	204,500	472,400	1,493,400	85.3	43.8
2011	1,762	881	881	28,918		136,300	66,000	129,900	144,600	587,200	1,064,000	101,800	173,900	214,200	489,900	1,553,900	88.2	43.5
2012	1,773	886	887	28,032		136,300	68,700	137,700	151,200	614,800	1,108,700	101,800	182,100	224,300	508,200	1,616,900	91.2	43.3
2013	1,785	892	893	27,140	344,000	136,300	71,400	146,200	158,300	643,700	1,155,900	101,800	190,700	234,800	527,300	1,683,200	94.3	43.0
2014	1,796	898	898	26,242		165,800	74,300	155,100	165,800	673,200	1,234,200	101,800	199,400	245,600	546,800	1,781,000	99.2	43.5
2015	1,808	904	904	25,338		165,800	77,300	164,500	173,500	704,900	1,286,000	101,800	208,800	257,100	567,700	1,853,700	102.5	43.3
2016	1,820	910	910	24,428		165,800	80,300	174,500	181,700	737,900	1,340,200	101,800	218,600	269,100	589,500	1,929,700	106.0	43.0
2017	1,831	915	916	23,513	402,400	165,800	83,600	184,800	190,000	772,500	1,396,700	101,800	228,800	281,800	612,400	2,009,100	109.7	42.8
2018	1,843	921	922	22,592		200,300	86,900	195,900	198,900	808,600	1,490,600	101,800	239,500	294,900	636,200	2,126,800	115.4	43.3
2019	1,854	927	927	21,665		200,300	90,400	207,700	208,200	845,600	1,552,200	0	250,400	308,400	558,800	2,111,000	113.9	41.1
2020	1,866	933	933	20,732		200,300	94,000	220,100	217,900	885,100	1,617,400	0	262,100	322,800	584,900	2,202,300	118.0	40.9
2021	1,877	938	939	19,794	470,800	110,800	97,800	233,000	227,800	926,400	1,595,800	0	274,300	337,900	612,200	2,208,000	117.6	39.2
2022	1,887	943	944	18,851		151,200	101,700	246,500	238,200	968,600	1,706,200	0	286,800	353,300	640,100	2,346,300	124.3	39.9
2023	1,898	949	949	17,902		151,200	105,700	262,200	249,300	1,012,700	1,781,100	0	299,900	369,400	669,300	2,450,400	129.1	39.8
2024	1,909	954	955	16,948		151,200	110,000	277,300	260,700	1,059,800	1,859,000	0	313,900	386,600	700,500	2,559,500	134.1	39.8
2025	1,920	960	960	15,988	550,800	151,200	114,400	293,600	272,800	1,108,000	1,940,000	0	328,200	404,100	732,300	2,672,300	139.2	39.7
2026	1,930	965	965	15,023		198,500	118,900	310,500	285,200	1,158,300	2,071,400	0	343,100	422,500	765,600	2,837,000	147.0	40.3
2027	1,941	970	971	14,053		198,500	123,700	328,300	298,100	1,212,100	2,160,700	0	359,000	442,100	801,100	2,961,800	152.6	40.2
2028	1,952	976	976	13,077		198,500	128,600	348,700	312,000	1,267,100	2,254,900	0	375,300	462,200	837,500	3,092,400	158.4	40.1
2029	1,962	981	981	12,096	644,300	198,500	133,800	368,600	326,100	1,324,500	2,351,500	0	392,300	483,100	875,400	3,226,900	164.5	40.1
2030	1,973	986	987	11,110		253,800	139,100	389,500	340,900	1,385,900	2,509,200	0	410,500	505,500	916,000	3,425,200	173.6	40.7
2031	1,978	989	989	10,121		232,200	144,700	410,700	355,600	1,444,300	2,587,500	0	427,800	526,800	954,600	3,542,100	179.1	40.3
2032	1,983	993	990	9,128		232,200	150,500	435,000	371,300	1,503,600	2,692,600	0	445,400	548,400	993,800	3,686,400	185.9	40.3
2033	1,987	997	990	8,131	753,800	232,200	156,500	459,100	387,700	1,563,700	2,799,200	0	463,200	570,400	1,033,600	3,832,800	192.9	40.2
2034	1,992	1,002	990	7,129		296,900	162,800	484,800	405,200	1,626,300	2,976,000	0	481,700	593,200	1,074,900	4,050,900	203.4	40.7
2035	1,997	1,007	990	6,122		271,700	169,300	513,800	423,600	1,691,300	3,069,700	0	501,000	616,900	1,117,900	4,187,600	209.7	40.4
2036	2,002	1,012	990	5,110		271,700	176,100	542,500	442,700	1,759,000	3,192,000	0	521,000	641,600	1,162,600	4,354,600	217.5	40.3
2037	2,007	1,017	990	4,093	881,800	271,700	183,100	572,700	462,700	1,829,400	3,319,600	0	541,800	667,200	1,209,000	4,528,600	225.6	40.2
2038	2,011	1,021	990	3,072		347,400	190,400	606,000	483,100	1,902,500	3,529,400	0	563,500	693,900	1,257,400	4,786,800	238.0	40.7
2039	2,016	1,026	990	2,046		317,900	198,000	639,500	504,900	1,978,600	3,638,900	0	586,000	721,700	1,307,700	4,946,600	245.4	40.4
2040	2,021	1,031	990	1,015		317,900	208,000	[illegible]	527,600	2,057,800	3,786,400	0	609,400	[illegible]	1,360,000	5,146,400	254.6	40.3
Totals:	85,173	42,985	42,188														Average:	42.1

(a) Remaining groundwater in storage is based on an estimated 44,000 million gallons recoverable supply.

(b) Discount rate @ 4 percent per year, to 1993 dollars.

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Recoverable In-City Groundwater: The estimated remaining recoverable groundwater in Plainview by the end of the planning period, according to this scenario, would be approximately 1,015 million gallons, which is less than one year's use of groundwater at the 2040 in-city use rate.

Capital Cost: Analysis of Plainview's water distribution system is discussed in Appendix F. For this life cycle cost analysis, a 24-inch pipeline along route No. 1 is selected. The capital cost of this line would be about $965,000 in 1993 dollars. The capital cost of this improvement is assumed to be paid out in 25 equal payments, starting in the year 1996, using 7 percent per year interest rate. Also, it is estimated that starting in 2005, Plainview would need to begin adding about one new groundwater well every four years. Table E-4 summarizes the capital costs incurred according to Scenario A-2. The total capital investment for the period from 1994 through 2040 would be about $2,378,000, in 1993 dollars.

The water production costs and CRMWA water costs for this scenario are developed in the way described for Scenario A-1.

Present Worth Unit Cost: The average 1994-2040 present worth unit cost of Plainview potable water according to Scenario A-2 would be about 42.1 cents per thousand gallons. The highest year unit cost would be about 46.8 cents per thousand gallons, in the year 1996. The construction of the distribution improvements and the increased use of more expensive surface water would cause an increase in the unit cost of potable water of about 9 cents per thousand gallons in the near future, and the supply

Table E-4

Capital Costs of Regional Water Supply to Plainview: 1994-2040
Assuming CRMWA Does Not Develop a New Supply Source
Scenario A-2: Make Distribution System Improvement

Year	Type of Improvement	Capital Cost of Improvement	
		1993 Cost	Cost with Inflation
1995	Distribution System Improvement	$ 964,800	$1,043,500
2005	New in-city groundwater well	157,000	251,400
2009	New in-city groundwater well	157,000	294,100
2013	New in-city groundwater well	157,000	344,000
2017	New in-city groundwater well	157,000	402,400
2021	New in-city groundwater well	157,000	470,800
2025	New in-city groundwater well	157,000	550,800
2029	New in-city groundwater well	157,000	644,300
2033	New in-city groundwater well	157,000	753,800
2037	New in-city groundwater well	157,000	881,800
Total		$2,377,800	

remains somewhat more expensive than the current approach.

Scenario A-3

Assuming that CRMWA does not develop additional water supply, Scenario A-3 is for Plainview to develop a new groundwater well field adequate to meet projected future growth and continue to use CRMWA water at the current rate. Table E-5 is the projected life cycle cost of potable water for the City of Plainview under this scenario, for the period form 1994-2040.

Development of a new groundwater well field according to this scenario would include the following steps:

- Plainview would purchase water rights outside the city limits. It is estimated that, with an average saturated thickness of 120 feet, about 10 sections (10 square miles) would provide a water supply that could last about 30 years. In this life-cycle cost analysis, it is assumed that in 1995 Plainview would purchase 10 square miles of water rights at an average unit price of $450/acre, for a total of about $2,880,000, in 1993 value. The cost of test hole drilling, electric logs, sieve analysis, water sampling and chemical analysis, which would be incurred prior to acquiring the water rights, is estimated at approximately $585,000 for as many as 25 test holes and water sampling and analysis for 10 existing wells. Table E-6 gives an opinion of costs for the development of new groundwater well fields.
- Plainview would construct a 5-mile water transmission pipeline, four wells and

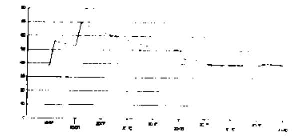

Table E-5
Projected Costs of Water to the City of Plainview: 1994 – 2040
Assuming CRMWA Does Not Develop a New Supply Source
Scenario A-3: Develop New Groundwater Well Fields

Year	Annual Water Use (MG)	Sources of Supply: In-City GW (MG)	Sources of Supply: CRMWA (MG)	Recoverable GW in City (MG) (a)	New GW Well Field: Production (MG)	New GW Well Field: Recoverable Storage (MG) (b)	Capital Cost	Debt Service	Water Production Costs: General O & M	Groundwater O & M: Pumping	Groundwater O & M: Other	Surface Water O&M	New GW Well Field O & M: Pumping	New GW Well Field O & M: Other	Total Production	Canadian River Municipal Water Authority Water Cost: Debt Service Reservoir/ Aqueduct	GOM Reservoir/ Aqueduct	Pumping, Energy & Chemicals	Total CRMWA	Annual Grand Total	Unit Cost in Cents per 1,000 Gal.	Pres. Worth Unit Cost in Cents per 1,000 Gal. (c)
1994	1,531	919	612	43,081	0	33,000		$0	33,900	54,500	77,400	209,400	0	0	375,200	101,800	50,500	76,400	228,700	603,900	39.4	37.9
[redacted]																						
1996	1,554	932	622	41,223	0	33,000		321,600	36,700	61,900	84,900	230,200	0	0	735,300	101,800	59,400	84,000	245,200	980,500	63.1	56.1
1997	1,566	940	626	40,283	0	33,000		321,600	38,100	66,000	89,100	240,900	0	0	755,700	101,800	64,300	87,900	254,000	1,009,700	64.5	55.1
1998	1,578	947	631	39,336	0	33,000		321,600	39,700	70,300	93,300	252,600	0	0	777,500	101,800	69,700	92,100	263,600	1,041,100	66.0	54.2
1999	1,589	953	636	38,383	0	33,000		321,600	41,200	75,200	97,700	264,800	0	0	800,500	101,800	75,600	96,600	274,000	1,074,500	67.6	53.4
[redacted]																						
2001	1,616	324	646	37,098	646	32,354		706,600	44,600	28,300	35,900	290,900	65,800	71,600	1,243,700	101,800	86,000	106,100	293,900	1,537,600	95.1	69.5
2002	1,631	327	652	36,771	652	31,702		706,600	46,400	29,800	37,700	305,300	69,700	75,200	1,270,700	101,800	90,300	111,400	303,500	1,574,200	96.5	67.8
2003	1,646	330	658	36,441	658	31,044		706,600	48,300	31,400	39,600	320,400	73,600	78,900	1,298,800	101,800	94,800	116,900	313,500	1,612,300	98.0	66.2
2004	1,661	333	664	36,108	664	30,380		706,600	50,200	33,200	41,500	336,300	77,900	82,800	1,328,500	101,800	99,500	122,700	324,000	1,652,500	99.5	64.6
[redacted]																						
2006	1,690	338	676	35,434	676	29,034		706,600	54,300	36,800	45,600	370,300	86,800	91,200	1,391,600	101,800	109,500	135,100	346,400	1,738,000	102.8	61.7
2007	1,705	341	682	35,093	682	28,352		706,600	56,500	39,000	47,800	388,600	91,800	95,700	1,426,000	101,800	114,900	141,700	358,400	1,784,400	104.7	60.5
2008	1,720	344	688	34,749	688	27,664		706,600	58,700	41,100	50,200	407,600	96,900	100,400	1,461,500	101,800	120,500	148,700	371,000	1,832,500	106.5	59.1
2009	1,735	347	694	34,402	694	26,970		706,600	61,100	43,400	52,600	427,700	102,500	105,300	1,499,200	101,800	126,400	156,000	384,200	1,883,400	108.6	58.0
[redacted]																						
2011	1,762	352	705	33,700	705	25,565		706,600	66,000	48,100	57,800	469,900	114,200	115,700	1,578,300	101,800	138,900	171,400	412,100	1,990,400	113.0	55.8
2012	1,773	355	709	33,345	709	24,856		706,600	68,700	50,700	60,600	491,400	120,400	121,000	1,619,400	101,800	145,300	179,300	426,400	2,045,800	115.4	54.8
2013	1,785	357	714	32,988	714	24,142		706,600	71,400	53,500	63,400	514,700	126,800	126,700	1,663,100	101,800	152,200	187,700	441,700	2,104,800	117.9	53.8
2014	1,796	360	718	32,628	718	23,424		706,600	74,300	56,400	66,400	538,300	133,700	132,500	1,708,200	101,800	159,200	196,300	457,300	2,165,500	120.6	52.9
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2016	1,820	364	728	31,902	728	21,973		883,700	80,300	62,300	72,700	590,300	148,600	145,300	1,983,200	101,800	174,600	215,300	491,700	2,474,900	136.0	55.2
2017	1,831	367	732	31,535	732	21,241		883,700	83,600	65,600	76,200	617,300	156,700	152,000	2,035,100	101,800	182,600	225,200	509,600	2,544,700	139.0	54.2
2018	1,843	369	737	31,166	737	20,504		883,700	86,900	69,300	79,700	646,400	164,900	159,100	2,090,000	101,800	191,200	235,800	528,800	2,618,800	142.1	53.3
2019	1,854	370	742	30,796	742	19,762		883,700	90,400	72,600	83,100	676,800	174,000	166,600	2,147,200	0	200,200	246,900	447,100	2,594,300	139.9	50.5
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2021	1,877	375	751	30,047	751	18,265		562,100	97,800	80,300	91,100	740,900	193,500	182,400	1,948,100	0	219,100	270,200	489,300	2,437,400	129.9	43.3
2022	1,887	377	755	29,670	755	17,510	489,600	562,100	101,700	84,800	95,200	774,700	203,400	190,700	2,012,600	0	229,100	282,500	511,600	2,524,200	133.8	42.9
2023	1,898	380	759	29,290	759	16,751		604,100	105,700	89,300	99,800	809,900	214,300	199,400	2,122,500	0	239,500	295,400	534,900	2,657,400	140.0	43.2
2024	1,909	381	764	28,909	764	15,987		604,100	110,000	93,500	104,100	847,900	226,000	208,700	2,194,300	0	250,700	309,200	559,900	2,754,200	144.3	42.8
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2026	1,930	386	772	28,139	772	14,447		418,700	118,900	103,900	114,100	926,600	250,100	228,100	2,160,400	0	274,000	338,000	612,000	2,772,400	143.6	39.4
2027	1,941	389	776	27,750	776	13,671		418,700	123,700	109,400	119,600	968,700	263,400	238,500	2,242,000	0	286,400	353,300	639,700	2,881,700	148.5	39.1
2028	1,952	390	781	27,360	781	12,890		418,700	128,600	114,600	124,700	1,013,900	277,800	249,600	2,327,900	0	299,800	369,800	669,600	2,997,500	153.6	38.9
2029	1,962	392	785	26,968	785	12,105	644,300	418,700	133,800	120,800	130,300	1,059,900	292,500	260,900	2,416,900	0	313,400	386,600	700,000	3,116,900	158.9	38.7
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2031	1,978	396	791	26,177	791	10,525		474,000	144,700	133,200	142,400	1,155,200	323,400	284,400	2,657,300	0	341,600	421,300	762,900	3,420,200	172.9	39.0
2032	1,983	397	793	25,780	793	9,732		474,000	150,500	139,500	148,400	1,204,400	339,600	296,500	2,752,900	0	356,200	439,300	795,500	3,548,400	178.9	38.8
2033	1,987	397	795	25,383	795	8,937		474,000	156,500	146,400	154,400	1,255,700	356,600	309,200	2,852,800	0	371,400	458,000	829,400	3,682,200	185.3	38.6
2034	1,992	398	797	24,985	797	8,140		474,000	162,800	153,300	161,000	1,309,200	373,600	322,300	2,956,200	0	387,200	477,500	864,700	3,820,900	191.8	38.4
[redacted]																						
2036	2,002	400	801	24,186	801	6,540	847,900	739,100	176,100	168,800	175,000	1,423,200	411,800	350,400	3,444,400	0	420,900	519,100	940,000	4,384,400	219.0	40.6
2037	2,007	401	803	23,785	803	5,737		811,800	183,100	176,700	182,400	1,483,800	432,400	365,300	3,635,500	0	438,800	541,200	980,000	4,615,500	230.0	41.0
2038	2,011	403	804	23,382	804	4,933		811,800	190,400	185,500	190,700	1,545,100	453,300	380,400	3,757,200	0	456,900	563,600	1,020,500	4,777,700	237.6	40.7
2039	2,016	404	806	22,978	806	4,127		811,800	198,000	195,000	198,800	1,610,900	475,900	396,600	3,887,000	0	476,400	587,600	1,064,000	4,951,000	245.6	40.4
[redacted]																						
Totals:	85,173	21,427	34,065		29,681																	
																					Average:	49.2

(a) Remaining groundwater in City is based on an estimated 44,000 million gallons recoverable supply.
(b) Remaining groundwater in new well field is based on an estimated 33,000 million gallons recoverable supply.
(c) Discount rate @ 4 percent per year, to 1993 dollars.

Table E-6

Development of New Groundwater Well Fields for the City of Plainview

Item	Units	In-City Quantity	In-City Unit Cost	In-City Cost	Outside City Limits Quantity	Outside City Limits Unit Cost	Outside City Limits Cost
Water Rights Costs							
Water Rights	Acre				6,400	450	2,880,000
Test Holes for Water Rights							
Nearby Water Sampling and Analyses	E A				10	5,000	50,000
Test Hole, Log and Sieve Analyses	E A				25	8,000	200,000
Water Sampling and Analyses	E A				25	8,000	200,000
Easement & Eng.	30 %				1	135,000	135,000
Total							$585,000 (a)
Test Holes for Production Wells							
Test Hole, Log and Sieve Analyses	E A	1	8,000	8,000	0.5 (b)	8,000	4,000
Water Sampling and Analyses	E A	1	8,000	8,000	0.5 (b)	8,000	4,000
Easement & Eng.	30 %	1	4,800	4,800	1	2,400	2,400
Subtotal				$20,800			$10,400
Production Wells							
Land Purchase	L S	1	1,000	1,000	1	1,000	1,000
Well Drilling	E A	1	80,000	80,000	1	80,000	80,000
Pump and Motor	E A	1	30,000	30,000	1	27,000	27,000
Inspection and Eng.	20 %	1	22,200	22,200	1	21,600	21,600
Well-Head Protection							
Survey	L S	1	5,000	5,000	1	15,000	15,000
Remediation	L S	1	varies	0	1	varies	0
Total Cost of a Production Well:				$159,000 (c)			$155,000 (c)

(a) The total costs could be less if well and water quality data are available that define the thickness, characteristics and water quality of the aquifer in at least part of the area acquired.

(b) It is assumed that some of the test holes drilled in the water rights area could be used as test holes for production wells. Therefore, the total cost of adding a production well is assumed to include 0.5 of a test hole cost.

(c) An average Well Production Cost for in-City and out-of-City well will be taken as $157,000 .

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associated collection facilities in the year 2000, and begin to use the water from the well field in 2001. The estimated capital cost of this construction is estimated at about $3,410,000, in 1993 value.

- The transmission facility brings well-field groundwater to the water treatment plant for blending with treated CRMWA water.
- Plainview adds additional wells and collection facilities to the new groundwater well field in the years 2015, 2025 and 2035 at estimated capital costs in 1993 dollars of about $714,000, $663,000 and $595,000, respectively.

Sources of Supply: For the period from 1996 through 2000, it is assumed that Plainview would keep using 40 percent surface water and 60 percent groundwater. From the year 2001 on, it is assumed that Plainview would be using 40 percent surface water, 40 percent groundwater from the new well field outside the City boundaries and 20 percent in-city groundwater. The projected total use of in-city groundwater supply, CRMWA supply and new well-field supply for this scenario would be approximately 21,427, 34,065 and 29,681 million gallons, respectively, through the year 2040.

Recoverable In-City Groundwater: The estimated remaining recoverable groundwater in Plainview by the end of the planning period, according to this scenario, would be approximately 22,573 MG - over 50 years of use at the 2040 in-city use rate.

New Groundwater Well Field - Recoverable Storage: According to the *Ground-Water Availability in the Vicinity of Plainview, Texas*, by Guyton Associates (1), it estimated that, with an average saturated thickness of 120 feet, there would be about 9,500 to 10,800 acre-feet of recoverable groundwater under each square mile, or approximately 3,300 million gallons, on the average. Hence, assuming Plainview to purchase 10 square miles of water rights, Table E-5 assumes the total recoverable groundwater in storage in the new acquired well field to be 33,000 million gallons. The estimated remaining recoverable groundwater in the new well field, by the end of the planning period, would be approximately 3,319 million gallons.

Capital Costs: Table E-7 summarizes the capital costs incurred according to this scenario, throughout the planning period. In addition to the capital costs associated with the development of the new groundwater well field, it is estimated that starting in the year 2015, Plainview would need to begin adding about one new in-city groundwater well every 7 years, at a 1993 cost of $157,000 per well. The total capital investment for the period from 1994 to 2040 would be about $9,475,000, in 1993 dollars.

Debt Service: The annual debt service payments on the capital costs are estimated assuming 25 equal payments and a 7 percent per year interest rate.

In-city water production costs for this scenario are developed in the way described for Scenario A-1.

New Groundwater Well-Field O & M - Pumping: Pumping cost from the new groundwater well field is estimated at approximately 7.4 cents per thousand gallons in 1993 costs. This assumes an energy cost of 6.0 cents per kilowatt-hour. The unit cost of pumping is assumed to increase by 4 percent per year with inflation. It is also assumed to increase as a function of the pumping head increase associated with the expected drop

Table E-7

Capital Costs of Regional Water Supply to Plainview: 1994-2040
Assuming CRMWA Does Not Develop a New Supply Source
Scenario A-3: Develop New Groundwater Well Field

Year	Type of Improvement	Capital Cost of Improvement: 1993 Cost	Capital Cost of Improvement: Cost with Inflation
1995	Purchase of water rights	$3,465,000	$3,747,700
2000	Construction of a 4-well field	3,410,000	4,487,300
2015	New in-city groundwater well plus 2 additional wells in new field	157,000 714,000	372,100 1,692,100
2022	New in-city groundwater well	157,000	489,600
2025	Two additional wells in new field	663,000	2,325,800
2029	New in-city groundwater well	157,000	644,300
2035	Two additional wells in	595,000	3,089,700
2036	New in-city groundwater well	157,000	847,900
Total		$9,475,000	

in static water levels in the new groundwater well field.

New Groundwater Well-Field O & M - Other: The unit cost associated with groundwater production from the new well-field, other than pumping, is taken to be the same as that for in-city unit cost, which is 8.1 cents per thousand gallons, as mentioned in Scenario A-1. This unit cost is also assumed to increase by 4 percent per year,throughout the planning period.

The estimation of CRMWA water costs is as described under Scenario A-1.

Present Worth Unit Cost: The average 1994-2040 present worth unit cost of Plainview potable water would be about 49.2 cents per thousand gallons. The highest year unit cost would be about 69.5 cents per thousand gallons, in the year 2001. The capital costs associated with the development of the new groundwater well field would cause the unit cost of potable water to increase by about 27 cents per thousand gallons over the next few years.

Scenario B-1

Assuming that CRMWA develops a groundwater source to supplement Lake Meredith, Scenario B-1 is for Plainview to continue the current practice of using 60 percent groundwater and 40 percent CRMWA water as long as possible. Table E-8 is the projected life cycle cost of potable water for the City of Plainview under this scenario, for the period from 1994 to 2040.

The sources of supply, the recoverable in-city groundwater and the water

Table E-8
Projected Costs of Water to the City of Plainview: 1994 – 2040
Assuming CRMWA Develops a Groundwater Supply from Roberts County
Scenario B-1: Continue Current Practice of Using 60 Percent Groundwater and 40 Percent Surface Water

Year	Annual Water Use (MG)	Sources of Supply: GW (MG)	Sources of Supply: CRMWA (MG)	Recoverable GW in City (MG) (a)	Water Production Costs: Capital Cost	Water Production Costs: Debt Service	Water Production Costs: General O & M	Water Production Costs: Groundwater O & M Pumping	Water Production Costs: Groundwater O & M Other	Water Production Costs: Surface Water O&M	Water Production Costs: Total Production	CRMWA Water Cost: Debt Service Reservoir/Aqueduct	CRMWA Water Cost: GOM Reservoir/Aqueduct	CRMWA Water Cost: Pumping, Energy & Chemicals	CRMWA Groundwater From Roberts County: Capital Cost	CRMWA Groundwater From Roberts County: Debt Service	CRMWA Groundwater From Roberts County: G O M	CRMWA Groundwater From Roberts County: Institutional	Total CRMWA	Annual Grand Total	Unit Cost in Cents per 1,000 Gal.	Pres. Worth Unit Cost in Cents per 1,000 Gal. (b)
1994	1,531	919	612	43,081		$0	33,900	54,500	77,400	209,400	$375,200	101,800	50,500	76,400					$228,700	$603,900	39.4	37.9
1995	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	35,300	58,100	81,100	219,600	394,100	101,800	54,800	80,300					236,700	630,800	40.9	37.6
1996	1,554	932	622	41,223		0	36,700	61,900	84,900	230,200	413,700	101,800	59,400	84,000					245,200	658,900	42.4	37.7
1997	1,566	940	626	40,283		0	38,100	66,000	89,100	240,900	434,100	101,800	64,300	87,900					254,000	688,100	43.9	37.5
1998	1,578	947	631	39,336		0	39,700	70,300	93,300	252,600	455,900	101,800	69,700	92,100					263,600	719,500	45.6	37.5
1999	1,589	953	636	38,383		0	41,200	75,200	97,700	264,800	478,900	101,800	75,600	96,600					274,000	752,900	47.4	37.5
2000	1,601	961	640	37,422		0	42,900	80,100	102,400	277,100	502,500	101,800	81,900	101,100	2,773,900				284,800	787,300	49.2	37.4
2001	1,616	970	646	36,452		0	44,600	85,500	107,500	290,900	528,500	101,800	86,000	106,100		238,000	41,800	14,100	587,800	1,116,300	69.1	50.5
2002	1,631	979	652	35,473		0	46,400	91,100	112,900	305,300	555,700	101,800	90,300	111,400		238,000	43,900	14,200	599,600	1,155,300	70.8	49.7
2003	1,646	988	658	34,485		0	48,300	97,600	118,500	320,400	584,800	101,800	94,800	116,900		238,000	46,000	14,300	611,800	1,196,600	72.7	49.1
2004	1,661	997	664	33,488		0	50,200	104,000	124,300	336,300	614,800	101,800	99,500	122,700		238,000	48,300	14,500	624,800	1,239,600	74.6	48.5
2005	1,676	1,006	670	32,482	281,400	0	52,200	110,700	130,500	352,900	646,300	101,800	104,400	128,700		238,000	50,700	14,600	638,200	1,284,500	76.8	47.8
2006	1,690	1,014	676	31,468		21,600	54,300	118,300	136,800	370,300	701,300	101,800	109,500	135,100		238,000	53,200	14,700	652,300	1,353,600	80.1	48.1
2007	1,705	1,023	682	30,445		21,600	56,500	125,900	143,500	388,600	736,100	101,800	114,900	141,700		238,000	55,800	14,900	667,100	1,403,200	82.3	47.5
2008	1,720	1,032	688	29,413	282,700	21,600	58,700	134,000	150,500	407,600	772,400	101,800	120,500	148,700		238,000	58,600	15,000	682,600	1,455,000	84.6	47.0
2009	1,735	1,041	694	28,372		45,900	61,100	143,200	157,900	427,700	835,800	101,800	126,400	156,000		238,000	61,400	15,100	698,700	1,534,500	88.4	47.2
2010	1,750	1,050	700	27,322		45,900	63,500	152,300	165,700	448,600	876,000	101,800	132,600	163,600		238,000	64,400	15,300	715,700	1,591,700	91.0	46.7
2011	1,762	1,057	705	26,265	318,100	45,900	66,000	162,300	173,400	469,900	917,500	101,800	138,900	171,400		238,000	67,500	15,400	733,000	1,650,500	93.7	46.3
2012	1,773	1,064	709	25,201		73,200	68,700	172,100	181,600	491,400	987,000	101,800	145,300	179,300		238,000	70,600	15,500	750,500	1,737,500	98.0	46.5
2013	1,785	1,071	714	24,130		73,200	71,400	183,400	190,100	514,700	1,032,800	101,800	152,200	187,700		238,000	73,900	15,600	769,200	1,802,000	101.0	46.1
2014	1,796	1,078	718	23,052	357,800	73,200	74,300	195,200	199,000	538,300	1,080,000	101,800	159,200	196,300		238,000	77,300	15,600	788,200	1,868,200	104.0	45.6
2015	1,808	1,085	723	21,967		103,900	77,300	206,900	208,300	563,700	1,160,100	101,800	166,700	205,600		238,000	81,000	15,800	808,900	1,969,000	108.9	46.0
2016	1,820	1,092	728	20,875		103,900	80,300	220,200	218,000	590,300	1,212,700	101,800	174,600	215,300		238,000	84,800	15,900	830,400	2,043,100	112.3	45.6
2017	1,831	1,099	732	19,776	402,400	103,900	83,600	233,300	228,200	617,300	1,266,300	101,800	182,600	225,200		238,000	88,700	16,000	852,300	2,118,600	115.7	45.1
2018	1,843	1,106	737	18,670		138,400	86,900	248,200	238,800	646,400	1,358,700	101,800	191,200	235,800		238,000	92,900	16,100	875,800	2,234,500	121.2	45.5
2019	1,854	1,112	742	17,558		138,400	90,400	263,600	249,700	676,800	1,418,900	0	200,200	246,900		238,000	97,200	16,200	798,500	2,217,400	119.6	43.1
2020	1,866	1,120	746	16,436	452,700	138,400	94,000	279,400	261,600	707,700	1,481,100	0	209,300	258,100		238,000	101,700	16,300	823,400	2,304,500	123.5	42.8
2021	1,877	1,126	751	15,312		177,200	97,800	296,700	273,500	740,900	1,586,100	0	219,100	270,200		238,000	106,400	16,400	850,100	2,436,200	129.8	43.3
2022	1,887	1,132	755	14,180		177,200	101,700	314,900	286,000	774,700	1,654,500	0	229,100	282,500		238,000	111,300	16,500	877,400	2,531,900	134.2	43.0
2023	1,898	1,139	759	13,041	509,200	177,200	105,700	334,500	299,200	809,900	1,726,500	0	239,500	295,400		238,000	116,400	16,500	905,800	2,632,300	138.7	42.8
2024	1,909	1,145	764	11,896		220,900	110,000	354,900	312,800	847,900	1,846,500	0	250,700	309,200		238,000	121,800	16,600	936,300	2,782,800	145.8	43.2
2025	1,920	1,152	768	10,744		220,900	114,400	376,400	327,300	886,400	1,924,400	0	262,100	323,500		238,000	127,300	16,700	967,400	2,891,800	150.6	42.9
2026	1,930	1,158	772	9,586	572,800	220,900	118,900	398,100	342,200	926,600	2,006,700	0	274,000	338,000			133,100	16,800	761,900	2,768,600	143.5	39.3
2027	1,941	1,165	776	8,421		270,000	123,700	422,500	358,100	968,700	2,143,000	0	286,400	353,300			139,200	16,900	795,800	2,938,800	151.4	39.9
2028	1,952	1,171	781	7,250		270,000	128,600	447,800	374,300	1,013,900	2,234,600	0	299,800	369,800			145,700	17,000	832,300	3,066,900	157.1	39.8
2029	1,962	1,177	785	6,073	644,300	270,000	133,800	474,600	391,300	1,059,900	2,329,600	0	313,400	386,600			152,300	17,100	869,400	3,199,000	163.0	39.7
2030	1,973	1,184	789	4,886		326,300	139,100	503,300	408,300	1,107,900	2,484,900	0	327,600	404,100			159,200	17,200	908,100	3,393,000	172.0	40.3
2031	1,978	1,187	791	3,702		303,700	144,700	531,800	426,800	1,155,200	2,562,200	0	341,600	421,300			165,900	17,200	946,000	3,508,200	177.4	40.0
2032	1,983	1,190	793	2,512	724,800	303,700	150,500	561,800	445,000	1,204,400	2,665,400	0	356,200	439,300			173,000	17,300	985,800	3,651,200	184.1	39.9
2033	1,987	1,192	795	1,320		365,900	156,500	593,000	463,500	1,255,700	2,834,600	0	371,400	458,000			180,400	17,300	1,027,100	3,861,700	194.3	40.5
2034	1,992	1,195	797	125		341,600	162,800	626,300	483,300	1,309,200	2,923,200	0	387,200	477,500			188,100	17,400	1,070,200	3,993,400	200.5	40.2
2035	1,997	1,198	799	(1,073)	815,300	341,600	169,300	661,300	503,900	1,364,000	3,041,100	0	403,700	497,600			196,100	17,400	1,116,100	4,156,200	208.1	40.1
2036	2,002	1,201	801	(2,274)		411,600	176,100	698,200	525,400	1,423,200	3,234,500	0	420,900	519,100			204,500	17,500	1,162,000	4,396,500	219.6	40.7
2037	2,007	1,204	803	(3,478)		384,300	183,100	737,000	547,700	1,483,800	3,335,900	0	438,800	541,200			213,200	17,500	1,210,700	4,546,600	226.5	40.3
2038	2,011	1,207	804	(4,685)	917,100	384,300	190,400	777,800	571,100	1,545,100	3,468,700	0	456,900	563,600			222,000	17,500	1,260,000	4,728,700	235.1	40.2
2039	2,016	1,210	806	(5,895)		463,000	198,000	820,800	595,400	1,610,900	3,688,100	0	476,400	587,600			231,400	17,600	1,313,000	5,001,100	248.1	40.8
2040	2,021	1,213	808	(7,108)		432,300	206,000	866,000	620,700	1,679,500	3,804,500	0	496,700	612,600			241,500	17,600	1,368,200	$5,172,700	255.9	40.5
Totals:	85,173	51,108	34,065																			
																					Average	42.9

(a) Remaining groundwater in storage is based on an estimated 44,000 million gallons recoverable supply.
(b) Discount rate @ 4 percent per year, to 1993 dollars.

production costs of this scenario match those in Table E-1 for Scenario A-1. Also, the CRMWA debt service payments on the reservoir/aqueduct, the general operation and maintenance costs of the reservoir/aqueduct, and the PE&C costs of this scenario match those of Table E-1.

Groundwater from Roberts County - Capital Cost: Based on *"Overview of Conjunctive Management Alternatives for the Canadian River Municipal Water Authority,"* by Parkhill, Smith and Cooper, and Lee Wilson and Associates (9), the estimated capital cost to develop the new groundwater supply from Roberts County would be about $56,895,000, in 1993 value. For the purpose of this study, it is assumed that Plainview's share of the capital cost would be equivalent to its share in the current dam and reservoir debt service payments, which is 3.705 percent. Thus, Plainview's share of the new capital investment would be about $2,108,000 in 1993 dollars. It is assumed that the project would be completed in the year 2000, and the debt service on this capital investment would be paid out over 25 years at a 7 percent interest rate, starting in 2001. Table E-9 summarizes the capital costs for Plainview during the planning period through 2040. The total capital investment would be about $3,992,000 in 1993 dollars.

Groundwater from Roberts County - GOM: The estimated annual general operation and maintenance cost of the new groundwater source would be about $1.6 million, in 1993 dollars (9). This assumes a production of 30,000 acre-feet per year by the CRMWA from the groundwater aquifer and 76,000 acre-feet per year from Lake Meredith. Therefore, the unit cost of GOM associated with the groundwater production

Table E-9

Capital Costs of Regional Water Supply to Plainview: 1994-2040
Assuming CRMWA Develops a Groundwater Supply from Roberts County
Scenario B-1: Continue Current Practice of Using
60 Percent Groundwater and 40 Percent Surface Water

Year	Type of Improvement	Capital Cost of Improvement	
		1993 Cost	Cost with Inflation
2000	Groundwater from Roberts County	$2,108,000	$2,774,000
2005	New in-city groundwater well	157,000	251,400
2008	New in-city groundwater well	157,000	282,700
2011	New in-city groundwater well	157,000	318,100
2014	New in-city groundwater well	157,000	357,800
2017	New in-city groundwater well	157,000	402,400
2020	New in-city groundwater well	157,000	452,700
2023	New in-city groundwater well	157,000	509,200
2026	New in-city groundwater well	157,000	572,800
2029	New in-city groundwater well	157,000	644,300
2032	New in-city groundwater well	157,000	724,800
2035	New in-city groundwater well	157,000	815,300
2038	New in-city groundwater well	157,000	917,100
Total		$3,992,000	

would be about 16.7 cents per thousand gallons. Plainview's share of this GOM cost is assumed to be 16.7 cents per thousand gallons of its annual projected use of CRMWA water multiplied by a 30,000/106,000 ratio, which is assumed the part of its water coming from the CRMWA groundwater source, subject to a 4 percent per year increase with inflation. It is assumed here that CRMWA's GOM unit costs on the reservoir/aqueduct would remain at 7.66 cents per thousand gallons, in 1993 costs, as described in Scenario A-1, and the GOM costs associated with the new groundwater supply would be separate operation and maintenance costs to bring groundwater to the CRMWA aqueduct.

Groundwater from Roberts County - Institutional: Institutional cost of groundwater from Roberts County, estimated by the same study above, is about $25 per acre-foot of water (approximately 7.7 cents per thousand gallons). This figure has been used here to project the institutional cost to Plainview assuming that about 28 percent (30,000/106,000) of Plainview's water from the CRMWA is subject to this cost. This unit cost is assumed not to increase with inflation during the planning period.

Total CRMWA: The total annual CRMWA charge to Plainview includes the debt service on the dam, reservoir and aqueduct, the GOM cost on the dam, reservoir and aqueduct, debt service on the groundwater project, GOM cost on the groundwater project, the institutional cost of groundwater from Roberts County, and the PE&C cost per thousand gallons of water pumped through the CRMWA system.

Present Worth Unit Cost: The average 1994-2040 present worth unit cost of the Plainview potable water according to Scenario B-1 would be approximately 42.9 cents per thousand gallons. The highest year present worth unit cost would be approximately 50.5 cents per thousand gallons, for the year 2001.

Scenario B-2

Assuming that CRMWA develops a groundwater source to supplement Lake Meredith, Scenario B-2 is for Plainview to increase the use of surface water to meet as much of the projected water needs as possible and use groundwater to provide the balance of the needs. Table E-10 is the projected life cycle cost of potable water for the City of Plainview under this scenario, for the period from 1994 to 2040.

Sources of Supply: In this scenario it is assumed that Plainview would continue its current use of 60 percent in-city groundwater and 40 percent CRMWA water through the year 2000. Starting in 2001, Plainview would increase its use of the CRMWA water to 70 percent of projected annual use, and the in-city groundwater would be used to supply the balance. The projected total groundwater supply and CRMWA water supply for this scenario would be about 28,843 and 56,330 million gallons, respectively, through the year 2040. By the end of the planning period, Plainview's water treatment plant would be operating at an average rate of about 3.9 million gallons per day, very near its rated capacity.

Recoverable In-City Groundwater: The estimated remaining recoverable groundwater within Plainview's city limits at the end of the planning period would be about 15,157 million gallons, which is about 25 years supply at the 2040 use rate.

Table E - 10
Projected Costs of Water to the City of Plainview: 1994 – 2040
Assuming CRMWA Develops a Groundwater Supply from Roberts County
Scenario B-2: Increase Use of CRMWA Water

Year	Annual Water Use (MG)	Sources of Supply		Recoverable GW In City (MG) (a)	Water Production Costs							Canadian River Municipal Water Authority Water Cost			Groundwater From Roberts County					Annual Grand Total	Unit Cost in Cents per 1,000 Gal.	Pres. Worth Unit Cost in Cents per 1,000 Gal. (b)
		GW (MG)	CRMWA (MG)		Capital Cost	Debt Service	General O & M	Groundwater Pumping	O & M Other	Surface Water O&M	Total Production	Debt Service Reservoir/ Aqueduct	GOM Reservoir/ Aqueduct	Pumping, Energy & Chemicals	Capital Cost	Debt Service	G O M	Institutional	Total CRMWA			
1994	1,531	919	612	43,081		$0	33,900	54,500	77,400	209,400	$375,200	101,800	50,500	76,400					$228,700	$603,900	39.4	37.9
1995	1,543	926	617	42,155		0	35,300	58,100	81,100	219,600	394,100	101,800	54,800	80,100					236,700	630,800	40.9	37.8
1996	1,554	932	622	41,223		0	36,700	61,900	84,900	230,200	413,700	101,800	59,400	84,000					245,200	658,900	42.4	37.7
1997	1,566	940	626	40,283		0	38,100	66,000	89,100	240,900	434,100	101,800	64,300	87,900					254,000	688,100	43.9	37.5
1998	1,578	947	631	39,336		0	39,700	70,300	93,300	252,600	455,900	101,800	69,700	92,100					263,600	719,500	45.6	37.5
1999	1,589	953	636	38,383		0	41,200	75,200	97,700	264,800	478,900	101,800	75,600	96,600					274,000	752,900	47.4	37.5
2000	1,601	961	640	37,422		0	42,900	80,100	102,400	277,100	502,500	101,800	81,900	101,100	2,773,900				284,800	787,300	49.2	37.4
2001	1,616	485	1,131	36,937		0	44,600	42,300	53,800	509,200	649,900	101,800	150,500	185,700		238,000	73,200	24,600	773,800	1,423,700	88.1	64.4
2002	1,631	489	1,142	36,448		0	46,400	44,800	56,400	534,800	682,400	101,800	158,000	195,100		238,000	76,800	24,900	794,600	1,477,000	90.6	63.7
2003	1,646	494	1,152	35,954		0	48,300	47,600	59,200	561,000	716,100	101,800	165,800	204,600		238,000	80,600	25,100	815,900	1,532,000	93.1	62.9
2004	1,661	498	1,163	35,456		0	50,200	50,100	62,100	589,000	751,400	101,800	174,100	214,800		238,000	84,600	25,300	838,600	1,590,000	95.7	62.2
2005	1,676	503	1,173	34,953		0	52,200	53,200	65,200	617,900	788,500	101,800	182,600	225,400		238,000	88,800	25,600	862,200	1,650,700	98.5	61.5
2006	1,690	507	1,183	34,446		0	54,300	56,300	68,400	648,100	827,100	101,800	191,500	236,400		238,000	93,100	25,800	886,600	1,713,700	101.4	60.9
2007	1,705	512	1,193	33,934		0	56,500	59,500	71,800	679,700	867,500	101,800	200,800	247,900		238,000	97,600	26,000	912,100	1,779,600	104.4	60.3
2008	1,720	516	1,204	33,418		0	58,700	62,900	75,300	713,400	910,300	101,800	210,800	260,200		238,000	102,500	26,200	939,500	1,849,800	107.5	59.7
2009	1,735	521	1,214	32,897		0	61,100	66,800	79,000	748,100	955,000	101,800	221,100	272,900		238,000	107,500	26,500	967,800	1,922,800	110.8	59.2
2010	1,750	525	1,225	32,372	305,600	0	63,500	70,600	82,800	785,100	1,002,000	101,800	232,000	286,300		238,000	112,800	26,700	997,600	1,999,600	114.3	58.7
2011	1,762	529	1,233	31,843		26,200	66,000	74,400	86,800	821,800	1,075,200	101,800	242,900	299,700		238,000	118,100	26,900	1,027,400	2,102,600	119.3	58.9
2012	1,773	532	1,241	31,311		26,200	68,700	78,600	90,800	860,200	1,124,500	101,800	254,300	313,800		238,000	123,600	27,000	1,058,500	2,183,000	123.1	58.4
2013	1,785	536	1,249	30,775		26,200	71,400	83,100	95,100	900,400	1,176,200	101,800	266,200	328,400		238,000	129,300	27,200	1,090,900	2,267,100	127.0	58.0
2014	1,796	539	1,257	30,236		26,200	74,300	87,700	99,500	942,400	1,230,100	101,800	278,600	343,700		238,000	135,400	27,400	1,124,900	2,355,000	131.1	57.5
2015	1,808	542	1,266	29,694		26,200	77,300	92,200	104,000	987,100	1,288,800	101,800	291,800	360,000		238,000	141,800	27,600	1,161,000	2,447,800	135.4	57.1
2016	1,820	546	1,274	29,148	387,000	26,200	80,300	97,500	109,000	1,033,100	1,346,100	101,800	305,400	376,800		238,000	148,400	27,800	1,198,200	2,544,300	139.8	56.7
2017	1,831	549	1,282	28,599		59,400	83,600	102,900	114,000	1,081,100	1,441,000	101,800	319,600	394,300		238,000	206,500	27,900	1,288,100	2,729,100	149.0	58.1
2018	1,843	553	1,290	28,046		59,400	86,900	108,800	119,400	1,131,400	1,505,900	101,800	334,500	412,700		238,000	216,100	28,100	1,331,200	2,837,100	153.9	57.7
2019	1,854	556	1,298	27,490		59,400	90,400	114,800	124,900	1,184,000	1,573,500	0	350,000	431,800		238,000	226,200	28,300	1,274,300	2,847,800	153.6	55.4
2020	1,866	560	1,306	26,930		59,400	94,000	121,300	130,800	1,238,900	1,644,400	0	366,200	451,900		238,000	236,700	28,500	1,321,300	2,965,700	158.9	55.1
2021	1,877	563	1,314	26,367		59,400	97,800	127,900	136,700	1,296,400	1,718,200	0	383,200	472,800		238,000	247,700	28,600	1,370,300	3,088,500	164.5	54.9
2022	1,887	566	1,321	25,801	489,600	59,400	101,700	134,400	143,000	1,355,400	1,793,900	0	400,700	494,400		238,000	258,900	28,800	1,420,800	3,214,700	170.4	54.6
2023	1,898	569	1,329	25,232		101,400	105,700	141,700	149,500	1,418,100	1,916,400	0	419,300	517,300		238,000	270,900	29,000	1,474,500	3,390,900	178.7	55.1
2024	1,909	573	1,336	24,659		101,400	110,000	149,700	156,600	1,482,600	2,000,300	0	438,400	540,800		238,000	283,200	29,100	1,529,500	3,529,800	184.9	54.8
2025	1,920	576	1,344	24,083		101,400	114,400	157,900	163,700	1,551,200	2,088,600	0	458,700	565,800		238,000	296,300	29,300	1,588,100	3,676,700	191.5	54.6
2026	1,930	579	1,351	23,504		101,400	118,900	166,500	171,100	1,621,600	2,179,500	0	479,500	591,500			309,800	29,400	1,410,200	3,589,700	186.0	51.0
2027	1,941	582	1,359	22,922		101,400	123,700	175,500	178,900	1,696,500	2,276,000	0	501,600	618,800			324,100	29,600	1,474,100	3,750,100	193.2	50.9
2028	1,952	586	1,366	22,336	619,500	101,400	128,600	185,300	187,300	1,773,400	2,376,000	0	524,400	646,800			338,800	29,800	1,539,800	3,915,800	200.6	50.8
2029	1,962	589	1,373	21,747		154,600	133,800	195,300	195,800	1,853,800	2,533,300	0	548,200	676,200			354,100	29,900	1,608,400	4,141,700	211.1	51.4
2030	1,973	592	1,381	21,155		154,600	139,100	205,900	204,700	1,939,200	2,643,500	0	573,400	707,300			370,500	30,100	1,681,300	4,324,800	219.2	51.4
2031	1,978	593	1,385	20,562		154,600	144,700	216,300	213,200	2,022,600	2,751,400	0	598,100	737,700			386,400	30,200	1,752,400	4,503,800	227.7	51.3
2032	1,983	595	1,388	19,967		154,600	150,500	227,500	222,500	2,108,100	2,863,200	0	623,400	768,900			402,700	30,200	1,825,200	4,688,400	236.4	51.2
2033	1,987	596	1,391	19,371		154,600	156,500	238,900	231,800	2,197,100	2,978,900	0	649,700	801,400			419,700	30,300	1,901,100	4,880,000	245.6	51.2
2034	1,992	598	1,394	18,773	783,900	154,600	162,800	251,300	241,900	2,289,900	3,100,500	0	677,100	835,200			437,500	30,400	1,980,200	5,080,700	255.1	51.1
2035	1,997	599	1,398	18,174		221,900	169,300	263,900	251,900	2,388,400	3,295,400	0	706,200	871,100			456,300	30,500	2,064,100	5,359,500	266.4	51.7
2036	2,002	601	1,401	17,573		195,700	176,100	277,500	262,900	2,489,200	3,401,400	0	736,000	907,900			475,500	30,500	2,149,900	5,551,300	277.3	51.3
2037	2,007	602	1,405	16,971		195,700	183,100	291,400	273,900	2,596,200	3,540,300	0	767,600	946,900			496,000	30,600	2,241,100	5,781,400	288.1	51.3
2038	2,011	603	1,408	16,368		195,700	190,400	305,900	285,300	2,705,800	3,683,100	0	800,000	986,900			516,900	30,700	2,334,500	6,017,600	299.2	51.2
2039	2,016	605	1,411	15,763		195,700	198,000	321,700	297,700	2,820,000	3,833,100	0	833,800	1,028,600			538,700	30,700	2,431,800	6,264,900	310.8	51.2
2040	2,021	606	1,415	15,157	991,900	195,700	206,000	337,700	310,100	2,941,200	3,990,700	0	869,600	1,072,800			561,900	30,800	2,538,100	$6,525,800	322.9	51.1
Totals:	85,173	28,843	56,330																		Average	53.0

(a) Remaining groundwater in storage is based on an estimated 44,000 million gallons recoverable supply.
(b) Discount rate @ 4 percent per year, to 1993 dollars.

Capital Cost: Table E-11 summarizes the capital costs incurred according to this scenario, including Plainview's share of the development of the CRMWA new supply and the construction of additional in-city groundwater wells. It assumed that Plainview would begin adding about one new groundwater well every 6 years, starting in the 2010. The total capital investment for the period from 1994 to 2040 would be about $3,050,000, in 1993 dollars.

Debt Service: All capital investments are assumed to be paid out in 25 equal payments, at 7 percent per year interest rate.

Present Worth Unit Cost: The average 1994-2020 present worth unit cost of Plainview's potable water would be about 53.0 cents per thousand gallons. The highest year present worth unit cost would be approximately 64.4 cents per thousand gallons, in the year 2001.

Scenario B-3

Even if the CRMWA develops a groundwater source to supplement Lake Meredith, Plainview would still have the option to continue to use CRMWA water at the current rate and develop a new groundwater well field outside the City limits. Scenario B-3 assumes that Plainview adopts this approach. Table E-12 is the projected life cycle cost of potable water for the City of Plainview under this scenario, for the period from 1994 to 2040.

Table E-11

Capital Costs of Regional Water Supply to Plainview: 1994-2040
Assuming CRMWA Develops a Groundwater Supply from Roberts County
Scenario B-2: Increase Use of CRMWA Water

Year	Type of Improvement	Capital Cost of Improvement	
		1993 Cost	Cost with Inflation
2000	Groundwater from Roberts County	$2,108,000	$2,774,000
2010	New in-city groundwater well	157,000	305,800
2016	New in-city groundwater well	157,000	387,000
2022	New in-city groundwater well	157,000	489,600
2028	New in-city groundwater well	157,000	619,500
2034	New in-city groundwater well	157,000	783,900
2040	New in-city groundwater well	157,000	991,900
Total		$3,050,000	

Table E-12

Projected Costs of Water to the City of Plainview: 1994 – 2040
Assuming CRMWA Develops a Groundwater Supply from Roberts County
Scenario B-3: Develop New Groundwater Well Fields

Year	Annual Water Use (MG)	Sources of Supply: In-City GW (MG)	Sources of Supply: CRMWA (MG)	Recoverable GW In City (MG) (a)	New GW Well Field: Production (MG)	New GW Well Field: Recoverable Storage (MG) (b)	Capital Cost	Debt Service	General O & M	Water Production Costs: Groundwater O & M: Pumping	Groundwater O & M: Other	Surface Water O&M	New GW Well Field O & M: Pumping	New GW Well Field O & M: Other	Total Production	CRMWA: Debt Service Reservoir/Aqueduct	CRMWA: GOM Reservoir/Aqueduct	CRMWA: Pumping, Energy & Chemicals	Groundwater From Roberts County: Capital Costs	Groundwater From Roberts County: Debt Service	Groundwater From Roberts County: G O M	Institutional	Total CRMWA	Annual Grand Total	Unit Cost in Cents per 1,000 Gal	Pres. Worth Unit Cost in Cents per 1,000 Gal. (c)
1994	1,531	919	612	43,081	0	33,000		$0	33,900	54,500	77,400	209,400	0	0	375,200	101,800	50,500	76,400					228,700	603,900	39.4	37.9
1995	[illegible]	[illegible]	[illegible]	[illegible]	0	33,000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]					236,700	[illegible]	40.9	37.8
1996	1,554	932	622	41,223	0	33,000		321,600	36,700	61,900	84,900	230,200	0	0	735,300	101,800	59,400	84,000					245,200	980,500	63.1	56.1
1997	1,566	940	626	40,283	0	33,000		321,600	38,100	66,000	89,100	240,900	0	0	755,700	101,800	64,300	87,900					254,000	1,009,700	64.5	55.1
1998	1,578	947	631	39,336	0	33,000		321,600	39,700	70,300	93,300	252,600	0	0	777,500	101,800	69,700	92,100					263,600	1,041,100	66.0	54.2
1999	1,589	953	636	38,383	0	33,000		321,600	41,200	75,200	97,700	264,600	0	0	800,500	101,800	75,600	96,600					274,000	1,074,500	67.6	53.4
2000	1,601	[illegible]	[illegible]	[illegible]	0	33,000	[illegible]	321,600	42,900	80,100	102,400	277,100	0	0	824,100	101,800	[illegible]	101,100	[illegible]				284,600	1,108,900	69.3	52.7
2001	1,616	324	646	37,098	646	32,354		706,600	44,600	28,300	35,900	290,900	65,600	71,600	1,243,700	101,800	86,000	106,100		238,000	41,800	14,100	587,800	1,831,500	113.3	82.8
2002	1,631	327	652	36,771	652	31,702		706,600	46,400	29,600	37,700	305,300	69,700	75,200	1,270,700	101,800	90,300	111,400		238,000	43,900	14,200	599,600	1,870,300	114.7	80.6
2003	1,646	330	658	36,441	658	31,044		706,600	48,300	31,400	39,600	320,400	73,600	78,900	1,298,800	101,800	94,800	116,900		238,000	46,000	14,300	611,600	1,910,600	116.1	78.4
2004	1,661	333	664	36,108	664	30,380		706,600	50,200	33,200	41,500	336,300	77,900	82,800	1,328,500	101,800	99,500	122,700		238,000	48,300	14,500	624,800	1,953,300	117.6	76.4
2005	[illegible]	[illegible]	670	[illegible]	670	29,710		706,600	52,200	36,000	43,600	352,600	82,200	86,900	1,360,400	101,800	104,400	128,700		[illegible]	50,700	14,600	638,200	1,997,600	119.2	74.5
2006	1,690	338	676	35,434	676	29,034		706,600	54,300	36,800	45,600	370,300	86,800	91,200	1,391,600	101,800	109,500	135,100		238,000	53,200	14,700	652,300	2,043,900	120.9	72.6
2007	1,705	341	682	35,093	682	28,352		706,600	56,500	39,000	47,800	388,600	91,800	95,700	1,426,000	101,800	114,900	141,700		238,000	55,800	14,900	667,100	2,093,100	122.8	70.9
2008	1,720	344	688	34,749	688	27,664		706,600	58,700	41,100	50,200	407,600	96,900	100,400	1,461,500	101,800	120,500	148,700		238,000	58,600	15,000	682,600	2,144,100	124.7	69.2
2009	1,735	347	694	34,402	694	26,970		706,600	61,100	43,400	52,600	427,700	102,500	105,300	1,499,200	101,800	126,400	156,000		238,000	61,400	15,100	698,700	2,197,900	126.7	67.6
2010	1,750	[illegible]	700	34,052	700	26,270		706,600	63,600	45,700	55,200	448,600	108,100	110,400	1,538,100	101,800	132,600	163,600		[illegible]	64,400	15,300	715,700	2,253,600	128.8	66.1
2011	1,762	352	705	33,700	705	25,565		706,600	66,000	48,100	57,600	469,900	114,200	115,700	1,578,300	101,800	138,900	171,400		238,000	67,500	15,400	733,000	2,311,300	131.2	64.6
2012	1,773	355	709	33,345	709	24,856		706,600	68,700	50,700	60,600	491,400	120,400	121,000	1,619,400	101,800	145,300	179,300		238,000	70,600	15,500	750,500	2,369,900	133.7	63.5
2013	1,785	357	714	32,988	714	24,142		706,600	71,400	53,500	63,400	514,700	126,600	126,700	1,663,100	101,800	152,200	187,700		238,000	73,900	15,600	769,200	2,432,300	136.3	62.2
2014	1,796	360	718	32,626	718	23,424		706,600	74,300	56,400	66,400	538,300	133,700	132,500	1,708,200	101,800	159,200	196,300		238,000	77,300	15,600	786,200	2,496,400	139.0	61.0
2015	[illegible]	[illegible]	723	[illegible]	723	22,701	[illegible]	706,600	77,300	59,300	69,500	563,700	140,600	138,800	1,756,000	101,800	166,700	205,600		[illegible]	81,000	15,800	808,900	2,564,900	141.9	59.9
2016	1,820	364	728	31,902	728	21,973		883,700	80,300	62,300	72,700	590,300	148,600	145,300	1,983,200	101,800	174,600	215,300		238,000	84,800	15,900	830,400	2,813,600	154.6	62.7
2017	1,831	367	732	31,535	732	21,241		883,700	83,600	65,600	76,200	617,300	156,700	152,000	2,035,100	101,800	182,600	225,200		238,000	88,700	16,000	852,300	2,887,400	157.7	61.5
2018	1,843	369	737	31,168	737	20,504		883,700	86,900	69,300	79,700	646,400	164,900	159,100	2,090,000	101,800	191,200	235,800		238,000	92,900	16,100	875,800	2,965,600	160.9	60.4
2019	1,854	370	742	30,798	742	19,762		883,700	90,400	72,600	83,100	676,800	174,000	166,600	2,147,200	0	200,200	246,900		238,000	97,200	16,200	798,500	2,945,700	158.9	57.3
2020	1,866	374	746	30,422	746	19,016		883,700	94,000	76,700	87,300	707,700	183,400	174,200	2,207,000	0	208,300	258,100		[illegible]	101,700	16,300	823,400	3,030,400	162.4	58.3
2021	1,877	375	751	30,047	751	18,265		562,100	97,800	80,300	91,100	740,900	193,500	182,400	1,948,100	0	219,100	270,200		238,000	106,400	16,400	850,100	2,798,200	149.1	49.7
2022	1,887	377	755	29,670	755	17,510	489,600	562,100	101,700	84,600	95,200	774,700	203,400	190,700	2,012,600	0	229,100	282,500		238,000	111,300	16,500	877,400	2,890,000	153.2	49.1
2023	1,898	380	759	29,290	759	16,751		604,100	105,700	89,300	99,800	809,900	214,300	199,400	2,122,500	0	239,500	295,400		238,000	116,400	16,500	905,600	3,028,300	159.6	49.2
2024	1,909	381	764	28,909	764	15,987		604,100	110,000	93,500	104,100	847,900	226,000	208,700	2,194,300	0	250,700	309,200		238,000	121,800	16,600	936,300	3,130,600	164.0	48.6
2025	1,920	384	768	[illegible]	768	15,219	2,325,800	604,100	114,400	98,500	109,100	886,400	238,100	218,200	2,266,800	0	262,100	323,300		[illegible]	127,300	16,700	967,400	3,236,200	168.6	48.1
2026	1,930	386	772	28,139	772	14,447		418,700	118,900	103,900	114,100	926,600	250,100	228,100	2,160,400	0	274,000	338,000			133,100	16,800	761,900	2,922,300	151.4	41.5
2027	1,941	389	776	27,750	776	13,671		418,700	123,700	109,400	119,600	968,700	263,400	238,500	2,242,000	0	286,400	353,300			139,200	16,900	795,800	3,037,800	156.5	41.2
2028	1,952	390	781	27,360	781	12,890		418,700	128,600	114,600	124,700	1,013,900	277,600	249,600	2,327,900	0	299,800	369,800			145,700	17,000	832,300	3,160,200	161.9	41.0
2029	1,962	392	785	26,968	785	12,105	644,300	418,700	133,800	120,600	130,300	1,059,900	292,500	260,900	2,416,900	0	313,400	386,600			152,300	17,100	869,400	3,286,300	167.5	40.6
2030	1,973	[illegible]	789	[illegible]	789	11,316		474,000	139,100	127,200	136,600	1,107,900	306,000	272,800	2,565,600	0	327,600	404,100			159,200	17,200	908,100	3,473,700	176.1	41.3
2031	1,978	396	791	26,177	791	10,525		474,000	144,700	133,200	142,400	1,155,200	323,400	284,400	2,657,300	0	341,600	421,300			165,900	17,200	946,000	3,603,300	182.2	41.0
2032	1,983	397	793	25,780	793	9,732		474,000	150,500	139,500	148,400	1,204,400	339,600	296,500	2,752,900	0	356,200	439,300			173,000	17,300	985,600	3,738,700	188.5	40.8
2033	1,987	397	795	25,383	795	8,937		474,000	156,500	146,400	154,400	1,255,700	356,600	309,200	2,852,600	0	371,400	458,000			180,400	17,300	1,027,100	3,879,900	195.3	40.7
2034	1,992	398	797	24,985	797	8,140		474,000	162,600	153,300	161,000	1,309,200	373,600	322,300	2,956,200	0	387,200	477,500			188,100	17,400	1,070,200	4,026,400	202.1	40.5
2035	[illegible]	[illegible]	[illegible]	[illegible]	799	7,341	[illegible]	474,000	169,300	160,500	167,600	1,365,000	392,300	336,100	3,065,000	0	403,700	497,900			196,100	17,400	1,115,100	4,180,100	209.3	40.3
2036	2,002	400	801	24,186	801	6,540	847,900	739,100	176,100	168,600	175,000	1,423,200	411,600	350,400	3,444,400	0	420,900	519,100			204,500	17,500	1,162,000	4,606,400	230.1	42.6
2037	2,007	401	803	23,785	803	5,737		811,600	183,100	176,700	182,400	1,483,600	432,400	365,300	3,635,500	0	438,800	541,200			213,200	17,500	1,210,700	4,846,200	241.5	43.0
2038	2,011	403	804	23,382	804	4,933		811,600	190,400	185,500	190,700	1,545,100	453,300	380,400	3,757,200	0	456,900	563,600			222,000	17,500	1,260,000	5,017,200	249.5	42.7
2039	2,016	404	806	22,978	806	4,127		811,600	198,000	195,000	198,800	1,610,900	475,900	396,600	3,887,000	0	476,400	587,600			231,400	17,600	1,313,000	5,200,000	257.9	42.5
2040	2,021	405	808	22,575	808	3,319		811,600	206,000	204,200	207,500	[illegible]	[illegible]	415,500	4,021,800	0	[illegible]	612,600			241,300	17,600	1,368,200	5,390,000	266.7	42.2
Totals:	65,173	21,427	34,065		29,681																				Average	54.5

(a) Remaining groundwater in City is based on an estimated 44,000 million gallons recoverable supply.
(b) Remaining groundwater in new well field is based on an estimated 33,000 million gallons recoverable supply.
(c) Discount rate @ 4 percent per year, to 1993 dollars.

Sources of Supply: The sources of supply for this scenario match those described for Scenario A-3: Plainview would continue to use 60 percent of its projected annual use from in-city groundwater and 40 percent from the CRMWA through the year 2000. From the year 2001 on, it is assumed that Plainview would be using 40 percent CRMWA water, 40 percent groundwater from the new well field, and 20 percent in-city groundwater.

Recoverable In-City Groundwater: The estimated remaining recoverable groundwater in Plainview by the end of the planning period, according to this scenario, would be approximately 22,573 MG - over 50 years of use at the 2040 in-city use rate.

Capital Cost: Table E-13 summarizes the capital costs incurred according to this scenario, throughout the planning period. This includes Plainview's capital costs associated with the new groundwater well field, as described in Scenario A-3; Plainview's share of the CRMWA groundwater supply source; and the additional in-city groundwater wells needed as the groundwater levels drops. The total capital investment for the period from 1994 to 2040 would be about $11,583,000, in 1993 dollars.

Debt Service: It is assumed that all capital investments would be paid out in 25 equal payments, at 7 percent per year interest rate.

Water production costs for this scenario match those of Table E-5, described for Scenario A-3. The Canadian River Municipal Water Authority water costs of Table E-12 match those presented earlier for Scenario B-1 and shown in Table E-8.

Table E-13

Capital Costs of Regional Water Supply to Plainview: 1994-2040
Assuming CRMWA Develops a Groundwater Supply from Roberts County
Scenario B-3: Develop New Groundwater Well Fields

Year	Type of Improvement	Capital Cost of Improvement	
		1993 Cost	Cost with Inflation
1995	Purchase of water rights	$3,465,000	$3,747,700
2000	Construction of a 4-well field	3,410,000	4,487,300
	Plus Groundwater from Roberts County	2,108,000	2,774,000
2015	New in-city groundwater well	157,000	372,100
	plus 2 additional wells in new field	714,000	1,692,100
2022	New in-city groundwater well	157,000	489,600
2025	Two additional wells in new field	663,000	2,325,800
2029	New in-city groundwater well	157,000	644,300
2035	Two additional wells in new field	595,000	3,089,700
2036	New in-city groundwater well	157,000	847,900
Total		$11,583,000	

Present Worth Unit Cost: The average 1994-2020 present worth unit cost of Plainview's potable water would be about 54.5 cents per thousand gallons. The highest year present worth unit cost would be approximately 82.8 cents per thousand gallons, in the year 2001. This approach leaves recoverable in-city groundwater reserves in 2040 of 22,573 million gallons - over 50 years of use at the 2040 use rate. The capital costs associated with developing the groundwater well field and the increased CRMWA water costs would cause this to be a relatively expensive scenario.

APPENDIX F

ANALYSIS OF WATER DISTRIBUTION

SYSTEM IMPROVEMENTS

APPENDIX F

ANALYSIS OF WATER DISTRIBUTION SYSTEM IMPROVEMENTS

This appendix describes a study of the City of Plainview's water distribution system made to determine whether improvements would allow increased use of supplies from the water treatment plant. The University of Kentucky KYPIPE computer model was used to conduct the network modeling of the water distribution system. A skeleton model of the system was created by modeling all 8-inch and larger water distribution lines and many of the 6-inch distribution lines. The network model has been permanently stored in Freese and Nichols' computer file database and is available to the City of Plainview.

Existing Water Distribution System

The principal elements of the City of Plainview water distribution system include pumping facilities, elevated storage tanks, ground storage tanks and a distribution system network of pipelines. The operation of the water distribution system involves the interaction of all of these elements.

The high service pumping facilities for the water distribution system are at the water treatment plant at 16th and Holliday Street. Treated water from the treatment plant is blended with groundwater from wells in a 2.0 million gallon ground storage tank, from which water is pumped into the distribution system by the high service pumps. The water treatment plant has a rated capacity of 4.2 million gallons per day (MGD) or 2,917 gallons per minute (GPM). The blending of the surface water with groundwater at the plant has been set to not exceed 60% surface water, with the remaining 40% being groundwater. The pumping capacity of the three high service pumps varies with changing demands but averages approximately 6,500 GPM. It is difficult to obtain the exact capacity of the high service pumps without conducting pump tests, since no pump curves are available. Approximate pump curves were developed for this analysis on the basis of the manufacturer of the pumps, the pump type, and information provided by the City on flow rates at several operating conditions.

Presently, there are 1.75 million gallons of elevated storage in the City of Plainview. This elevated storage is located at five different storage tanks within the City. The elevated storage tanks are listed in Table F-1 and shown on Figure F-1.

There are four ground storage tanks with booster pumps located throughout the city, not including the clearwell tank at the water treatment plant. Table F-2 lists the ground storage tanks, which have a total capacity of 3.0 million gallons. The ground storage tanks are also shown on Figure F-1.

In addition to the booster pumps located at the ground storage tanks, there are two groundwater wells that pump directly into the distribution system. The well located at 14th and Baltimore Street has a pumping capacity of 1,000 gpm. The well located at Pecos and Highland Street has a pumping capacity of 1,200 gpm.

Table F-1

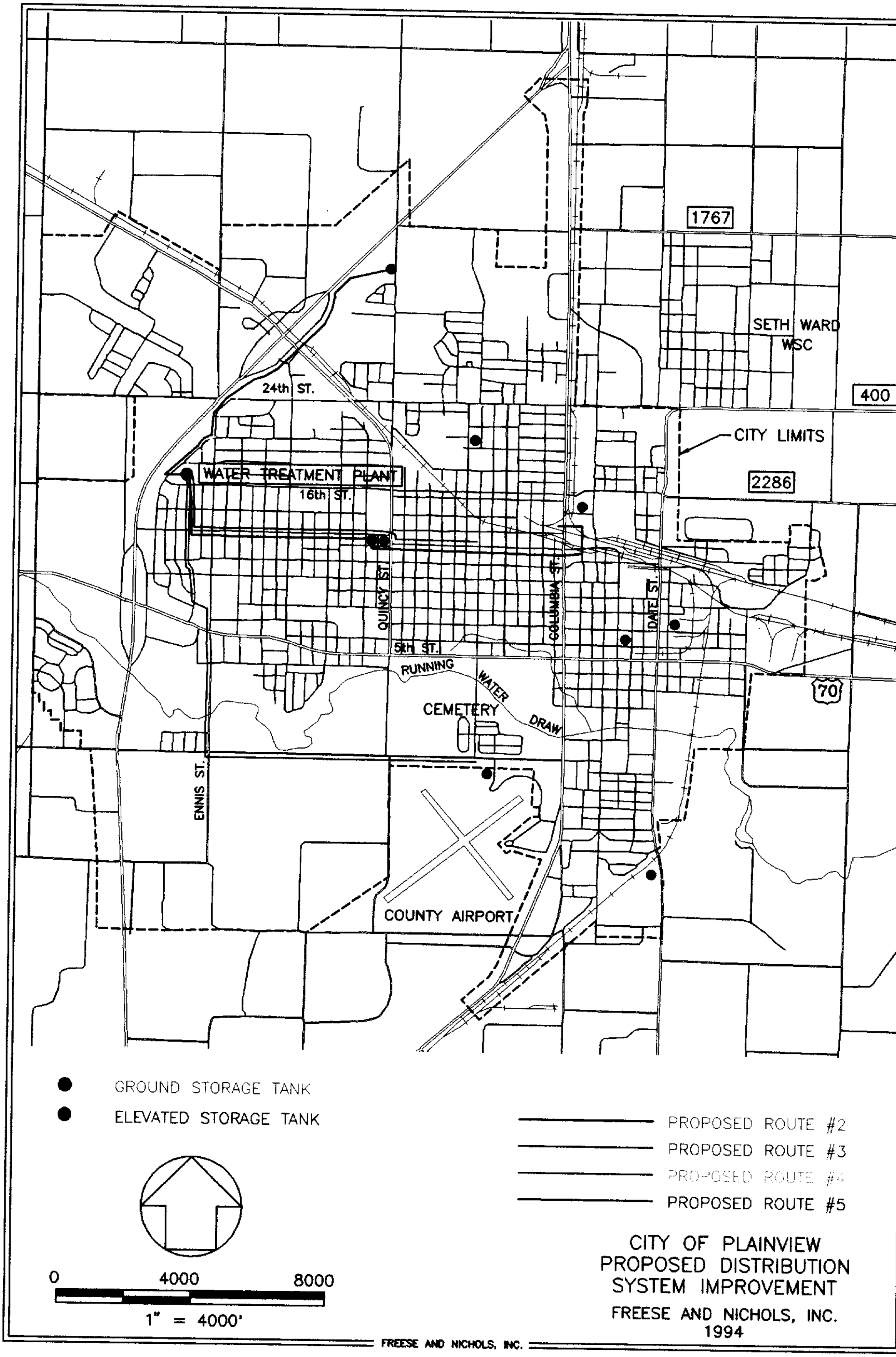
Elevated Storage Tanks

Location	Volume
12th & Smyth Street	0.25 Million Gallons
7th & Beech Street	0.20 Million Gallons
14th & Baltimore Street	0.30 Million Gallons
South Date Street	0.50 Million Gallons
North Quincy Street and I-27	0.50 Million Gallons

Table F-2

Ground Storage Tanks

Location	Volume	Pumping Capacity
12th & Smyth Street	0.5 Million Gallons	3 Pumps Providing 3,750 GPM
20th & Kokomo Street	1.0 Million Gallons	3 Pumps Providing 5,150 GPM
7th & Elm Street	0.5 Million Gallons	2 Pumps Providing 2,200 GPM
Southwest 3rd & Joliet Street	1.0 Million Gallons	2 Pumps Providing 3,950 GPM



1767
SETH WARD WSC
400
CITY LIMITS
2286
24th ST.
WATER TREATMENT PLANT
16th ST.
QUINCY ST.
COLUMBIA ST.
DATE ST.
5th ST.
RUNNING WATER DRAW
CEMETERY
70
ENNIS ST.
COUNTY AIRPORT
GROUND STORAGE TANK
ELEVATED STORAGE TANK
PROPOSED ROUTE #2
PROPOSED ROUTE #3
PROPOSED ROUTE #4
PROPOSED ROUTE #5
0
4000
8000
1" = 4000'
CITY OF PLAINVIEW
PROPOSED DISTRIBUTION
SYSTEM IMPROVEMENT
FREESE AND NICHOLS, INC.
1994
FREESE AND NICHOLS, INC.

FIGURE F-1

Analysis of the Water Distribution System

The water distribution system was modeled as a single pressure plane with an assumed Hazen-Williams C-factor roughness value of 100, which is appropriate for older small pipelines in distribution systems. The model was calibrated using information from the City of Plainview and a 1976 water distribution study by Parkhill, Smith and Cooper. The existing water distribution system uses surface water from the water treatment plant and groundwater from wells and storage tanks to meet demands throughout the city. The water treatment plant in the last few years has operated at about 2 MGD, or about half of its maximum capacity of 4.2 MGD. Reasons for this include lower water demands and the inability of the distribution system to convey water from the treatment plant to the east side of the city during summer months.

The existing population of Plainview is approximately 22,000. A design population of 25,000 was used in the analysis representing the projected population in year 2020. A water usage of 180 gallons per day per person was used to develop an average day demand of 4.5 MGD. A multiplier of 2.8 was applied to the average day demand to obtain an approximate peak day demand of 12.6 MGD. A multiplier of 1.8 was applied to the peak day demand to obtain an approximate peak hour demand of 22.7 MGD. For the night time demand, a multiplier of 0.5 was applied to the average day demand to give a night time demand of 2.25 MGD. These demands will be met from the high service pumps and from ground and elevated storage within the distribution system.

Several alternative improvements to the water distribution system designed to increase the use of water from the water treatment plant were analyzed using the computer model. The existing pressures within the distribution system are adequate to meet regulatory requirements under peak operating demands. Therefore, the primary goal of the improvements studied is to increase the quantity of flow from the treatment plant into the distribution system. The alternative improvements were evaluated using all three high service pumps at the treatment plant for both peak hour and night time demand conditions. The three pumps were used since the best available pumping information is with all pumps operating. It is recognized that in practice fewer pumps will be used under some demand conditions. For the peak hour demand condition, one pump from each of the ground storage tanks was used, as were the groundwater wells that pump directly into the distribution system. This pumping scheme matched the simulated conditions in the Parkhill, Smith and Cooper study. For the night time demand condition all booster pumps were turned off to simulate tank refilling.

The five alternative distribution system improvements examined are as follows:

- Route 1 - a new north pipeline from the treatment plant to Kokomo and 24th Street with an approximate length of 11,300 feet.
- Route 2 - a new pipeline from the treatment plant to the tank at 14th and Baltimore street with an approximate length of 16,700 feet.
- Route 3 - a new pipeline from the treatment plant to Kokomo and West 12th Street with an approximate length of 11,100 feet.
- Route 4 - a new south pipeline from the treatment plant to Southwest 3rd and Joliet Street with an approximate length of 17,100 feet.
- Route 5 - a new north pipeline from the treatment plant going directly to

the North Quincy Street Tank with an approximate length of 10,300 feet.

The five proposed routes are shown in Figure F-1.

Two different pipeline sizes (18-inch and 24-inch) were examined for each of the routes to determine what size pipeline would provide an economical way to increase the use of water from the water treatment plant. The pumping rates of the high service pumps at the water treatment plant and the amount of inflows and outflows from the elevated tanks for the alternative pipeline routes studied are shown in Tables F-3 and F-4.

Table F-3

Flow Rates at Critical Points in the System during Peak Hour Demand Conditions*

	High Service Pumps (GPM)	12th & Smith Tank (GPM)	North Quincy Tank (GPM)	14th & Balt. Tank (GPM)	7th & Beech Tank (GPM)	South Date Tank (GPM)
Existing System	7,092	1,419	1,181	850	-584	80
18" Pipeline Route 1	7,675	1,570	612	730	-630	-195
24" Pipeline Route 1	8,092	1,684	133	680	-635	-190
18" Pipeline Route 2	7,872	453	750	1,790	-826	-270
24" Pipeline Route 2	8,198	225	757	1,700	-842	-275
18" Pipeline Route 3	7,906	1,057	1,029	685	-685	-230
24" Pipeline Route 3	8,235	960	983	550	-730	-240
18" Pipeline Route 4	7,807	1,333	1,246	800	-861	-560
24" Pipeline Route 4	8,153	1,200	972	752	-905	-650
18" Pipeline Route 5	7,690	1,919	-60	880	-520	-160
24" Pipeline Route 5	8,123	2,194	-880	900	-460	-130

*The positive flows indicate water entering the distribution system, while the negative flows indicate water leaving the distribution system and entering the elevated tanks.

Table F-4

Flow Rates at Critical Points in the System during Night Time Demand Conditions*

	High Service Pumps (GPM)	12th & Smith Tank (GPM)	North Quincy Tank (GPM)	14th & Balt. Tank (GPM)	7th & Beech Tank (GPM)	South Date Tank (GPM)
Existing System	5,793	-1,571	-581	220	-361	80
18" Pipeline Route 1	6,802	-1,350	-1,281	-270	-395	75
24" Pipeline Route 1	7,372	-1,334	-1,636	-460	-430	70
18" Pipeline Route 2	7,129	-2,024	-566	-620	-400	65
24" Pipeline Route 2	7,742	-1,700	-438	-1,700	-385	70
18" Pipeline Route 3	7,100	-2,220	-680	-260	-420	55
24" Pipeline Route 3	7,622	-2,418	-785	-420	-460	48
18" Pipeline Route 4	6,972	-1,270	-340	145	-890	-1,040
24" Pipeline Route 4	7,465	-1,150	-185	123	-955	-1,385
18" Pipeline Route 5	6,977	-692	-2,828	320	-302	100
24" Pipeline Route 5	7,603	-300	-3,866	325	-285	110

*The positive flows indicate water entering the distribution system, while the negative flows indicate water leaving the distribution system and entering the elevated tanks.

Conclusions, Recommendations and Cost Estimates

From Tables F-3 and F-4 it can be seen that the ability to convey water from the treatment plant to the distribution system increases with pipe size. This must be balanced with the increase in cost for the larger pipeline. The following conclusions were reached on the basis of the distribution system analyses:

a. A pipeline along Route 4 is not practical, since it provides less flow to the northeast part of the city for tank refilling conditions than the existing system as well as being the longest and most expensive of the four routes studied.

b. A pipeline along Route 2 does convey more water to the elevated tanks for tank refilling than the existing system, but the increase in flows is not economical, especially since the last several hundred feet of Pipeline Route 2 would require boring underneath several railroads.

c. A pipeline along Route 5 does convey much more water to the North Quincy Tank, but it is not recommended. This route would pull water away from the central part of the city during peak demand conditions, as shown in the amount of water draining out of the tank at 12th and Smyth Street in Table F-3. The route would also make it more difficult to fill the elevated tanks in the central and south part of the city, as shown in Table F-4. Another problem with this route is that it does not take advantage of parallel piping to reduce the cost of a new pipeline, as do Pipeline Routes 1 and 3.

d. A pipeline along Route 1 or 3 would be less expensive and would provide increased use of flow from the treatment plant in meeting peak flows and tank refilling at night time. Route 1 provides more flow to the northeast part of the city near Seth Ward than does Route 3. Using Route 1 should allow the automated controls of the distribution system to remain at the Smyth Street tank, since the flows leaving the tank during peak demands and the flows filling the tank during night time demands are more similar to the existing system than any of the other proposed routes examined.

e. Proposed Pipeline Routes 1 and 3 travel along routes of existing pipelines. Therefore, in several places along both of these routes it would not be necessary to install all new pipeline of the size studied to produce the flows shown. In areas along these routes where 12-inch or larger pipelines already exist and are in good condition, it would be more economical to parallel the existing lines to achieve the flow capacity of a 18-inch or 24-inch pipeline. In most cases, it is not practical to parallel pipe much smaller than 12 inches in diameter because of the frictional losses encountered in smaller pipelines. For both pipeline routes, a flow capacity of an 18-inch pipeline could be achieved by paralleling an existing 14-inch pipe with 8-inch pipe, and paralleling 12-inch pipe with a 10-inch pipe. For both pipeline routes, a flow capacity of a 24-inch pipeline could be achieved by paralleling an existing 14-inch pipe with 16-inch pipe, and paralleling 12-inch pipe with an 18-inch pipe. The quantities of the different size pipe for Routes 1 and 3 are shown in Table F-5.

Table F-5

Pipe Quantities
Proposed Pipeline Route 1

18-Inch Pipeline Capacity

Pipe size	Length
8-inch	2,100 ft.
10-inch	4,900 ft.
18-inch	4,300 ft.

24-Inch Pipeline Capacity

Pipe Size	Length
12-inch	400 ft.
16-inch	2,100 ft.
18-inch	4,900 ft.
24-inch	3,900 ft.

Total Pipeline Length of Route 1 = 11,300 ft.

Proposed Pipeline Route 3

18-Inch Pipeline Capacity

Pipe size	Length
10-inch	4,000 ft.
18-inch	7,100 ft.

24-Inch Pipeline Capacity

Pipe Size	Length
18-inch	4,000 ft.
24-inch	7,100 ft.

Total Pipeline Length of Route 3 = 11,100 ft.

f. Cost estimates for both of these alternative pipeline routes for both of the sizes examined are shown in Table F-6 through Table F-9. Proposed Pipeline Route 3 is more expensive than Pipeline Route 1, but uses more surface water from the water treatment plant. An 18-inch pipeline does not move as much water from the treatment plant to the distribution system as does a 24-inch pipeline, but it would be significantly less expensive. Route 1 has the advantage of using a similar design as the existing system for the automated controls, which minimizes the cost of needing additional valving at the elevated tanks. Route 1 also has the significant advantage of increasing the flow of water to the North Quincy Tank, a tank that has traditionally been difficult to fill. Based on these items and the proposed cost estimates, we recommend that Pipeline Route 1 be used with either a 18-inch or 24-inch pipeline capacity.

g. It is also recommended that pump tests be conducted on the high service pumps at the water treatment plant before installing any new lines. Pump tests will provide accurate pump curves of the high service pumps which can be used in conjunction with the computer model to verify the results described in this study.

Table F-6

Proposed Pipeline Route 1 - 18" Pipeline Capacity
Estimated Probable Construction Cost

Item	Quantity	Unit	Unit Cost	Amount
18-inch Water Line	4,300	L.F.	$ 45	$193,500
10-inch Water Line	4,900	L.F.	25	122,500
8-inch Water Line	2,100	L.F.	20	42,000
Railroad Boring and Casing	200	L.F.	120	24,000
Connections	12	Each	4,000	48,000
Street Replacement	11,300	L.F.	15	169,500
Subtotal				$599,500
20% Contingency				$119,900
Total				$719,400

Table F-7

Proposed Pipeline Route 1 - 24" Pipeline Capacity
Estimated Probable Construction Cost

Item	Quantity	Unit	Unit Cost	Amount
24-inch Water Line	3,900	L.F.	$ 60	$234,000
18-inch Water Line	4,900	L.F.	45	220,500
16-inch Water Line	2,100	L.F.	40	84,000
12-inch Water Line	400	L.F.	30	12,000
Railroad Boring and Casing	200	L.F.	140	28,000
Connections	12	Each	4,000	48,000
Street Replacement	11,300	L.F.	15	169,500
Subtotal				$796,000
20% Contingency				$159,200
Total				$955,200

Table F-8

Proposed Pipeline Route 3 - 18" Pipeline Capacity
Estimated Probable Construction Cost

Item	Quantity	Unit	Unit Cost	Amount
18-inch Water Line	7,100	L.F.	$ 45	$319,500
10-inch Water Line	4,000	L.F.	25	100,000
Connections	13	Each	4,000	52,000
Street Replacement	11,100	L.F.	15	166,500
Subtotal				$638,000
20% Contingency				$127,600
Total				$765,600

Table F-9

Proposed Pipeline Route 3 - 24" Pipeline Capacity
Estimated Probable Construction Cost

Item	Quantity	Unit	Unit Cost	Amount
24-inch Water Line	7,100	L.F.	$ 60	$426,000
18-inch Water Line	4,000	L.F.	45	180,000
Connections	13	Each	4,000	52,000
Street Replacement	11,100	L.F.	15	166,500
Subtotal				$824,500
20% Contingency				$164,900
Total				$989,400

APPENDIX G

COMMENTS OF THE TEXAS WATER DEVELOPMENT BOARD

APPENDIX G

COMMENTS OF THE TEXAS WATER DEVELOPMENT BOARD

The next two pages are a copy of the comments of the Texas Water Development Board on the draft report. Acknowledgment of TWDB funding has been added to the cover and the title page. No other comments were received on the draft report.

TEXAS WATER DEVELOPMENT BOARD

April 6, 1994

Mr. James P. Jeffers
City Manager
City of Plainview
901 Broadway
Plainview, Texas 79072

Dear Mr. Jeffers:

Re:Draft Final Report for the City of Plainview, Texas Water Development Board (Board) Contract Number 92-483-317

Staff members of the Board have completed a review of the draft final report under Board Contract No. 92-483-317 with the City of Plainview. Review comments are presented in Attachment 1.

The Board looks forward to receiving twelve copies of the Final Report following any revisions. Please contact Mr. Curtis Johnson, the Board's designated Contract Manager for this project, at (512) 463-8060 if you have any questions concerning the comments.

Sincerely,

Tommy Knowles
Deputy Executive Administrator
for Planning

Attachment

ATTACHMENT 1

1. Acknowledgement of funding for this study from the Texas Water Development Board should be shown in a predominant place on both the report cover and on the title page of the report.

2. The following is simply a comment from our environmental section:

   From previous experience in the Southern High Plains region, several points may be raised concerning the potential environmental impacts of any project developed using this plan. Mechanized agriculture and development of transportation systems have heavily altered the landscape surrounding Plainview over the last century. The extent to which the recommended projects further alter the landscape will depend on the selection of pipeline routes. Pipeline routes located within existing disturbed highway or railroad easements will involve the least impacts to the remaining natural environment. Archeological sites may be impacted in high probability areas near playa lakes or streams, such as Running Water Draw. Additionally, should any area of native pasture remain, they are considered to be significant by the Texas Parks and Wildlife Department.