HILL COUNTRY WATER SUPPLY FEASIBILITY STUDY

CONTRACT NO. 9-483-738

Submitted to:

Texas Water Development Board

and

Circle C Municipal Utility District No. 3

Prepared by:

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I. EXECUTIVE SUMMARY

The Hill Country Water Supply Corporation (HCWSC) was incorporated in September of 1979 as a non-profit Texas corporation. The purpose of organizing the water supply corporation was to find a good quality water supply for its residents. The corporation, encompassing almost 7035 acres in southwestern Travis County and northern Hays County, consists of several non-contiguous tracts. In 1988, the HCWSC entered into a contract with the City of Austin for the purpose of constructing and operating a domestic water supply system. This contract was renegotiated this summer. The new contract should satisfy the loan requirements of the funding agency.

The Hill Country Water Supply (HCWS) Study Area generally includes the boundaries of the HCWSC and the area lying between the corporation and Circle C MUDs #3 and #4 to the east. The Study Area comprises approximately 23.9 square miles of which 12.3 square miles are within Travis County and 11.6 square miles are within Hays County.

In 1984, the Circle C Municipal Utility District (MUD) #3 was granted a petition from the Texas Water Commission allowing its creation. The Circle C Municipal Utility District #3 was created to provide water service to approximately 658 acres within the Circle C subdivision. Under the Texas Water Code, the municipal utility district also has the authority to provide water service outside its boundaries. The contract bond facilities consisting of storage, pumping and transmission funded jointly by Circle C MUD No. 3 and the City of Ausitn are City of Austin facilities and are available for use by the HCWS Study Area residents.

The purpose of the Hill Country Water Supply Service Feasibility Study was to recommend a regional surface water supply system capable of meeting the projected growth and water demands forecast for the Hill Country Water Supply (HCWS) Study Area. The feasibility study was undertaken using a matching funds grant involving participation from Circle C Municipal Utility District #3, City of Austin contract bonds, and state funds allocated from the Texas Water Development Board.

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HILL COUNTRY WATER SUPPLY SERVICE FEASIBILITY STUDY

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This study identifies the existing City of Austin water facilities in the vicinity of the Study Area and evaluates their capacities with respect to the additional demands placed by the HCWS Study Area. The existing water storage facility serving the Southwest 'B' area will be impacted by these new demands. The study has identified a new storage facility will be required around the year 2000 based on the projected growth trends. The transmission mains serving the Southwest 'B' water system appear to be adequate for the additional demands placed by the HCWS Study Area.

As requested by the HCWSC, this report investigated three (3) alternatives or scenarios. Scenario #1, the most costly, was designed for ultimate build-out (year 2020) and provided a minimum of 500 gpm of fire flow throughout the water system. Scenario #2 was scaled back to meet the water demands projected for the year 2000 and also provided a minimum of 500 gpm of fire flow throughout the water system. Scenario #3, the least costly, was also designed for the year 2000 water demand but only provided a minimum fire flow of 500 gpm throughout the transmission mains. Upon evaluation of the costs and level of water service of the three scenarios, it was determined the recommended system, or THE SYSTEM, would consist of a variation of scenario #1.

The recommended system referred to as THE SYSTEM was designed for ultimate build-out (year 2020 demand) and provides a minimum of a 500 gpm fire flow throughout the transmission main portion of the water system. The total construction-related cost for THE SYSTEM is estimated to be $11,180,070 including contingencies, engineering/surveying and geotechnical support. Construction costs alone are estimated to be $8,469,750 for THE SYSTEM.

This report recommended THE SYSTEM be constructed in three (3) phases. Phasing construction of THE SYSTEM will add an additional $2,133,344 to the construction-related cost. The first phase, Phase I, will provide water service to meet the following design year demands. Phase I improvements include transmission mains sized for the ultimate demand (year 2020). Storage , distribution and pumping for the year 2000 demand (1561 connections) and water services for 1200 connections are provided. Water service for 1200 connections was provided instead of the 1561 connections projected for the year 2000 since the Texas Water Development Board has indicated 1200 connections is an acceptable number for obtaining funding. The estimated construction-related cost associated with Phase I is $8,325,042.

Phase II improvements consist of additional storage, pumping, distribution and water services to accommodate the year 2010 projected demand. The estimated construction-related cost to complete Phase II is $2,995,600.

The improvements proposed for Phase III include the necessary storage, pumping, distribution and water services to meet the year 2020 (ultimate) demand. Phase III construction-related cost is estimated to be $1,992,772.

Monthly water service cost were compared for the existing individual water wells and a surface water system purchasing water from the City of Austin. The surface water system was determined to be less expensive than the well system. This report recommends obtaining financing to fund Phase I. The cost of financing and monthly water service were compared assuming the water supply entity was a corporation and as a district. The district was determined to be the least expensive of all the options. The estimated monthly cost per user is $119.00 for the district, $123.00[1] for the corporation, and $217.00 for the individual water well option.

Based on the findings described above, it is recommended the corporation re-organize as a special district and request funding and participation from the Texas Water Development Board to finance the cost to construct Phase I. It is recommended that this special district apply for low interest rate funds available through the Texas Water Development Board to fulfill its needs for an economical and dependable water supply system.

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[1]*This does not include the cost to finance the capitalized interest since this is not allowed in the corporation bond issue.*

II. INTRODUCTION TO STUDY

A. Concept

1. <u>History of Hill Country Water Supply Corporation</u>

The Hill Country Water Supply Corporation was incorporated September 14, 1979 as a non-profit Texas Corporation. The movement to incorporate was led by Mr. and Mrs. Lloyd Leffingwell in order to find an alternative for a good quality water supply to serve the area. Wells in the vicinity of the corporation typically yield poor quality water that is extremely hard and prohibitively expensive to treat. Initially the corporation's goal was to find a good well site in the Edwards Aquifer, obtain FMHA (Farmer's Home Administration) financing and establish a cooperative water supply system. In the early 1980's, a well site was found and the test well results indicated water of good quality and adequate yield for its 900 members. However, funding through FMHA was rejected. At that time interest rates were high; therefore, private financing was not feasible and the project's future appeared bleak.

Recent legislation and potential funding through State Agencies have revived the efforts to establish a non-profit water supply cooperative. Over the past eight years, when the future was in question for the water supply cooperative many members either moved or withdrew from the organization. The corporation's current membership is approximately 500. In spite of the ground water problems, the area has continued to grow.

Recently, the corporation investigated three (3) water sources - City of Austin, Lower Colorado River Authority (LCRA) and the corporation's existing well. As a result of the recent significant deterioration and unreliability of ground water in the area and potential funding for a surface water system, the corporation decided to sell its well site and proceed with the surface water options only. The LCRA's proposed regional water system was investigated and found to be an attractive alternative; however, service from LCRA would be several years away. With the recent completion of two major Southwest 'A' and Southwest 'B' storage facilities and a Southwest 'B' pump station along FM 1826, City of Austin water is available along the corporation's eastern boundary. As a result, the City of Austin option was found to be the most practical alternative. The Texas Water Development Board has indicated funding would be available if the corporation's membership increased to at least 1200.

2. Texas Water Development Board and Circle C MUD #3 Contract

Circle C Municipal Utility District (MUD) #3 was created by the Texas Water Commission pursuant to Chapter 54 of the Texas Water Code. The Texas Water Commission granted the petition requesting organization of the District November 19, 1984. The District was created to provide water to an area of Southwest Travis County within the boundaries of Circle C. In accordance with the Texas Water Code, Chapter 54.201, the Circle C MUD #3 is authorized to purchase, construct, acquire, own, operate, maintain, repair, improve or extend inside and outside its boundaries any and all works, improvements and facilities necessary to accomplish the purpose of its creation. As stipulated in Chapter 54.519 of the Texas Water Code, the District has the authority to provide water service to areas outside the District. This provision for service encompasses planning, designing, acquiring and constructing of all necessary facilities. The facilities which exist along FM 1826 (Southwest 'B' Reservoir and Transmission Main) were built with contract bond funds and now exist as City of Austin facilities for use by other than residents of Circle C MUD's. In May of 1988, the Hill Country Water Supply Corporation entered into a three year water service contract with the City of Austin for the purpose of constructing and operating a domestic water supply distribution system. At the end of the three year contract, it was hoped water service to the area would be provided by the LCRA through their proposed regional water supply system.

On June 1, 1989, in accordance with the Texas Administrative Code Section 335.104(a)(6)(c), notice was given that Circle C MUD #3 would participate in a 50/50 matching funds grant with the Texas Water Development Board (TWDB) for state funds allocated from the Research and Planning Fund to develop a regional water service plan for the Hill Country Water Supply Corporation and surrounding areas. The plan will consist of a study identifying long-range water service needs and will conform with the current State Water Quality Management Plan.

3. Study Scope Summary

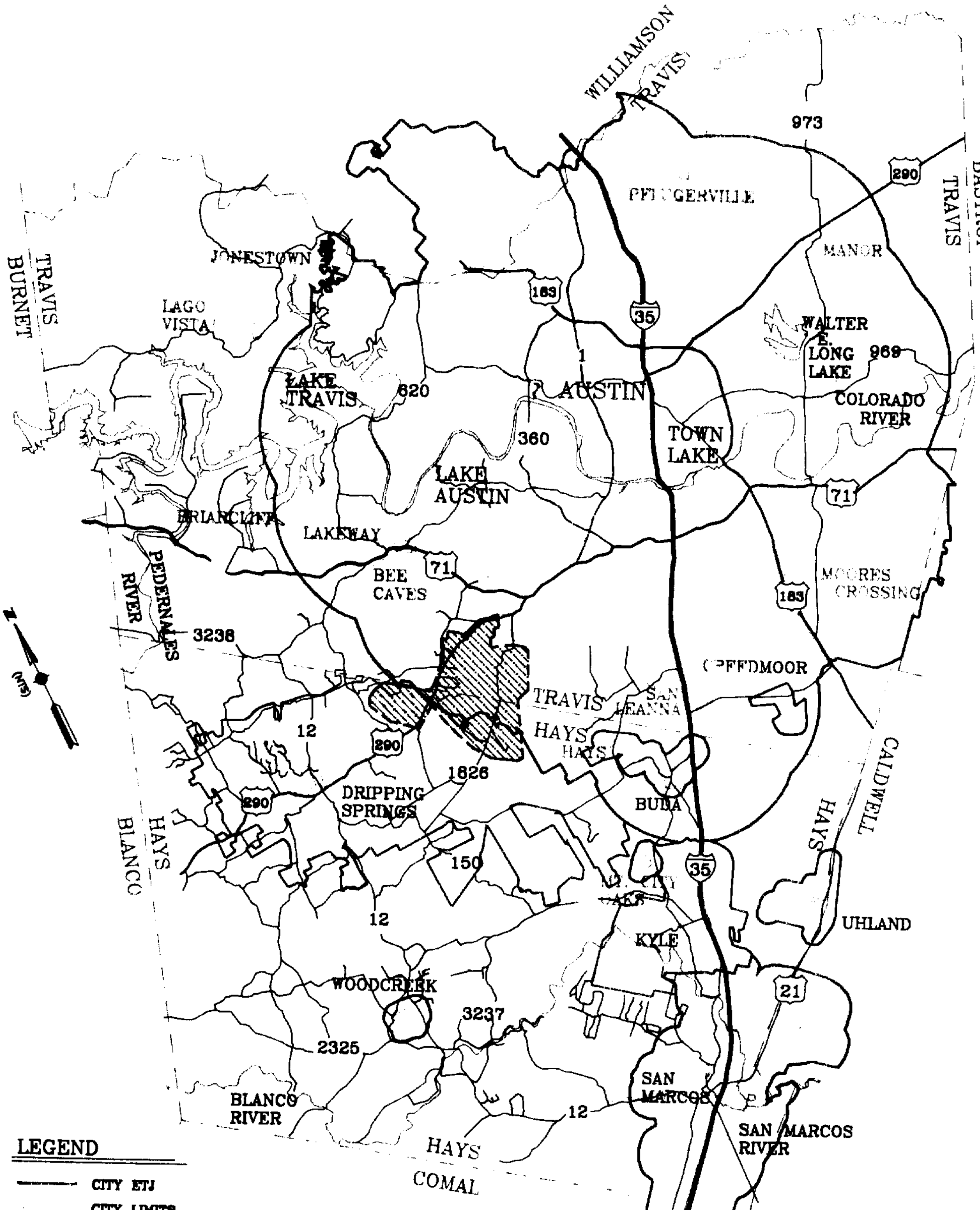
The Study Area generally includes the boundaries of the Hill Country Water Supply Corporation, and areas lying between Hill Country Water Supply Corporation and Circle

C MUDs #3 and #4. A Location Map showing the Study Area and surrounding regions is presented in Figure 1. The Study Area lies within the extraterritorial jurisdictions of the City of Austin and the City of Dripping Springs. Water service in the area has been provided by individual well sites as well as small, centralized well systems.

The purpose of the study was to develop a plan to meet the long range water service needs of the area. The study has evaluated the existing water systems in the area. An existing population has been determined and future population projections analyzed utilizing current development trends and restrictions. The population forecasts have been converted to equivalent water demands. The City of Austin water facilities have been evaluated in developing alternatives for the regional water system. These existing facilities have been integrated with the recommended improvements wherever feasible. Environmental constraints have been investigated with regards to the projected development plans. The environmental impacts associated with existing and proposed wastewater septic systems, quality of surface water, and underground aquifers have also been examined.

This study has investigated the need for any improvements to the City of Austin water system so that the City can provide water service to the study area without impacting the water capacity required by its existing customers, such as Circle C MUD #3. A master plan for a water supply and distribution system for the service area has been developed as part of this study. An investigation has been made to determine if the proposed LCRA Southwest Regional Water Supply System can provide water service to the area. The study has recommended a water conservation plan for the area and provided recommendations to upgrade existing water facilities to meet Texas Department of Health design standards.

Circle C MUD # 3 (the District) as a legal management authority is coordinating the planned improvements with adjacent governmental entities to facilitate the regional planning concept. A management plan has been developed to coordinate the various operations of the water system, manage water conservation efforts and implement regional improvements. An implementation plan has been developed for the recommended improvements. This plan includes a phasing schedule showing the necessary sequencing, timing and cost of the recommended improvements.



LEGEND

CITY ETJ

CITY LIMITS

COUNTY LINE

STUDY AREA

LOCATION MAP

MEC

MURFEE ENGINEERING COMPANY

1101 SOUTH CAPITAL OF TEXAS HIGHWAY
BUILDING D, SUITE 110
AUSTIN, TEXAS 78746
(512) 327-9204

FIGURE 1

III. DETAIL OF STUDY SCOPE

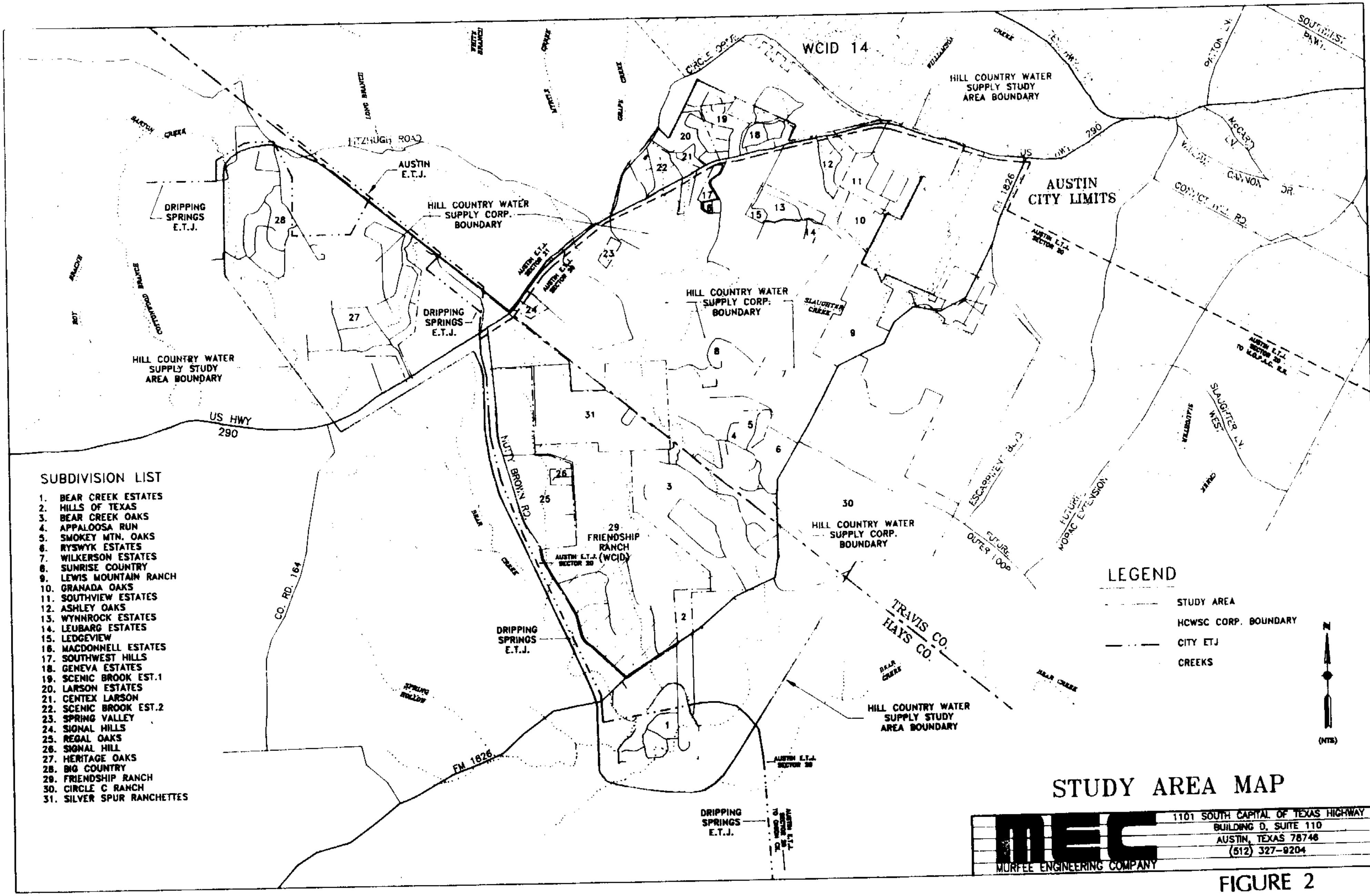
A. Growth Scenarios

1. Study Area

The Hill Country Water Supply (HCWS) Study Area generally includes the boundaries of the Hill Country Water Supply Corporation and the area lying between Hill Country Water Supply Corporation and the Circle C Municipal Utility Districts #3 and #4 to the east. The Study Area comprises approximately 23.9 square miles of which 12.3 square miles are within Travis County and 11.6 square miles are within Hays County. The Study Area Map depicting the boundaries of the Study Area and the Hill Country Water Supply Corporation as supplied to Murfee Engineering by the Hill Country Water Supply Corporation is presented in Figure 2.

Development within the Study Area generally consists of low density (1 to 3 acre lots) subdivisions, ranchettes (5 to 10 acres) and ranches. The higher density subdivisions, generally located east of FM 1826 such as Circle C West, are platted at a density of 3 lots/acre or greater for single-family development and up to 10 units/acre for village cluster development. The Circle C West subdivision also has an 18-hole golf course and 465 acres designated for research and development use. Friendship Ranch which was originally planned with 1000 units, but never granted legal subdivision status, has been estimated at a density of 1 unit/2 acres, or 404 units in this report.

Approximately 6386 acres within the Study Area have been planned or platted as subdivisions. The Study Area Map which follows depicts the boundaries of the Study Area and Hill Country Water Supply Corporation. A list of these subdivisions indicating developable densities is provided in Table 1. The subdivisions have been identified by corresponding numbers in Table 1 and on Figure 2.



WCID 14
HILL COUNTRY WATER SUPPLY STUDY AREA BOUNDARY
FITZHUGH ROAD
AUSTIN E.T.J.
DRIPPING SPRINGS E.T.J.
HILL COUNTRY WATER SUPPLY CORP. BOUNDARY
AUSTIN CITY LIMITS
US HWY 290
FM 1826
NUTTY BROWN RD.
CO. RD. 164
FRIENDSHIP RANCH (WCID)
TRAVIS CO.
HAYS CO.
ESCARPMENT BLVD
FUTURE OUTER LOOP
FUTURE MOPAC EXTENSION
CONVICT HILL RD.
SLAUGHTER LN
SLAUGHTER CREEK
BEAR CREEK
SUBDIVISION LIST
1. BEAR CREEK ESTATES
2. HILLS OF TEXAS
3. BEAR CREEK OAKS
4. APPALOOSA RUN
5. SMOKEY MTN. OAKS
6. RYSWYK ESTATES
7. WILKERSON ESTATES
8. SUNRISE COUNTRY
9. LEWIS MOUNTAIN RANCH
10. GRANADA OAKS
11. SOUTHVIEW ESTATES
12. ASHLEY OAKS
13. WYNNROCK ESTATES
14. LEUBARG ESTATES
15. LEDGEVIEW
16. MACDONNELL ESTATES
17. SOUTHWEST HILLS
18. GENEVA ESTATES
19. SCENIC BROOK EST.1
20. LARSON ESTATES
21. CENTEX LARSON
22. SCENIC BROOK EST.2
23. SPRING VALLEY
24. SIGNAL HILLS
25. REGAL OAKS
26. SIGNAL HILL
27. HERITAGE OAKS
28. BIG COUNTRY
29. FRIENDSHIP RANCH
30. CIRCLE C RANCH
31. SILVER SPUR RANCHETTES
LEGEND
STUDY AREA
HCWSC CORP. BOUNDARY
CITY ETJ
CREEKS
N
(NTS)
STUDY AREA MAP
MEC
MURFEE ENGINEERING COMPANY
1101 SOUTH CAPITAL OF TEXAS HIGHWAY
BUILDING D, SUITE 110
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FIGURE 2

TABLE 1

HILL COUNTRY WATER SUPPLY STUDY AREA SUBDIVISIONS

Identification Number	Subdivision	Single Family Acres	Single Family Lots	Density: Unit/Acre	Density: Person/Acre[1]	Density: Acre/Unit
4	Appaloosa Run	249.9	36	0.14	0.43	6.94
4	Appaloosa Run Sec.1-A	11.5	3	0.26	0.78	3.84
4	Appaloosa Run Resubd. Lots 35 & 36	37.2	4	0.11	0.32	9.30
NA	Appaloosa Run	19.7	2	0.10	0.31	9.85
12	Ashley Oaks	78.3	31	0.40	1.19	2.53
1	Bear Creek Estates	207.0	77	0.37	1.12	2.69
3	Bear Creek Oaks	532.0	92	0.17	0.52	5.78
28	Big Country	278.0	106	0.38	1.14	2.62
21	Centex Larson	11.0	3	0.27	0.82	3.67
30	Circle C West	255.0	740	2.90	8.71	0.34
29	Friendship Ranch	808.0	404	0.50	1.50	2.00
18	Geneva Estates	51.9	43	0.83	2.49	1.21
10	Granada Oaks	68.4	49	0.72	2.15	1.40
27	Heritage Oaks	558.0	233	0.42	1.25	2.39
2	Hills of Texas	52.0	66	1.27	3.81	0.79
20	Larson Estates	61.0	20	0.33	0.98	3.05
15	Ledgeview Addition	10.0	4	0.40	1.20	2.5
14	Levbarg Estates	10.0	3	0.30	0.90	3.33
9	Lewis Mountain	87.0	99	1.14	3.41	0.88
16	MacDonald Estates	4.9	4	0.82	2.45	1.23

TABLE 1
(continued)

Identification Number	Subdivision	Single Family Acres	Single Family Lots	Density		
				Unit/Acre	Person/Acre[1]	Acre/Unit
25	Regal Oaks	428.0	92	0.22	0.65	4.65
6	Ryswyk Estates	40.4	10	0.25	0.74	4.04
19	Scenic Brook Estates Section 1	115.0	91	0.79	2.73	1.26
22	Scenic Brook Estates Section 2	98.0	39	0.40	1.19	2.51
26	Signal Hill	20.0	30	1.50	4.71	0.66
24	Signal Hills	22.0	22	1.0	4.5	1.00
31	Silver Spur	533.0	31	0.06	0.17	17.19
5	Smokey Mountain Oaks	51.8	19	0.37	1.10	2.73
11	Southview Estates	87.3	38	0.44	1.31	2.30
11	Southview Estates Section 2	63.1	29	0.46	1.38	2.18
17	Southwest Hills Addition	18.6	15	0.81	2.42	1.24
8	Sunrise Country	82.9	53	0.64	1.92	1.56
23	Spring Valley	18.0	6	0.33	1.00	3.00
7	Wilkerson Estates	68.4	25	0.37	1.10	2.73
7	Wilkerson Estates Resubdivision of Lot 12	7.5	6	0.81	2.42	1.24
13	Wynnrock Estates	80.0	32	0.40	1.20	2.50

[1]Density: Person/Acre = Unit/Acre x 3 persons/unit

The Hill Country Water Supply Corporation, encompassing almost 7035 acres, consists of several non-contiguous tracts. The HCWSC boundaries can be generally defined as Big Country/Heritage Oaks subdivisions on the west, Nutty Brown Road in Hays County on the south and southwest, FM 1826 along the southeast, Granada Oaks and Southview Estate subdivisions on the east, and Highway 290 on the north and northwest. A cluster of four subdivisions, Scenic Brook Estates, Centex Larson, Larson Estates, and Geneva Estates located on the north side of Highway 290 are also within the corporation's boundaries. The 808-acre Friendship Ranch which is located within HCWSC along its southern boundary has been organized as a Water Control and Improvements District by the Hays County Commissioner's Court. Approximately 4685 acres or 67% of the corporation's area consists of planned subdivisions. These subdivisions comprise a total of 1689 lots. This figure includes 404 units for Friendship Ranch as opposed to the 1000 units cited in earlier reports. The 404 units probably represents a conservative density due to the new ordinances and regulations that govern this area.

2. Existing Population

The current population within the Hill Country Water Supply Study Area was determined by identifying existing structures shown on the 1986 USGS 7 1/2 minute series topographic map for the Signal Hill and Dripping Springs quadrants and applying a density multiplier of 3 persons/unit. A total of 849 structures or an equivalent population of 2547 persons was established for 1990. This should represent a very conservative population estimate for the Study Area since it does not account for any growth in the last three years. The City of Austin Planning and Growth Management Department (PGM) and Austin Plan both recommend a density of 3 persons/unit for this area.

Of the 2547 persons living within the Hill Country Water Supply Study Area, 63% or 1593 persons reside within existing subdivisions. Approximately 46% of the Study Area's population reside within Travis County, while the other 54% live in Hays County. Almost one-third of the existing subdivisions located west of FM 1826 in Travis County have been developed compared to 42% of the lots in the Hays County portion of the Study Area.

Of the 849 structures identified within the Hill Country Water Supply Study Area, approximately 684 structures are located within the Hill Country Water Supply Corporation's boundaries. Applying a density of 3 persons/unit yields an equivalent population of 2052 for the Hill Country Water Supply Corporation. It is estimated that 47% of the Corporation's population, or 960 persons live in Travis County while the remaining 1092 persons reside in Hays County. Approximately 75% of the Corporation's population reside within existing subdivisions.

3. Population Forecasts

Essential to the overall planning effort is the projection of growth within the Hill Country Water Supply Study Area. The projected population growth and land uses will provide the footprint for determining the study area's future water needs. Population projections and land use trends have been analyzed utilizing data provided by the City of Austin Planning and Growth Management Department, Austin Plan, Austin Transportation Study (ATS) High and Low Projections, Texas Department of Water Resources, Hays County Water Development Board, Lower Colorado River Authority and the Texas Water Development Board - High and Low Projections.

City of Austin Planning and Growth Management

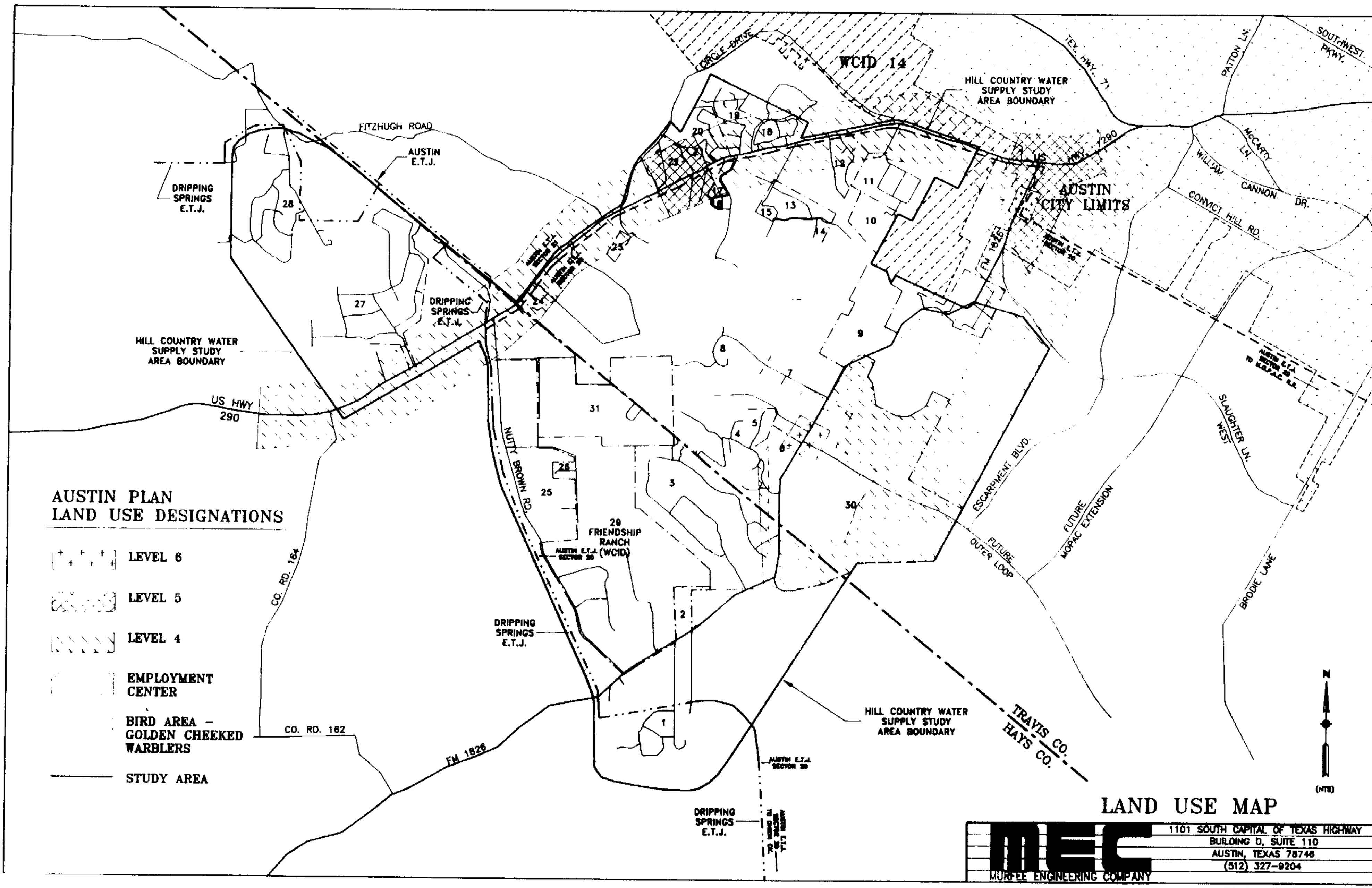
The City of Austin Planning and Growth Management (PGM) Department conducts population forecasts for the Austin Metropolitan Statistical Area (AMSA) which includes all of Travis, Hays and Williamson Counties. Until 1984, the PGM forecasts were based on a standard demographic technique using a cohort component model. In 1984 the PGM forecasts were revised using a Delphi technique. The latest effort, GROWTH WATCH, published in 1987 monitored growth and development in Austin between 1980 and 1987. Historical data generated by this publication indicate the City of Austin, Travis County, and Austin MSA all experienced a significant annual growth rate of more than five percent between 1980 and 1985, much higher than the national average of 1.2% for that same period. This trend of rapid growth in Austin has ended. Since 1986, Austin has experienced a significant downturn in the economy; however, historical data indicates a city-wide average annual growth rate approaching 2% with suburban areas in the southwest growing at a somewhat faster pace. This data compares favorably with the PGM forecasts for 1990 even though the PGM forecasts are actually intended for long-term projections. PGM forecasts an AMSA-wide 3.4% annual growth rate between 1990 and 2000, a 2.9% annual growth for 2000 - 2010 and a 2.7% annual growth for 2010 to 2020.

City of Austin "Austin Plan"

In 1989, the City of Austin's Charter-mandated comprehensive plan known as the Austin Plan was published. The Austin Plan represents the City's policy toward growth and land use through the year 2020. This plan projects a range for average annual growth rates between 1.31% and 2.76% study-wide based on the year 2020 forecast. The Austin Plan is unique from the other population projection studies described in this report which rely on a standard demographic technique for forecasting population growth. The Austin Plan utilizes planning goals, environmental preservation and public facilities and services as tools for projecting population growth. Austin Plan divided its study area into 24 planning sectors and conducted detailed studies of each sector. A large portion of the HCWS Study Area is located within Sector 20; while the area north of Highway 290 is situated within the boundaries of Sector 21. During the early 1980's while the entire City was experiencing a boom, Sector 20 grew three times faster than the Austin MSA. Historical data indicates homes in Sector 20 are larger than average and are typically owner occupied, thus suggesting a stable neighborhood environment. Housing densities within Sector 20 approach 3 persons/unit, approximately 12% higher than the City average. Figure 3 depicts the Land Use Map utilizing data taken from the Austinplan Sector 20 and 21 studies. For purposes of this report, it is assumed the Study Area encompassing portions of Sectors 20 and 21 exhibit similar growth rates.

Austin Transportation Study

The Austin Transportation Study (ATS) published in 1985 by Cambridge Systematics, Inc. and CRS Sirrine, Inc. represents an amalgam of numerous projections that had been previously forecast for the Austin, Travis County, Hays County and Williamson County areas. Density restrictions in environmentally sensitive areas and current land use trends have been taken into consideration. The ATS utilizes a modified Delphi AMSA level forecast to provide small area forecasts for three levels of growth and two scenarios of distribution. This report is concerned with only the low and high levels of growth and a midpoint between the two scenarios of distribution. These two distribution scenarios are (1) the Controlled Growth Option which generally follows the City of Austin preferred growth corridor concept and (2) the Free Market option which allows more development in the environmentally sensitive western region of Austin. The ATS-High forecasts an area wide 3.8% average annual growth rate between 1990 and 2000, then slowly to a 2.2% annual


AUSTIN PLAN
LAND USE DESIGNATIONS
LEVEL 6
LEVEL 5
LEVEL 4
EMPLOYMENT CENTER
BIRD AREA - GOLDEN CHEEKED WARBLERS
STUDY AREA
LAND USE MAP
1101 SOUTH CAPITAL OF TEXAS HIGHWAY
BUILDING D, SUITE 110
AUSTIN, TEXAS 78746
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MEC
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WCID 14
HILL COUNTRY WATER SUPPLY STUDY AREA BOUNDARY
AUSTIN CITY LIMITS
DRIPPING SPRINGS E.T.J.
AUSTIN E.T.J.
FITZHUGH ROAD
CIRCLE DRIVE
TEX. HWY. 71
PATTON LN.
SOUTHWEST PKWY.
McCARTY LN.
WILLIAM CANNON DR.
CONVICT HILL RD.
US HWY 290
FM 1826
NUTTY BROWN RD.
CO. RD. 164
CO. RD. 162
29 FRIENDSHIP RANCH (WCID)
ESCARPMENT BLVD.
FUTURE OUTER LOOP
FUTURE MOPAC EXTENSION
SLAUGHTER LN. WEST
BRODIE LANE
TRAVIS CO.
HAYS CO.
N
(NTS)

FIGURE 3

rate for the following twenty years. The ATS-Low projects a similar trend. Between 1990 and 2000, a 2.7% average annual growth rate is projected. A slower annual growth rate of 2.0% is predicted from the year 2000 to 2020.

Texas Department of Water Resources

The Texas Department of Water Resources (TDWR) forecast is based on the Population Component Model which was the foundation for the original City of Austin Planning and Growth Management (PGM) forecast. The TDWR and PGM forecasts are almost identical through the year 2000 at which point the two deviate and the PGM forecast in 2020 is approximately 11% higher than the TDWR data. Both forecasts assume the high growth rates experienced in the early 1980's have ended and growth will remain at a moderate level in the future. The TDWR forecast for Travis County indicates an average annual growth rate of 3.2% for the next ten years, reducing somewhat and holding steady at 2.3% for each of the following twenty years.

Hays County Water Development Board

Founded in 1986, the Hays County Water Development Board (HCWDB) has developed population projections categorized by river basin and aquifer system. These categories are essential since the County currently takes all its water supply from ground water sources. These projections were formulated as part of the 1989 Hays County Water and Wastewater Study prepared by HDR Engineering, Inc. to develop a regional water supply and wastewater service plan for Hays County. The continued rapid growth in Hays County, the drought conditions being experienced in Hays County over the last several years and the on-going regional planning efforts for the Edwards Aquifer being conducted by the San Antonio - Edwards Underground Water District have contributed to the immediate need to assimilate a water conservation plan and drought contingency plan in order to extend the life of the existing water supplies. Historical data indicates that Hays County has experienced substantial growth over the last thirty years and will most assuredly continue to grow. Since 1960 the County growth rate has exceeded 3% per year. During the 1980's the average annual growth rate exceeded 6%. The 1988 data indicates 11% of the population lives in northeastern Hays County. The Dripping Springs ETJ which includes a portion of the Hill County Water Supply Study Area has experienced significant but steady growth. The HCWDB projection for the Trinity Group Aquifer forecasts a steady growth rate over the next thirty years. From 1990 to 2000 the annual growth rate for the Trinity Group Aquifer area is projected to average 4.15%. For the following twenty year period the annual growth rate levels off somewhat to average 3.26%.

Lower Colorado River Authority

The Lower Colorado River Authority has developed population projections as part of the Turner, Collie and Braden, Inc. 1985 Lake Travis (West) Regional Water and Wastewater System Feasibility Study and the 1988 updated report of that same study. The purpose of that study was to investigate the feasibility of the LCRA developing and implementing a comprehensive water and wastewater regional plan for the Lake Travis (West) Study Area which overlaps a portion of the Hill Country Water Supply Corporation Study Area. The LCRA projections incorporate several different studies. The Travis County portion of the Lake Travis (West) Study Area are based on the Austin Transportation Study (ATS) growth forecasts while the Hays County portion of the Study Area utilize City of Austin PGM projection. Population forecasts were also projected by watershed. The 1988 update adjusted the short-term population projections to reflect the current slower growth rate. The update determined that the long term projections for the year 2010 were still valid. The update reviewed current growth trends showing higher growth rates in the vicinity of the Dripping Springs ETJ and along Highway 290 and FM 1826 than other areas of the County.

Texas Water Development Board

The Texas Water Development Board (TWDB) provided the 1989 preliminary High and Low rural population projections for Travis County and 1986 population projections for Hays County. The Travis County projections represent county-wide estimates and range from a 2.69% (low) to 3.27% (high) annual growth rate between 1990 and 2000, 1.696% (low) to 2.17% (high) annual growth rate between 2000 and 2010 and 1.23% (low) to 2% (high) annual growth rate between 2010 and 2020. Since these forecasts are county-wide averages, they do not necessarily reflect the annual growth rate of the HCWS Study Area. The Hays County forecasts conducted by the TWDB are noticeably higher than the Travis County forecasts. The Hays County projections range from a 3.21% (low) to 4.5% (high) annual growth rate from 1990 to 2000, a 2.58% (low) to 3.65% (high) annual growth rate from 2000 to 2010, and a 2.02% (low) to 2.49% (high) annual growth rate from 2010 to

2020. The TWDB 1986 estimated population has proven to be 3200 to 6800 lower than the actual 1988 population which could explain the overall differences in population projected through the year 2020 presented in Table 2. Table 3 presents population data for Travis County comparing the different studies. The Population Forecast Graph depicted in Figure 4 compares the similarities and differences of the population forecasts for the Austin Metropolitan Statistical Area (AMSA).

TABLE 2
HAYS COUNTY POPULATION PROJECTION COMPARISON

Year	HCWDB[1] Projection	TWDB Projection[2] Low	TWDB Projection[2] High
1988	66,473[3]		
1990	71,364	60,661*	63,244*
2000	100,314	80,771	93,047
2010	129,270	102,160	128,276
2020	162,587	123,215	161,006

[1]Hays County Water Development Board Projections - May, 1989 presented by HDR Engineering, Inc. in the 1989 Hays County Water and Wastewater Study.

[2]Texas Water Development Board Projections - February, 1986.

[3]Actual 1988 population, HCWDB.

*Note TWDB projections for 1990 are lower than the actual population for 1988.

TABLE 3

TRAVIS COUNTY POPULATION PROJECTION COMPARISON

Year	PGM[1]	ATS[2] Low	ATS[2] High	TWDB Projection[3] Low	TWDB Projection[3] High	TDWR[4]
1987	575,813[5]					
1990	591,849	651,200	762,000	589,037	595,896	643,183
2000	787,707	853,300	1,102,600	731,305	775,468	849,001
2010				863,201	953,572	1,044,271
2020	1,265,788	1,264,400	1,706,300	975,160	1,153,427	1,284,453

[1]City of Austin Planning and Growth Management, 1986.

[2]Austin Transportation Study (ATS) 1985.

[3]Texas Water Development Board, 1989 preliminary population projections, November 1989.

[4]TDWR estimates on based annual growth rates projected for the Austin Metropolitan Statistical Area 1982.

[5]Actual 1987 population, City of Austin Growth Watch Annual Edition (1987), 1989.

4. Population Recommendations

The methodology used to forecast the future population for the Hill Country Water Supply Study Area takes into consideration all the data provided by the different studies. However, the Austin Plan-Sector 20, the Lower Colorado River Authority study and the Hays County Water Development Board study play the most significant roles in projecting growth for the Study Area. Each of these studies included at least a portion of the HCWS Study Area thus taking a closer look at growth in suburban and rural areas as opposed to analyzing City-wide, county-wide, or Austin MSA trends. These studies all utilize the numerous demographic studies referenced in this report and several others, such as the Capital Area Planning Council (CAPCO) Growth Trends Report (1987), Bureau of Business Research (BBR) 1987 Report, Texas Update, Inc. 1984 Report, Bureau of Economic Analysis (BEA) - U.S. Department of Commerce (1980), Texas A&M University Department of Rural Sociology and Edwards Aquifer Research and Data Center (EARDC) for forecasting growth.

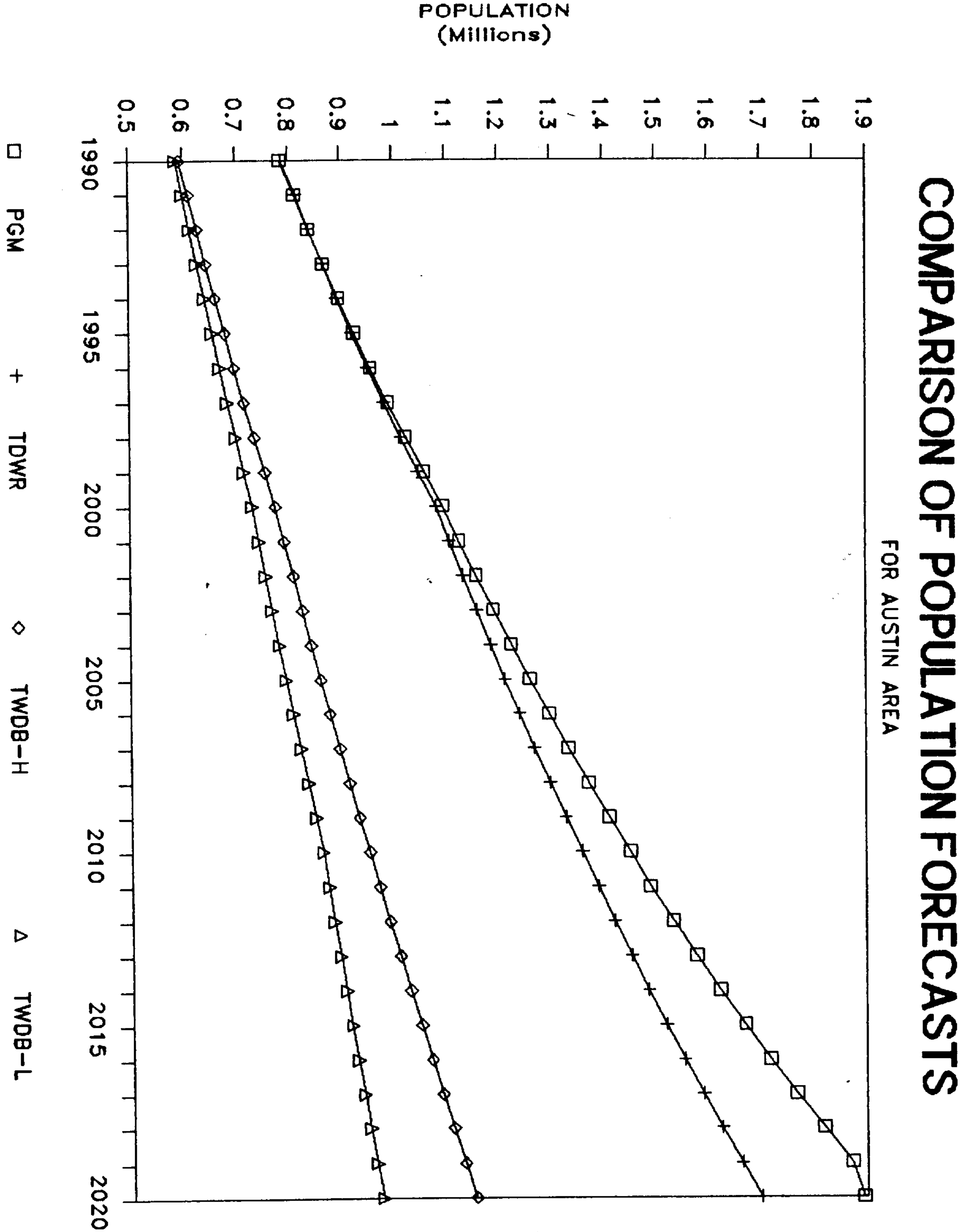


FIGURE 4
Population Forecast Graph - AMSA

These studies or their updates are all very recent, having been conducted within the last two years. Their population projections have accounted for both the dramatic growth of the early 1980's and the waning economy of the last three years. Between 1980 and 1985 Sector 20 experienced dramatic growth, 17% per year, almost doubling in that five year period. These studies indicate the general Study Area including northern Hays County, Highway 290 and FM 1826 has continued to grow, but at a much slower nonetheless healthy pace. These studies all conclude that the Texas Water Development Board data being based on average county-wide projections are low for this specific area. As pointed out earlier, the HCWDB data suggested that the TWDB discrepancies were compounded by using estimates which were considerably lower than the actual population to project growth over a thirty year period. The Austin Transportation Study - Median Range forecasts a population and employment base of 86,522 for Sector 20 by the year 2020. Austin Plan projects a residential population range of 27,000 to 38,000 for Sector 20 in addition to an employment base of 12,000 for the year 2020. This translates into a city-wide growth rate between 0.9% and 3.4% per year utilizing the year 2020 forecast and compares favorably with current trends.

Each of these studies takes into consideration certain factors which affect growth and are unique to this area. These factors include (1) the desirability of living in the scenic Hill Country, (2) the environmentally sensitive nature of the Hill Country and the importance of protecting its pristine beauty, (3) the limited ground water capacity; and (4) the developmental regulations designed to protect this area.

Another factor to be considered is current development trends. Residential development in southwest Austin has been the dominant growth area in the City since 1987. Subdivisions like Circle C and Legend Oaks have consistently led the residential building market. Since November 1987, Circle C has sold 430 lots representing an average monthly growth rate of 3.6% over the last 28 months. Legend Oaks, Phase A, Sections 2, 3A and 3B, a 219 lot subdivision, has sold-out over a similar period. It is reasonable to assume growth will continue at a healthy pace. The vegetation and terrain, ongoing improvements to the roadway network, such as the South MoPac Extension, relative proximity to downtown, availability of recreational facilities and parks all contribute to the desirability to settle in this sector of Austin.

Table 4 presents a comparison of the population projections which were utilized in developing the Hill Country Water Supply Study Area population forecasts for the low density area. The population projections presented in Table 4 have intentionally excluded the proposed Lewis Mountain, Circle C West, and McKnownville subdivisions and the Del Curto and Hielscher tracts. Lewis Mountain, Circle C West, Del Curto and Hielscher tracts were excluded since their proposed residential densities are considerably higher than the rest of the Study Area. The proposed Circle C West subdivision consists of single-family lots planned at 3 units/acre and village cluster planned at a maximum of 10 units/acre. The Del Curto and Hielscher tract densities have been estimated at 12.5 person/acre in the 1985 Preliminary Engineering Report for Southwest 'B' System Improvements prepared for the City of Austin. Lewis Mountain, as planned, contains 99 single-family lots and a large multi-family tract. Lewis Mountain also has an approved City of Austin water approach main and is already tied into the City's water system. Approximately half of the McKnownville subdivision is situated within the Study Area; however, all of that area is below the 900 msl, thus below the City's Southwest 'B' water service area.

These higher density subdivisions which skew the proposed population projection comparisons presented in Table 4 are listed in Table 5. Each of the three studies referenced in Table 4 developed their population projections for a lower density. For example, the LCRA projections developed for the Lake Travis (West) Study encompasses an area of 448 square miles including portions of Burnet, Hays, Blanco, and Travis counties. A large portion of this study contains rural development and lower density residential development. The HCWDB projections developed by HDR Engineering, Inc. for Hays County also include a substantial amount of rural and lower density residential development. The population projections developed for the Trinity Group Aquifer area of the HCWDB study were utilized in Table 4 and are representative of lower density residential development. The growth projections developed utilizing the Sector 20 data incorporate the interpolated low range forecast proposed in the Austin Plan and Sector 20 Study.

As previously explained, the comparison of population projections presented in Table 4 does not include the entire Study Area. Table 4 was developed to illustrate the methodology used in determining the recommended population forecasts for the more rural section (developing at less than or equal to 1 unit/acre) of the Study Area. As stated earlier, the area east of FM 1826 will be developed at more than 3 units/acre.

TABLE 4

COMPARISON OF POPULATION PROJECTIONS FOR RURAL PORTION OF HCWS STUDY AREA[1]

Year	Unit (Pop) Recommended Projections	Sector 20 Austin Plan[2]	(Hays County Area Only) HCWDB[3]	LCRA[4]
1990				
w/in	531 (1593)		318 (954)	
o/s	318 (954)		140 (420)	
Total	849 (2547)	849 (2547)	458 (1374)	849 (2547)
1995				
w/in	703 (2109)			
o/s	358 (1074)			
Total	1061 (3183)	1380 (4140)	553 (1659)	1039 (3117)
2000				
w/in	1104 (3312)			
o/s	457 (1370)			
Total	1561 (4683)	1911 (5733)	648 (1944)	1489 (4467)
2005				
w/in	1318 (3954)			
o/s	762 (2286)			
Total	2080 (6240)	2442 (7326)	754 (2262)	1940 (5820)
2010				
w/in	1468 (4404)			
o/s	1066 (3198)			
Total	2534 (7602)	2973 (8919)	861 (2583)	2389 (7167)
2015				
w/in	1587 (4761)			
o/s	1295 (3885)			
Total	2882 (8646)	3504 (10,512)	1000 (3000)	2840 (8520)

TABLE 4
(continued)

Year	Unit (Pop) Recommended Projections	Sector 20 Austin Plan[2]	(Hays County Area Only) HCWDB[3]	LCRA[4]
2020				
w/in	1722 (5166)			
o/s	1523 (4569)			
Total	3245 (9735)	4036 (12,108)	1140 (3420)	3290 (9870)

w/in = within existing subdivisions
o/s = outside existing subdivisions

[1]excludes Lewis Mountain, Circle C West, Del Curto, Hielscher, and McKnownville Subdivisions.

[2]Projections interpolated from data presented in Austin Plan - Sector 20, 1989.

[3]Projections interpolated from data presented in the HDR Engineering, Inc. Hays County Water and Wastewater Study conducted for the HCWDB, 1989. (Data obtained for Trinity Group Aquifer area utilized.)

[4]Projections interpolated from data presented in the Turner, Collie and Braden, Inc. Lake Travis (West) Regional Water/Wastewater Feasibility Study (1985) and Update (1987/88). (Study Area growth rates for Travis County and Hays County have been utilized.)

Table 5 lists the recommended residential population forecasts broken out to show population projections for the entire Hill Country Water Supply Study Area and the Southwest 'B' water service area south of Highway 290 West. Population projections for the Hill Country Water Supply Study Area have been divided into two groups: (1) That area exhibiting more rural type development with densities equal to or less than 1 unit/acre, and (2) that area exhibiting suburban subdivision development with densities equal to or greater than 3 units/acre. The area south of Highway 290 West outside of the HCWS Study Area, but within the City of Austin designated Southwest 'B' water service area (Shadowridge Crossing, Upper Williamson Creek, Spillar Ranch 1090-acre tract, and Yates 169-acre tract), also has been included in the population projections. All three (3) population categories impact the City of Austin Southwest 'B' water system. As planned, these three (3) population groups will receive water via the existing Southwest 'B' water storage facility located along FM 1826 at the intersection of La Crosse Avenue. The population projections and densities for Circle C MUD #4, Del Curto, Hielscher, Shadowridge Crossing and the Upper Williamson Creek area have been taken from the 1985 Preliminary Engineering Report Southwest 'B' System Improvements. The population forecasts for Circle C West and for Circle C MUD #3 have been revised from the 1985 report to reflect their current land plans. Approach main requests for residential development have been approved for the Spillar Ranch 1090-acre tract and Yates 169-acre tract.

TABLE 5

RECOMMENDATIONS FOR RESIDENTIAL POPULATION GROWTH[1]

Year	HCWS Study Area Density < 1 Unit/Ac.		HCWS Study Area Density > 3 Unit/Ac.2		Total HCWS Study Area		SW 'B' Service Area (S. of Hwy. 290W) Outside HCWS Study Area3		Total Population	
1990	849	(2547)	461	(1294)	1310	(3841)	48	(168)	1358	(4009)
2000	1561	(4683)	2153	(6389)	3714	(11,072)	457	(1600)	4171	(12,672)
2010	2534	(7602)	3504	(10,220)	6038	(17,822)	1208	(4230)	7246	(22,052)
2020	3245	(9735)	4506	(13,518)	7751	(23,253)	1208	(4230)	9324	(27,483)

[1]Residential Units (Population).

[2]Category includes McKnownville, Lewis Mountain, Circle C West, Del Curto and Hielscher tracts.

[3]Category includes Shadowridge Crossing, Upper Williamson Creek, Circle C MUDs #3 and #4, Spillar Ranch-1090 acres, and Yates 169-acre tract.

B. Water Demand Projections

Water demand projections have been developed for the Hill Country Water Supply Study Area. The water demand in terms of quantity and distribution depends on the projected population, land use and water-use characteristics. Determination of a per capita water demand in gallons per capita per day (gpcd) is fundamental for projecting the future water needs. Incorporating per capita water demands with projected population and land use data produces the total future water demands for the Hill Country Water Supply Study Area.

The projected population distribution will determine where the water demand centers are located.

1. Existing Demands

Statistical data indicates rural areas typically use less water than their urban counterparts. However, even rural areas vary in water usage. Water demand records published for Hays County which receives all of its water supply from groundwater indicate demand ranges from a low of 90 gpcd to 220 gpcd. Dripping Springs ETJ consumes an average of 150 gpcd. The Lower Colorado River Authority study which included both rural and urban areas concluded that the neighborhoods with the more expensive homes consumed the most water. The LCRA Study Area which included Lost Creek MUD, Davenport Ranch and much of the Lake Travis area exhibited an average daily per capita water demand between 160 and 190 gpcd.

At the request of the Texas Water Commissioners, the Texas Water Development Board and Texas Water Commission are conducting a study of the Trinity Group Aquifer. The draft study indicates that although there is adequate ground water in the area, its availability is unreliable, quality is very poor, and the ground water is not able to meet the increased residential demand. The study's advisory committee has recommended an underground conservation district which would regulate well usage and well spacing and impose possible water use restrictions.

As a result of many individual water wells within the Study Area drying up and the publicity of a regional water shortage, people are becoming very aware of the seriousness of the problem and how it may impact their lives. Many residents within the Study Area have taken extreme measures to conserve what water they have. Many have abandoned landscape watering. Some collect rain water in cisterns for household use and irrigation.

2. Demand Forecasts

The peak water demand projections presented in Table 6 include not only the Hill Country Water Supply Study Area but also the area south of Highway 290W within the City of Austin Southwest 'B' water service area since all will feed off the existing City of Austin 2 MG Southwest 'B' elevated storage tank. The residential areas outside of the Study Area include Upper Williamson Creek (ultimate population - 1250), Shadowridge Crossing (ultimate population - 2980), Spillar Ranch and Yates 169-acre tract. There are also retail/office/commercial tracts associated with Shadowridge Crossing and Upper Williamson Creek totaling approximately 318 acres. The proposed population, density, and peak demands for Upper Williamson Creek, Shadowridge Crossing, Circle C MUD #4, Del Curto and Hielscher tracts were taken from the 1985 Preliminary Engineering Report Southwest 'B' System Improvements prepared for and adopted by the City of Austin. Projections for Circle C MUD #3 and Circle C West have been updated since the 1985 Report and are reflected in Table 6.

City of Austin water and wastewater approach mains have been granted for the 1090-acre Spillar Ranch and 169-acre Yates Tract. Table 6 reflects the most recent information. Peak water demands for the general area east of FM 1826, where residential densities equal or exceed 3 units/acre, meet the City of Austin criteria of 2.2 gpm/connection. The portion of the HCWS Study Area consisting of densities approaching 1 unit/acre incorporates the Texas Health Department criteria of 1.5 gpm/connection.

TABLE 6

PEAK WATER DEMAND PROJECTIONS

Year	Within HCWS Study Area < 1 unit/ac.	Within HCWS Study Area > 3 units/ac.	SW "B" Svc. Area Outside HCWS Study Area (S. of Hwy. 290)	Total Demand Projections
1990	1274	1004	106	2384
2000	2956	4885	1058	8899
2010	4407	7542	2518	14,467
2020	5474	9843	352	18,843

Demand Usage

A majority of the water demand in the Study Area currently is and will remain for residential purposes. Commercial demand has been limited to the Highway 290 and

Farm-to-Market Road FM 1826 area. Growth projections have taken into consideration the recommended Austin Plan - Sector 20 and 21 population and land use trends which consider factors such as; (1) the existing and proposed roadway systems, (2) environmental constraints including federally protected species habitats, (3) location of existing subdivisions and developments and (4) current development trends. Agricultural use has not been considered in the demand projections. It is assumed that any agricultural water demands within the Study Area will be met by available ground water. As the Study Area develops, the agricultural land use will be displaced by low density residential subdivisions. As a surface water supply becomes available and residential customers connect to a centralized water supply system, the availability of ground water for agricultural purposes should stabilize.

Discussions with the City of Austin Water and Wastewater Department have resulted in the recommendation that the Hill Country Water Supply Study Area implement the City of Austin Water Conservation Plan. As it is, the residents within the Study Area have already been forced to practice water conservation measures due to the limited quantities and poor quality of their ground water supply. It is reasonable to assume that once a reliable and good quality surface water supply is available, the residents within the Study Area will increase their water usage to suit their needs. As a result, it is anticipated the water demands for the Study Area will approach a typical 150 to 180 gpcd water demand; therefore, this system will utilize water demand projections based on the Texas Department of Health "Rules and Regulations for Public Water Systems" for the purpose of developing demand nodes necessary for sizing the proposed system.

C. Existing Water Facilities

1. Existing Surface Water Facilities

The Hill Country Water Supply Corporation Study Area is located within the established Southwest 'A' and Southwest 'B' pressure planes of the City of Austin water system. The Southwest 'A' pressure plane utilizes an overflow elevation of 1015 mean sea level (msl) serving a range of ground elevations between 750 msl and 900 msl. The Southwest 'B' pressure zone serves a range of ground elevations between 900 msl and 1030 msl from an overflow elevation of 1140 msl. City of Austin water serving these pressure planes is supplied from the Ullrich Water Treatment Plant through a series of booster pump stations and reservoirs. The existing water systems are illustrated in Figure 5.

Existing Southwest 'A' and Southwest 'B' City of Austin facilities in the immediate vicinity of the Study Area include the Davis Lane 48" Southwest 'A' transmission main feeding the 6 million gallon Southwest 'A' ground storage reservoir located along Slaughter Lane near FM 1826, the Southwest 'B' 15,000 gallon per minute (gpm) booster pump station located adjacent to the Southwest 'A' reservoir and the 2 mg Southwest 'B' elevated storage tank located further south along FM 1826 at the proposed La Crosse Avenue intersection. The Southwest 'B' pump station and tank are connected by a 36" transmission main which extends along FM 1826. Construction will begin shortly on the 36" transmission main which will tie the Southwest 'B' facilities described above to the Southwest 'B' system located on the north side of Highway 290. These improvements will bring the area north of Highway 290 up to the established Southwest 'B' 1140 msl pressure plane.

The existing Southwest 'B' facilities north of Highway 290 consist of a water system belonging to WCID #14 and the City of Austin. WCID #14 which occupies approximately 6200 acres and serves 900 customers buys water from the City of Austin via two master meters. The system has limited pumping capacity. Storage consists of three ground storage tanks having a capacity of over 800,000 gallons and one 75,000 gallon elevated storage tank. The City of Austin system includes the 1 MG Southwest 'B' (1068 msl overflow) Old Bee Cave Road reservoir, the 1600 gpm Eberhart Southwest 'B' booster pump station and a transmission main network of 14" and 16" diameter pipe.

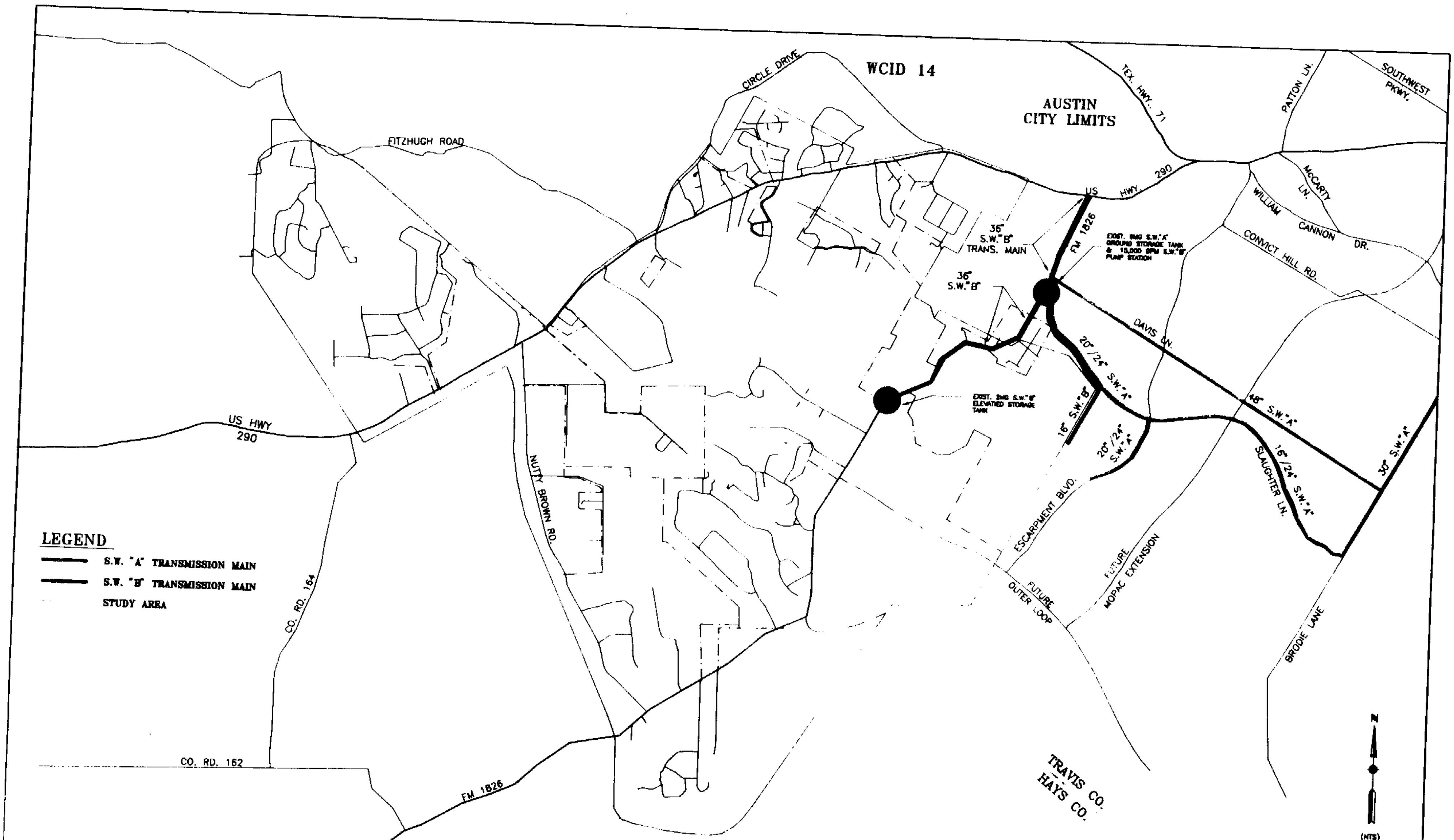
Planned Southwest 'B' improvements for the area south of Highway 290 include an additional 2 MG elevated storage tank to be constructed at the existing FM 1826 storage facility and completion of the 16"-36" Southwest 'B' Loop through Circle C West and Circle C. North of Highway 290 W, a 2 mg (effective storage) Southwest 'B' elevated storage tank to be located on Circle Drive and an extensive transmission network will result in an efficient looped Southwest 'B' water system for that area.

A standard overflow elevation for a Southwest 'C' pressure plane has never been adopted by the City of Austin. However, the City has acknowledged the need for a Southwest 'C' system if City service were to be expanded west of FM 1826. Travis County WCID #14 utilizes an overflow elevation of 1220 msl; however, this overflow elevation accommodates the District's designated service area only and may not be the best elevation for the Southwest 'C' water service area.

2. Existing Ground Water Supplies

The Trinity Group Aquifer is the sole supplier of ground water for the Hill Country Water Supply Study Area. The aquifer is illustrated in Figure 6 by the Hydro/Geological Map. The aquifer produces water of extremely variable quality and from relatively low yielding wells. The water is typically very hard, high in sulfates and minerals. The ground water generated within the Dripping Springs area and to the north and east of that community is a very poor quality and produces extremely low yields. Total Dissolved Solids (TDS) levels in this area range upward to 3000 milligrams/liters (mg/l), equivalent to 6 times the maximum desirable level of 500 mg/l imposed by the Texas Department of Health. The majority of the Study Area is on individual well systems. A large majority of these wells generate poor quality water similar to that described above. Many of these wells have recently dried up due to the persistent drought-like conditions and increased use of ground water for rural residential growth.

The Trinity Group Aquifer which lies close to the surface is highly susceptible to temperature. Permeability is low and recharge occurs primarily from rainfall on outcrop, vertical leakage and seepage from lakes and streams. Ground water in the aquifer moves slowly downdip to the south and east-southeast. The Balcones Fault Zone just east of the Hill Country Water Supply Study Area greatly restricts water movement. As a result, the declining ground water level, low permeability, restricted water circulation and increase in temperature have all contributed to the ground water becoming more highly mineralized, thus requiring the added expense of demineralization.



EXISTING WATER SYSTEM

MEC
MURFEE ENGINEERING COMPANY
1101 SOUTH CAPITAL OF TEXAS HIGHWAY
BUILDING D, SUITE 110
AUSTIN, TEXAS 78748
(512) 327-9204

FIGURE 5

As stated previously, most of the Hill Country Water Supply (HCWS) Study Area is on individual well systems; however, there are several community well systems in the area. These systems are described as follows:

Regal Oaks Water Supply Company, Inc.

This facility consists of one 20 gpm well and a 27,000 gallon water storage tank. This system serves approximately 20 connections (estimated 45 persons).

Signal Hills No. 24 Cooperative

This system contains a 35 gpm well producing from the Glen Rose formation of the Trinity Group Aquifer and a 22,000 gallon storage tank. There are approximately 15 connections serving 45 persons. This system does not meet Texas Department of Health standards for sulfates and fluorides.

Signal Hills No. 30 Cooperative

This facility serves 7 connections (population 21) with one 35 gpm well and a 24,000 gallon ground storage tank. This system also experiences extremely high concentrations of sulfates.

Potential Effects of Ground Water by Proposed Aquifer District

The current draft of the Ground Water Protection and Management Strategies for the Hill Country Area - A Critical Area Ground Water Study being conducted by the Texas Water Development Board (TWDB) and the Texas Water Commission (TWC) proposes an underground water conservation district for all of Bandera, Blanco, Gillespie, Kendall and Kerr counties and for portions of Comal, Hays, Medina and Travis Counties. Once created by the Texas Water Commission, the District would have the authority to regulate spacing of water wells and septic systems. The Hill Country Water Supply Study Area lies within the proposed boundary of this district and would be subjected to these regulations. The Hill Country Critical Area boundaries are shown in Figure 7.

HILL COUNTRY CRITICAL AREA MAP

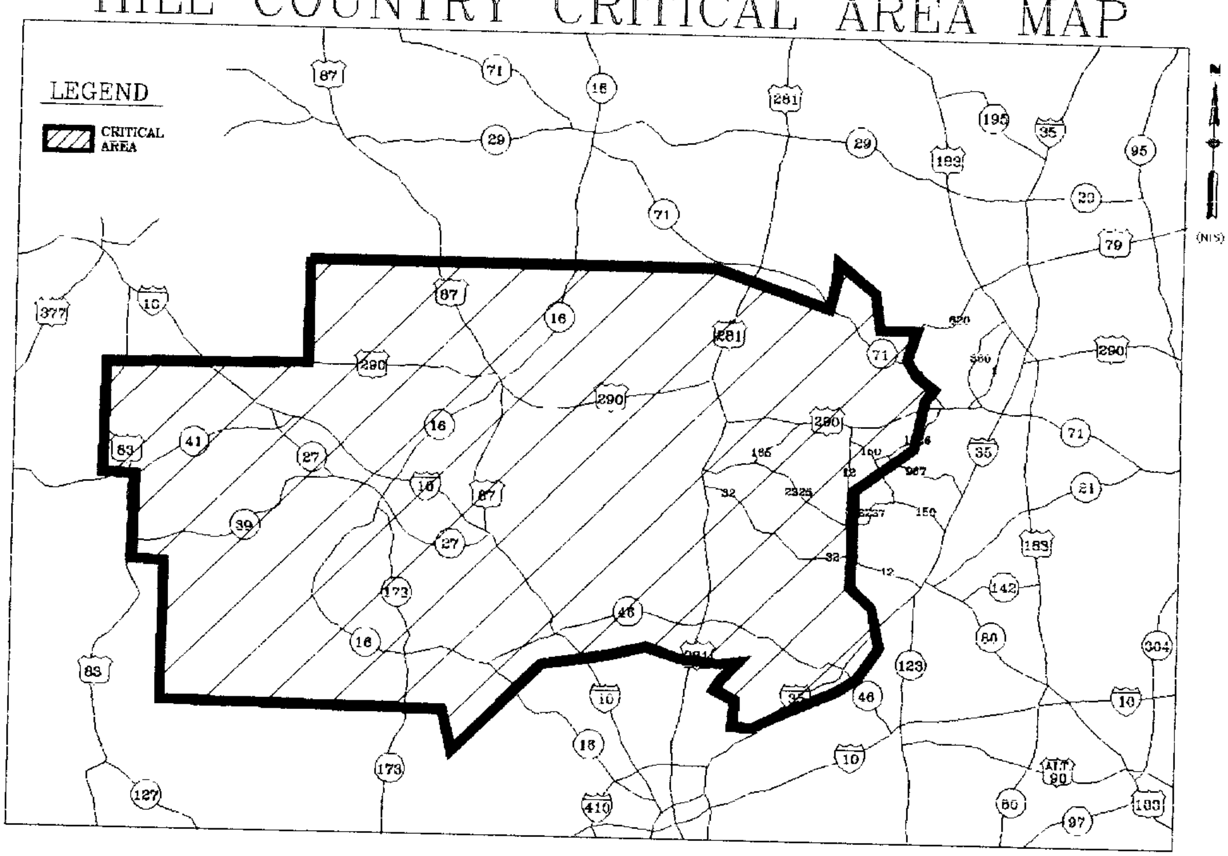


FIGURE 7

3. Comparison of Individual Water Well System and Centralized Surface Water System Costs

Good quality ground water as a potable water supply has historically been a less expensive water source than surface water systems. Ground water systems do not incur the costs associated with raw water storage, water treatment and conveying water from storage reservoirs to the water demand centers. However, limited quantity and poor quality increase operating costs significantly.

The costs for a ground water well system typically include the initial costs associated with well drilling, casing, pump, wiring, pressure tank, ancillary plumbing and other related facilities which may include water softening and special water treatment. Related facilities may even include purchasing bottled water for cooking and drinking if the taste and odor of the well water is objectionable due to saline conditions resulting from water softening (ion exchange process). The expense of purchasing bottled water may average between $16 and $32 each month. For purposes of estimating monthly expenses the lower figure has been used. The typical cost associated with drilling a 700' deep well is $7000. This cost includes drilling a well and installing pump, controls, pressure tank, and ancillary plumbing.

Water softening is necessary due to the high mineral levels. The water softening process contains an ion exchange unit, brine tank and ancillary plumbing. A water softener typically costs between $250 and $500. The monthly costs for salt ranges from $10 to $25.

Periodic pump and pressure tank maintenance is necessary to prevent corrosion caused by minerals and freeze damage. Average monthly cost for this maintenance and other well related components is estimated to run about $15 when considering replacement of parts over a 5 year period.

For systems requiring water treatment, this may range from a simple activated carbon filter to sophisticated reverse osmosis units. The up front cost as well as the operation and maintenance cost for these systems vary significantly. This report will assume the less expensive method of filtering is adequate and monthly operation and maintenance costs are equivalent to the bottled water cost even though some systems can cost up to $100/month to maintain.

Electrical service for the HCWS Study Area is provided by the Pedernales Electric Co-op. The current rate for electrical services is $6.00/kilowatt hour (KWH) for the first 25 KWH, $6.38/KWH for the next 975 KWH and $5.874/KWH over 1000 KWH. Water well consumption of electricity depends on two factors: (1) pump horsepower (HP) based on delivery volume and well depth and (2) pumping frequency or amount of water being consumed. For the purpose of this report, it is assumed a 2 HP pump is needed for a depth of up to 800 feet to generate a 10-15 gpm flow rate. Estimated average daily water demand is 180 gallons per day (gpd) for a three person household. Based on these assumptions, the monthly power requirement is 18.65 kilowatts for a pump operating 9 hours/month. The average monthly power requirement of 167.85 KWH would cost approximately $15/month.

Listed below is a breakdown of total monthly expenses to operate and maintain an individual water well system. The well and appurtenances have been amortized over a five year period since most well pumps carry a five year warranty.

Well (Complete System @ 10%)	$149.00
System Maintenance	15.00
Electrical Cost	15.00
Subtotal	$179.00
Water Softener/Salt	22.00
Bottled Water or Special Treatment	16.00
Subtotal	$38.00
TOTAL ESTIMATED MONTHLY COST	$217.00

The cost for water service through the City of Austin includes other fees in addition to the costs associated with construction and operation and maintenance. These fees are described as follows. The City charges a Capital Recovery Fee (CRF) to be paid at the time of construction of each service. This fee is used by the City to fund water capital improvement projects. The CRF is based on the size of the house or square footage (S.F.). Assuming the typical house in the Study Area ranges from 1601 SF to 1700 SF, the Capital Recovery Fee for a water connection is currently approximately $1200. As the wholesale water supplier, the City of Austin will sell water to the Hill Country Water Supply Corporation. In accordance with the negotiated contract between the City and the Corporation, the wholesale water fee will be charged at the same rate as an inside - city residential customer. This rate may change depending on future contract negotiations. An average daily per capita water demand of 150 gpcpd is projected. Based on these conditions, the estimated wholesale water fee per connection is approximately $33.00/month. (Depending on financing arrangements, additional monthly costs may be incurred as surcharges for retirement of debt. (Refer to Table 12.)

Other incidental fees to be incurred by the homeowner connecting to the surface water system include inspection fees for installation of meter and/or pressure reducing valve (PRV), and installation of the water service line between the meter and the house. These fees will be established by the Study Area's operator. If homeowners abandon their existing water wells, then additional costs will be incurred to cap their wells.

Figure 8 illustrates the plumbing modifications required to convert the existing well systems to a centralized water distribution systems. If it is desired to maintain the existing connection to the well for landscape watering purposes, then separate plumbing connections are required in accordance with the Uniform Plumbing Code.

D. Water Conservation Plan

The City of Austin water conservation measures described in the September, 1985 "Austin Water Management Plan" estimate a net reduction in water use of 6.9%. The net savings is equivalent to approximately one year of growth or water demand within the City service area. The savings to the Hill Country Water Supply Study Area customers could be two fold. First, if the proposed water system is phased, savings in initial pumping and storage costs could be realized. Secondly, if the City cost participated with the HCWS Study Area customers for the water saving fixtures and devices as it does with it's customers within the City limits, then the HCWS customers would benefit in reduced monthly water usage.

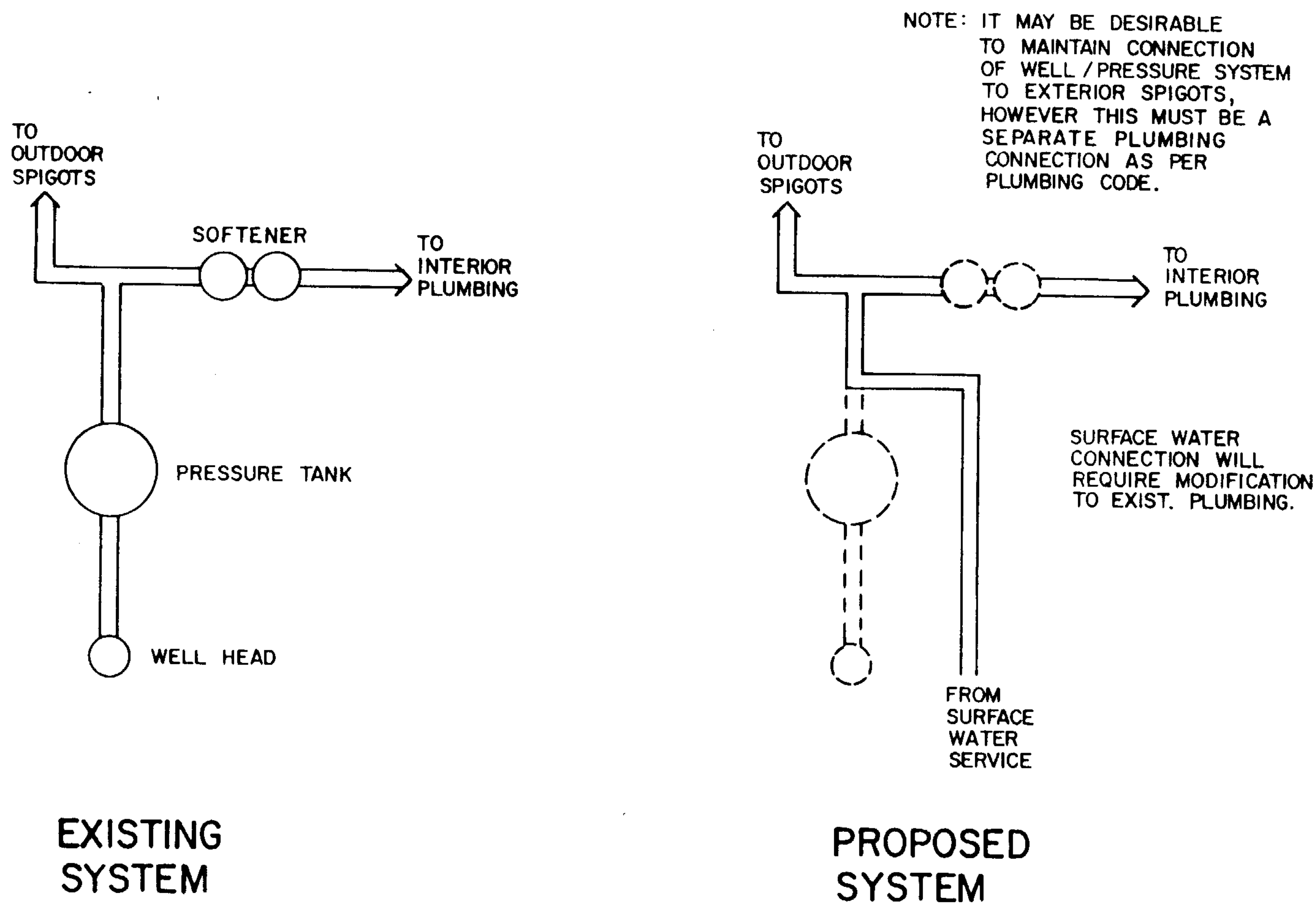


FIGURE 8
PLUMBING MODIFICATIONS

E. Regional Water Service Alternatives

1. General Discussion

Paramount in formulating a regional water system is the availability and limitations of the water supply sources. Both ground water and surface water are available within the Study Area. However, as noted earlier in this report, the quantity and quality of the Trinity Group aquifer ground water is dubious especially when planning for the future. As a result ground water has been ruled out as a viable alternative. The primary focus in the planning of this regional water system study is to develop alternatives to provide surface water supply and distribution facilities capable of meeting the immediate and long term demands of the Study Area.

2. Criteria and Plan Options

Three (3) different water service alternatives (Scenarios #1, #2, and #3) were explored for the Hill Country Water Supply Corporation Study Area. Each scenario assumes the City of Austin as the water supplier will have adequate storage for the life of the improvements. Each scenario has been developed utilizing the University of Kentucky Water Model. Static water models utilized to size the transmission mains for each scenario have been included in Appendix A of this report. Each scenario incorporates the design criteria of the Texas Department of Health (TDH) "minimum requirements" for surface water systems, where applicable. The area utilizing Texas Department of Health criteria includes most of the land west of FM 1826 and all land within the Study Area not included in the City of Austin water service area. Utilizing the TDH "minimum requirements" helps minimize the initial water system capital costs. The TDH minimum criteria provides a reliable and long-term solution for the Study Area water demands.

The applicable TDH "minimum requirements" criteria for surface water systems are described as follows:

Transmission/Distribution Mains

All lines will be sized for a peak demand of 1.5 gpm/connection. All lines will be designed to provide a minimum residual pressure of 20 psi under peak design conditions and 35 psi under normal operating conditions.

Total Storage Capacity

Storage capacity totalling 200 gallons per connection with a maximum of 5.0 MG is required. This does not include pressure tank applications, if any.

Pressure Maintenance Facilities

Elevated storage based on 100 gallons per connection, with a maximum of 5.0 MG required or pressure tank capacity of 2500 gallons for each 125 connections or fraction of 125 connections will be utilized to maintain water pressure. Elevated storage in the amount of 200 gallons per connection may be substituted for ground storage and pressure tank installations.

Pressure Tank

Pressure tank installations are not recommended for systems having more than 1000 connections. Elevated storage in the amount of 100 gallons per connection is required for systems with more than 2500 connections or for systems where a minimum residual pressure of 20 psi under peak design conditions or 35 psi under normal operating conditions cannot be maintained.

Service Pumps

Service pumps shall consist of two or more pumps with a total rated capacity of 2.0 gallons per minute per connection or total capacity of 1000 gpm and able to meet peak demand, whichever is less.

The area east of FM 1826 located within the boundaries of the HCWS Study Area which is already part of the City of Austin water service area generally incorporates City of Austin criteria. The one exception is that none of the scenarios are designed to meet City of Austin fire flow requirements. The City of Austin design criteria is described as follows:

Transmission/Distribution Lines

All lines are sized for a peak hour demand of 2.2 gpm/connection. Minimum pressure at any point within system must not be less than 35 psi during peak hour demand.

Storage

Equalization* Storage	= 100 gal/capita
Emergency Storage	= 100 gal/capita
TOTAL STORAGE	= 200 gal/capita

*Equalization storage must be effective. Effective is defined as "providing a minimum of 35 psi (80 feet) of pressure at the highest elevation in the pressure zone."

Service Pumps

Pumps are designed to meet peak day demand of 1.3 gpm/connection.

Description of Plan Options

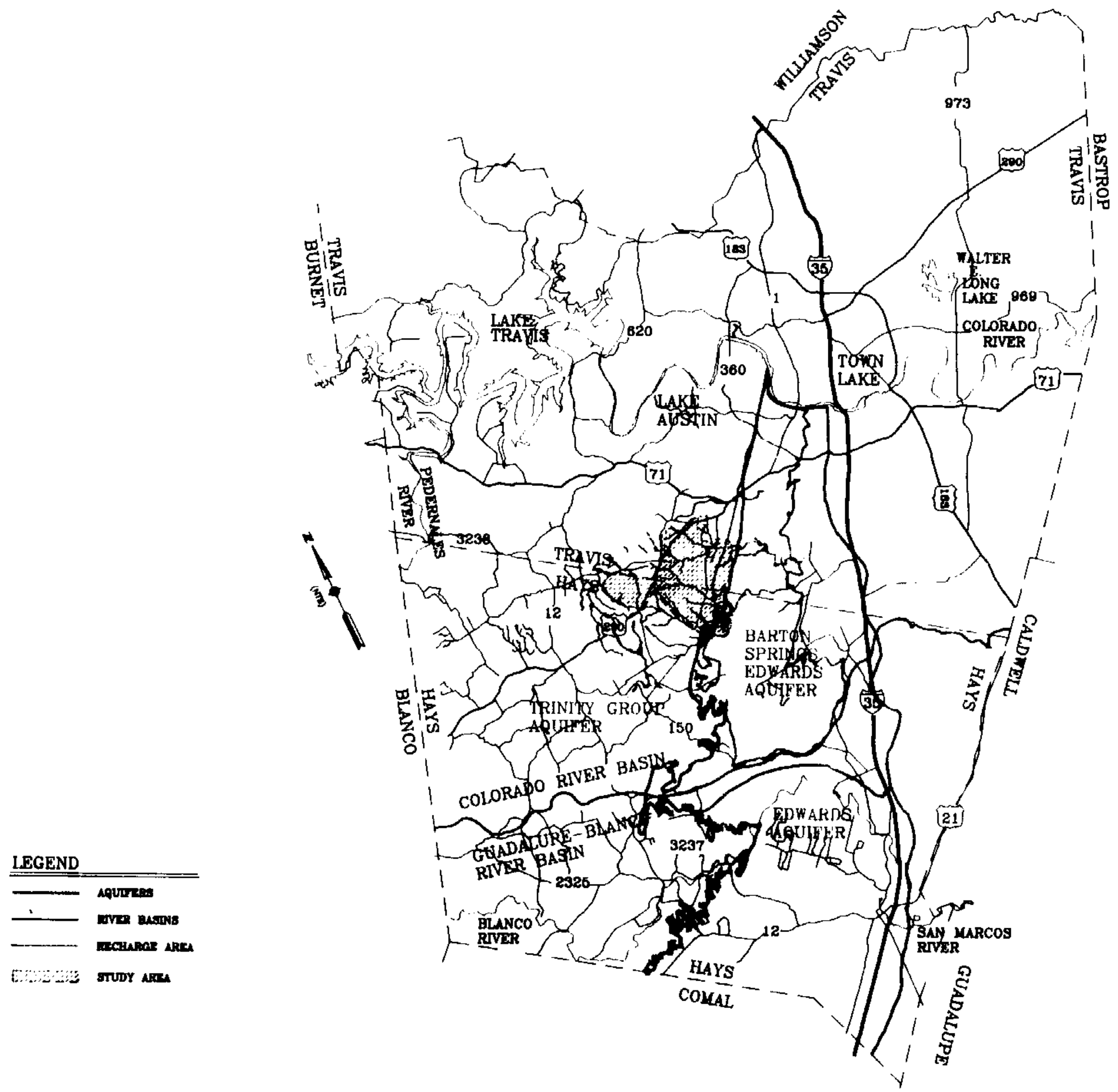
The three (3) different water service scenarios are outlined briefly as follows:

Scenario #1: System designed for ultimate build-out; 500 gpm fire flow provided throughout system. (Figure 9)

Scenario #2: System designed for Year 2000 population; 500 gpm fire flow provided throughout system. (Figure 10)

Scenario #3: System designed for Year 2000 population; 500 gpm fire flow provided wherever lines 6" and larger are proposed. (Figure 11)

Scenario #1 depicted in Figure 9 represents the ultimate water system required to serve the Study Area if it were completely developed. Where applicable, this scenario utilizes either Texas Health Department or City of Austin criteria for sizing mains with the exception of meeting City of Austin fire flow requirements. This scenario is not designed to meet the City of Austin fire flow requirements. A minimum fire flow of 500 gpm has been provided throughout the system. Along the major transmission mains much higher fire flows can be sustained. This scenario assumes all existing subdivisions have been built-out and all the area outside of the existing subdivisions has been developed at an average density of one unit per five acres.



HYDRO/GEOLOGICAL MAP

MEC
MURFEE ENGINEERING COMPANY
1101 SOUTH CAPITAL OF TEXAS HIGHWAY
BUILDING D, SUITE 110
AUSTIN, TEXAS 78746
(512) 327-9204

FIGURE 6

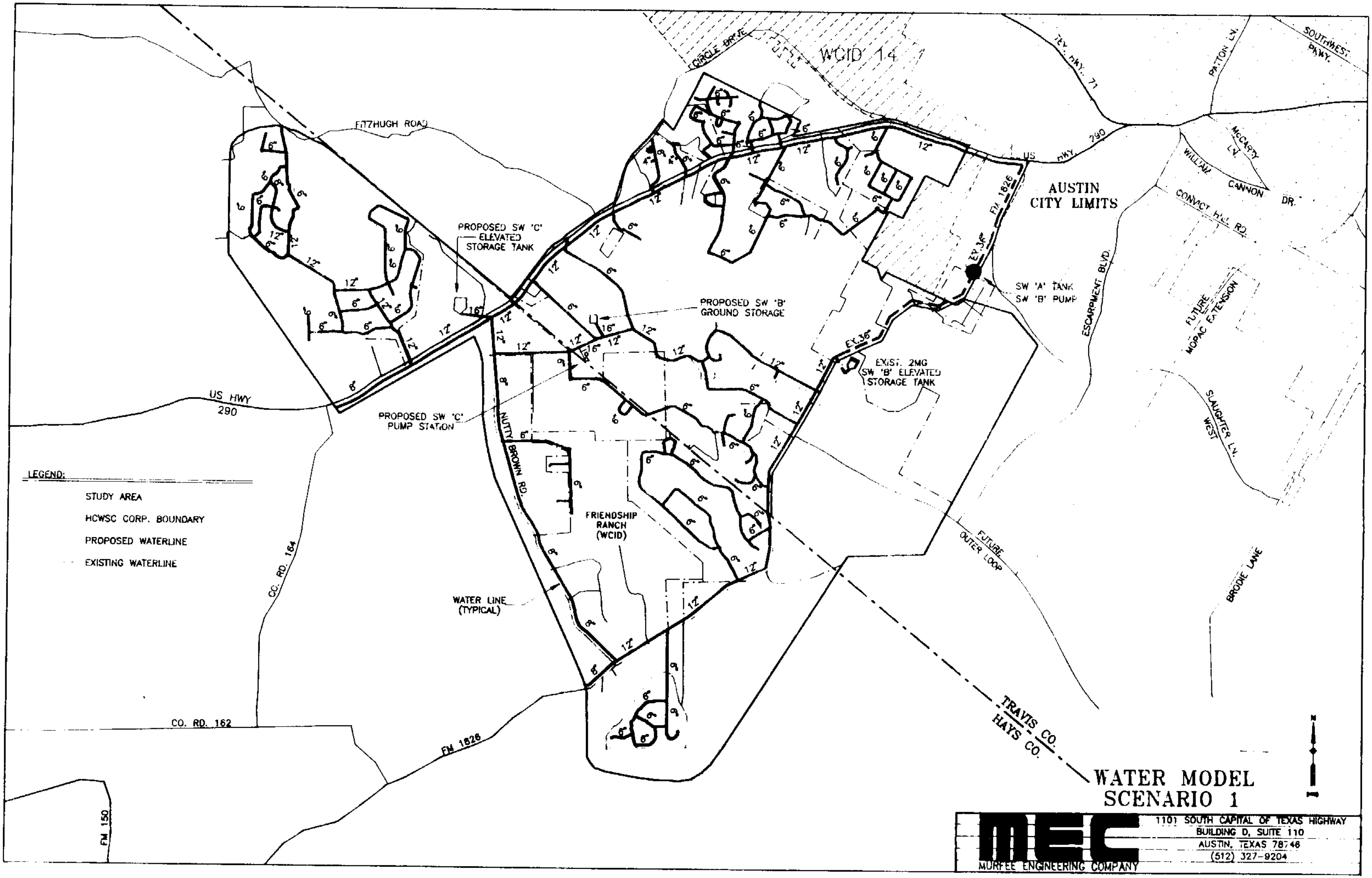

FITZHUGH ROAD
CIRCLE DRIVE
WCID 14
TEX. HWY. 71
PATTON LN.
SOUTHWEST PKWY.
US HWY. 290
MCCARTY LN.
WILLIAM CANNON DR.
AUSTIN CITY LIMITS
CONVICT HILL RD.
FM 1826
PROPOSED SW 'C' ELEVATED STORAGE TANK
PROPOSED SW 'B' GROUND STORAGE
SW 'A' TANK
SW 'B' PUMP
ESCARPMENT BLVD.
FUTURE MOPAC EXTENSION
EX.36"
EXIST. 2MG SW 'B' ELEVATED STORAGE TANK
US HWY 290
PROPOSED SW 'C' PUMP STATION
NUTTY BROWN RD.
SLAUGHTER LN. WEST
FRIENDSHIP RANCH (WCID)
FUTURE OUTER LOOP
BRODIE LANE
WATER LINE (TYPICAL)
CO. RD. 164
CO. RD. 162
FM 1826
FM 150
TRAVIS CO.
HAYS CO.
LEGEND:
STUDY AREA
HCWSC CORP. BOUNDARY
PROPOSED WATERLINE
EXISTING WATERLINE
WATER MODEL SCENARIO 1
MEC
MURFEE ENGINEERING COMPANY
1101 SOUTH CAPITAL OF TEXAS HIGHWAY
BUILDING D, SUITE 110
AUSTIN, TEXAS 78746
(512) 327-9204

FIGURE 9

This system assumes the proposed City of Austin transmission mains along FM 1826 and Highway 290 will not be constructed by the time this water system is placed on-line; therefore, in these locations these lines are sized for the HCWS Study Area demands only. This system requires one of the other planned 2 MG Southwest 'B' elevated storage tanks be in operation. This system consists of two main looped networks and numerous minor loops to ensure optimum efficiency. Dead end lines have been looped wherever feasible. A 275,000 gallon Southwest 'B' ground storage tank, 400,000 gallon Southwest 'C' elevated storage tank, and 2200 gpm Southwest 'C' booster pump station are proposed as part of the system improvements. The proposed construction related cost for the system is estimated to be $13,233,330 excluding house services. (See Table 7 for component breakdown.)

Scenarios #2 and #3 illustrated in Figures 10 and 11, respectively, represent the system required to meet this report's projected year 2000 water demands. These two scenarios assume the existing subdivisions are 80% built-out as opposed to the current 40% build-out and the area outside of the existing subdivisions to be 30% built-out as opposed to the existing 21% build-out. Both scenarios utilize two looped networks to optimize operational efficiency. As in the first scenario, it is assumed the proposed City of Austin transmission mains in FM 1826 and Highway 290 will not be constructed by the time this water system is placed on-line; therefore, these lines are sized for the HCWS Study Area demands only. (See Table 7 for component breakdown.)

Both systems propose a 125,000 gallon Southwest "B" ground storage tank, a 200,000 gallon Southwest 'C' elevated storage tank, and 1100 gpm Southwest 'C' booster pump station as part of the system improvements. The main differences between the two systems is that Scenario #2 provides a minimum 500 gpm flow throughout the system; while Scenario #3 provides a minimum 500 gpm fire flow only where the transmission and/or distribution lines are 6" and larger. Also, Scenario #3 does not provide as many internal distribution loops as Scenario #2 resulting in numerous dead end lines. The estimated construction related costs (excluding house services) for Scenarios #2 and #3 are $10,770,468 and $8,732,916, respectively.

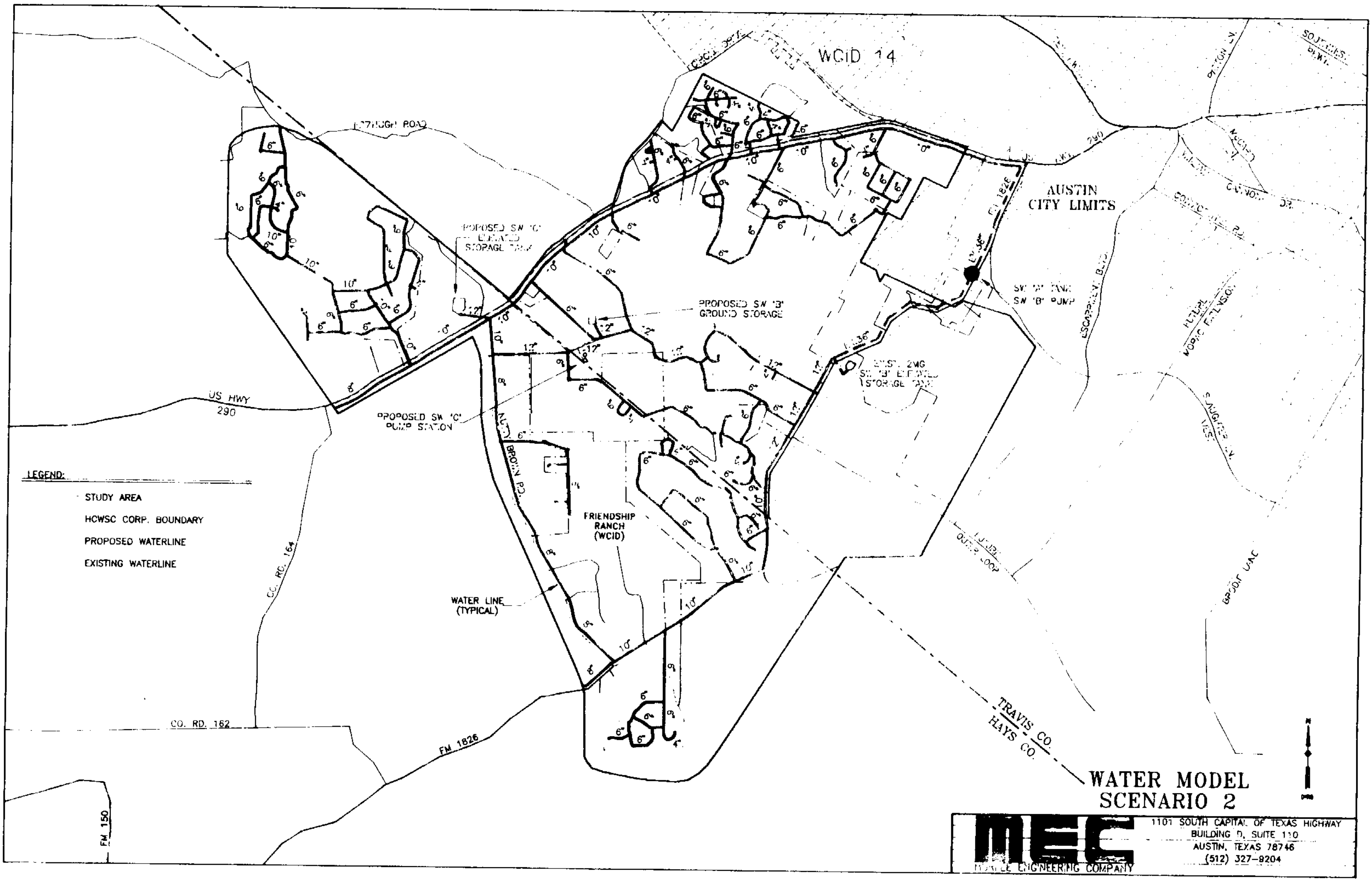
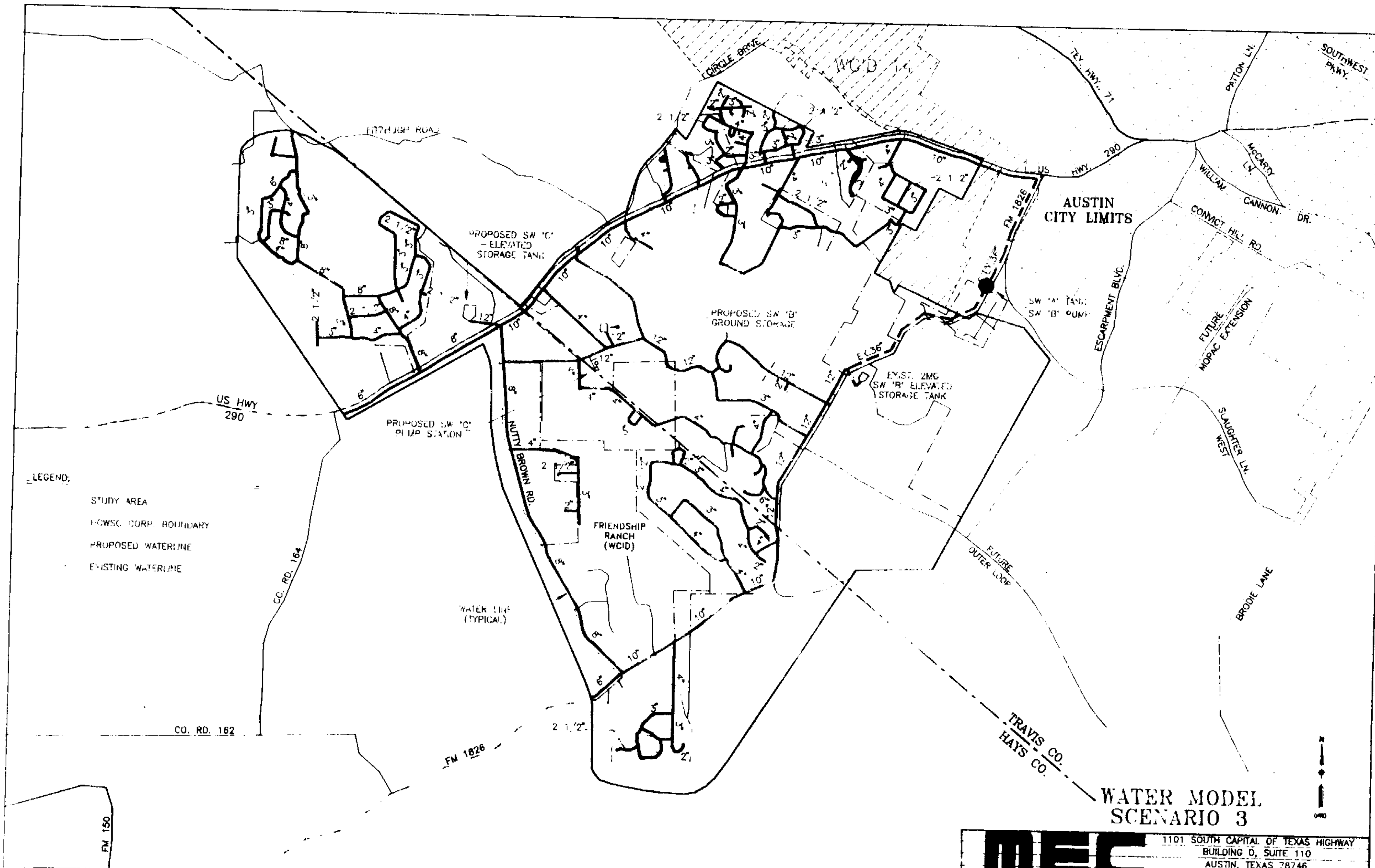

WCID 14
AUSTIN CITY LIMITS
US HWY 290
PROPOSED SW "C" ELEVATED STORAGE TANK
PROPOSED SW "B" GROUND STORAGE
PROPOSED SW "C" PUMP STATION
SW "B" TANK
SW "B" PUMP
EXIST. 2MG SW "B" ELEVATED STORAGE TANK
FRIENDSHIP RANCH (WCID)
WATER LINE (TYPICAL)
CO. RD. 164
CO. RD. 162
FM 1826
FM 150
TRAVIS CO.
HAYS CO.
LEGEND:
STUDY AREA
HCWSC CORP. BOUNDARY
PROPOSED WATERLINE
EXISTING WATERLINE
WATER MODEL
SCENARIO 2
1101 SOUTH CAPITAL OF TEXAS HIGHWAY
BUILDING D, SUITE 110
AUSTIN, TEXAS 78746
(512) 327-9204

FIGURE 10



WATER MODEL
SCENARIO 3

MEC
MURFEE ENGINEERING COMPANY
1101 SOUTH CAPITAL OF TEXAS HIGHWAY
BUILDING D, SUITE 110
AUSTIN, TEXAS 78746
(512) 327-9204

FIGURE 11

Each of the three scenarios has been modeled with a 500 gpm flow located along FM 1826 at the most southerly point of the Study Area. This flow represents a future demand south of the Study Area as it is presently defined. This future demand parallels the long-term planning of the proposed LCRA water service area which would include Dripping Springs, Driftwood and Western Hays and Travis counties.

3. <u>Review of Costs</u>

A breakdown of the total construction related costs for the proposed infrastructure for each scenario is provided in Table 7. Construction related costs are considered the sum of the actual construction costs, contingencies and engineering/surveying fees. Major transmission mains have been defined as those lines making up the two major network loops for each scenario. Included in the transmission main costs are fire hydrants, valving (i.e. air release, gate, butterfly, flushing), fittings, thrust blocking, restrained joints and other related appurtenances. Distribution lines are those lines within the internal network which convey water to the subdivisions and outlying area. The costs for the distribution mains also include fire hydrants (except wherever lines are smaller than 6" diameter), valves, fittings, thrust blocking and other related appurtenances. Service lines have been separated into (1) the lines and appurtenances extending from the distribution system to the customer meter box and (2) the service line and appurtenances extending from the customer meter box to the house tieing into the plumbing system. All linework costs are based on approved Texas Department of Health and City of Austin construction materials and methods. These costs take into consideration the numerous oil and gas pipeline, and other utility crossings required to construct the proposed water system.

TABLE 7

WATER SERVICE ALTERNATIVES
CONSTRUCTION RELATED COSTS

	Scenario #1[1]	Scenario #2[2]	Scenario #3[2]
Transmission	$4,490,178	$4,061,574	$4,061,574
Storage	1,049,400	508,200	508,200
Pumping	231,000	132,000	132,000
Distribution	4,978,380	4,873,572	2,836,020
Service to Meter Box	2,141,700	1,030,260	1,030,260
Meter/PRV	342,672	164,862	164,862
Subtotal	$13,233,330	$10,770,468	$8,732,916
Service from Meter Box to House	4,497,470	2,163,546	2,163,546
TOTAL	$17,730,900	$12,934,014	$10,896,462

[1]Assumes ultimate buildout of study area

[2]Assumes a buildout equivalent to the projected year 2000 population

4. <u>Service Via the LCRA Southwest Regional Water Supply System</u>

The three different regional water supply options all rely on connecting to the City of Austin system. Recent discussions with the Lower Colorado River Authority (LCRA) continue to support the willingness of the LCRA to serve the Study Area with surface water. In order for this to happen several issues must be resolved. First, the LCRA must enter into a contract with the City of Austin as the water provider to the Hill Country Water Supply Study Area even though the actual infrastructure connections are with the City system. It is unknown what impact this type of intergovernmental agreement would have on the cost and/or timing of water service to the Study Area. The Hill Country Water Supply Study Area was included in the Lake Travis (West) Feasibility Study as a potential service node. Secondly, any existing jurisdictional conflicts due to the Hays County portion of the Study Area being outside the LCRA service area would have to be resolved. Special legislation would be needed to resolve this issue. Thirdly, it is the LCRA's policy at this time to enter into service contracts with political subdivisions only. Therefore, a district would have to be created to contract with the LCRA.

The Lower Colorado River Authority (LCRA) may decide to own, operate and maintain the water system if it is the water provider. If that is the case, there are obvious long-term advantages for the Study Area to pursue the LCRA option versus the City of Austin option. There is also the possibility of low cost funding through the LCRA not available with the City of Austin option. This funding could include cost participation with other State agencies such as the Texas Water Development Board and/or the Texas Water Commission.

F. Water Plan Implementation Constraints

Local regulations and topographical features for the Study Area are not the only factors affecting development and growth in the area. Construction of the proposed water supply system will also have to conform to a variety of constraints. These restrictions are described as follows in this section.

1. Lower Colorado River Authority Service Constraints

The Lower Colorado River Authority (LCRA) has been contacted regarding the feasibility of the HCWS Study Area being included in the LCRA regional water service area. As mentioned earlier, before receiving water service from LCRA, several issues must be addressed. First, an intergovernmental agreement between the LCRA and City of Austin would be required in order to transport LCRA water through the City of Austin water system. Second, a contract must be executed between the Hill Country Water Supply Corporation and the LCRA. Third, the LCRA must resolve the jurisdictional issue regarding water service to Hays County since Hays County is within the Guadalupe-Blanco River Authority service area and not the LCRA's service area. Fourth, the LCRA must decide if service could be granted to this Study Area as a corporation or district.

2. City of Austin System Constraints

In May of 1988, the Hill Country Water Supply Corporation (HCWSC) entered into a water three year service contract with the City of Austin for the purpose of constructing and operating a domestic water supply distribution system for its customers in Travis and Hays County. As part of this contract the City of Austin agreed to sell water to the corporation on an as needed basis up to a maximum flow rate of two million (2,000,000) gallons per day at a pressure of not less than twenty (20) pounds per square inch (psi). By this contract, the City would be required to begin selling water to HCWSC no earlier than January 1, 1990. In purchasing the water, HCWSC agreed to pay the City of Austin applicable capital recovery fees for water service in addition to the City's standard wholesale rate. By this agreement, HCWSC originally had until May of 1989 to obtain financing for the proposed water improvements; however, this deadline has been extended.

Discussions between the City of Austin and the HCWSC attorney have suggested the City would be willing to extend the water service contract for a period considerably longer than the initial three year contract. This is imperative if funding is to be obtained through a Texas Water Development Board (TWDB) loan. The Texas Water Development Board requires a water service contract be guaranteed for the life of the loan. Another condition for a TWDB loan is for the HCWSC to have a commitment from the City assuring the necessary water be available without limitations for the life of the loan. The existing City of Austin water system is sufficient to serve the immediate needs of the HCWS Study Area. However, as growth occurs within the Study Area and within the City of Austin Southwest 'B' service area, the City of Austin Southwest 'B' water system would require additional elevated storage either at the La Crosse Avenue or Circle Drive location. In order for the HCWS to meet their long term financial obligations, it will be imperative for the additional Southwest 'B' elevated storage facility to be constructed so that the corporation can connect new customers as development occurs and thus reduce the debt burden on its initial users.

The Study Area is located within the City of Austin and City of Dripping Springs Extraterritorial Jurisdictions (ETJ). There is the possibility the City of Austin may annex all or a portion of the Study Area currently within its ETJ. However, there are many issues which will impact the potential for annexation. One of the primary considerations for the City of Austin will be the amount of indebtedness it will encumber by annexation. Other issues which will affect the City's decision regarding annexation include: 1) whether the LCRA is the water supplier for the Study Area; 2) the Study Area is within the Pedernales Electric Cooperative Service Area precluding service via the City of Austin Electric Utility, and 3) a Certificate of Convenience and Necessity (CCN) is filed and approved by another entity.

3. <u>The Possible Effect of Local Regulation and Controls Austin Plan - Sector 20 Impact on Study Area</u>

A portion of the Hill Country Water Supply Study Area lies within the limits of the Austin

Plan - Sector 20. The Austin Plan - Sector 20 which represents the City of Austin's policy toward growth and land use in that sector emphasizes the importance of future development being sensitive to the environment. Sector 20 envisions the HCWS Study Area will retain its suburban/rural character. Sector 20 recommends a residential land use level of 3 recommended throughout much of the Study Area. Level 3 is defined as large lot single-family subdivisions consisting of 1 to 3 units per acre. Slightly higher densities (levels 4 and 5) are recommended for the Circle C West area/FM 1826 and along Highway 290. Levels 4 and 5 allow cluster residential units and small scale commercial and campus-style research developments.

Development Constraints

There are numerous City, County, State and Federal regulations governing the Hill Country Water Supply Study Area. The Study Area is located within the City of Austin 2-mile and 5-mile extraterritorial jurisdictions (ETJ) and is governed through the subdivision regulations contained in the City of Austin Land Development Code. Three City ordinances in particular control development in this area. Each ordinance is described briefly as follows:

Comprehensive Watersheds Ordinance-

The Comprehensive Watersheds Ordinance controls development density based on drainage basin location, waterway classification and delineation of critical water quality zones, water quality buffer zones, and uplands zones. The HCWS Study Area is divided into two (2) watershed classifications. That area east of FM 1826 within the Slaughter and Williamson Creek Watersheds is known as the Water Supply Suburban Watershed. The area west of FM 1826 within the Slaughter, Williamson, Bear and Onion Creek Watersheds is classified as the Water Supply Rural Watershed. The Water Supply Suburban (WSS) Watershed is less restrictive than the Water Supply Rural (WSR) Watershed; however, neither allows development in the Critical Water Quality Zone (CWQZ). Impervious cover in the uplands zone of the WSS Watershed is limited to 30% or more with use of transfers. Development intensity in the uplands zone of the WSR Watershed is more restricted. One and two-family residential housing units at an average density of one unit or less for every two (2) acres of Net Site Area with a minimum lot size of three quarter acre, or up to one unit or less for every acre with a minimum lot size of one-half acre if transfers are utilized. Net Site Area is defined as that area in the Uplands Zone excluding land designated for wastewater irrigation and then calculated to include all acreage on 0-15% slopes plus 40% of the acreage on 15-25% slopes plus 20% of the acreage on 25-35% slopes.

Parkland Ordinance-

The Parkland Ordinance requires a portion of all residential subdivisions be dedicated as parkland. The amount of land required is calculated at the rate of not less than five acres of parkland per 1000 ultimate residents. Land dedicated as parkland must be of a size, characteristic and location consistent with the standards outlined in the City's Comprehensive Plan and the Park and Recreation Action Plan.

Waterway Development Ordinance-

The Waterway Development Ordinance regulates development within the 100-year floodplain. The ordinance assures any development activities maintain the "natural and traditional character" of the land and waterways (Chapters 13-2, 13-6, and 13-7 of the Land Development Code and 9-10 of the City Code).

In addition to City of Austin ordinances, Travis County and Hays County each have regulations controlling subdivision development in their respective jurisdictions. Hays County places density restrictions on subdivisions located within the Edwards Aquifer Recharge Zone (EARZ) of 1 unit/acre. Outside of the EARZ, the minimum lot size is 20,000 square feet (SF) or 0.46 acres. Both counties place restrictions on spacing of water wells and private septic systems, soil percolation rates, and development on slopes which also affects lot size.

4. Hill Country Critical Area Underground Conservation District

The creation of the Hill Country Critical Area Underground Conservation District which would include the Hill Country Water Supply Study Area within its boundaries implies regulatory control of development. These controls will probably affect the spacing of water wells and septic systems. Minimum lot spacing or residential density controls may also be affected. Density limitations may result in a lower level residential development. Existing subdivisions may also be impacted by these regulations. Restrictions placed on water well and septic system spacing may preclude the future development of lots within these subdivisions unless a surface water supply is available. The Hill Country Critical Area Underground Conservation District may also be created as a Chapter 52 District having taxing authority.

5. Texas Water Commission Water Quality Control Regulation

The Texas Water Commission has completed public hearings regarding Water Quality Control Regulations targeting the contributing zone of the Edwards Aquifer. These regulations set standards governing discharge and spray irrigation of wastewater within certain distances of the Edwards Aquifer Recharge Zone. To quote the language of Title 31, Natural Resources and Conservation, Part IX. Texas Water Commission, Chapter 313, Edwards Aquifer Subchapter A, "Proposed new provisions for municipal wastewater treatment plants require that within five miles upstream of the recharge zone the plant must, at a minimum, attain 30-day average maximum concentrations of five milligrams/liter (mg/l) biochemical oxygen demand, five mg/l total suspended solids, 2 mg/l ammonia nitrogen, and one mg/l phosphorus; between five and 10 miles upstream of the recharge

TEXAS WATER COMMISSION
REGULATION MAP

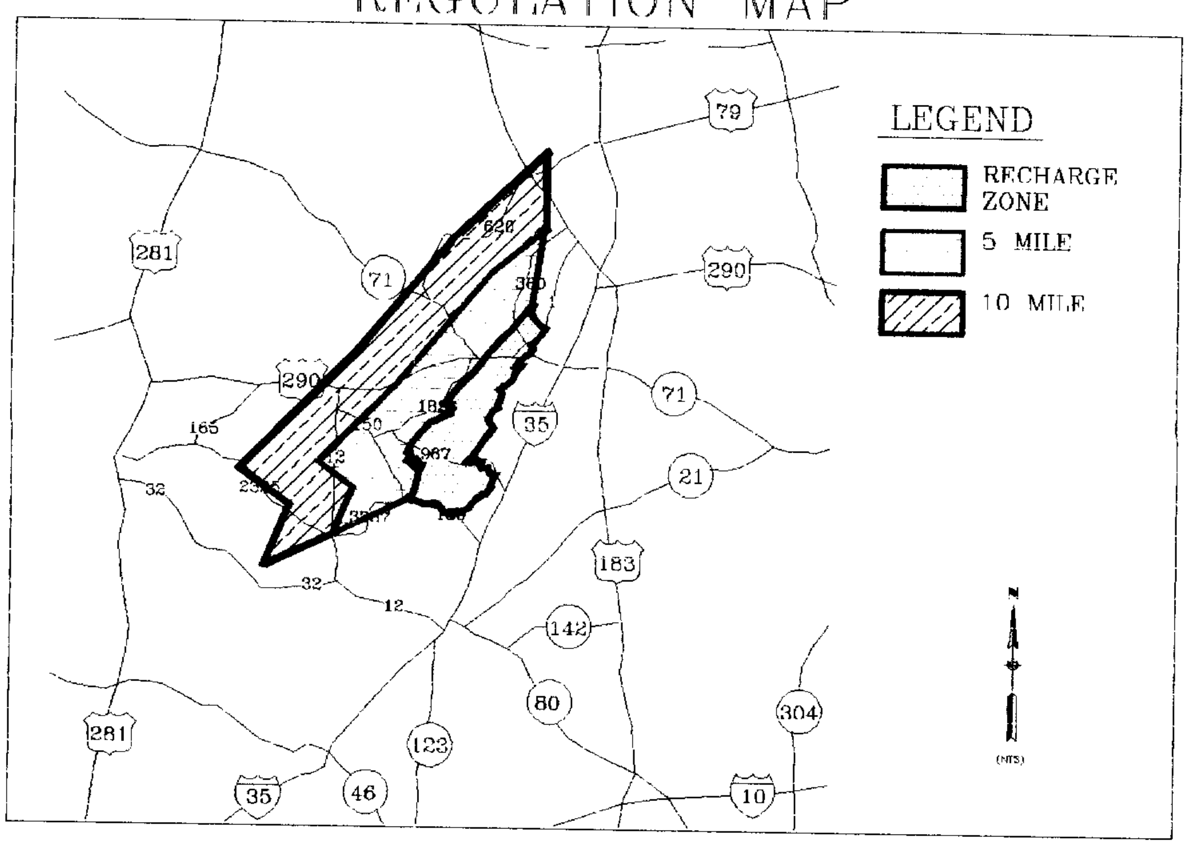


FIGURE 12

zone the plant must, at a minimum, attain maximum concentrations of Effluent Set 2N, as defined in 31 TAC, Chapter 309 (relating to Effluent Standards); and discharges greater than five miles upstream from the recharge zone and entering stream segments 1427 or 1428 of the Colorado River Basin must conform to Paragraph 311.43 (relating to Effluent Requirements for All Tributaries of Segment 1428 of the Colorado River and Segment 1427, Onion Creek, and its Tributaries, of the Colorado River Basin). Also, proposed Paragraph 313.6, contains provisions for general design of wastewater treatment plants. Existing permitted industrial dischargers zero to 10 miles upstream of the recharge zone must at all times discharge effluent in accordance with their permitted limits, and applications for new industrial discharge permits for within zero to 10 miles upstream of the recharge zone will be approved on a case-by-case basis." Figure 12 depicts the Texas Water Commission 5-mile and 10-mile boundaries for wastewater irrigation.

6. <u>Environmental Constraints</u>

Environmental Data-

The study area is situated within the physiographic region known as the Edwards Plateau. This physiography of this region is distinguished primarily on the basis of topographic relief. Other considerations include vegetation, soil, and bedrock units characteristic of the region. The Edwards Plateau contains slopes generally ranging from 5 percent to 15 percent. Topographically, the altitude above sea level in the vicinity of the Study Area varies from 850 feet along the eastern boundary to 1200 feet along the western boundary.

Vegetation characteristic of the region consists of juniper-oak; juniper (mountain cedar) mixed with spanish oak and live oak; and juniper locally absent where areas have been cleared for pasture improvement. This vegetation group is commonly found among the mixed limestone and dolomite and dolomitic limestone which comprise the dissected Hill Country. The study area is generally suited to rangeland. Native grasses include little bluestem, sideoats grama, tall grama, indiangrass, silver and pinhole bluestem and Texas grama.

Soils within the study area consist of bedrock soils and alluvial soils. The bedrock soils are generally dark brown to gray brown, calcareous silty or stony clays and clay loams ranging less than 20 inches deep. The alluvial soils found along creek beds are gray brown to dark brown, calcareous gravelly clays and silty loams less than 24 inches deep. These soils are described more completely in the following section of this report titled "Soils".

Several different bedrock units and one alluvial unit are found in the study area. The bedrock units range from hard limestone and mixed limestone comprising the majority of the study area to isolated areas of soft limestone and dolomite and dolomitic limestone. The limestone categories do not generally pose any construction limitations with respect to foundation strength or slope stability. Blasting is typically required for excavation. Corrosion of metal pipelines is moderate. The alluvial unit consists of sand and gravel deposits found along creek beds. These deposits have moderate to low slope stability, thus making erosion a common problem. The potential for corrosion to metal pipes is moderate to high.

The geology of the study area is characterised by the Cretaceous strata which gently dips to the southeast until it meets the Balcones Fault just to the east of the study area. The Balcones Fault is the geologic structure which significantly affects ground water in the area. The hydrologic unit which yields ground water within the Study Area is the Trinity Group. This group yields small quantities of generally poor quality drinking water. The water is usually neutral and very hard. The quality ranges from fresh to slightly saline in most cases. The quality tends to decrease downdip to the southeast. Low permeability, restricted water circulation, and an increase in temperature cause the ground water to become highly mineralized in the downdip portion of the aquifer. The stairstep topography formed by the alternating beds of limestone and shale or marl typifies this member. The primary sources of ground water in the Trinity Group aquifer are rainfall which falls on the outcrops and infiltration of surface water from lakes and streams on or crossing its outcrops. Recharge to the Trinity Group aquifer is derived primarily from the rainfall on the outcrops, underflow, vertical leakage, and seepage from lakes and streams. Ground water in the Trinity Group aquifer slowly moves downdip to the south and east-southeast. The direction of the ground water movement is perpendicular to the water-level contour lines and toward lower elevations. Faults appear to greatly restrict the movement of water throughout the aquifer.

The study area lies within the Colorado River Basin and contains all or portions of the major tributaries of the Slaughter, Williamson, and Bear Creek watersheds. There is an extensive creek network throughout the study area. The study area is located within the Edwards Aquifer Contributing Zone, thus contributing drainage to the recharge zone to the east of the area.

The climate of Austin is classified as sub-humid. The humidity is typically relatively high. Winters are generally mild and short; the summers are hot and long. The prevailing wind is southerly. Rain is fairly evenly distributed throughout the year; however, the major storms typically occur in the spring and fall. The average annual rainfall is approximately 32 inches; while the growing season averages 270 days.

The City of Austin Sectors 20 and 21 studies conducted as part of Austinplan have identified several critical environmental features (CEFs) which have been determined to be of critical importance to the protection of the area's environmental resources. The identified CEFs in the Study Area vicinity include springs, caves and sinkholes. These features are very susceptible to urban runoff, erosion and sedimentation unless protected properly. Sedimentation, siltation and impervious cover result in reduced ground water recharge and spring flow. Caves, sinkholes and karstic limestone recharge the aquifer directly. Any pollutants in the urban runoff threaten the aquifer unless structural water quality controls are utilized to protect these features.

There are Environmentally Sensitive Areas (ESAs) that have also been identified in the Austinplan Sectors 20 and 21 reports. ESAs have been defined as areas having important biological habitat. In the vicinity of the Study Area, several ESAs have been identified. They include habitat for the Golden-cheeked Warbler, a rare bird, and high quality riparian and upland woodlands referred to as priority woodlands. The Golden-cheeked Warbler is a state protected non-game species. The Golden-cheeked Warbler has been listed on the Federal List of Endangered Species by the U.S. Parks and Wildlife Service. Several habitats for this bird have been identified within the Study Area. The Environmentally Sensitive Areas are different from the Critical Environmental Features in that ESAs are of significant area-wide extent as opposed to being specific features as is the case with CEFs. ESAs can generally be protected by clustering development where there is a lesser environmental sensitivity.

As required by the Texas Water Development Board, the Texas Parks and Wildlife Department and Texas Antiquities Committee have been contacted to ascertain the existence of any threatened or endangered species and any historic or archeological sites. The Parks and Wildlife Department responded that a search of the Texas Natural Heritage Program Information System revealed several species likely to occur in the general vicinity of the proposed project. Listed below are the potentially affected species and their official designations:

Federal and State Endangered-
Vireo atricapillus (**Black-capped Vireo**) G2G3 S2

Federal Endangered and State Threatened-
Dendroica chrysoparia (**Golden-cheeked Warbler**) G2 S2

Federal Category 2-
Amorpha roemerana (**Texas amorpha**) G3 S3
Eurycea neotenes (**Texas Salamander**) G3 S3 found in the springs of the Edwards Plateau region

Philadelphus ernestii (**canyon mock-orange**) G2 S2 found on rock outcrops
Streptanthus bracteatus (**bracted twistflower**) G2 S2 survey for this plant in spring, April - mid-May

Other rare species-
Tridens buckleyanus (**Buckley tridens**) G2 S2 survey for this plant in late summer and fall

The Texas Antiquities Committee review of this report has indicated that since most the disturbance related to this project will consist of excavation for water lines within existing right-of-ways, "the probability that these excavations will impact previously undisturbed archeological deposits is relatively remote. Additionally, there are no previously recorded archeological sites or historic sites in the direct path of these lines." Therefore, the Texas Antiquities Committee will not require archeological surveys of the proposed water line routes. The Committe will require archeological surveys of the water storage tank and pumping station locations prior to construction. The Texas Antiquities Committee has determined they will require these surveys "because of the more extensive nature of those construction impacts and because this area does contain a relatively high probability for the discovery of prehistoric Indian archeological deposits."

This report also incorporates environmental data provided by the City of Austin Planning and Environmental Departments regarding locations of potential golden-cheeked warbler habitat in the vicinity of the Study Area. The LAND USE MAP, designated as FIGURE 3 in this report, depicts general locations of potential warbler habitat as provided by Chuck Sexton of the City's Environmental Department.

Other environmental constraints which affect development and which are prevalent within the Study Area include floodplains, steep slopes, and the karstic limestone terrain. These constraints and those previously described are all regulated by the City of Austin Land Development Code which was adopted with the intent of protecting the environment. Hays County also has instituted ordinances which regulate development.

It should be noted that with the use of ion-exchange softening as a component of the well systems, enormous quantites of salt are being discharged into the surface stratas of the Hill Country Study Area through the septic tank drain fields. With the use of lime softening of treated surface water, this detrimental impact will be greatly reduced.

Environmental Impact of Proposed Project-

The proposed project has been analyzed for potential impacts on the natural environment. The primary emphasis of this study is on identifying the potential for impacts on sensitive resources. This study has evaluated both direct and indirect impacts on water resources, sensitive ecological resources and impacts on specific environmental features where relevant. Direct impacts include impacts associated with construction and operation of the proposed water supply facilities. Indirect impacts include those impacts which might result from land use changes, where the potential for such changes could be construed to be the direct result of the proposed project. Although the provision of water supply facilities does not affect the amount of a given land use, it can influence the location of more intensive land uses. Any shift in location of more intensive land uses may have an adverse impact on sensitive resources.

The potential for significant impacts can be measured by evaluating surface water, ground water, native habitat, rare and endangered species, critical environmental features, and air quality. Significant impacts can be defined as those which cause a perceptible adverse change in the natural environment over the long term, or have a severe short term impact.

The potential impact on surface water can be determined by the number of major and minor stream crossings and other aspects of the terrain. The site specific characteristics which affect the impact on surface water include the floodplain characteristics, slope steepness, and general proximity to waterways. These factors influence the effectiveness of erosion controls in mitigating construction impacts. The proposed project will have a temporary adverse impact during construction across creek beds. These impacts can be mitigated by the use and continued monitoring of effective erosion and sedimentation controls and immediate revegetation of the disturbed area once construction is complete.

The proposed project will also have a short term impact on the ground water resources during construction. Special construction techniques aimed to minimize disturbance of recharge features will be investigated prior to beginning construction. Special precautions will be undertaken to avoid construction activities in the immediate vicinity of ground water recharge features, such as caves and sinkholes, in order to mitigate any adverse impacts.

Any potential impact on native habitats is determined by examination of biological resource maps which depict areas of priority woodlands, priority grasslands, and other native habitat types. There are several rare and endangered species dependent on specific habitats found in the vicinity of the Study Area. Two bird species of particular concern are the golden-cheek warbler and black-capped vireo. Since the Study Area is located within the extraterritorial jurisdiction (ETJ) of the City of Austin and is also covered by the Regional Habitat Conservation Plan, a survey will be required which might affect specific water supply sites and water line routing outside of existing right-of-ways.

It is not known if the proposed project will have an impact on any critical environmental features. It is likely there are critical environmental features within the limits of the Study Area; however, no known critical environmental features exist in the immediate vicinity of the proposed construction. Special precautions will be undertaken to avoid conducting construction in the immediate vicinity of any critical environmental features, such as caves, springs, or sinkholes.

Air and Noise quality in the vicinity of the proposed construction will also be impacted. The degree of impact will depend on the duration of construction, emissions from construction equipment and amount of dust generated. For this type of project, the most important concern is dust which can be controlled by applying water periodically.

The construction of the proposed water supply facilities can impact virtually all aspects of the environment. Prior to the construction of the proposed facilities, each should be analyzed to identify potential site-specific impacts which might affect the environment.

The short-term adverse impacts associated with this type of project include (1) increased air pollution, generally in the form of dust, (2) disruption of the natural soil, (3) emigration of wildlife, and (4) temporary loss of natural habitat within the immediate vicinity of construction due to construction noise. These negative short-term impacts can be mitigated during the construction phase. Some examples to be incorporated with this project include (1) the application of water to reduce dust; (2) the use of erosion control devices, such as silt fences and rock berms to reduce sedimentation in creek beds; (3) the revegetation of utility trenches and construction sites with native grasses as soon as possible; and (4) minimization of erosion potential by limiting the area of excavation associated with trenching. The proposed utility line construction will generally take place within existing right-of-ways; therefore, no significant habitat for animal or plant life should be adversely impacted. The limited utility linework and sitework planned outside of the eixsting roadways will result in temporary displacement of wildlife that should return after the construction ends.

The project will provide short-term economic and social benefits to the Study Area. There will be increased employment during construction which will generate increased business activity. There will probably be an increase in land development activities. Both of these examples of short-term benefits will be the result of having a reliable and good quality water supply.

The primary long-term adverse impact will be in the form of increased energy consumption required to operate the storage tanks and pump stations. There will be a decrease in electric use attributed to the abandoning of individual water well pumping for drinking water; however, no doubt some of the wells may remain in operation for irrigation purposes.

The long-term beneficial impacts of the proposed project are considerable. The project will mean a significant reduction in pumping of ground water, which in turn, will have a positive impact on the aquifer. This is especially important due to the aquifer's recent consistently low levels caused by the constantly increasing water demands placed on the aquifer. The use of surface water instead of ground water for drinking purposes will alleviate the potential for septic systems polluting the drinking water. There will be economic and social benefits associated with having a reliable and good quality drinking water supply. As a result, socio-economic growth will be stimulated. These benefits will also materialize in the form of increased value and marketability of homes in the Study Area.

Other considerations associated with the proposed project include increased water and wastwater usage. Also, the proposed construction will not result in the displacement of any residences or traffic interruption. All construction activities within the existing right-of-ways will be staged such that driveway access and roadway traffic will not be interrupted.

The alternative to the proposed project to provide a reliable, good qualtiy drinking water supply includes no action. No action would mean maintaining the existing ground water resources for drinking water. The ground water in the area is limited in quantity and of poor quality. Maintaining this level of water supply will result in slower socio-economic growth of the area.

7. <u>Soil Constraints</u>

The Study Area is described by three (3) major soil associations. The soil association characterizing most of the Travis County portion of the Study Area is known as the Brackett association. This association is typical of the rolling, steep hills of the Edwards Plateau. The Brackett association soils are generally shallow, stony, calcareous, and loamy. These soils are found overlying interbedded limestone and marl. The Brackett group, typically found on narrow ridges, comprises the majority of the association. The Brackett soil surface layer consists of a six inch layer of gravelly clay loam. The remainder of the association in the Study Area consists of the Tarrant, Volente and San Saba soils. The Brackett association exhibits moderate erosion potential and high shrink-swell potential. Due to the shallow nature of the soils, slope limitations, and seepage potential; these soils place severe limitations on construction of roadways, utilities, and septic system drainfields.

East of FM 1826, the Speck-Tarrant association is found. Similar to the Brackett association, these soils are very shallow, stony, and loamy. This soil association contains underlying limestone fragments. The Speck soils and the Tarrant soils are evenly represented in this association. The Speck soil is a noncalcareous, but mildly alkaline soil averaging about 18 inches in depth over limestone. The Tarrant soil is typically 8 inches thick over limestone. The surface layer contains large limestone fragments and is generally calcareous. Also prevalent in the Speck-Tarrant association but in much smaller quantities is the San Saba and Crawford clays and the Volente complex. These soils restrict development due to their shallow nature and thick beds of limestone beneath the soils. As a result, cutting streets to grade, trenching for utilities and excavating septic drainfields is difficult.

The soil association dominating the Hays County portion of the Study Area is known as the Brackett-Comfort-Real association. This unit consists of fairly well drained soils on slopes ranging from 1 to 30 percent. The soils within this association are generally shallow, overlying limestone or alternating layers of marl and chalk. This unit has a benched appearance characteristic of the Edwards Plateau region. Other than rock outcrop, the Brackett soils comprise the largest single unit. The Comfort soils make up the next largest unit. These soils found on ridges overlying fractured limestone outcrops are also very shallow. The Real soils consist of the next largest soil group in the association. These soils range from undulating to steep and are thicker than the Brackett and Comfort units. They consist of gravelly loam overlying platy chalk. The other soil units within the association found in the vicinity of the Study Area are identified briefly as follows:

Doss, Purves, and Tarpley soils - shallow, clay-like; found on ridges and benches

Eckrant soils - shallow, stony and clay-like; found on steep slopes

Denton soils - moderately deep clay

Bolar soils - moderately deep loam

Krum soils - deep clay
Sunev soils - deep loam found on bottom slopes in valleys
Lewisville soils - deep soil found in stream terraces
Orif soils - deep soil found in narrow floodplain.

This soil's association also places similar restrictions on construction due to its shallowness, slope and stony nature.

8. Archeological Constraints

The Texas Archaeological Research Laboratory has identified several archaeological sites from the Prehistoric and Middle-to-Late Archaic eras in the general vicinity of the Study Area. The Prehistoric sites are composed of camp sites and workshop sites found along creeks and have been flooded and become eroded over the years. The identified Middle-to-Late Archaic sites are found along creek beds and uplands areas. These sites include quarry areas and rock middens, or eating/cooking areas.

Historical sites are protected by law. Any proposed construction activities should avoid these areas. There are no known archeological or historic sites along the existing right-of-ways where much of the water line route is located. However, the potential exists in the areas where the storage and pump facilities are proposed. These facilities will be located as close to the existing right-of-way as possible to minimize any conflict. Protection of any sites will be investigated closely during the preliminary and final design phases and construction phase of the water system.

G. Implementation and Management

1. Service Differences Between City of Austin and LCRA

Implementation and management of the proposed system will vary dramatically depending on which entity serves the Hill Country Water Supply Study Area with surface water. Although the actual connection to the existing City of Austin system will be the same for either option, the City of Austin and LCRA approach implementation and management differently.

As the wholesale water supplier, the City of Austin will enter into a contract with the Hill

Country Water Supply Corporation (or District). Their involvement in implementation and operation will be simply as the wholesale water supplier. Water usage will be recorded via master meters installed at any connection points to the City system. The master meters will be read by the City and water usage billed to the Hill Country Water Supply Corporation at whatever rate was applicable based on the contractual agreement. The City has no desire to participate in the construction or implementation of infrastructure for the Study Area at this time.

The Lower Colorado River Authority (LCRA) will be more likely to become involved in the design and building aspects of the project. Although it is not the policy of the LCRA to provide grant monies, it could make available its engineering and legal staff to help with implementation and management issues. Depending on the outcome of negotiations with the LCRA, the LCRA Board may determine that ownership in the system would be to its advantage. It is important to note that the Hays County portion of the Study Area is not within the LCRA's regional water service area. In any case, the system's construction, management and operation will have to pay for itself within the finance period. If the LCRA option is to be pursued, a request on the part of the Hill Country Water Supply Study Area, local legislators, and/or other local interests, must be made for service.

2. <u>General Discussion</u>

An implementation and management plan will follow a general format with variations depending on the type of funding arrangements. Due to pending legislation and numerous potential funding options through the Texas Water Development Board and/or Lower Colorado River Authority, this report will present a financing amortization schedule assuming the base scenario; that is the Hill Country Water Supply Area operating as a non-profit water supply cooperative. Assuming the Hill Country Water Supply Study Area operates as a water supply corporation, any required contracts could be executed by resolution of the board of directors rather than election, as required for a utility district. Implementation of the water supply system will require the design take into consideration previously mentioned environmental and topographical features. Although the majority of improvements will follow existing right-of-ways, some facilities will require site specific investigations to insure that the unique characteristics of the Hill Country are maintained and protected.

3. Southwest 'B' and Southwest 'C' Service Areas

The Hill Country Water Supply Study Area is situated between natural ground elevations ranging from a low of 850 mean sea level (msl) along its eastern boundary to a high of 1200 msl along its western boundary. The Study Area has been divided into two pressure planes which will maintain water pressures within a suitable operating range. Each pressure plane is defined in terms of its hydraulic grade line (HGL), or overflow elevation. The two (2) pressure planes located within the Study Area are the established Southwest 'B' system with an overflow of 1140 msl and a proposed Southwest 'C' system with an overflow of 1315 msl. The different pressure planes are illustrated in Figure 13.

The City of Austin has an established Southwest 'B' pressure plane which serves a range of ground elevations between 900 msl and 1030 msl from an overflow elevation of 1140 msl. The current Southwest 'B' service area includes areas to the north and south of Highway 290 West. The Southwest 'B' service area south of Highway 290 containing approximately 2523 acres is bounded by FM 1826 on the west. This area includes Circle C West and portions of Shadowridge Crossing, Upper Williamson Creek, Del Curto and Hielscher tracts. The Southwest 'B' service area north of Highway is bounded on the north and east by Highway 71 and on the west by Travis County WCID #14. This area currently operates below the established Southwest 'B' overflow elevation of 1140 msl but will be upgraded to the prescribed pressure plane once the 36" transmission main in FM 1826 connects to the 24" Southwest 'B' transmission main along Highway 290 West.

The City of Austin has not adopted an overflow elevation for a Southwest 'C' pressure plane. However, the City acknowledges the need for a Southwest 'C' system if its service area were extended west of FM 1826. This report recommends a Southwest 'C' overflow of 1315 msl which will serve a range of ground elevations between 1030 msl and 1200 msl. This pressure plane will serve the highest elevation within the Study Area. There are approximately 6311 acres in the Study Area within the proposed Southwest 'C' system.

4. Development Plan

A general format detailing sequencing of an implementation and management plan follows:

1) Once a water system plan has been approved, a final cost estimate itemizing construction costs, contingencies, engineering and legal fees will be prepared.

2) These costs will be incorporated with user base information and a financial feasibility statement generated.

3) A funding plan will be identified and negotiated. Potential financing sources will be investigated. Discussion with the Texas Water Development Board, Lower Colorado River Authority, and the City of Austin will identify a funding plan.

4) The Hill Country Water Supply Study Area will enter into negotiations with potential surface water suppliers.
   a) If a district is considered, a creation report and documentation will be drafted and creation pursued at the Texas Water Commission or legislature. Upon approval, a confirmation election will then be scheduled and information package sent out to the residents of the service area.
   b) If the LCRA is chosen as the water provider, negotiations between the LCRA and the City of Austin will identify the cost for utilizing City of Austin water infrastructure for LCRA service.

5) Depending on the estimated cost of the system and implementation of phasing, potential system users will be contracted with (agreement/commitment for service contracts must be entered into with service area residents in order to identify the beginning user base) to project initial revenue returns. This discussion needs to occur concurrently with Items 3) and 4). A Certificate of Convenience and Necessity will be pursued at this time.

6) Upon agreement with the governmental entities to fund or participate in the improvements, consultants will be contracted to prepare a funding package, design the system, provide necessary reports, operate and manage the system.

7) Funding documents will then be reviewed by the participating entities. Design plans will be reviewed by the Texas Health Department, the Hill Country Water Supply Corporation's engineer, and whatever other entity that may contractually have that right.

8) Construction plans will then be let for bid. The bids will be reviewed by the appropriate entities and approval to proceed with construction issued. If easements for construction are required, they must be in-hand prior to issuance of the contractor's notice to proceed. Any necessary agreements with outside utilities should also be in place at this time; such as, electrical service to system improvements or relocation of utilities that conflict with system improvements.

9) It is important to determine which customers have unique service requirements. During the design process, it may be determined that groups of users or areas of the service area are either too spread out or too far from the transmission/ distribution lines to be included in the initial construction phasing (referred to as "micro-systems" hereafter). It may then be necessary to design or plan for "micro-systems" to be funded as service extensions by that group of users. Special consideration may be given to these users in the form of offsets or connection fee adjustments. It will be advantageous to negotiate these special extension situations with the low-bid contractor at this time in order to obtain the best possible installation price.

10) Whether the system is managed by the Hill Country Water Supply or the LCRA, an independent operator will be utilized. At this point in the process, initial users will be identified and rates established. The operation and management consultant/firm will set up the billing system and the maintenance plan. Billings, depending on the final revenue plan, may need to be issued before construction is complete and a new-connection policy and associated cost will be agreed on by participating agencies.

11) Upon completion of construction, final inspection and testing, start up procedures will be employed. Official acceptance of the utility system should only be granted after as-built drawings of the system improvements are distributed to the operation

and management consultant/firm, the Hill Country Water Supply Corporation engineer and the funding entity. The policy regarding responsibility for updating these drawings as additions and extensions to the system, need to be determined at this time. (This is usually the corporation or district engineer's responsibility.)

5. Recommended Water System - **THE SYSTEM**

The recommended water system (referred hereafter as "**The System**") discussed in this section represents the ultimate system for the study period. Phasing of **The System** will be discussed later in this report. **The System** is basically Scenario #1 described earlier in this report with the only exception being the distribution lines (2" - 4") are sized for domestic demand only and do not accommodate a 500 gpm fire flow. A minimum of 500 gpm fire flow will be achieved throughout the transmission main network.

The System has been designed to provide water supply and transmission/distribution facilities capable of conveying potable surface water in sufficient quantities and at a suitable operating pressure throughout the Study Area. The proposed components consist of storage reservoirs and booster pumping stations for each pressure plane, as required. Water is conveyed to the supply facilities and service connections by transmission and distribution mains. **The System** is illustrated in Figure 14, Recommended Infrastructure Map.

The System has been sized for a total of 3245 connections of which 1339 are Southwest 'B' and 1906 are Southwest 'C' connections. This represents the ultimate projected number of connections for that portion of the Study Area that do not already have City water service. This includes the low density subdivisions (less than or equal to 1 unit/acre) generally located west of FM 1826 and the surrounding rural areas assumed to be developed at 1 unit/5 acres. A total of 404 connections has been designated for the Friendship Ranch Water Control and Improvements District (WCID).

The System will provide storage through a combination of ground storage and elevated storage facilities. Due to the hilly terrain within the Study Area, the proposed Southwest 'B' ground storage facilities will be installed at appropriate elevations so that pressure is maintained throughout the Southwest 'B' distribution system. This eliminates the need for pumps at the ground storage reservoirs and results in an economical alternative for providing the required storage capacity. The proposed Southwest 'C' elevated storage facilities will be installed in the vicinity of the highest elevation within the Study Area to minimize construction costs. Booster pumps will maintain the water levels in the elevated storage facilities, enabling the prescribed water pressure to be maintained. This arrangement will allow the pumps to operate at a uniform rate, with storage either making up or absorbing the difference between the pump discharge and system demand.

The required storage for the ultimate Southwest 'B' and Southwest 'C' systems is 275,000 gallons and 400,000 gallons, respectively. The Southwest 'C' pumping requirements total 2,200 gallons per minute for **The System**. The transmission system consists of two connected looped networks of 6", 8", 12" and 16" diameter pipe. The distribution system has been sized to meet domestic water demands only. Line sizes range from 2" to 4". The distribution lines have been extended to each of the existing subdivisions and portions of the rural areas. Due to the large size of the Study Area, the proposed distribution line network is limited outside of the existing subdivisions. Distribution lines have been proposed in the vicinity of the projected future development. Water service lines have been proposed throughout the existing subdivisions. Water services outside the existing subdivisions will be extended to the nearest transmission or distribution line depending on the remoteness of the water customer. Pressure regulating valves are required to maintain the optimum operating pressures for the Southwest 'B system. Water pressure will be regulated by a combination of individual and transmission and/or distribution line pressure reducing valves.

Table 8 outlines the breakdown of the construction related costs for **THE SYSTEM**. The total construction related cost is $11,180,070. This does not include the $4,497,570 estimated for the cost of service lines between the customer's meter and his house. It should be noted that the $4,497,570 assumes a distribution line in the ground at the homeowner's tract frontage. There may be cases where the proposed house connection is so remote with respect to the distribution line that other arrangements must be made, thus affecting this cost estimate.

TABLE 8
RECOMMENDED SYSTEM - THE SYSTEM
CONSTRUCTION RELATED COSTS
(ULTIMATE CONFIGURATION)

<u>Transmission Mains</u>			
500 LF 16"	$50/LF	$ 25,000	
80,450 LF 12"	$36/LF	2,896,200	
17,450 LF 8"	$21/LF	366,450	
6,000 LF 6"	$19/LF	114,000	
	Subtotal	$3,401,650	
	Contingency 10%	340,165	
	Engineering 20%	748,363	
	TOTAL		$4,490,178
<u>Storage</u>			
SW 'B' ground storage 275,000 gallon		$ 275,000	
SW 'C' elevated storage 400,000 gallon		520,000	
	Subtotal	$ 795,000	
	Contingency 10%	79,500	
	Engineering 20%	174,900	
	TOTAL		$1,049,400
<u>Pumping</u>			
SW 'C'	2,200 gpm	$ 175,000	
	Subtotal	$ 175,000	
	Contingency 10%	17,500	
	Engineering	38,500	
	TOTAL		$ 231,000
<u>Distribution Mains</u>			
64,000 LF 4"	$15/LF	$ 960,000	
64,000 LF 3"	$12/LF	768,000	
36,000 LF 2-1/2"	$10/LF	360,000	
16,000 LF 2"	$ 8/LF	128,000	
	Subtotal	$2,216,000	
	Contingency 10%	221,600	
	Engineering	487,520	
	TOTAL		$2,925,120
<u>Services to Meter Box</u>			
3245 Ea. @ $500/Ea.	Subtotal	$1,622,500	
	Contingency 10%	162,250	
	Engineering	356,950	
	TOTAL		$2,141,700
<u>Meter/PRV</u>			
3245 Ea. @ $80/Ea.	Subtotal	$ 259,600	
	Contingency 10%	25,960	
	Engineering	57,112	
	TOTAL		$ 342,672
HILL COUNTRY INFRASTRUCTURE AND DISTRIBUTION TOTAL			**$11,180,070**
<u>Services to House</u>			
3245 Ea. 150 LF @ $7/LF	Subtotal	$ 3,407,250	
	Contingency 10%	340,725	
	Engineering	749,595	
	TOTAL		$ 4,497,570
	GRAND TOTAL		**$15,677,640**

6. Operation and Maintenance Issues

The phased development of the ultimate system results in more than one Southwest 'B' and Southwest 'C' storage facilities. This will provide improved operation flexibility in the event a reservoir is temporarily removed from service for maintenance. The electrical power source for the proposed pump facilities will be the Pedernales Electric Cooperative, Inc. There is existing electrical service in the vicinity of the proposed pumping facilities. The projected energy costs for servicing the proposed Southwest 'C' service area are estimated by determining the electrical power requirements and using a cost of $0.475/KWH for the first 20,000 KWH and $.0425/KWH over 20,000 KWH. The total estimated electrical operating cost will be approximately $25,367/year for Phase I and $37,139/year for the ultimate system, The System.

The operation and maintenance costs for the different components of the recommended water system have been delineated in Table 9. This Table also includes the costs associated with the general accounting and customer billings.

TABLE 9

HILL COUNTRY WATER SUPPLY
PROJECTED OPERATION AND MAINTENANCE COSTS

	Description	Standard Unit Cost Per Month	Yearly Cost	Comments
1.	General Accounting	$250 per month	$3,000	Payables reviewed once per month
2.	Customer Billings	$3.50/customer*	$50,400*	Billing once per month (or $4,200)
3.	Basic Operations			
	A) Storage & line maintenance	$1,200/lump sum	$14,400	Storage tank & line flushing per Texas Health Dept.
	B) Fire hydrant maintenance	$200/lump sum	$2,500	Maintenance as per manufacturers recommendations
	C) Booster station maintenance	$100/lump sum	$1,200	Maintenance as per manufacturers recommendations w/Landscape maintenance of Booster station and reservoir grounds
	D) Booster Station electrical charge (Phase I)	$2,140 per month	$25,367	Electricity Source: Pedernales Electric Cooperative
4.	Clean tanks (2)		$500	Once per year (lump sum)
5.	Emergency Service	Estimate $400	$5,000 (estimated)	For broken fire hydrants, hydrants, dug up mains and service lines, etc.
	TOTAL	$8,490**	$102,367**	

Note: The accuracy of customer meters decreases as much as 80% over a 5 to 10 year period. With age, meters gradually begin to read less consumption than actual. It is recommended that the maintenance consultant/firm begin a meter testing and change-out program within the first 5 years of operation in order to maintain appropriate revenues. Therefore, there will be additional costs associated with meter replacement, field operations and testing for this period.

*Based on 1200 customers

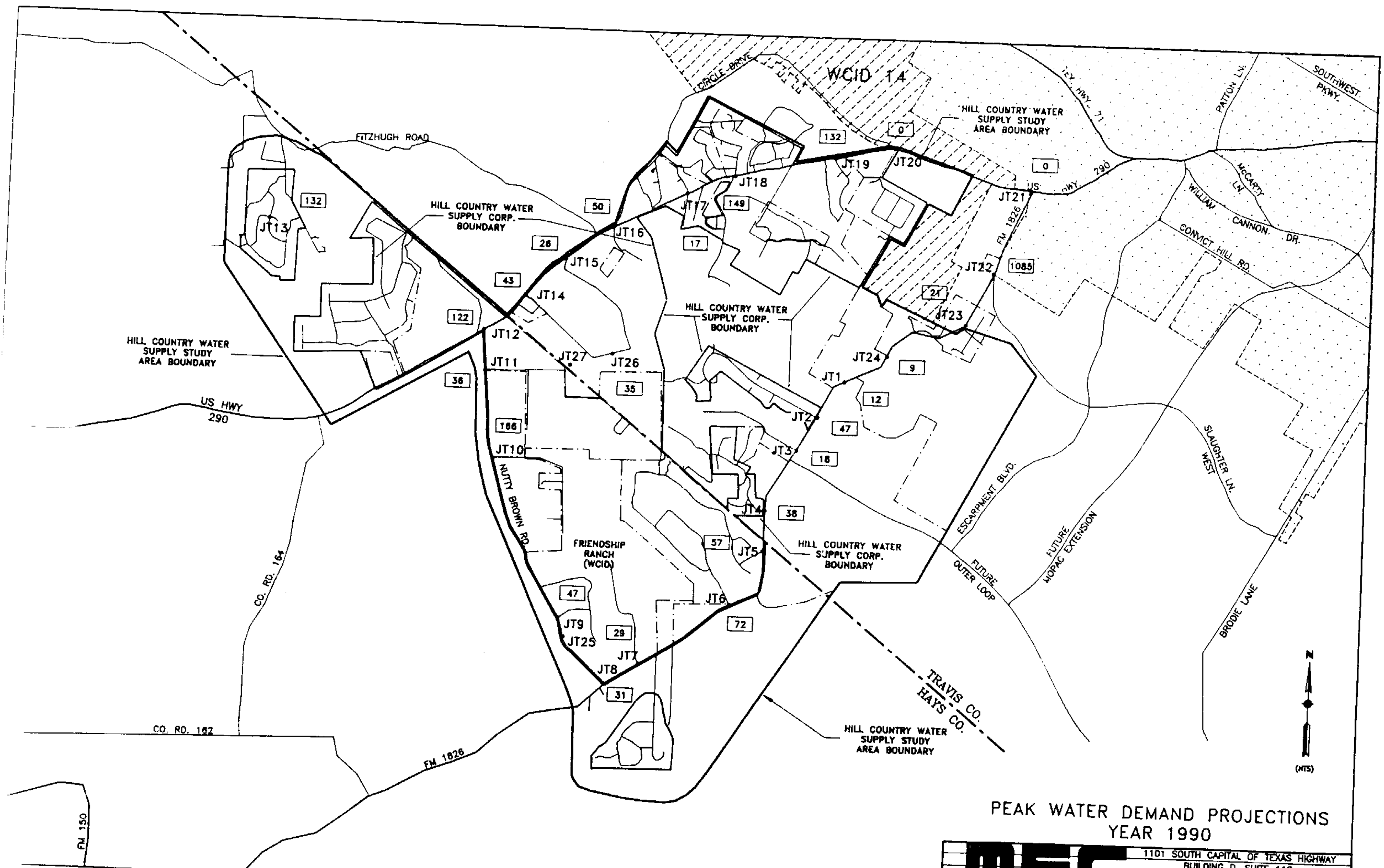
**Assumes repainting of Phase I storage tanks will occur when Phase II storage tanks are constructed.

7. Phasing of Recommended Water System

This report recommends **The System** be implemented as a three (3) phase development. Phasing is considered in ten year increments (year 2000, 2010 and 2020) in order to minimize initial construction costs and long term operation and maintenance costs. The proposed phasing has been developed based on the projected population growth, land uses and projected water demand areas identified for the Study Area. These population forecasts and water demands should be reviewed periodically throughout the study period and adjusted as needed to ensure the appropriate water system improvements are constructed to accommodate the needs of the Study Area. Figures 15, 16, 17 and 18 illustrate the water demands and demand centers for 1990, 2000, 2010, and 2020, respectively.

Table 10 presents a breakdown of the proposed construction related costs by Phase. The total accumulated construction related costs for **The System** (ultimate configuration) when built according to the three (3) proposed phases amount to $13,313,414 in today's dollars. The additional $2,133,344 in construction related cost (Table 8 vs. Table 10) is attributed to several factors. The transmission main costs increase slightly due to the additional mains associated with providing more than one storage facility for each pressure plane. The total distribution system costs represent the largest increase. The distribution system costs estimated for Phases II and III have been projected using an equivalent cost per connection of $1,530 derived from Phase I (1561 connections - design year 2000) and a distribution line construction cost of $2,387,880. These costs represent pro-rata projected costs for estimating purposes. Phasing construction of the distribution system will result in some parallel lines thus increasing the construction related costs; therefore, it is recommended that distribution lines be looped and interconnected wherever possible. This in turn will increase the service potential or capacity and preclude the need for parallel systems in many cases.

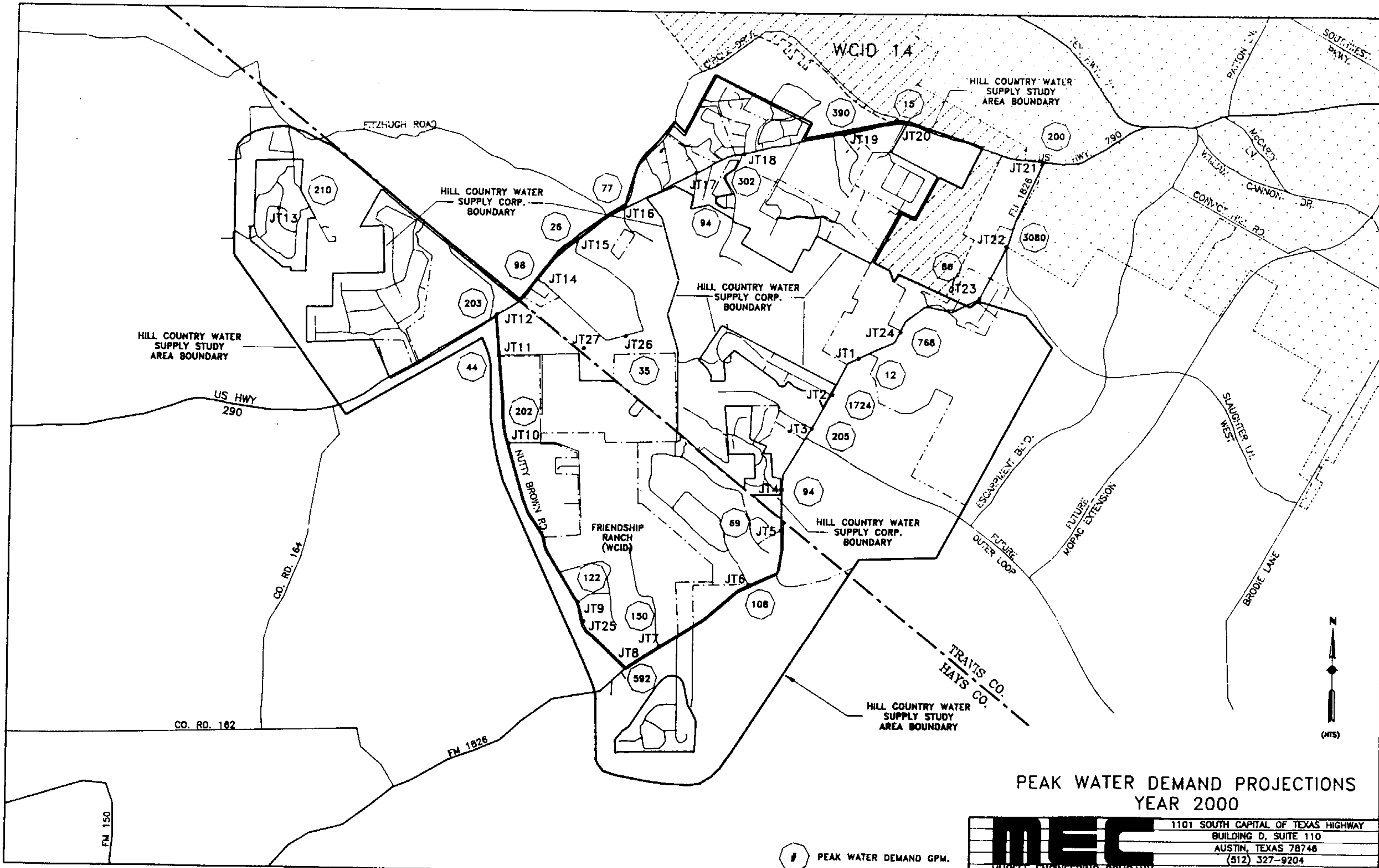
The System provides a minimum fire flow of 500 gpm throughout the transmission main portion of the system. Therefore, fire protection is provided along the major roads within the Study Area. These roads include FM 1826, Highway 290 and Nutty Brown Road. The distribution system, regardless of phasing, has not been sized to accommodate fire flow. A minimum 6" diameter distribution network would be required to provide fire protection. The proposed storage facilities have capacity available for emergency fire flow so that any future expansion of the distribution system can be retrofitted with 6" diameter pipe at an additional expense to the Study Area, if so desired.



PEAK WATER DEMAND PROJECTIONS
YEAR 1990

PEAK WATER DEMAND GPM.

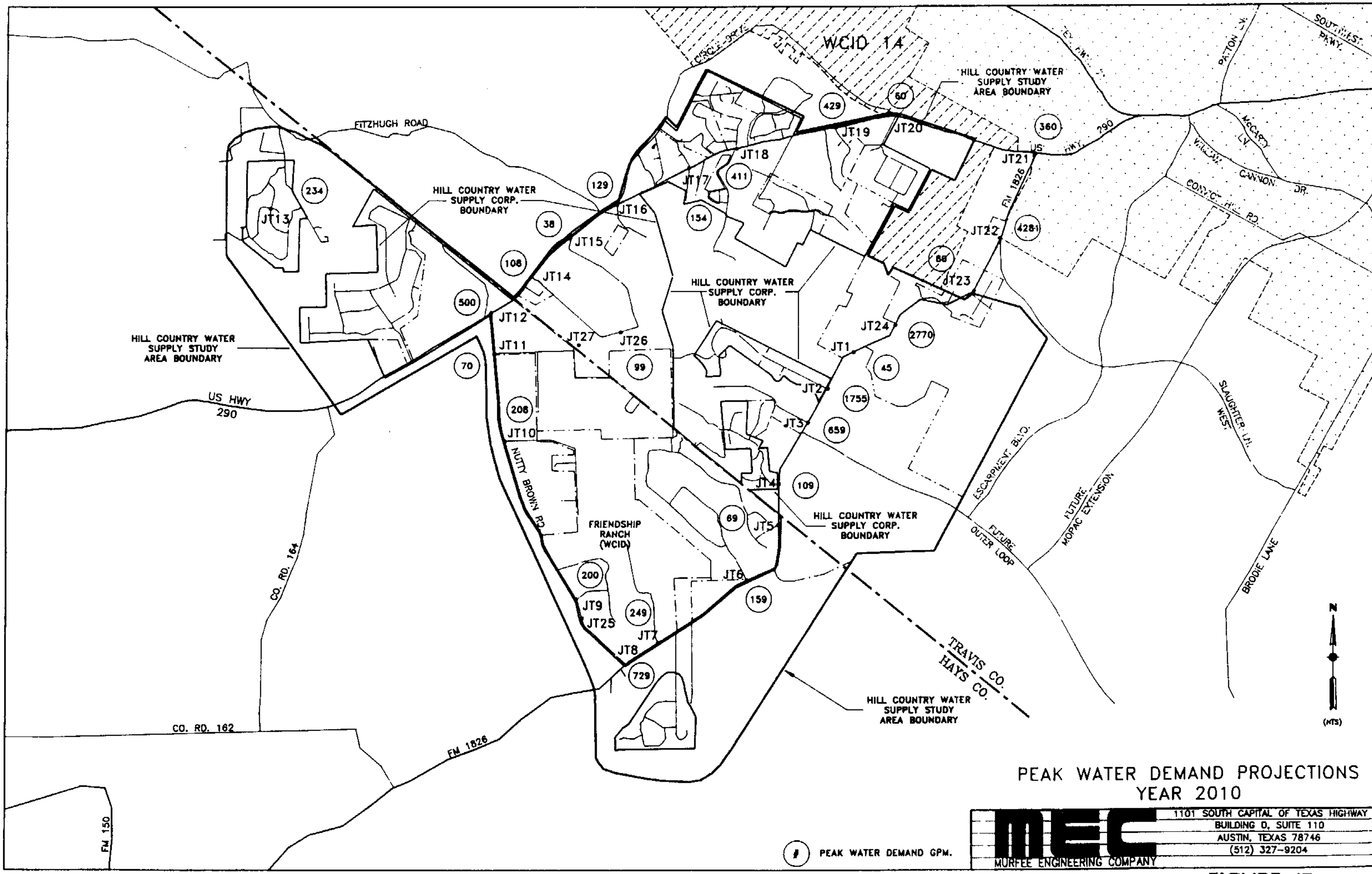
MEC
MURFEE ENGINEERING COMPANY
1101 SOUTH CAPITAL OF TEXAS HIGHWAY
BUILDING D, SUITE 110
AUSTIN, TEXAS 78746
(512) 327-9204



PEAK WATER DEMAND PROJECTIONS
YEAR 2000

MEC
MURFEE ENGINEERING COMPANY
1101 SOUTH CAPITAL OF TEXAS HIGHWAY
BUILDING D, SUITE 110
AUSTIN, TEXAS 78746
(512) 327-9204

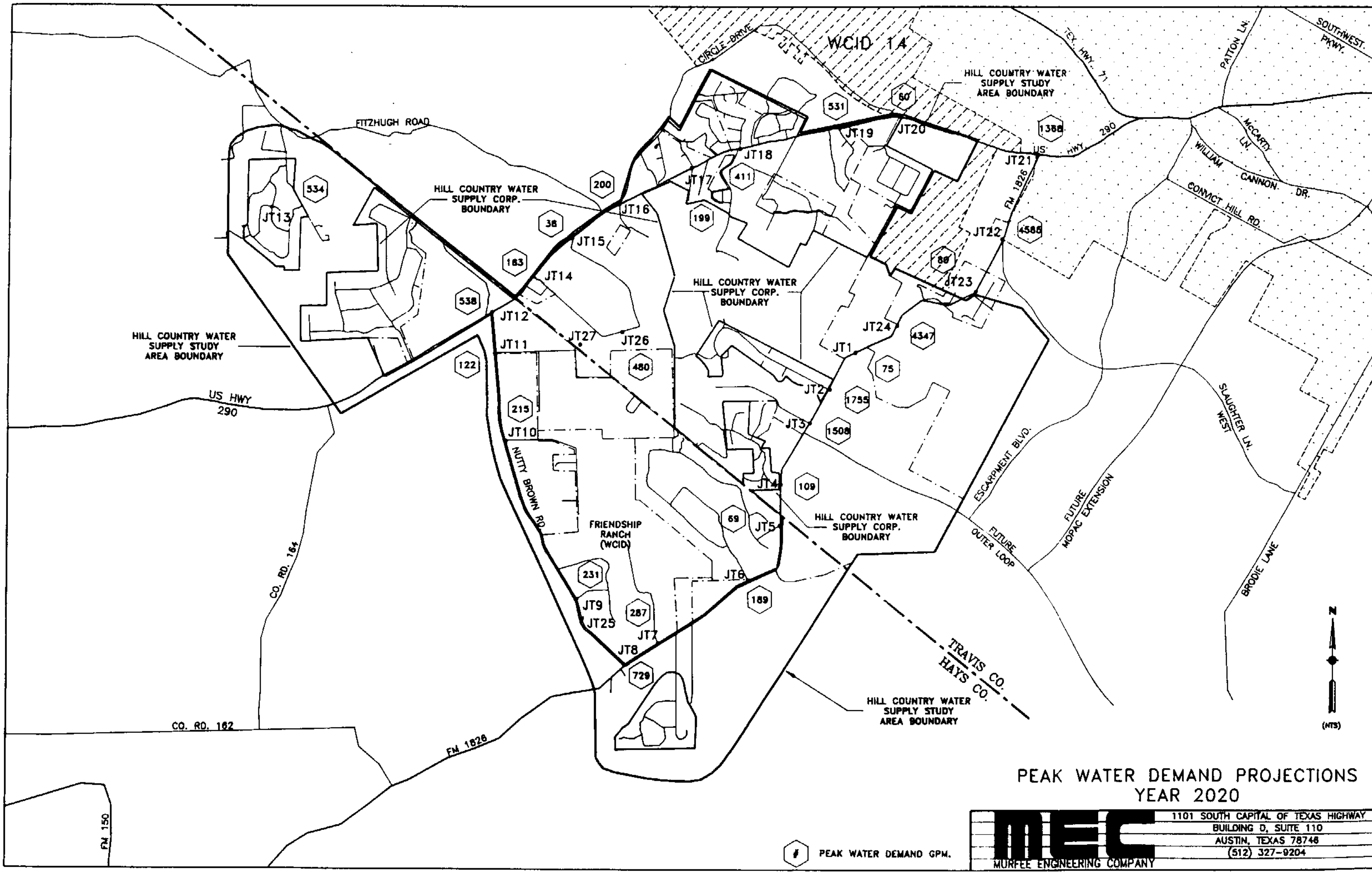
FIGURE 16



PEAK WATER DEMAND PROJECTIONS
YEAR 2010

MEC
MURFEE ENGINEERING COMPANY
1101 SOUTH CAPITAL OF TEXAS HIGHWAY
BUILDING D, SUITE 110
AUSTIN, TEXAS 78746
(512) 327-9204

FIGURE 17



PEAK WATER DEMAND PROJECTIONS
YEAR 2020

MEC
MURFEE ENGINEERING COMPANY
1101 SOUTH CAPITAL OF TEXAS HIGHWAY
BUILDING D, SUITE 110
AUSTIN, TEXAS 78746
(512) 327-9204

FIGURE 18

TABLE 10

PHASING OF CONSTRUCTION RELATED COSTS[1]

	Phase I	Phase II	Phase III	TOTAL
Transmission Mains	$4,378,242	$ 125,000	$ 24,000	$4,527,242
Storage	508,200	270,600	270,600	1,049,400
Pumping	132,000	90,000	66,000	288,000
Distribution Mains	2,387,880	1,488,690[2]	1,087,830[2]	4,964,400[2]
Services to Meter Box[3]	792,000	880,440	469,260	2,141,700
Meter/PRV	126,720	140,870	75,082	342,672
Subtotal	$8,325,042	$2,995,600	$1,992,772	$13,313,414
Services to House[4]	1,663,200	1,848,924	985,446	4,497,570
TOTAL	$9,988,242	$4,844,524	$2,978,218	$17,810,984

[1]Construction Related Costs include construction, contingency and engineering, surveying, geotechnical and other support.

[2]Due to size of the Study Area, scattered development outside of the existing subdivisions, and many unknown factors regarding where future development will occur; the distribution system costs for Phases 2 and 3 have been estimated at the equivalent cost/connection utilized for the Phase I design year 2000 (1561 connections).

[3]Assumes the service line is extended to the lot. The distance to the lot from the distribution main is assumed to be 50 feet. Distribution line costs will increase with distance. Phase I assumes 1200 water services, Phase II - 1334, Phase III - 711.

[4]Assumes the service line from the property line to the house is 150 feet. Costs will increase as this distance increases.

The Phase I system depicted in Figure 19 consists of constructing transmission, distribution and service lines, storage tanks, and pumping facilities. Table 11 provides a breakdown of the construction-related costs for Phase I. The storage, pumping, and distribution facilities have been designed for the year 2000 projected population (1561 Living Unit Equivalents) and a 500 gpm demand for future development at the southernmost point of the Study Area. Phase I includes water service lines for only 1200 customers since the Texas Water Development Board (TWDB) has indicated this would be a preferred customer base for finance participation.

The transmission system proposed for Phase I is sized to accommodate the ultimate (year 2020) water demands on the system. By constructing the ultimate transmission network in Phase I, substantial savings are realized. The construction cost difference between an interim transmission system and the proposed ultimate transmission system is approximately $325,000. The construction of the ultimate transmission system as part of Phase I guarantees that system capacity is available for growth and therefore additional revenue. This capacity will provide incentive for growth within the Study Area. Downsizing this element of the system will result in redundant costs later when new demand areas are identified. Other elements of the system such as storage and pumping can be more easily upgraded due to their site specific nature.

Phase I proposes storage facilities sized to meet projected demands through the year 2000. These facilities consist of a 125,000 gallon Southwest 'B' ground storage reservoir and a 200,000 gallon Southwest 'C' elevated storage tank. Booster pumping facilities are proposed as part of the Phase I Southwest 'C' improvements. A 1100 gpm Southwest 'C' pump station is proposed which will meet the maximum day demands projected through the year 2000.

TABLE 11

BREAKDOWN OF PHASE I - THE SYTSTEM CONSTRUCTION RELATED COSTS

Transmission Mains			
80,900 LF 12"	$36/LF	$2,912,400	
17,450 LF 8"	$21/LF	366,450	
2,000 LF 6"	$19/LF	38,000	
	Subtotal	$3,316,850	
	Contingency 10%	331,685	
	Engineering 20%	729,707	
	TOTAL		$4,378,242
Storage			
SW "B" ground storage	125,000 gallons	$125,000	
SW "C" elevated storage	200,000 gallons	260,000	
	Subtotal	$385,000	
	Contingency 10%	38,500	
	Engineering 20%	84,700	
	TOTAL		$508,200
Pumping			
SW "C"	1100 gpm	$100,000	
	Subtotal	$100,000	
	Contingency 10%	10,000	
	Engineering 20%	22,000	
	TOTAL		$132,000
Distribution Mains			
37,000 LF 4"	$15/LF	$555,000	
58,000 LF 3"	$12/LF	696,000	
39,000 LF 2 1/2"	$10/LF	390,000	
21,000 LF 2"	$8/LF	168,000	
	Subtotal	$1,809,000	
	Contingency 10%	180,900	
	Engineering 20%	397,980	
	TOTAL		$2,387,880
Services to Meter Box			
1200 EA	$500/EA	$600,000	
	Subtotal	$600,000	
	Contingency 10%	60,000	
	Engineering 20%	132,000	
	TOTAL		$792,000
Meter/PRV			
1200 EA	$80/EA	$96,000	
	Subtotal	$96,000	
	Contingency 10%	9,600	
	Engineering 20%	21,120	
	TOTAL		$126,720

TABLE 11
(continued)

PHASE I - HILL COUNTRY INFRASTRUCTURE			$8,325,042
Services to House			
1200 EA	150 LF @ $7/LF	$1,260,000	
	Subtotal	$1,260,000	
	Contingency 10%	126,000	
	Engineering 20%	277,200	
	TOTAL		$1,663,200
	GRAND TOTAL		**$9,988,242**

Distribution lines proposed as part of the Phase I construction have been sized for the ultimate domestic demands within the existing subdivisions. Outside of the existing subdivisions in the rural areas, the distribution network is limited. Many distribution lines either dead end (plugged for later extension or connection) or have been sized based on where development is forecast between 1990 and 2000. By phasing the distribution system in this manner, a substantial savings can be realized initially; however, it may mean that parallel distribution lines will be required as development occurs in the future. It is recommended the distribution lines be phased this way since no one knows for certain if the areas where growth has been projected will actually occur as forecasted. This phasing will also allow flexibility for planning future distribution lines as growth occurs in other areas. Again looping is encouraged whenever and wherever possible. This will also allow smaller lines to carry a greater capacity and may avoid parallel construction of distribution and service extensions.

The recommended Phase II improvements are sized to accommodate the year 2010 customer and demand projections. These improvements consist of extending the distribution lines to accommodate development and service lines to accommodate an additional 1334 connections. Projections for the year 2010 forecast an additional 384 Southwest 'B' connections and 589 Southwest 'C' connections between the years 2000 and 2010 associated with storage and pumping facilities. Additional storage and associated transmission piping is proposed for the Southwest 'B' and Southwest 'C' systems. The recommended Phase II storage facilities include a 75,000 gallon Southwest 'B' ground storage reservoir and a 100,000 gallon Southwest 'C' elevated storage tank. Southwest 'C' system pumping requirements include an additional capacity of 600 gpm.

The recommended Phase III improvements will upgrade the system to accommodate the projected ultimate peak demands for the year 2020. Distribution and service lines will be extended to accommodate development. Expansion of the storage and pumping facilities will be necessary to serve the additional 331 Southwest 'B' connections and 380 Southwest 'C' connections projected for the year 2020. The Phase III improvements will include a 75,000 gallon Southwest 'B' ground storage reservoir, a 100,000 gallon Southwest 'C' elevated storage tank, and an additional Southwest 'C' pumping capacity of 500 gpm. It is important that growth within the Study Area be tracked so that any expansion of the system will be constructed as the water demands dictate. It is possible growth may dictate that Phase III pumping and storage improvements be constructed concurrent with Phase II.

The existing City of Austin Southwest 'B' facilities which impact the Study Area consist of a 36" transmission main connecting the 15,000 gpm Southwest 'B' pump station located along Slaughter Lane at the intersection with FM 1826 and the 2 mg Southwest 'B' elevated storage tank located approximately 10,000 feet south of Slaughter Lane along FM 1826. The 15,000 gpm Southwest 'B' pump station is designed to serve a population of 50,000 assuming a per capita maximum day demand of 0.3 gpm/capita.

The 1985 Preliminary Engineering Report - Southwest 'B' System Improvements defines the City of Austin Southwest 'B' water service area. The defined pump station service area includes Circle C West and portions of Circle C MUD(s) #3 and #4, Shadowridge Crossing, Upper Williamson Creek, Del Curto and Hielscher tracts. FM 1826 is the western boundary for the service area. These areas have been projected at a residential and employment base design population of 33,700; therefore, based on the 1985 report, there is approximately 5000 gpm of additional capacity at the Southwest 'B' pump station. The 1985 report indicates this additional pump capacity might be used to serve the Southwest 'B' system north of Highway 290 W. In addition to this 5000 gpm pump capacity, the existing 39,000 gpm Southwest 'A' Davis Lane pump station will provide approximately 12,000 gpm of water to the Southwest 'B' system based on a Southwest 'A' service population of 89,636.

Based on the population forecasts developed in this report and the following assumptions regarding storage requirements, the existing La Crosse 2 MG Southwest 'B' elevated storage tank will approach its capacity sometime around the year 2000 and the second funded 2 MG reservoir will be required. A storage capacity of 200 gallons per connection is required for the portion of the Hill Country Water Supply (HCWS) Study Area located outside of the City of Austin's existing Southwest 'B' service area. The subdivisions located south of Highway 290 West within the boundaries of the City's Southwest 'B' service area, including those situated within the HCWS Study Area, require 200 gallons per capita storage capacity or 560 gallons per connection. Table 12 which follows shows the effect of the recommended population projections presented in Table 5 on the existing City Southwest 'B' storage facility.

Table 12 defines the required storage capacity in gallons. An Extended Period Simulation (EPS) of the University of Kentucky water model was utilized to determine storage requirements and review the impact of the HCWS Study Area water demands on the City of Austin storage facilities.

TABLE 12

REQUIRED STORAGE CAPACITY OF SOUTHWEST 'B' SYSTEM

Year	Within HCWS Study Area Density < 1 Unit/Ac. (Gallons)	Within HCWS Study Area Density > 3 Unit/Ac. (Gallons)	Total HCWS Study Area (Gallons)	SW 'B' Service Area Outside Study Area (Gallons)	Total Storage Req't (Gallons)
1990	169,800	253,200	423,000	33,600	456,600
2000	312,200	1,256,600	1,568,800	320,000	1,888,800
2010	506,800	2,022,800	2,529,600	846,000	3,375,600
2020	649,000	2,714,200	3,363,200	846,000	4,209,200

H. Institutional, Legal and Financial Analysis

1. Entities Which Affect Implementation of a Regional Water System

There are numerous legal entities with the power to control, construct, own and operate water systems. These different entities and their impact on the implementation of a regional water system are described as follows:

Texas Water Commission

The Texas Water Commission (TWC) has the general authority to control the use of surface and subsurface waters in the State of Texas. The TWC is the issuing authority of Certificates of Convenience and Necessity (CCN). The TWC has the authority to review the tax rates proposed by the holder of the CCN. The review is conducted by the TWC staff who in turn make recommendations to the Texas Water Commission Board. A public hearing is conducted so that the tax payers are given the opportunity to participate in the process. The TWC would review tax rates set by the City of Austin and/or LCRA. The TWC would not review rates set by a non-profit water supply corporation. The rates proposed by a corporation could be addressed in the contractual agreement with the funding agency. The TWC also has the authority to prevent waste of water through negligence. This power could probably extend to regulating the various utility programs.

Texas Water Development Board

The Texas Water Development Board (TWDB) acts as the implementing agency of water development projects for the State of Texas. The TWDB would be the funding agency for improvements within the Hill Country Study Area.

Guadalupe-Blanco River Authority

The Guadalupe-Blanco River Authority (GBRA) and other river authorities were created by the legislature at the request of the federal government in order to implement flood control and related activities within the State of Texas. The Hays County portion of the Study Area is located within the jurisdiction of the Guadalupe-Blanco River Authority. In discussions with the GBRA it was felt that the LCRA was the logical choice to serve the northern portion of Hays County, since it is located entirely within the Lower Colorado River Basin and GBRA permission for the LCRA to serve this area would probably be granted.

Lower Colorado River Authority

The Lower Colorado River Authority (LCRA) like the GBRA was created by the State Legislature at the request of the federal government. The LCRA owns large reservoirs with potential capacity for surface water supplies for the Study Area. The LCRA has indicated it is interested in owning wholesale water supply systems and is currently investigating the feasibility of serving the Study Area as part of its proposed regional water plan. Hays County is not within the LCRA's service area; however, as a result of the LCRA and GBRA discussions, the LCRA, if requested, would pursue implementation of this portion of their regional plan. The LCRA also does not have taxing authority but may use system revenues to finance construction and maintenance as well as make available engineering staff and provide legal assistance for implementing the project. As mentioned in earlier sections, the LCRA policy is to contract with political subdivisions such as districts in order to assure a tax base for debt retirement.

City of Austin

The City of Austin can provide water service to the Study Area. The City's service area extends to FM 1826. The City has the authority to extend its service outside of its city limits. The City has expressed interest in providing water as a wholesale supplier only. The Hill Country Water Supply Corporation and the City currently have a three year contract which commits the City to provide wholesale water service up to a maximum of 2 million gallons per day. A new contract must be negotiated for the term of the funding before financing will be approved by the TWDB. The City will possibly be a short term wholesale water supplier if the LCRA implements its regional water service area. This issue will be taken into consideration during contract negotiations.

Hill Country Water Supply Corporation

The Hill Country Water Supply Corporation is a non-profit Texas corporation controlled by its members. A CCN would be required for any areas the corporation provides water service. The corporation does not have taxing authority and would be limited to revenue bonds to finance the system. Rates of the corporation would not be subject to Texas Water Commission review unless a complaint was filed. A contract would be required with all wholesale customers requiring payment of tap fees or other fees in an amount sufficient to cover debt service for construction and operation and maintenance of the system.

2. Recommended Involvement of Various Institutions

It is important that the participants of the Hill Country Water Supply Study Area explore all potential options for a surface water supply. Contractual negotiations are enhanced greatly when service issues and commitments have been identified. Two potential service entities, the Lower Colorado River Authority and the City of Austin, have been discussed throughout this report.

City of Austin water supply infrastructure is in place within the boundaries of the Study Area. A three year water service contract between the City and HCWSC has been negotiated; however, the contract period is near its expiration date. New negotiations with the City need to proceed toward an ultimate service goal. These negotiations should include input from the Texas Water Development Board (TWDB) and meet all applicable TWDB regulations regarding funding. If it is decided that a special utility district (SUD) is to be utilized, the TWC must also review and approve the District's creation document. Since the infrastructure is in place, City of Austin water is the most immediately available source. Regardless of the LCRA's plans to ultimately serve the Study Area, consideration should be given to the availability of water, flexibility of service and the needs of the Study Area when negotiating a water service contract with the City of Austin.

As mentioned previously, the LCRA will not entertain serving the Study Area unless requested. This request should be made immediately since it is imperative that the LCRA and the City of Austin address necessary intergovernmental issues as soon as possible so that negotiations between the Study Area and the LCRA can address cost comparisons. Again, this service potential implies different contractual arrangements than does service from the City of Austin. It is the policy of the LCRA to contract with other political subdivisions, such as districts.

There are other entities which may be involved in this service negotiation process. The City of Dripping Springs will be interested in a Certificate of Convenience and Necessity (CCN) which overlaps their extraterritorial jurisdiction (i.e., the Heritage Oaks and Big Country subdivisions). The Texas Water Commission will review the CCN application and must be kept informed as to area's service plans. THe Guadalupe-Blanco River Authority (GBRA) will be concerned with water service within their statutory area - Hays County. The Hays County Commissioner's Court created the Friendship Ranch WCID and will therefore need to be informed if this political subdivision is to be included in the adopted service plan of the Study Area. The Travis County Commissioner's Court will also be interested in a service plan for this area since it now serves some of the residents by trucking water. It is advised that representatives of the Study Area meet with and discuss these issues with these entities to elicit aid in their endeavor to supply safe and adequate surface water supply to the Study Area.

In addition, there may be other entities that will be involved with the implementation of water service to the Study Area. It is necessary to work closely with local representatives, financial consultants, legal consultants, engineers, and state and local agencies in order to identify other entities which must be involved in the process.

3. Legal Implementation

The entity designated to provide retail water service to land within the Study Area must have the legal authority to provide this service. A Certificate of Convenience and Necessity (CCN) is the permit which empowers the designated entity to provide water service. The Texas Water Code, Chapter 13, and the Texas Water Commission Rules and Regulations, 31 TAC 291.101 et. al., established procedures and requirements for obtaining a Certificate of Convenience and Necessity. A CCN grants to the holder the right and obligation to provide adequate and continuous water utility service to a designated area of land.

The type entity which will ultimately provide water service to the Study Area affects the review of the Certificate of Convenience and Necessity (CCN) application. As established, the existing non-profit Water Supply Corporation should request a CCN in order to define its service area boundary and preclude any other entities not holding a CCN from providing water service to the same area. In the event a regional utility, such as the LCRA, provides retail water service to the Study Area, then that entity should apply for the CCN. If more than one CCN is applied for, it is important the various entities coordinate so that a cooperative service plan is presented to the Texas Water Commission. If any certificates exist or are issued overlap the Study Area, these certificates must be amended. If the applying entity has the authority to incur long term debt and assess taxes to repay the debt, the applicant may have an advantage over competing entities since it can demonstrate a mechanism exists to retire its debt.

Before a Certificate of Convenience and Necessity can be approved, several issues must be addressed to the satisfaction of the Texas Water Commission. These issues include (1) the adequacy of the existing system, (2) need of additional service in the Study Area, (3) the impact of issuance of the CCN upon the recipient and any retail public entity providing the same kind of service in the area, (4) the ability of the CCN applicant to provide adequate service, (5) the environmental integrity, and (6) the probable improvement of service or decreased costs to the Study Area customers resulting from issuance of the CCN. The applicant must submit detailed information showing it has the ability to provide adequate and continuous water service to its customers at a reasonable cost, to fund necessary capital improvements, and to operate and maintain the system. A continuous water source must be demonstrated and a long term contract with this water source negotiated. Lastly, prior to submitting the application, the entity should have the support of its potential customers to avoid any delays in this several month process. If there is dissension within the service area, the TWC can conduct public hearings to ascertain the appropriate action. This process can become time consuming and delay the CCN application.

4. Customer Fees

Table 13 outlines the estimated customer fees associated with Phase I assuming a 1200 customer base. The Table identifies the initial fees to be paid by the customer at the time of hookup and the monthly fees. The monthly fees have been estimated for two (2) scenarios. The corporation scenario assumes the Hill Country Water Supply Corporation (HCWSC) remains a non-profit Texas corporation. The District scenario assumes the HCWSC becomes a District, such as a Special Utility District (SUD). The estimated monthly costs include a water usage fee, bond retirement fee and operation and maintenance fee. The water usage fee is based on an average water use of 150 gallons per capita per day. The bond requirement fees include construction costs, contingencies, legal fees, fiscal agent fees and engineering/surveying fees. It assumes a capitalized interest rate of 10% for the corporation and 8% for the district for 18 months. The capitalized interest is not allowed as part of the bond issue for the corporation and therefore will have to be financed privately. The retirement of this debt to the lender may be retired through the rate, tap fee, or surcharge depending on the contractual arrangements make with the lender or with the water supply corporation participants. Capitalized interest is allowed in the bond issue for the district scenario. Tables 14 and 15 outline the costs identified for the bond issue requirements of the corporation and district scenarios, respectively. The operation and maintenance (O&M) fee is estimated utilizing the O&M cost identified in Table 9 presented earlier in this report.

Table 13 indicates the district scenario as the less expensive alternative. Comparing the district scenario costs to the individual water well also illustrates the district as the less expensive and more reliable water service option:

Individual Well (Complete System @ 10%)		$149.00
System Maintenance		15.00
Electrical Cost		15.00
	Subtotal	$179.00
Water Softener/Salt		$ 22.00
Bottled Water or Special Treatment		16.00
	Subtotal	$ 38.00
TOTAL ESTIMATED MONTHLY COST		$217.00

Based on the assumptions presented in Table 13, the district scenario monthly cost runs approximately 55% of the individual water well monthly costs as described in Section 3 Comparison of Individual Water Well System and Centralized Surface Water System Cost.

TABLE 13

ESTIMATED CUSTOMER FEES

Initial Customer Costs		
City of Austin Capital Recovery Fee		$1,200
Corporation/District Tap Fee[1]		1,300
Service Line to House/Plumbing Modifications[2]		1,050
	Total Initial Cost	$3,550

Monthly Costs (assuming 1200 customers)	Corporation[3]	District
Estimated Water Usage Fee	$ 33.00	$ 33.00
Estimated Bond Retirement Fee	$ 83.00	$ 79.00
Estimated Operation and Maintenance Fee	$ 7.00	$ 7.00
Subtotal	$123.00[4]	$119.00[4]

[1]Per information provided previously by Hill Country Water Supply Corporation.

[2]Service line to house assumes extension of service line for approximately 150 feet. If the actual distance is greater, then this cost will increase. Plumbing modifications include those modifications needed to convert to the centralized surface water system.

[3]The monthly cost for the corporation scenario should include financing for the capitalized interest calculated to be $1,390,399. This cost has not been included in the $123.00/month charge.

[4]This is not a bond application. These numbers will necessarily be modified to reflect the rules of the TWDB and the Board of Directors of HCWSC. The final bond issue numbers will be calculated by the financial advisor upon bond application.

TABLE 14

BOND PROJECT - CORPORATION
COST SUMMARY

<u>Construction Costs</u>	
Water Transmission	$3,316,850
Storage	385,000
Pumping	100,000
Water Distribution	1,809,000
Service to Lot	600,000
Water Meter/PRV	96,000
Contingencies 10%	630,685
Engineering, Surveying, Geotechnical, etc.	1,387,507
Total Hard Construction Costs	$8,325,042
<u>Non-Construction Costs</u>	
Legal	$ 140,000
Fiscal Fees	145,549
Bond Issue Cost	19,409
Total Non-Construction Costs	$ 304,958
Total Bond Issue Requirements	$8,630,000

TABLE 15

BOND PROJECT - DISTRICT
COST SUMMARY

Construction Costs	
Water Transmission	$3,316,850
Storage	385,000
Pumping	100,000
Water Distribution	1,809,000
Service to Lot	600,000
Water Meter/PRV	96,000
Contingencies 10%	630,685
Engineering, Surveying, Geotechnical, etc.	1,387,507
Total Hard Costs	$8,325,042
Non-Construction Costs	
Legal	$ 140,000
Fiscal Fees	145,549
Capitalized Interest	1,096,424
Bond Issue Cost	18,985
Total Non-Construction Costs	$1,400,958
Total Bond Issue Requirements	$9,726,000

APPENDIX A

AMORTIZATION SCHEDULES

AMORTIZATION SCHEDULE
CORPORATION SCENARIO

Year	Annual Accrued Interest	Annual Amortization	Total Annual Payment
1	903,674	0	0
2	985,758	96,319	595,352
3	983,062	207,641	1,190,704
4	961,319	229,384	1,190,704
5	937,300	253,404	1,190,704
6	910,765	279,938	1,190,704
7	881,452	309,251	1,190,704
8	849,069	341,634	1,190,704
9	813,296	377,408	1,190,704
10	773,776	416,927	1,190,704
11	730,119	460,585	1,190,704
12	681,889	508,814	1,190,704
13	628,610	562,094	1,190,704
14	569,751	620,952	1,190,704
15	504,730	685,974	1,190,704
16	432,899	757,804	1,190,704
17	353,547	837,156	1,190,704
18	265,886	924,818	1,190,704
19	169,046	1,021,658	1,190,704
20	62,065	1,128,639	1,190,704
TOTAL	13,398,015	10,020,399	22,028,015

Assumptions:

1) Interest Rate - 10.00%.

2) Capitalized Interest after 18 months is $1,390,399.

AMORTIZATION SCHEDULE
DISTRICT SCENARIO

Year	Annual Accrued Interest	Annual Amortization	Total Annual Payment
1	807,288	0	0
2	864,733	132,247	568,545
3	856,242	280,848	1,137,091
4	832,932	304,159	1,137,091
5	807,687	329,404	1,137,091
6	780,347	356,744	1,137,091
7	750,737	386,354	1,137,091
8	718,670	418,421	1,137,091
9	683,941	453,150	1,137,091
10	646,330	490,761	1,137,091
11	605,597	531,494	1,137,091
12	561,483	575,607	1,137,091
13	513,708	623,383	1,137,091
14	461,968	675,123	1,137,091
15	405,933	731,158	1,137,091
16	345,247	791,844	1,137,091
17	279,525	857,566	1,137,091
18	208,347	928,744	1,137,091
19	131,262	1,005,829	1,137,091
20	47,778	1,089,312	1,137,091
TOTAL	11,309,757	10,962,146	21,036,181

Assumptions:

1) Interest Rate - 8.00%

2) Capitalized Interest after 18 months is $1,096,424.

APPENDIX B

WATER MODELS

SCENARIO #1

TRANSMISSION MAINS SIZED FOR HCWSC

& LOW DENSITY PORTION OF HCWS STUDY AREA ONLY

FLOWRATE IS EXPRESSED IN GPM AND PRESSURE IN PSIG

A SUMMARY OF THE ORIGINAL DATA FOLLOWS

PIPE NUMBER	NODE NUMBERS		LENGTH (FEET)	DIAMETER (INCHES)	ROUGHNESS	MINOR LOSS K	FIXED GRADE
1	0	1	50.0	36.0	100.0	0.00	1140.00
2	1	2	2000.0	12.0	100.0	0.00	
3	2	3	2000.0	12.0	100.0	0.00	
4	3	4	3000.0	12.0	100.0	0.00	
5	4	5	2000.0	12.0	100.0	0.00	
6	5	6	3500.0	12.0	100.0	0.00	
7	6	7	4750.0	12.0	100.0	0.00	
8	7	8	2500.0	12.0	100.0	0.00	
9	8	25	4000.0	8.0	100.0	0.00	
10	25	9	50.0	8.0	100.0	0.00	
THERE IS A CHECK VALVE IN LINE NUMBER 10							
11	9	10	9000.0	8.0	100.0	0.00	
12	10	11	4400.0	8.0	100.0	0.00	
13	11	12	2000.0	12.0	100.0	0.00	
14	0	12	100.0	16.0	100.0	0.00	1315.00
15	12	13	14100.0	12.0	100.0	0.00	
16	12	14	2000.0	12.0	100.0	0.00	
17	14	15	3400.0	12.0	100.0	0.00	
18	2	26	8000.0	12.0	100.0	0.00	
19	0	26	100.0	16.0	100.0	0.00	1140.00
20	26	27	2500.0	12.0	100.0	0.00	
THERE IS A CHECK VALVE IN LINE NUMBER 20							
21	27	11	4000.0	12.0	100.0	0.00	
22	0	27	50.0	16.0	100.0	0.00	1140.00
THERE IS A PUMP IN LINE 22 WITH USEFUL POWER =					70.00		
23	15	16	3000.0	12.0	100.0	0.00	
24	16	17	4000.0	12.0	100.0	0.00	
25	17	18	2500.0	12.0	100.0	0.00	
26	18	19	5000.0	12.0	100.0	0.00	
27	20	19	3000.0	12.0	100.0	0.00	
28	21	20	7200.0	12.0	100.0	0.00	
THERE IS A CHECK VALVE IN LINE NUMBER 28							
29	22	21	5100.0	36.0	100.0	0.00	
30	23	22	4600.0	36.0	100.0	0.00	
31	24	23	2500.0	36.0	100.0	0.00	
32	1	24	2700.0	36.0	100.0	0.00	

JUNCTION NUMBER	DEMAND	ELEVATION	CONNECTING PIPES			
1	75.00	1035.00	1	2	32	
2	127.00	993.00	2	3	18	
3	3.00	993.00	3	4		
4	107.00	983.00	4	5		
5	69.00	982.00	5	6		
6	129.00	910.00	6	7		
7	287.00	950.00	7	8		
8	729.00	945.00	8	9		
9	200.00	1000.00	10	11		
10	215.00	1108.00	11	12		
11	132.00	1170.00	12	13	21	
12	538.00	1190.00	13	14	15	16

13	534.00	1201.00	15		
14	183.00	1160.00	16	17	
15	38.00	1076.00	17	23	
16	200.00	1115.00	23	24	
17	199.00	1077.00	24	25	
18	411.00	1110.00	25	26	
19	531.00	981.00	26	27	
20	60.00	1070.00	27	28	
21	1368.00	953.00	28	29	
22	4585.00	1000.00	29	30	
23	80.00	900.00	30	31	
24	4347.00	930.00	31	32	
25	0.00	1030.00	9	10	
26	490.00	1030.00	18	19	20
27	0.00	1030.00	20	21	22

OUTPUT SELECTION: ALL RESULTS ARE OUTPUT EACH PERIOD

THIS SYSTEM HAS 32 PIPES WITH 27 JUNCTIONS ,   2 LOOPS AND   4 FIXED GRADE NODES

THE FOLLOWING RESULTS ARE OBTAINED AFTER 6 TRIALS WITH A RELATIVE ACCURACY = 0.00059

HCWSC MODEL - ULTIMATE BUILD-OUT/RESIDENTIAL DEMANDS ONLY
BOOSTER PUMP ACTING TO MAINTAIN 35 PSI @ ELEV. 1200, HCWSC-SW'C' & SW'B' TANKS
PEAK HOUR DEMAND: 1.5 GPM/LUE (EXCEPT DEMANDS FROM SWB REPORT)

PIPE NO.	NODE NUMBERS		FLOWRATE	HEAD LOSS	PUMPHEAD	MINOR LOSS	VELOCITY	HL/1000
1	0	1	11441.47	0.09	0.00	0.00	3.61	1.79
2	1	2	986.47	8.04	0.00	0.00	2.80	4.02
3	2	3	1326.00	13.90	0.00	0.00	3.76	6.95
4	3	4	1323.00	20.77	0.00	0.00	3.75	6.92
5	4	5	1214.00	11.81	0.00	0.00	3.44	5.90
6	5	6	1145.00	18.54	0.00	0.00	3.25	5.30
7	6	7	1016.00	20.17	0.00	0.00	2.88	4.25
8	7	8	729.00	5.74	0.00	0.00	2.07	2.30
9	8	25	0.00	0.00	0.00	0.00	0.00	0.00
THE CHECK VALVE IN LINE NUMBER 10 IS CLOSED								
11	9	10	-200.00	-13.57	0.00	0.00	-1.28	-1.51
12	10	11	-415.00	-25.63	0.00	0.00	-2.65	-5.83
13	11	12	784.26	5.26	0.00	0.00	2.22	2.63
14	0	12	1907.74	0.34	0.00	0.00	3.05	3.37
15	12	13	534.00	18.19	0.00	0.00	1.51	1.29
16	12	14	1622.00	20.19	0.00	0.00	4.60	10.10
17	14	15	1439.00	27.50	0.00	0.00	4.08	8.09
18	2	26	-466.53	-8.04	0.00	0.00	-1.32	-1.00
19	0	26	956.53	0.09	0.00	0.00	1.53	0.94
THE CHECK VALVE IN LINE NUMBER 20 IS CLOSED								
21	27	11	1331.26	28.01	0.00	0.00	3.78	7.00
22	0	27	1331.26	0.09	208.03	0.00	2.12	1.73
23	15	16	1401.00	23.09	0.00	0.00	3.97	7.70
24	16	17	1201.00	23.15	0.00	0.00	3.41	5.79
25	17	18	1002.00	10.34	0.00	0.00	2.84	4.14
26	18	19	571.00	7.78	0.00	0.00	1.68	1.56
27	20	19	-60.00	-0.07	0.00	0.00	-0.17	-0.02
THE CHECK VALVE IN LINE NUMBER 28 IS CLOSED								
29	22	21	1368.00	0.18	0.00	0.00	0.43	0.03
30	23	22	5953.00	2.45	0.00	0.00	1.88	0.53
31	24	23	6033.00	1.36	0.00	0.00	1.90	0.55
32	1	24	10300.00	4.03	0.00	0.00	3.27	1.49

JUNCTION NUMBER	DEMAND	GRADE LINE	ELEVATION	PRESSURE
1	75.00	1139.91	1035.00	45.46
2	127.00	1131.87	998.00	58.01
3	3.00	1117.97	993.00	54.15
4	109.00	1097.20	983.00	49.49
5	69.00	1085.39	982.00	44.80
6	129.00	1066.85	910.00	67.97
7	287.00	1046.69	950.00	41.90
8	729.00	1040.95	945.00	41.58
9	200.00	1280.72	1000.00	121.65
10	215.00	1294.29	1108.00	80.72
11	132.00	1317.92	1170.00	64.97
12	538.00	1314.66	1190.00	54.02
13	534.00	1296.48	1201.00	41.37
14	183.00	1294.47	1160.00	58.27
15	38.00	1266.97	1076.00	82.75
16	200.00	1243.88	1115.00	55.85
17	199.00	1220.73	1077.00	62.28

18	411.00	1210.38	1110.00	43.50
19	531.00	1202.60	981.00	96.03
20	60.00	1202.53	1070.00	57.43
21	1368.00	1131.89	953.00	77.52
22	4585.00	1132.07	1000.00	57.23
23	80.00	1134.52	900.00	101.63
24	4347.00	1135.88	930.00	89.22
25	0.00	1040.75	1030.00	4.74
26	490.00	1139.91	1030.00	47.63
27	0.00	1347.94	1030.00	137.77

THE NET SYSTEM DEMAND = 15639.00

SUMMARY OF INFLOWS(+) AND OUTFLOWS(-) FROM FIXED GRADE NODES

PIPE NUMBER	FLOWRATE
1	11441.47
14	1909.74
19	956.53
22	1331.26

THE NET FLOW INTO THE SYSTEM FROM FIXED GRADE NODES = 15639.00

THE NET FLOW OUT OF THE SYSTEM INTO FIXED GRADE NODES = 0.00

A SUMMARY OF CONDITIONS SPECIFIED FOR THE NEXT SIMULATION FOLLOWS

THE DEMANDS ARE CHANGED FROM ORIGINAL VALUES BY A FACTOR = 0.67

THE FOLLOWING RESULTS ARE OBTAINED AFTER 2 TRIALS WITH A RELATIVE ACCURACY = 0.00004

ASSUMES PEAK DAY 1 GPM/LUE, 1.3 GPM/LUE

PIPE NO.	NODE NUMBERS		FLOWRATE	HEAD LOSS	PUMPHEAD	MINOR LOSS	VELOCITY	HL/1000
1	0	1	7665.79	0.04	0.00	0.00	2.42	0.85
2	1	2	660.74	3.83	0.00	0.00	1.87	1.91
3	2	3	888.42	6.62	0.00	0.00	2.52	3.31
4	3	4	886.41	9.89	0.00	0.00	2.51	3.30
5	4	5	813.38	5.62	0.00	0.00	2.31	2.81
6	5	6	767.15	3.83	0.00	0.00	2.18	2.52
7	6	7	680.72	9.61	0.00	0.00	1.93	2.02
8	7	8	488.43	2.73	0.00	0.00	1.39	1.09
9	8	25	0.00	0.00	0.00	0.00	0.00	0.00
THE CHECK VALVE IN LINE NUMBER 10 IS CLOSED								
11	9	10	-134.00	-6.46	0.00	0.00	-0.86	-0.72
12	10	11	-278.05	-12.21	0.00	0.00	-1.77	-2.77
13	11	12	951.95	7.53	0.00	0.00	2.70	3.76
14	0	12	853.03	0.08	0.00	0.00	1.36	0.76
15	12	13	357.78	8.66	0.00	0.00	1.01	0.61
16	12	14	1086.74	9.62	0.00	0.00	3.08	4.81
17	14	15	964.13	13.10	0.00	0.00	2.73	3.85
18	2	26	-312.57	-3.83	0.00	0.00	-0.89	-0.48
19	0	26	640.87	0.04	0.00	0.00	1.02	0.45
THE CHECK VALVE IN LINE NUMBER 20 IS CLOSED								
21	27	11	1318.44	27.51	0.00	0.00	3.74	6.88
22	0	27	1318.44	0.08	210.05	0.00	2.10	1.69
23	15	16	938.67	11.00	0.00	0.00	2.66	3.67
24	16	17	804.67	11.03	0.00	0.00	2.28	2.76
25	17	18	671.34	4.93	0.00	0.00	1.90	1.97
26	18	19	375.97	3.71	0.00	0.00	1.12	0.74
27	20	19	-40.20	-0.03	0.00	0.00	-0.11	-0.01
THE CHECK VALVE IN LINE NUMBER 28 IS CLOSED								
29	22	21	916.56	0.08	0.00	0.00	0.29	0.02
30	23	22	3988.51	1.17	0.00	0.00	1.26	0.25
31	24	23	4042.11	0.65	0.00	0.00	1.27	0.26
32	1	24	6954.60	1.92	0.00	0.00	2.19	0.71

JUNCTION NUMBER	DEMAND	GRADE LINE	ELEVATION	PRESSURE
1	50.25	1139.76	1035.00	45.48
2	85.09	1136.13	998.00	59.86
3	2.01	1129.51	993.00	59.15
4	73.03	1119.61	983.00	59.20
5	46.23	1113.99	982.00	57.20
6	86.43	1105.16	910.00	84.57
7	192.29	1095.55	950.00	63.07
8	488.43	1092.82	945.00	64.06
9	134.00	1303.78	1000.00	131.64
10	144.05	1310.24	1108.00	87.64
11	88.44	1322.45	1170.00	66.06
12	360.46	1314.92	1190.00	54.13
13	357.78	1306.26	1201.00	45.61
14	122.61	1305.31	1160.00	62.97
15	25.46	1292.21	1076.00	93.69
16	134.00	1281.21	1115.00	72.02
17	133.33	1270.18	1077.00	83.71

18	275.37	1265.25	1110.00	67.28
19	355.77	1261.55	981.00	121.57
20	40.20	1261.52	1070.00	82.99
21	916.56	1136.14	953.00	79.36
22	3071.95	1136.22	1000.00	59.03
23	53.60	1137.39	900.00	102.87
24	2912.49	1138.04	930.00	90.15
25	0.00	1092.82	1030.00	27.22
26	328.30	1139.96	1030.00	47.65
27	0.00	1347.97	1030.00	138.65

THE NET SYSTEM DEMAND = 10478.13
SUMMARY OF INFLOWS(+) AND OUTFLOWS(-) FROM FIXED GRADE NODES

PIPE NUMBER	FLOWRATE
1	7665.79
14	853.03
19	640.87
22	1318.44

THE NET FLOW INTO THE SYSTEM FROM FIXED GRADE NODES = 10478.13
THE NET FLOW OUT OF THE SYSTEM INTO FIXED GRADE NODES = 0.00

A SUMMARY OF CONDITIONS SPECIFIED FOR THE NEXT SIMULATION FOLLOWS

THE DEMANDS ARE CHANGED FROM ORIGINAL VALUES BY A FACTOR = 0.67

THE FOLLOWING SPECIFIC DEMAND CHANGES ARE MADE :

JUNCTION NUMBER	DEMAND
3	1477.00
13	856.00
19	887.00
22	2744.00
24	2566.00

THE FOLLOWING RESULTS ARE OBTAINED AFTER 2 TRIALS WITH A RELATIVE ACCURACY = 0.00009

ASSUMES PEAK DAY 1 GPM/LUE, 1.3 GPM/LUE
500 GPM FIRE FLOW @ JT 13, JT 19
1250 GPM FIRE FLOW @ JT 3

PIPE NO.	NODE NUMBERS		FLOWRATE	HEAD LOSS	PUMPHEAD	MINOR LOSS	VELOCITY	HL/1000
1	0	1	7993.66	0.05	0.00	0.00	2.52	0.92
2	1	2	1663.25	21.15	0.00	0.00	4.72	10.58
3	2	3	2363.41	40.55	0.00	0.00	6.70	20.27
4	3	4	886.41	9.89	0.00	0.00	2.51	3.30
5	4	5	813.38	5.62	0.00	0.00	2.31	2.81
6	5	6	767.15	8.83	0.00	0.00	2.18	2.52
7	6	7	680.72	9.61	0.00	0.00	1.93	2.02
8	7	8	488.43	2.73	0.00	0.00	1.39	1.09
9	8	25	0.00	0.00	0.00	0.00	0.00	0.00
THE CHECK VALVE IN LINE NUMBER 10 IS CLOSED								
11	9	10	-134.00	-6.46	0.00	0.00	-0.86	-0.72
12	10	11	-278.05	-12.21	0.00	0.00	-1.77	-2.77
13	11	12	953.13	7.54	0.00	0.00	2.70	3.77
14	0	12	1881.30	0.33	0.00	0.00	3.00	3.27
15	12	13	856.00	43.58	0.00	0.00	2.43	3.09
16	12	14	1617.97	20.10	0.00	0.00	4.59	10.05
17	14	15	1495.36	27.53	0.00	0.00	4.24	8.69
18	2	26	-785.25	-21.08	0.00	0.00	-2.23	-2.63
19	0	26	1113.55	0.12	0.00	0.00	1.78	1.24
THE CHECK VALVE IN LINE NUMBER 20 IS CLOSED								
21	27	11	1312.62	27.56	0.00	0.00	3.74	6.89
22	0	27	1319.62	0.08	209.86	0.00	2.11	1.70
23	15	16	1467.90	25.24	0.00	0.00	4.17	8.41
24	16	17	1335.90	28.19	0.00	0.00	3.79	7.05
25	17	18	1202.57	14.50	0.00	0.00	3.41	5.80
26	18	19	927.20	17.92	0.00	0.00	2.63	3.58
27	20	19	-40.20	-0.03	0.00	0.00	-0.11	-0.01
THE CHECK VALVE IN LINE NUMBER 28 IS CLOSED								
29	22	21	916.56	0.08	0.00	0.00	0.29	0.02
30	23	22	3660.56	1.00	0.00	0.00	1.15	0.22
31	24	23	3714.16	0.56	0.00	0.00	1.17	0.22
32	1	24	6280.16	1.59	0.00	0.00	1.98	0.59

JUNCTION NUMBER	DEMAND	GRADE LINE	ELEVATION	PRESSURE
1	50.25	1139.95	1035.00	45.48
2	85.07	1118.80	998.00	52.35
3	1477.00	1078.25	993.00	36.94
4	73.03	1068.36	983.00	36.99
5	46.23	1062.73	982.00	34.99
6	86.43	1053.70	910.00	62.36
7	192.29	1044.30	950.00	40.86
8	488.43	1041.57	945.00	41.84
9	134.00	1303.55	1000.00	131.54
10	144.05	1310.01	1108.00	87.54
11	88.44	1322.22	1170.00	65.96
12	360.46	1314.67	1190.00	54.02
13	856.00	1271.09	1201.00	30.37
14	122.61	1294.57	1160.00	58.31
15	25.46	1265.04	1076.00	81.92
16	134.00	1237.00	1115.00	54.00
17	133.33	1211.61	1077.00	58.33

18	275.37	1197.11	1110.00	37.75
19	887.00	1179.19	981.00	85.88
20	40.20	1179.15	1070.00	47.30
21	916.56	1136.73	953.00	79.62
22	2744.00	1136.81	1000.00	59.29
23	53.60	1137.81	900.00	103.05
24	2566.00	1138.37	930.00	90.29
25	0.00	1041.57	1030.00	5.01
26	328.30	1137.88	1030.00	47.61
27	0.00	1349.78	1030.00	138.57

THE NET SYSTEM DEMAND = 12308.13
SUMMARY OF INFLOWS(+) AND OUTFLOWS(-) FROM FIXED GRADE NODES

PIPE NUMBER	FLOWRATE
1	7993.66
14	1881.30
19	1113.55
22	1317.62

THE NET FLOW INTO THE SYSTEM FROM FIXED GRADE NODES = 12308.13
THE NET FLOW OUT OF THE SYSTEM INTO FIXED GRADE NODES = 0.00

SCENARIO #2

TRANSMISSION MAINS SIZED FOR HCWSC &

LOW DENSITY PORTION OF HCWS STUDY AREA ONLY

FLOWRATE IS EXPRESSED IN GPM AND PRESSURE IN PSIG

A SUMMARY OF THE ORIGINAL DATA FOLLOWS

PIPE NUMBER	NODE NUMBERS		LENGTH (FEET)	DIAMETER (INCHES)	ROUGHNESS	MINOR LOSS K	FIXED GRADE
1	0	1	50.0	36.0	100.0	0.00	1140.00
2	1	2	2000.0	12.0	100.0	0.00	
3	2	3	2000.0	12.0	100.0	0.00	
4	3	4	3000.0	12.0	100.0	0.00	
5	4	5	2000.0	12.0	100.0	0.00	
6	5	6	3500.0	10.0	100.0	0.00	
7	6	7	4750.0	10.0	100.0	0.00	
8	7	8	2500.0	10.0	100.0	0.00	
9	8	25	4000.0	8.0	100.0	0.00	
10	25	9	50.0	8.0	100.0	0.00	
THERE IS A CHECK VALVE IN LINE NUMBER 10							
11	9	10	4000.0	8.0	100.0	0.00	
12	10	11	4400.0	8.0	100.0	0.00	
13	11	12	2000.0	10.0	100.0	0.00	
14	0	12	100.0	12.0	100.0	0.00	1315.00
15	12	13	14100.0	10.0	100.0	0.00	
16	12	14	2000.0	10.0	100.0	0.00	
17	14	15	3400.0	10.0	100.0	0.00	
18	2	26	12000.0	10.0	100.0	0.00	
19	0	26	100.0	12.0	100.0	0.00	1140.00
20	26	27	2500.0	10.0	100.0	0.00	
THERE IS A CHECK VALVE IN LINE NUMBER 20							
21	27	11	4000.0	10.0	100.0	0.00	
22	0	27	50.0	12.0	100.0	0.00	1140.00
THERE IS A PUMP IN LINE 22 WITH USEFUL POWER = 50.00							
23	15	16	3000.0	10.0	100.0	0.00	
24	16	17	4000.0	10.0	100.0	0.00	
25	17	18	2500.0	10.0	100.0	0.00	
26	18	19	5000.0	10.0	100.0	0.00	
27	20	19	3000.0	10.0	100.0	0.00	
28	21	20	7200.0	10.0	100.0	0.00	
THERE IS A CHECK VALVE IN LINE NUMBER 28							
29	22	21	5100.0	36.0	100.0	0.00	
30	23	22	4600.0	36.0	100.0	0.00	
31	24	23	2500.0	36.0	100.0	0.00	
32	1	24	2700.0	36.0	100.0	0.00	

JUNCTION NUMBER	DEMAND	ELEVATION	CONNECTING PIPES			
1	12.00	1035.00	1	2	32	
2	96.00	998.00	2	3	18	
3	10.00	993.00	3	4		
4	94.00	983.00	4	5		
5	69.00	982.00	5	6		
6	108.00	910.00	6	7		
7	150.00	930.00	7	8		
8	592.00	945.00	8	9		
9	122.00	1000.00	10	11		
10	202.00	1100.00	11	12		
11	44.00	1170.00	12	13	21	
12	203.00	1190.00	13	14	15	16

13	210.00	1201.00	15		
14	98.00	1160.00	16	17	
15	26.00	1076.00	17	23	
16	77.00	1115.00	23	24	
17	94.00	1077.00	24	25	
18	302.00	1110.00	25	26	
19	390.00	981.00	26	27	
20	15.00	1070.00	27	28	
21	200.00	953.00	28	29	
22	2495.00	1000.00	29	30	
23	80.00	900.00	30	31	
24	768.00	930.00	31	32	
25	0.00	1030.00	9	10	
26	35.00	1030.00	18	19	20
27	0.00	1030.00	20	21	22

OUTPUT SELECTION: ALL RESULTS ARE OUTPUT EACH PERIOD

THIS SYSTEM HAS 32 PIPES WITH 27 JUNCTIONS , 2 LOOPS AND 4 FIXED GRADE NODES

THE FOLLOWING RESULTS ARE OBTAINED AFTER 5 TRIALS WITH A RELATIVE ACCURACY = 0.00084

HCWSC STUDY AREA MODEL - 2000 PROJECTED DEVELOPMENT/RESIDENTIAL DEMANDS ONLY
HCWSC - ONE PUMP ACTING TO MAINTAIN 35 PSI @ ELEV. 1200, SW'C' & SW'B' TANKS
PEAK HOUR DEMAND: 1.5 GPM/LUE (EXCEPT DEMANDS FROM SWB REPORT)

PIPE NO.	NODE NUMBERS		FLOWRATE	HEAD LOSS	PUMPHEAD	MINOR LOSS	VELOCITY	HL/1000
1	0	1	4467.34	0.02	0.00	0.00	1.41	0.31
2	1	2	912.54	6.96	0.00	0.00	2.59	3.48
3	2	3	1031.00	3.72	0.00	0.00	2.92	4.36
4	3	4	1013.00	12.67	0.00	0.00	2.87	4.22
5	4	5	919.00	7.05	0.00	0.00	2.61	3.53
6	5	6	850.00	25.95	0.00	0.00	3.47	7.41
7	6	7	742.00	27.38	0.00	0.00	3.03	5.76
8	7	8	592.00	9.49	0.00	0.00	2.42	3.79
9	8	25	0.00	0.00	0.00	0.00	0.00	0.00
THE CHECK VALVE IN LINE NUMBER 10 IS CLOSED								
11	9	10	-122.00	-2.41	0.00	0.00	-0.78	-0.60
12	10	11	-324.00	-16.21	0.00	0.00	-2.07	-3.68
13	11	12	547.38	5.61	0.00	0.00	2.24	3.30
14	0	12	865.62	0.32	0.00	0.00	2.46	3.16
15	12	13	210.00	7.85	0.00	0.00	0.86	0.56
16	12	14	1002.00	20.11	0.00	0.00	4.09	10.05
17	14	15	904.00	28.25	0.00	0.00	3.69	8.31
18	2	26	-214.46	-6.94	0.00	0.00	-0.88	-0.58
19	0	26	247.46	0.03	0.00	0.00	0.71	0.32
THE CHECK VALVE IN LINE NUMBER 20 IS CLOSED								
21	27	11	917.38	34.16	0.00	0.00	3.75	8.54
22	0	27	917.38	0.18	215.63	0.00	2.60	3.51
23	15	16	878.00	23.62	0.00	0.00	3.59	7.87
24	16	17	801.00	26.57	0.00	0.00	3.27	6.64
25	17	18	707.00	13.18	0.00	0.00	2.89	5.27
26	18	19	405.00	9.39	0.00	0.00	1.65	1.88
27	20	19	-15.00	-0.01	0.00	0.00	-0.06	0.00
THE CHECK VALVE IN LINE NUMBER 28 IS CLOSED								
29	22	21	200.00	0.01	0.00	0.00	0.06	0.00
30	23	22	2695.00	0.56	0.00	0.00	0.85	0.12
31	24	23	2775.00	0.32	0.00	0.00	0.87	0.13
32	1	24	3543.00	0.55	0.00	0.00	1.12	0.20

JUNCTION NUMBER	DEMAND	GRADE LINE	ELEVATION	PRESSURE
1	12.00	1139.98	1035.00	45.49
2	96.00	1133.03	998.00	58.51
3	18.00	1124.30	993.00	56.90
4	94.00	1111.63	983.00	55.74
5	69.00	1104.58	982.00	53.12
6	108.00	1078.63	910.00	73.07
7	150.00	1051.25	950.00	43.88
8	592.00	1041.77	945.00	41.93
9	122.00	1302.67	1000.00	131.16
10	202.00	1305.07	1108.00	85.40
11	44.00	1321.29	1170.00	65.56
12	203.00	1314.68	1190.00	54.03
13	210.00	1306.84	1201.00	45.86
14	98.00	1294.57	1160.00	58.32
15	26.00	1266.32	1076.00	82.47
16	77.00	1242.70	1115.00	55.34
17	94.00	1216.14	1077.00	60.29

18	302.00	1202.76	1110.00	40.28
19	390.00	1193.57	981.00	92.11
20	15.00	1193.55	1070.00	53.54
21	200.00	1138.54	953.00	80.40
22	2495.00	1138.55	1000.00	60.04
23	80.00	1139.11	900.00	103.61
24	768.00	1139.43	930.00	90.75
25	0.00	1041.77	1030.00	5.10
26	35.00	1139.77	1030.00	47.65
27	0.00	1355.45	1030.00	141.03

THE NET SYSTEM DEMAND = 6500.00
SUMMARY OF INFLOWS(+) AND OUTFLOWS(-) FROM FIXED GRADE NODES

PIPE NUMBER	FLOWRATE
1	4467.54
14	865.62
19	249.46
22	917.38

THE NET FLOW INTO THE SYSTEM FROM FIXED GRADE NODES = 6500.00
THE NET FLOW OUT OF THE SYSTEM INTO FIXED GRADE NODES = 0.00

A SUMMARY OF CONDITIONS SPECIFIED FOR THE NEXT SIMULATION FOLLOWS

THE DEMANDS ARE CHANGED FROM ORIGINAL VALUES BY A FACTOR = 0.67

THE FOLLOWING SPECIFIC DEMAND CHANGES ARE MADE :

JUNCTION NUMBER	DEMAND
13	710.00
19	890.00
22	1517.00
24	454.00

THE FOLLOWING RESULTS ARE OBTAINED AFTER 4 TRIALS WITH A RELATIVE ACCURACY = 0.00013

ASSUMES PEAK DAY 1 GPM/LUE, 1.3 GPM/LUE
FIRE FLOW 500 GPM @ JT 13, 19

PIPE NO.	NODE NUMBERS		FLOWRATE	HEAD LOSS	PUMPHEAD	MINOR LOSS	VELOCITY	HL/1000
1	0	1	2965.81	0.01	0.00	0.00	0.93	0.15
2	1	2	611.41	3.31	0.00	0.00	1.73	1.66
3	2	3	690.77	4.16	0.00	0.00	1.96	2.08
4	3	4	678.71	6.03	0.00	0.00	1.93	2.01
5	4	5	615.73	3.36	0.00	0.00	1.75	1.68
6	5	6	567.50	12.36	0.00	0.00	2.33	3.53
7	6	7	497.14	13.04	0.00	0.00	2.03	2.75
8	7	8	396.64	4.52	0.00	0.00	1.62	1.81
9	8	25	0.00	0.00	0.00	0.00	0.00	0.00
THE CHECK VALVE IN LINE NUMBER 10 IS CLOSED								
11	9	10	-81.74	-1.15	0.00	0.00	-0.52	-0.29
12	10	11	-217.08	-7.72	0.00	0.00	-1.39	-1.75
13	11	12	662.99	9.36	0.00	0.00	2.71	4.68
14	0	12	1295.30	0.67	0.00	0.00	3.67	6.66
15	12	13	710.00	74.91	0.00	0.00	2.90	5.31
16	12	14	1112.28	24.40	0.00	0.00	4.54	12.20
17	14	15	1046.62	37.06	0.00	0.00	4.28	10.90
18	2	26	-143.68	-3.31	0.00	0.00	-0.59	-0.28
19	0	26	167.13	0.02	0.00	0.00	0.47	0.15
THE CHECK VALVE IN LINE NUMBER 20 IS CLOSED								
21	27	11	909.55	33.62	0.00	0.00	3.72	8.40
22	0	27	909.55	0.17	217.48	0.00	2.58	3.46
23	15	16	1029.20	31.70	0.00	0.00	4.20	10.57
24	16	17	977.61	30.42	0.00	0.00	3.99	9.61
25	17	18	914.63	21.23	0.00	0.00	3.74	8.49
26	18	19	712.29	26.72	0.00	0.00	2.91	5.34
27	20	19	177.71	1.23	0.00	0.00	0.73	0.41
28	21	20	187.76	3.26	0.00	0.00	0.77	0.45
29	22	21	321.76	0.01	0.00	0.00	0.10	0.00
30	23	22	1838.76	0.28	0.00	0.00	0.58	0.06
31	24	23	1892.36	0.16	0.00	0.00	0.60	0.06
32	1	24	2346.36	0.26	0.00	0.00	0.74	0.09

JUNCTION NUMBER	DEMAND	GRADE LINE	ELEVATION	PRESSURE
1	8.04	1139.99	1035.00	45.50
2	64.32	1136.68	998.00	60.09
3	12.06	1132.52	993.00	60.46
4	62.98	1126.49	983.00	62.18
5	46.23	1123.13	982.00	61.16
6	72.36	1110.77	910.00	87.00
7	100.50	1097.73	950.00	64.02
8	396.64	1093.21	945.00	64.22
9	81.74	1314.82	1000.00	136.42
10	135.34	1315.97	1108.00	90.12
11	29.48	1323.69	1170.00	66.60
12	136.01	1314.33	1190.00	53.88
13	710.00	1239.43	1201.00	16.65
14	65.66	1289.93	1160.00	56.31
15	17.42	1252.08	1076.00	76.65
16	51.59	1221.10	1115.00	46.01
17	62.98	1182.75	1077.00	45.83

18	202.34	1161.52	1110.00	22.33
19	890.00	1134.80	981.00	66.65
20	10.05	1136.03	1070.00	28.61
21	134.00	1137.29	953.00	80.72
22	1517.00	1139.30	1000.00	60.36
23	53.60	1137.38	900.00	103.82
24	454.00	1139.74	930.00	90.89
25	0.00	1093.21	1030.00	27.39
26	23.45	1139.98	1030.00	47.66
27	0.00	1337.31	1030.00	141.83

THE NET SYSTEM DEMAND = 5337.79
SUMMARY OF INFLOWS(+) AND OUTFLOWS(-) FROM FIXED GRADE NODES

PIPE NUMBER	FLOWRATE
1	2965.81
14	1295.30
19	167.13
22	909.55

THE NET FLOW INTO THE SYSTEM FROM FIXED GRADE NODES = 5337.79
THE NET FLOW OUT OF THE SYSTEM INTO FIXED GRADE NODES = 0.00

A SUMMARY OF CONDITIONS SPECIFIED FOR THE NEXT SIMULATION FOLLOWS

THE DEMANDS ARE CHANGED FROM ORIGINAL VALUES BY A FACTOR = 0.67

THE FOLLOWING SPECIFIC DEMAND CHANGES ARE MADE :

JUNCTION NUMBER	DEMAND
22	1517.00
24	454.00

SCENARIO #3

TRANSMISSION MAINS SIZED FOR HCWSC

& LOW DENSITY PORTION OF HCWS STUDY AREA ONLY

FLOWRATE IS EXPRESSED IN GPM AND PRESSURE IN PSIG

A SUMMARY OF THE ORIGINAL DATA FOLLOWS

PIPE NUMBER	NODE NUMBERS		LENGTH (FEET)	DIAMETER (INCHES)	ROUGHNESS	MINOR LOSS K	FIXED GRADE
1	0	1	50.0	36.0	100.0	0.00	1140.00
2	1	2	2000.0	12.0	100.0	0.00	
3	2	3	2000.0	12.0	100.0	0.00	
4	3	4	3000.0	12.0	100.0	0.00	
5	4	5	2000.0	12.0	100.0	0.00	
6	5	6	3500.0	10.0	100.0	0.00	
7	6	7	4750.0	10.0	100.0	0.00	
8	7	8	2500.0	10.0	100.0	0.00	
9	8	25	4000.0	8.0	100.0	0.00	
10	25	9	50.0	8.0	100.0	0.00	
THERE IS A CHECK VALVE IN LINE NUMBER 10							
11	9	10	4000.0	8.0	100.0	0.00	
12	10	11	4400.0	8.0	100.0	0.00	
13	11	12	2000.0	10.0	100.0	0.00	
14	0	12	100.0	12.0	100.0	0.00	1315.00
15	12	13	14100.0	10.0	100.0	0.00	
16	12	14	2000.0	10.0	100.0	0.00	
17	14	15	3400.0	10.0	100.0	0.00	
18	2	26	12000.0	10.0	100.0	0.00	
19	0	26	100.0	12.0	100.0	0.00	1140.00
20	26	27	2500.0	10.0	100.0	0.00	
THERE IS A CHECK VALVE IN LINE NUMBER 20							
21	27	11	4000.0	10.0	100.0	0.00	
22	0	27	50.0	12.0	100.0	0.00	1140.00
THERE IS A PUMP IN LINE 22 WITH USEFUL POWER = 50.00							
23	15	16	3000.0	10.0	100.0	0.00	
24	16	17	4000.0	10.0	100.0	0.00	
25	17	18	2500.0	10.0	100.0	0.00	
26	18	19	5000.0	10.0	100.0	0.00	
27	20	19	3000.0	10.0	100.0	0.00	
28	21	20	7200.0	10.0	100.0	0.00	
THERE IS A CHECK VALVE IN LINE NUMBER 28							
29	22	21	5100.0	36.0	100.0	0.00	
30	23	22	4600.0	36.0	100.0	0.00	
31	24	23	2500.0	36.0	100.0	0.00	
32	1	24	2700.0	36.0	100.0	0.00	

JUNCTION NUMBER	DEMAND	ELEVATION	CONNECTING PIPES			
1	12.00	1035.00	1	2	32	
2	96.00	998.00	2	3	18	
3	18.00	993.00	3	4		
4	94.00	983.00	4	5		
5	69.00	982.00	5	6		
6	108.00	910.00	6	7		
7	150.00	950.00	7	8		
8	592.00	945.00	8	9		
9	122.00	1000.00	10	11		
10	202.00	1100.00	11	12		
11	44.00	1170.00	12	13	21	
12	203.00	1190.00	13	14	15	16

13	210.00	1201.00	15		
14	98.00	1160.00	16	17	
15	26.00	1076.00	17	23	
16	77.00	1115.00	23	24	
17	94.00	1077.00	24	25	
18	302.00	1110.00	25	26	
19	390.00	981.00	26	27	
20	15.00	1070.00	27	28	
21	200.00	953.00	28	29	
22	2495.00	1000.00	29	30	
23	80.00	900.00	30	31	
24	768.00	930.00	31	32	
25	0.00	1030.00	9	10	
26	35.00	1030.00	18	19	20
27	0.00	1030.00	20	21	22

OUTPUT SELECTION: ALL RESULTS ARE OUTPUT EACH PERIOD

THIS SYSTEM HAS 32 PIPES WITH 27 JUNCTIONS , 2 LOOPS AND 4 FIXED GRADE NODES

THE FOLLOWING RESULTS ARE OBTAINED AFTER 5 TRIALS WITH A RELATIVE ACCURACY = 0.00084

HCWSC STUDY AREA MODEL - 2000 PROJECTED DEVELOPMENT/RESIDENTIAL DEMANDS ONLY
HCWSC - ONE PUMP ACTING TO MAINTAIN 35 PSI @ ELEV. 1200, SW'C' & SW'B' TANKS
PEAK HOUR DEMAND: 1.5 GPM/LUE (EXCEPT DEMANDS FROM SWB REPORT)

PIPE NO.	NODE	NUMBERS	FLOWRATE	HEAD LOSS	PUMPHEAD	MINOR LOSS	VELOCITY	HL/1000
1	0	1	4467.34	0.02	0.00	0.00	1.41	0.31
2	1	2	912.54	6.96	0.00	0.00	2.59	3.48
3	2	3	1031.00	8.72	0.00	0.00	2.92	4.36
4	3	4	1013.00	12.67	0.00	0.00	2.87	4.22
5	4	5	919.00	7.05	0.00	0.00	2.61	3.53
6	5	6	850.00	25.95	0.00	0.00	3.47	7.41
7	6	7	742.00	27.38	0.00	0.00	3.03	5.76
8	7	8	592.00	9.49	0.00	0.00	2.42	3.79
9	8	25	0.00	0.00	0.00	0.00	0.00	0.00
THE CHECK VALVE IN LINE NUMBER 10 IS CLOSED								
11	9	10	-122.00	-2.41	0.00	0.00	-0.78	-0.60
12	10	11	-324.00	-16.21	0.00	0.00	-2.07	-3.68
13	11	12	549.38	6.61	0.00	0.00	2.24	3.30
14	0	12	865.62	0.32	0.00	0.00	2.46	3.16
15	12	13	210.00	7.85	0.00	0.00	0.86	0.56
16	12	14	1002.00	20.11	0.00	0.00	4.09	10.05
17	14	15	904.00	28.25	0.00	0.00	3.69	8.31
18	2	26	-214.46	-6.94	0.00	0.00	-0.88	-0.58
19	0	26	249.46	0.03	0.00	0.00	0.71	0.32
THE CHECK VALVE IN LINE NUMBER 20 IS CLOSED								
21	27	11	917.38	34.16	0.00	0.00	3.75	8.54
22	0	27	917.38	0.18	215.63	0.00	2.60	3.51
23	15	16	878.00	23.62	0.00	0.00	3.59	7.87
24	16	17	801.00	26.57	0.00	0.00	3.27	6.64
25	17	18	707.00	13.18	0.00	0.00	2.89	5.27
26	18	19	405.00	9.39	0.00	0.00	1.65	1.88
27	20	19	-15.00	-0.01	0.00	0.00	-0.06	0.00
THE CHECK VALVE IN LINE NUMBER 28 IS CLOSED								
29	22	21	200.00	0.01	0.00	0.00	0.06	0.00
30	23	22	2695.00	0.56	0.00	0.00	0.85	0.12
31	24	23	2775.00	0.32	0.00	0.00	0.87	0.13
32	1	24	3543.00	0.55	0.00	0.00	1.12	0.20

JUNCTION NUMBER	DEMAND	GRADE LINE	ELEVATION	PRESSURE
1	12.00	1139.98	1035.00	45.49
2	96.00	1133.03	998.00	58.51
3	18.00	1124.30	993.00	56.90
4	94.00	1111.63	983.00	55.74
5	69.00	1104.58	982.00	53.12
6	108.00	1078.63	910.00	73.07
7	150.00	1051.25	950.00	43.88
8	592.00	1041.77	945.00	41.93
9	122.00	1302.67	1000.00	131.16
10	202.00	1305.07	1108.00	85.40
11	44.00	1321.29	1170.00	65.56
12	203.00	1314.68	1190.00	54.03
13	210.00	1306.84	1201.00	45.86
14	98.00	1294.37	1160.00	58.32
15	26.00	1266.32	1076.00	82.47
16	77.00	1242.70	1115.00	55.34
17	94.00	1216.14	1077.00	60.29

18	302.00	1202.76	1110.00	40.28
19	390.00	1193.57	981.00	92.11
20	15.00	1193.55	1070.00	53.54
21	200.00	1138.54	953.00	80.40
22	2495.00	1138.55	1000.00	60.04
23	80.00	1139.11	900.00	103.61
24	768.00	1139.43	930.00	90.75
25	0.00	1041.77	1030.00	5.10
26	35.00	1139.77	1030.00	47.65
27	0.00	1355.45	1030.00	141.03

THE NET SYSTEM DEMAND = 6500.00

SUMMARY OF INFLOWS(+) AND OUTFLOWS(-) FROM FIXED GRADE NODES

PIPE NUMBER	FLOWRATE
1	4467.54
14	865.62
19	249.46
22	917.38

THE NET FLOW INTO THE SYSTEM FROM FIXED GRADE NODES = 6500.00

THE NET FLOW OUT OF THE SYSTEM INTO FIXED GRADE NODES = 0.00

A SUMMARY OF CONDITIONS SPECIFIED FOR THE NEXT SIMULATION FOLLOWS

THE DEMANDS ARE CHANGED FROM ORIGINAL VALUES BY A FACTOR = 0.67

THE FOLLOWING SPECIFIC DEMAND CHANGES ARE MADE :

JUNCTION NUMBER	DEMAND
13	710.00
19	890.00
22	1517.00
24	454.00

THE FOLLOWING RESULTS ARE OBTAINED AFTER 3 TRIALS WITH A RELATIVE ACCURACY = 0.00003

ASSUMES PEAK DAY 1 GPM/LUE, 1.3 GPM/LUE
NO FIRE FLOW-DOMESTIC MAX DAY DEMAND ONLY

PIPE NO.	NODE NUMBERS		FLOWRATE	HEAD LOSS	PUMPHEAD	MINOR LOSS	VELOCITY	HL/1000
1	0	1	2778.06	0.01	0.00	0.00	0.88	0.13
2	1	2	611.42	3.32	0.00	0.00	1.73	1.66
3	2	3	690.77	4.16	0.00	0.00	1.96	2.08
4	3	4	678.71	6.03	0.00	0.00	1.93	2.01
5	4	5	615.73	3.36	0.00	0.00	1.75	1.68
6	5	6	569.50	12.36	0.00	0.00	2.33	3.53
7	6	7	497.14	13.04	0.00	0.00	2.03	2.75
8	7	8	396.64	4.52	0.00	0.00	1.62	1.81
9	8	25	0.00	0.00	0.00	0.00	0.00	0.00
THE CHECK VALVE IN LINE NUMBER 10 IS CLOSED								
11	9	10	-81.74	-1.15	0.00	0.00	-0.52	-0.29
12	10	11	-217.08	-7.72	0.00	0.00	-1.39	-1.75
13	11	12	661.12	9.31	0.00	0.00	2.70	4.66
14	0	12	286.93	0.04	0.00	0.00	0.81	0.41
15	12	13	140.70	3.74	0.00	0.00	0.57	0.27
16	12	14	671.34	9.58	0.00	0.00	2.74	4.79
17	14	15	605.68	13.46	0.00	0.00	2.47	3.96
18	2	26	-143.67	-3.31	0.00	0.00	-0.59	-0.28
19	0	26	167.12	0.02	0.00	0.00	0.47	0.15
THE CHECK VALVE IN LINE NUMBER 20 IS CLOSED								
21	27	11	907.60	33.49	0.00	0.00	3.71	8.37
22	0	27	907.60	0.17	217.93	0.00	2.57	3.45
23	15	16	588.26	11.25	0.00	0.00	2.40	3.75
24	16	17	536.67	12.65	0.00	0.00	2.19	3.16
25	17	18	473.62	6.28	0.00	0.00	1.93	2.51
26	18	19	271.35	4.47	0.00	0.00	1.11	0.89
27	20	19	-10.05	-0.01	0.00	0.00	-0.04	0.00
THE CHECK VALVE IN LINE NUMBER 28 IS CLOSED								
29	22	21	134.00	0.00	0.00	0.00	0.04	0.00
30	23	22	1651.00	0.23	0.00	0.00	0.52	0.05
31	24	23	1704.60	0.13	0.00	0.00	0.54	0.05
32	1	24	2158.60	0.22	0.00	0.00	0.68	0.08

JUNCTION NUMBER	DEMAND	GRADE LINE	ELEVATION	PRESSURE
1	8.04	1139.99	1035.00	45.50
2	64.32	1136.68	998.00	60.09
3	12.06	1132.52	993.00	60.46
4	62.98	1126.49	983.00	62.18
5	46.23	1123.13	982.00	61.16
6	72.36	1110.77	910.00	87.00
7	100.50	1097.73	950.00	64.02
8	396.64	1093.21	945.00	64.23
9	81.74	1315.40	1000.00	136.67
10	135.34	1316.55	1108.00	90.37
11	29.48	1324.27	1170.00	66.85
12	136.01	1314.96	1190.00	54.15
13	140.70	1311.22	1201.00	47.76
14	65.66	1305.38	1160.00	63.00
15	17.42	1291.92	1076.00	93.57
16	51.59	1280.67	1115.00	71.79
17	62.98	1268.02	1077.00	82.78

18	202.34	1261.74	1110.00	65.76
19	261.30	1257.27	981.00	119.72
20	10.05	1257.26	1070.00	81.15
21	134.00	1139.41	953.00	80.78
22	1517.00	1139.41	1000.00	60.41
23	53.60	1139.64	900.00	103.85
24	454.00	1139.77	930.00	90.90
25	0.00	1093.21	1030.00	27.39
26	23.45	1139.78	1030.00	47.66
27	0.00	1357.76	1030.00	142.03

THE NET SYSTEM DEMAND = 4139.79
SUMMARY OF INFLOWS(+) AND OUTFLOWS(-) FROM FIXED GRADE NODES

PIPE NUMBER	FLOWRATE
1	2778.06
14	286.93
19	167.12
22	907.68

THE NET FLOW INTO THE SYSTEM FROM FIXED GRADE NODES = 4139.79
THE NET FLOW OUT OF THE SYSTEM INTO FIXED GRADE NODES = 0.00

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