Texas Water Development Board

Report 338

Ground-Water Publication Abstracts, 1991

Edited by
Janie Payne, Geologist

March 1992

Published and Distributed
by the
Texas Water Development Board
P.O. Box 13231
Austin, Texas 78711-3231

FOREWORD

Beginning in 1913 with the creation of the first water agency in Texas, the Board of Water Engineers, and continuing through the tenure of the Texas Department of Water Resources, numerous agencies have administered the Constitution and laws of the State pertaining to the use, development, conservation, and protection of its surface- and ground-water resources. On September 1, 1985, the 69th Legislature abolished the Department of Water Resources and divided State water administration into two agencies—the present Texas Water Development Board (TWDB) and the Texas Water Commission.

The TWDB provides financial assistance for water supply, wastewater treatment (sewage), flood control, municipal solid waste, and agricultural projects. Funds for these projects are provided from bond proceeds obtained from the sale of Texas Water Development Bonds. Although financing is its most visible responsibility, the TWDB has the additional responsibility of forecasting and planning to meet the water needs of the State for the next 50 years.

The Ground Water Section of the TWDB conducts studies, independently and with other entities, of local and regional area water-quality problems and water needs in order to provide for the orderly development and management of the State's water resources. Ground Water personnel collect and analyze data to assess the ground-water resources of Texas aquifers and to provide an accurate database of these aquifers to the public. The objective of ground-water sampling is to determine the baseline characteristics and changes in the quality of ground water from selected aquifers. The objective of ground-water level monitoring is to determine changes in the amount of water in underground storage, the depth to water, and the direction and rate of water movement.

Publications presented herein summarize the results of ground-water investigations conducted by the TWDB during 1991. Reports were prepared by Ground Water Section geologists primarily from data collected by staff technicians, and illustrations were prepared by Mark Hayes and Steve Gifford. Complete versions of these publications may be purchased by contacting:

Texas Water Commission Library
P.O. Box 13087
Austin, TX 78711-3087
512/463-7837

The library is located in the basement of the Stephen F. Austin State Office Building, 1700 North Congress Avenue in the State Capitol Office Complex, and is open from 8:00 a.m. to 5:00 p.m. weekdays except holidays.

CONTENTS

NOTE:

LP – Limited Publication
UM – User's Manual
HA – Hydrologic Atlas

Abstracts

Report 326
Evaluation of Water Resources in Bell, Burnet, Travis, Williamson and Parts of Adjacent Counties, Texas
by Gail Duffin
January 1991

This report summarizes the results of an investigation to determine if Williamson County and parts of adjacent counties in central Texas are experiencing or likely to experience ground-water supply or quality problems in the next twenty years. The two principal aquifers in the area are the Edwards Formation and Trinity Group. A second objective of the study, conducted jointly by staff of the Texas Water Development Board and the Texas Water Commission, was to determine whether an underground water conservation district should be created in order to address such problems.

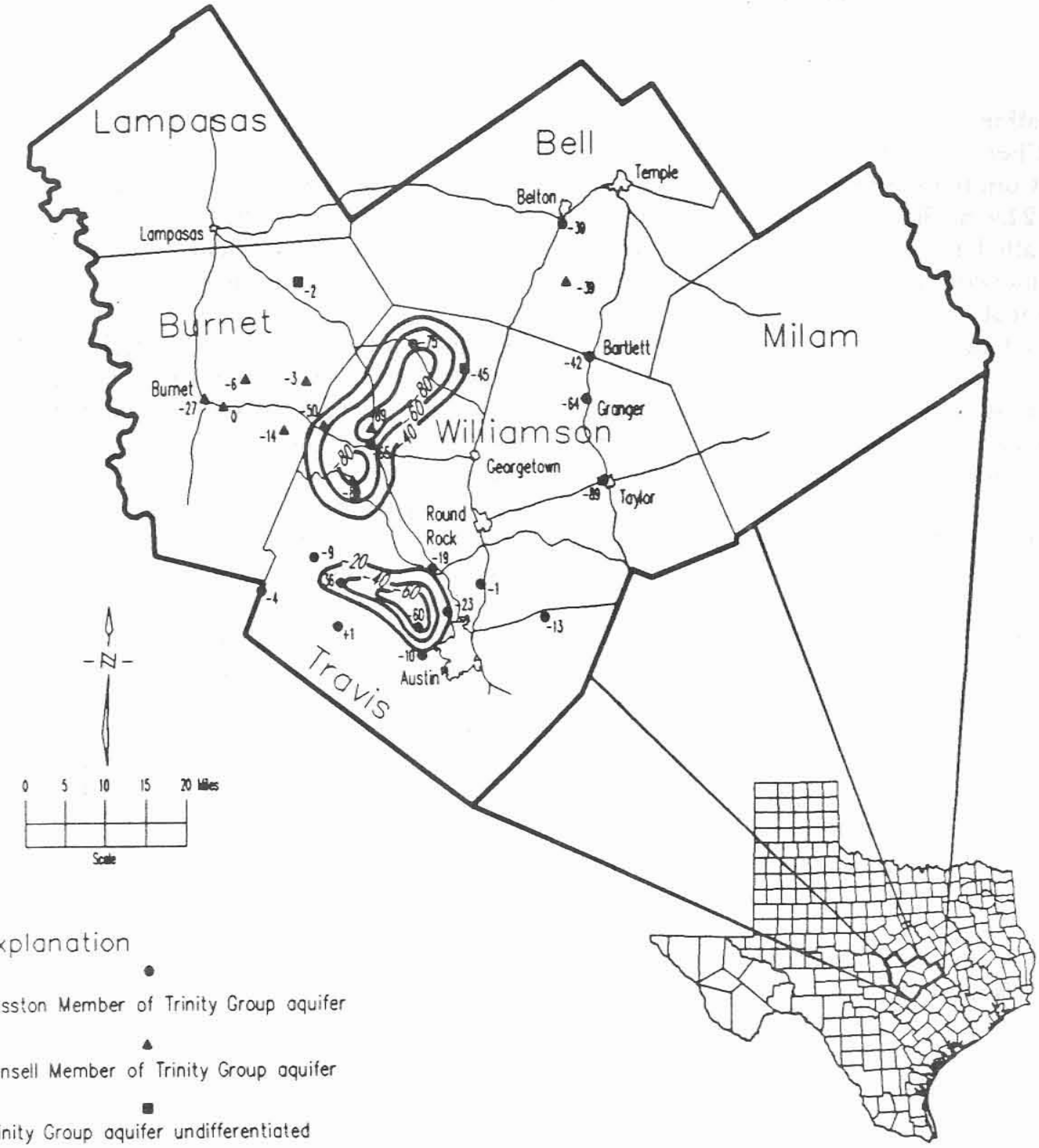
The study area covers 2,710 square miles in parts of six counties: Bastrop, Bell, Burnet, Milam, Travis, and Williamson. The area is bounded on the north by the Lampasas and Little Rivers, on the south by the Colorado River, on the west by the updip limit of the outcrop of the Travis Peak Formation, and on the east by the downdip limit of fresh to slightly saline water (3,000 milligrams per liter dissolved solids) in the lower member of the Trinity Group aquifer. The 1985 estimated population of 457,039 includes residents within these major cities: Austin, Round Rock, Georgetown, Taylor, Burnet, Salado, Cedar Park, Leander, Elgin, and Manor. The economy is largely industrial and commercial in and around Austin. Farming and ranching are the primary activities outside of Austin.

The Trinity Group aquifer yields small to moderate amounts of water in the western part of the study area due to relatively low permeabilities. Yields are greater in the eastern half of the area because of increased aquifer thickness, porosity, and permeability. Estimated ground-water availability from the Trinity is 6,700 acre-feet per year. Ground water in the Trinity is typically hard, ranges from fresh to slightly saline, and often contains high levels of iron, fluoride, and sodium bicarbonate. Water quality deteriorates downdip as a result of impaired circulation.

Availability of water from the Edwards aquifer is limited. The amount of water available from storage in the aquifer is not known, but is considered to be small due to the low average porosity of the aquifer. Another indication of low storage capability is the rapid and significant decline of water levels in wells during periods of low recharge or high pumpage. Figure 1 illustrates water-level declines in the Trinity Group aquifer from 1975 to 1986. The availability of ground water during drought conditions is calculated to be 7,464 acre-feet annually. Water quality is generally good; ground water typically contains less than 500 mg/l dissolved solids along the Interstate Highway 35 corridor. Water quality deteriorates rapidly downdip toward the east within a relatively short distance as it increases in sulfate, chloride, and dissolved-solids content.

Ground-water problems in the area include a lack of reliable supply for both short-term drought demand and long-term economic development. During late summer dry spells and drought, water levels drop quickly in the Edwards aquifer. Current utilizations of both aquifers exceed the amount projected for a long-term safe yield (drought reliable) supply. Water quality in both aquifers in the eastern portion of the study area presents problems for public supply.

An underground water conservation district is not the most appropriate management approach for the area at this time. The increasing reliance on surface water presents issues which are generally outside the purview of ground-water districts. Most of the water resource problems can be addressed through existing entities. The varied interests in the area preclude the consolidation of political support needed to create a district. Finally, many area residents indicated that they would not support an additional taxing entity.



Explanation

● Hosston Member of Trinity Group aquifer

▲ Hensell Member of Trinity Group aquifer

■ Trinity Group aquifer undifferentiated

-36 ● Number indicates the water-level decline in feet for the period 1975–1986

(A positive number indicates a rise)

-20 Contour lines indicating water-level declines in 20-foot intervals

Figure 1

Water-level declines in the Trinity Group aquifer, 1975–1986.

Report 327
Evaluation of Ground-Water Resources in the Vicinity of the Cities of Henderson, Jacksonville, Kilgore, Lufkin, Nacogdoches, Rusk, and Tyler in East Texas
By Richard D. Preston
February 1991

This evaluation of water resources in parts of Angelina, Cherokee, Gregg, Nacogdoches, Rusk, and Smith Counties was in response to passage of House Bill 2 by the Sixty-ninth Texas Legislature. This bill called for the identification of areas within the state with critical ground-water problems or the potential for such problems within the next twenty years. This "critical area" in northeast Texas has a diverse economy based on agriculture, production of lumber and lumber products, petroleum and petroleum products, and the manufacturing of other goods.

The area uses water from both ground- and surface-water sources. The major source of ground water is the Carrizo-Wilcox aquifer, but significant amounts are also produced from the Queen City and Sparta aquifers. Surface water is produced from several reservoirs. About 63 percent of the total water use in 1985 was from ground-water sources. In response to expected population growth, total water demand is projected to increase from the 101,712 acre-feet used in 1985 to 135,425 acre-feet in 2010. Most of the increase will be for municipal and industrial uses.

Historically, large withdrawals of ground water have caused water-level declines, especially from within relatively small areas with large numbers of high-capacity municipal and industrial supply wells. Two areas beneath which the largest water-level declines have occurred are the central part of Smith County around Tyler and the area between Lufkin and Nacogdoches in Angelina and Nacogdoches Counties (Fig. 1). Water-levels in both of these areas have declined as much as 500 feet since before World War II. Recent measurements indicate that the declines have slowed and are perhaps stabilizing due to reduction in ground-water pumpage and increased reliance on surface water by Tyler, Nacogdoches, and industrial users within the area.

The chemical quality of ground water is generally good. The major quality problem is the erratic occurrence of relatively high concentrations of iron. Some evidence indicates past contamination of ground water by oil-field brine, but reported sites are few and of limited extent.

Within Angelina, Cherokee, Gregg, Nacogdoches, Rusk, and Smith Counties, the estimated annual effective recharge totals about 105,000 acre-feet for the Carrizo-Wilcox aquifer; 208,000 acre-feet for the Queen City aquifer; and 31,000 acre-feet for the Sparta aquifer. Relatively low well yields and high concentrations of iron make much of the water from the Queen City and Sparta uneconomical for municipal and industrial development. Large amounts of additional pumpage could be derived from the Carrizo-Wilcox over much of the study area, but new wells must be located an adequate distance from existing centers of heavy pumpage and constructed for the most efficient operation. The artesian nature of the aquifer over most of the study area and the distance from areas of recharge increase pumping heads. These conditions, along with the inefficient spacing and construction of many existing wells, may reduce the total amount of water available from the Carrizo-Wilcox aquifer on a long-term basis.

Large amounts of surface water are available from several reservoirs both within and just outside of the study area. The cities of Tyler, Nacogdoches, Jacksonville, Kilgore, and Liberty and industries in the vicinity of Lufkin-Nacogdoches are currently using surface water in conjunction with ground water from the Carrizo-Wilcox aquifer. Surface water, if used in conjunction with available ground-water supplies, is adequate to provide for growth in the study area well beyond 2010.

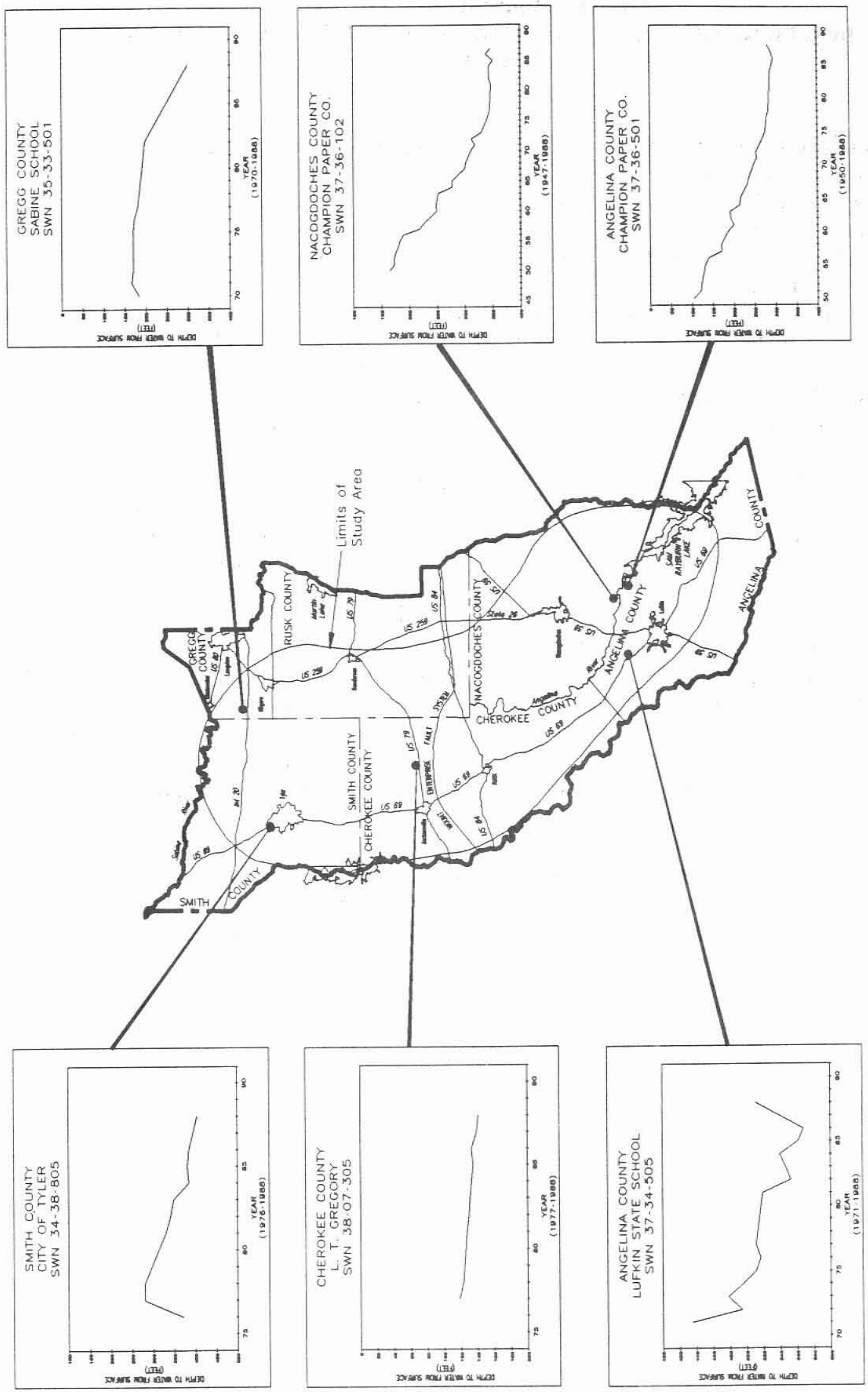


Figure 1

Hydrographs of selected wells illustrating large water–level declines north of Lufkin and around Tyler.

Report 330
Evaluation of Ground-Water Resources in the Southern High Plains of Texas
by John B. Ashworth, Prescott Christian, and Theresa Waterreus
July 1991

The evaluation of ground-water resources in the southern High Plains of Texas is in response to the 1985 passage of House Bill 2 by the Sixty-ninth Texas Legislature, which called for the identification and study of areas in the State that are experiencing or are expected to experience critical underground water problems within the next twenty years. Primary emphasis is placed on Andrews, Gaines, Lynn, and Terry Counties, and parts of Borden, Ector, Garza, Howard, and Midland Counties. Oil and gas production, raising cattle, and irrigated farming are the mainstays of the local economy. Water needs for the area are supplied mostly from the Ogallala aquifer with lesser amounts pumped from underlying Cretaceous and Triassic aquifers.

Water-level declines of up to 50 feet have occurred from predevelopment to 1980 in the heavily irrigated areas of western Gaines and Martin Counties. Additional declines of up to 30 feet have occurred in western Gaines County from 1980 to 1990. However, a net water-level rise during the past decade has been noted over most of the study area.

The chemical quality of the Ogallala aquifer is generally poorer in the southern part of the Texas High Plains than it is to the north, with dissolved solids ranging from less than 1,000 to over 3,000 milligrams per liter (Fig. 1). The quality of the aquifer may be substantially influenced by upward leakage and subsequent mixing of water from the underlying Cretaceous aquifers. Numerous chemical analyses indicate that fluoride, nitrate, and selenium concentration levels are often in excess of recommended maximum safe drinking water standards. High sodium-chloride concentration and high chloride/bromide ratios in some Ogallala aquifer samples suggest contamination from brine sources.

In 1985, the total pumpage of ground water from the High Plains aquifer system within Andrews, Gaines, Lynn, and Terry Counties was about 446,000 acre-feet, of which 96 percent was used for agricultural irrigation. The total annual demand for ground water within this area is projected to decrease by 36 percent by the year 2010 as a result of an expected decline in irrigation pumpage. By the year 2010, approximately 19 percent of the recoverable ground water presently held in storage in the entire study area will have been used, with approximately 24 million acre-feet remaining. Although there appears to be a reasonable quantity of ground water available for all uses in the area through the year 2010, the continued deterioration of the chemical quality could limit the usefulness of some of this water.

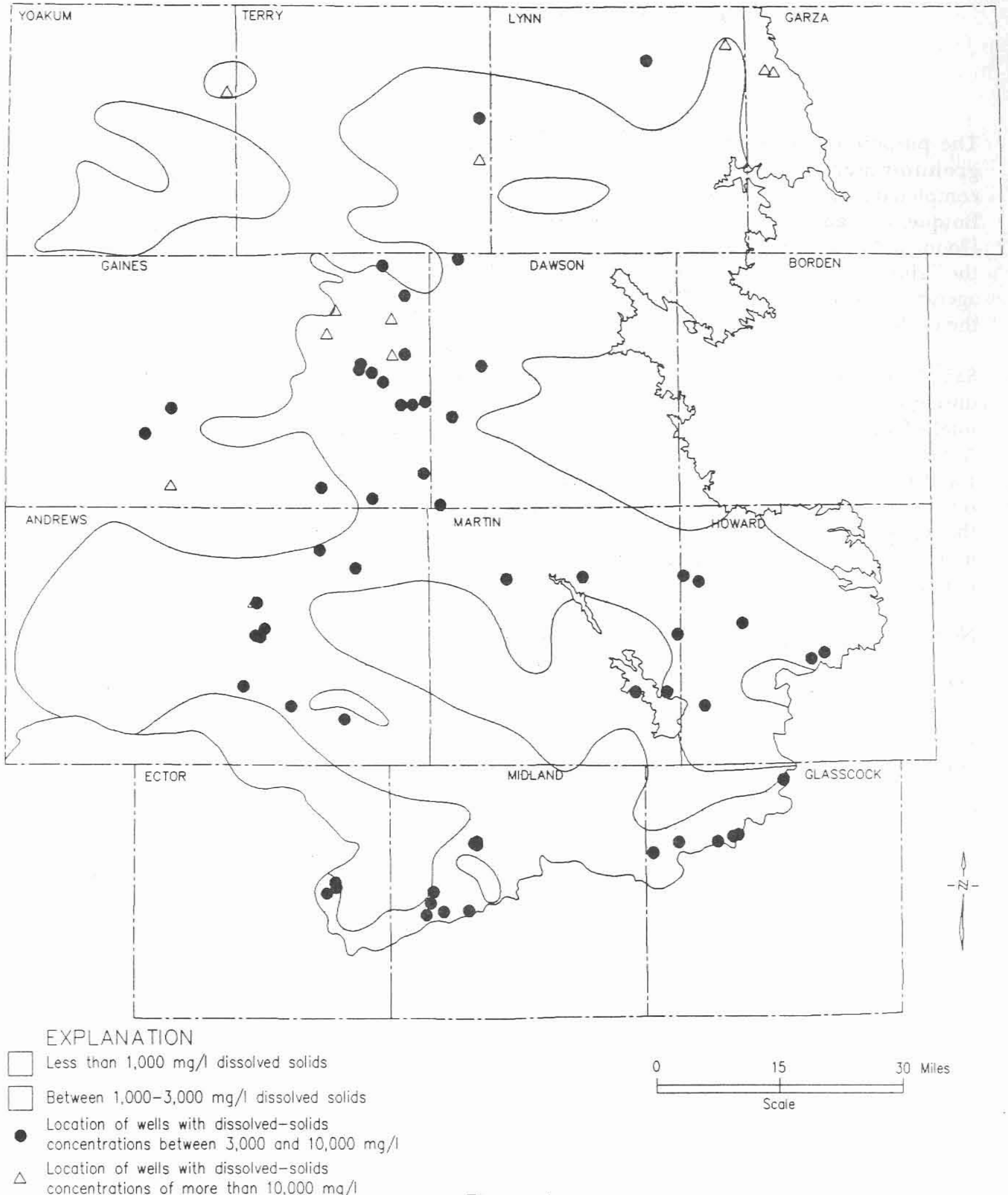


Figure 1

Dissolved–solids content of water in the Ogallala aquifer.

Report 331
Ground-Water Quality Monitoring of the Trinity Aquifer in the Vicinity of Erath County
by Barbara E. Beynon
July 1991

The purpose of this study was to examine the ground-water quality from selected wells completed in the Trinity Group in all or parts of Bosque, Comanche, Eastland, Erath, Hamilton, Hood, and Somervell Counties. This segment of the Trinity was selected to coincide with a multi-agency study investigating dairy operations and their effect on ground water.

Sampling and laboratory analyses were performed during the second and third quarters of 1990. A total of 66 wells were sampled: 4 wells in the Antlers Formation; 6 wells in the Paluxy Formation; 1 well in the Glen Rose Formation; and 55 wells in the Twin Mountains Formation. All analyses in this report are presented in four sections: dissolved inorganic constituents; nutrients; pesticides; and radioactivity.

No wells in the Antlers Formation exceeded the established Maximum Contaminant Levels (MCLs) for dissolved inorganic constituents. In Erath County the Paluxy Formation had 2 wells which had excessive dissolved inorganic constituents: chloride (1 well); dissolved solids (2 wells); iron (2 wells); and manganese (1 well). The Twin Mountains Formation had 13 wells, located in Comanche, Eastland, Erath, and Hood Counties, which had excessive dissolved inorganic constituents: chloride (4 wells); dissolved solids (2 wells); iron (9 wells); and manganese (1 well).

No wells in the Antlers Formation exceeded the MCL for nitrate of 10 mg/l (as N). The Paluxy Formation had 1 well in Hamilton County which exceeded the MCL for nitrate. Four wells in the Twin Mountains Formation, located in Comanche and Erath Counties, exceeded the MCL for nitrate (Fig. 1).

None of the 66 wells sampled in this study had any detectable amounts of insecticides or herbicides.

No wells in either the Antlers Formation or the Paluxy Formation contained MCLs in excess of limits established for radioactivity. Five wells in the Twin Mountains Formation, located in Erath and Hood Counties, exceeded the established MCLs in gross alpha (5 wells) and combined Radium-226 and Radium-228 (4 wells). A subjective attempt to compare previous water-quality analyses of these same wells to these analyses was done using three parameters: chloride, sulfate, and dissolved solids. Of the 4 wells sampled in the Antlers Formation, only 2 had previous sampling data; and no change in water quality was noted. Of the 55 wells sampled in the Twin Mountains, 36 wells had previous sampling data. Of these, no significant change in water quality was noted in 25 wells; some improvement was observed in 5 wells; and some deterioration was noted in 6 wells. Overall the water quality in the study area is good and to date has shown little change.

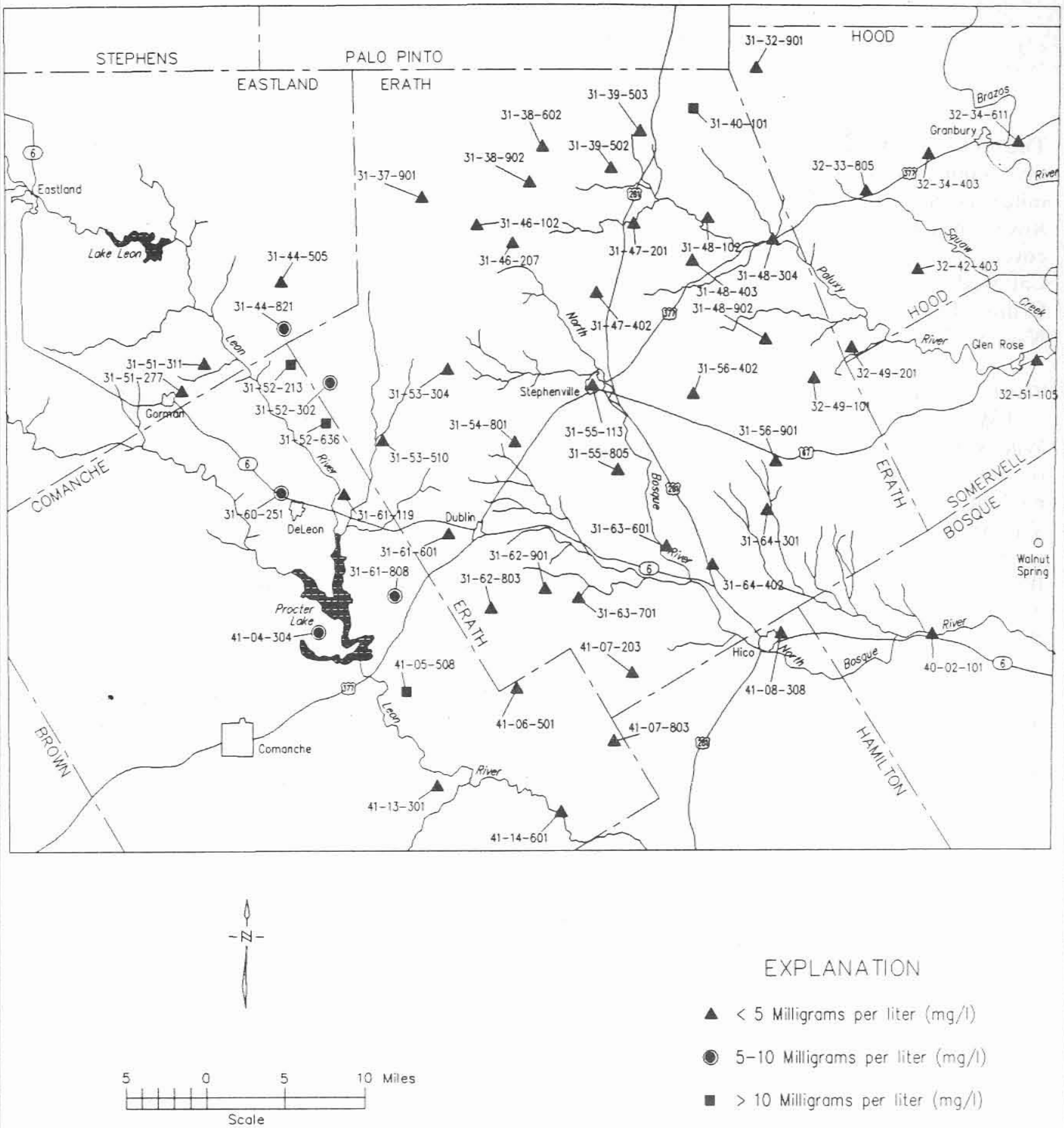


Figure 1

Map showing location of five wells completed in the Twin Mountains Formation in the western part of the study area exceeding the established Maximum Contaminant Levels.

Report 332
Ground-Water Resources in the Carrizo-Wilcox Aquifer in the Central Texas Region
by David Thorkildsen and Robert D. Price

The area of the Carrizo-Wilcox aquifer studied in this report covers approximately 6,000 square miles in central Texas. It extends from the Trinity River southwest to the San Marcos River and covers all or parts of Bastrop, Brazos, Burleson, Caldwell, Falls, Fayette, Freestone, Gonzales, Grimes, Lee, Leon, Limestone, Madison, Milam, Navarro, Robertson, and Williamson Counties.

The hydrologically connected Carrizo Formation and Wilcox Group regionally form the Carrizo-Wilcox aquifer. Collectively these units, composed dominantly of sand and shale, represent extensive ancient deposition in a river and delta complex. The Wilcox Group can be further subdivided northeast of the Colorado River into the Calvert Bluff, Simsboro, and Hooper Formations (Fig. 1). The Carrizo and Simsboro sands are the most significant water-bearing units.

Recharge to the Carrizo-Wilcox aquifer enters the aquifer primarily through infiltration in the outcrop from rainfall and from streams which cross its outcrop. Since the aquifer is nearly full, a substantial amount of recharge is rejected in the outcrop and only a small amount moves downdip. Additionally, a considerable amount of interformational leakage from overlying younger beds is occurring. With increased pumpage, both annual effective recharge to the outcrop and interformational leakage can be increased. Model-derived data on the north half of the study area suggest that slightly less than 3 percent of the mean annual rainfall over the outcrop is effective recharge. With increased pumpage under controlled conditions, effective recharge can be increased to about 5 percent.

All water-bearing units of the Carrizo-Wilcox aquifer contain fresh to slightly saline ground water. Well yields from the formations range from less than 100 to greater than 2,500 gallons per minute (gal/min) with the largest yields available from the Carrizo and Simsboro Formations. More than 90 percent of the wells included in this study produce water with less than 1,000 milligrams per liter (mg/l) dissolved solids that is suitable for most purposes. Water from the aquifer is suitable for irrigation, but is generally used only as a supplement during times of deficient rainfall.

About 40,800 acre-feet of ground water was used within the study area for all purposes during 1980. Of this amount, approximately 83 percent was used for public supply; 8 percent for rural, domestic, and livestock needs; 5 percent for irrigation; and 4 percent for industrial purposes. Because of the small amount of ground-water consumption, water-level declines have been restricted to small isolated areas of pumpage; in many wells, water levels have remained steady or have periodically risen.

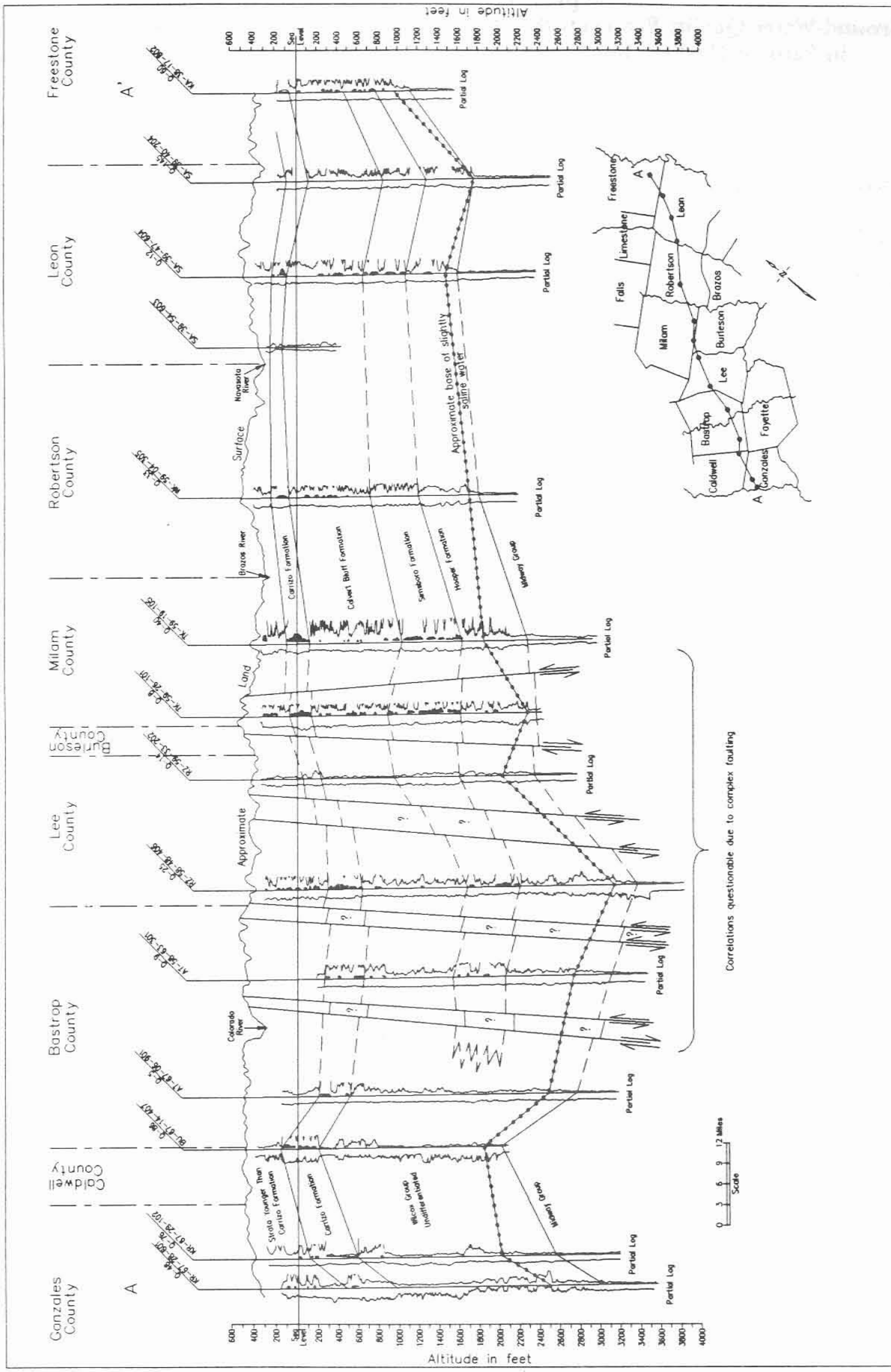


Figure 1

Geologic section A–A' illustrating presence of the Simsboro northeast of the Colorado River. The Carrizo and Simsboro sands are the most significant water-bearing units.

Report 333
Joint Ground-Water Quality Project with the Texas Department of Agriculture in Parts of Haskell, Knox, and Stonewall Counties, 1990

by Phillip L. Nordstrom

December 1991

As part of a cooperative project with the Texas Department of Agriculture (TDA), the Seymour aquifer in parts of Haskell, Knox, and Stonewall Counties was sampled in order to provide inorganic constituent data to complement pesticide data collected by the TDA. Other objectives satisfied by the project included acquisition of water-quality data for routine monitoring of a major aquifer, evaluation of a designated critical area for water resources, and establishment of interagency cooperation as described in Groundwater Protection Committee documents.

This project was initiated in response to positive detections of pesticides by the TDA in previous surveys. Forty-seven wells were sampled: 34 in Knox County and 13 along the boundary between Haskell and Stonewall Counties during August 1990. For the first time in this area, tests were conducted to determine the presence of nineteen minor inorganic elements, five nutrients, and four radioactive elements in addition to the major cations and anions. This testing helped establish more complete baseline water-quality data. Ground-water quality problems determined during this project were similar to those uncovered in previous studies.

Excessive nitrate concentration continues to be the most prevalent problem (Fig. 2). The average nitrate concentration of 70.8 mg/l was well above the drinking water standard of 44.3 mg/l. Instances of high chloride and sulfate concentrations, along with elevated dissolved-solids content, indicate pockets of contamination including several with documented oil-field type problems. Hardness in excess of 600 mg/l as calcium carbonate also poses a minor problem.

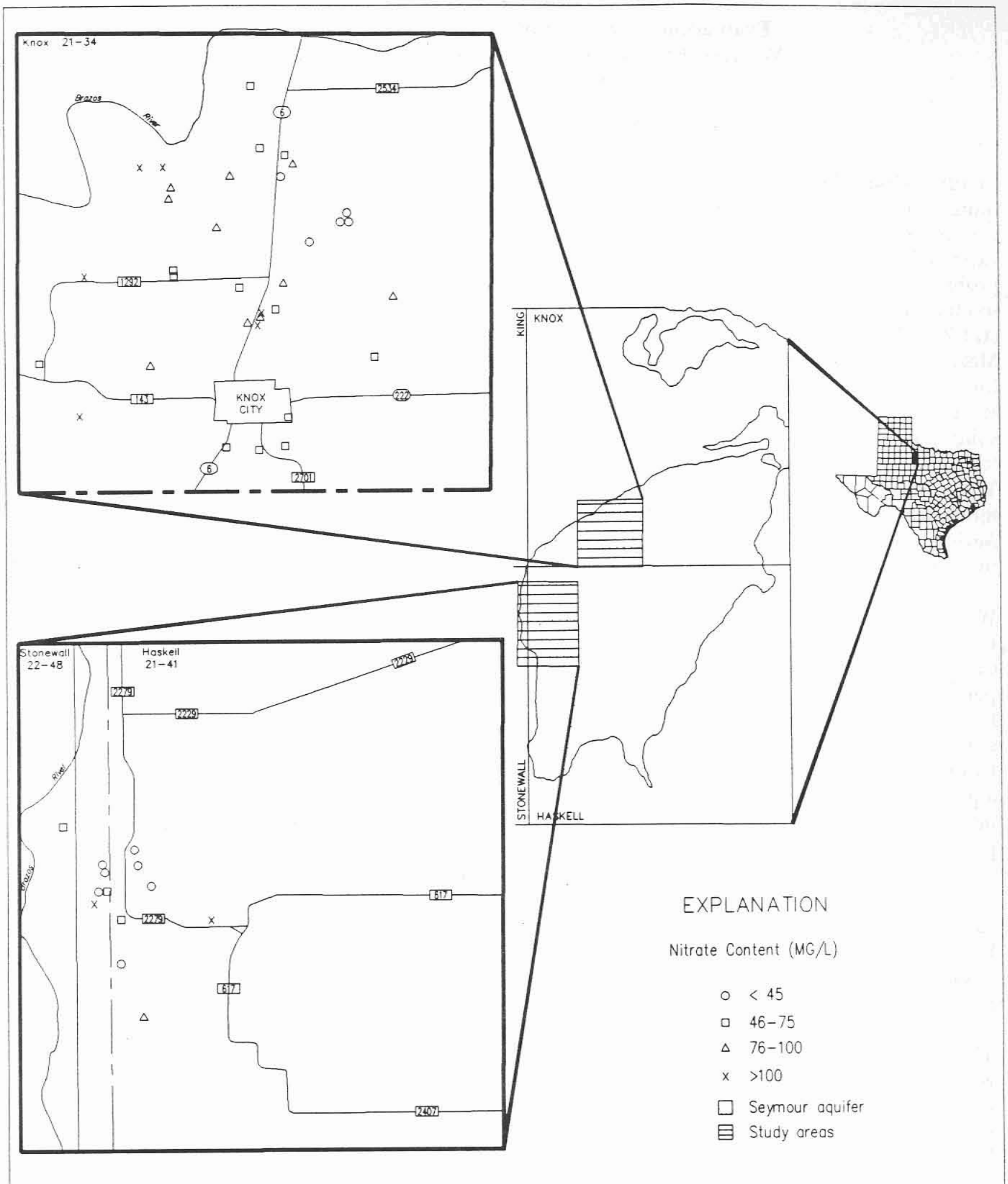


Figure 2

Nitrate content of water from wells sampled in Stonewall, Haskell, and Knox Counties, 1990.

Report 334
Evaluation of the Ground-Water Resources in the Western Portion of the Winter Garden Area, Texas
by T. Wesley McCoy
October 1991

In 1985, House Bill 2 was enacted by the Sixty-ninth Texas Legislature, which recognized that certain areas of the State were experiencing or expected to experience critical ground-water problems within the next twenty years. One area so identified for study includes Dimmit, La Salle, and Zavala Counties and portions of Maverick, McMullen, and Webb Counties; these counties form the western portion of what is known as the Winter Garden area. This study area, located southwest of San Antonio and southeast of Del Rio, is bounded on the west by the Rio Grande. The climate of the region is semi-arid with low to moderate rainfall and a high rate of evaporation. Agriculture and petroleum production dominate the regional economy.

Water needs for the western portion of the Winter Garden Area are supplied primarily from the Carrizo aquifer. Surface water accounts for 11 percent of the total water used and is only available from widely scattered, small-capacity retention structures and through water rights from the Rio Grande and Nueces River. Several less productive aquifers that overlie the Carrizo aquifer are unsuitable for heavy development due to their poor water quality and low transmissivity.

High well yields from the Carrizo aquifer and the suitability of its water for irrigation have led to heavy agricultural development over the years. Ground water used for irrigation amounts to about 82 percent of the total water used in the area.

The chemical quality of water in the Carrizo aquifer is generally fresh and meets Texas Department of Health drinking water standards. Dissolved solids usually range from 450 to 1,000 milligrams per liter with low sodium, chloride, and sulfate concentrations. The sodium hazard and sodium-adsorption ratio are usually low; the salinity hazard is low to medium, thus making Carrizo ground water especially suitable for irrigation.

Ground-water contamination appears to be localized. The two potential means of contamination in the region are from brine associated with petroleum production and saline-water encroachment into the Carrizo aquifer from overlying water-bearing units which contain poor-quality water. In the Carrizo outcrop area where direct infiltration of recharge occurs through sandy soils, leakage of oilfield brine from unlined surface disposal pits may have caused localized contamination, particularly before the Railroad Commission of Texas 1969 "no-pit" order. In some areas in Dimmit and Zavala Counties, excessive water-level declines due to heavy pumpage may lead to infiltration of highly-mineralized water from the overlying Bigford Formation into the Carrizo through improperly completed or abandoned wells.

Previous work by the Texas Water Development Board indicates that approximately 118,000 acre-feet per year of ground water is available in the study area for development. Heavy ground-water withdrawals have been removing water from storage in the Carrizo aquifer for many years; large areas of water-level declines are evident in Dimmit, La Salle, McMullen, and Zavala Counties (Fig. 1). Even though the total annual water demands are projected to decrease from 132,905 acre-feet to 118,764 acre-feet by the year 2010, localized heavy pumpage could still result in significant water-level declines and extensive cones of depression.

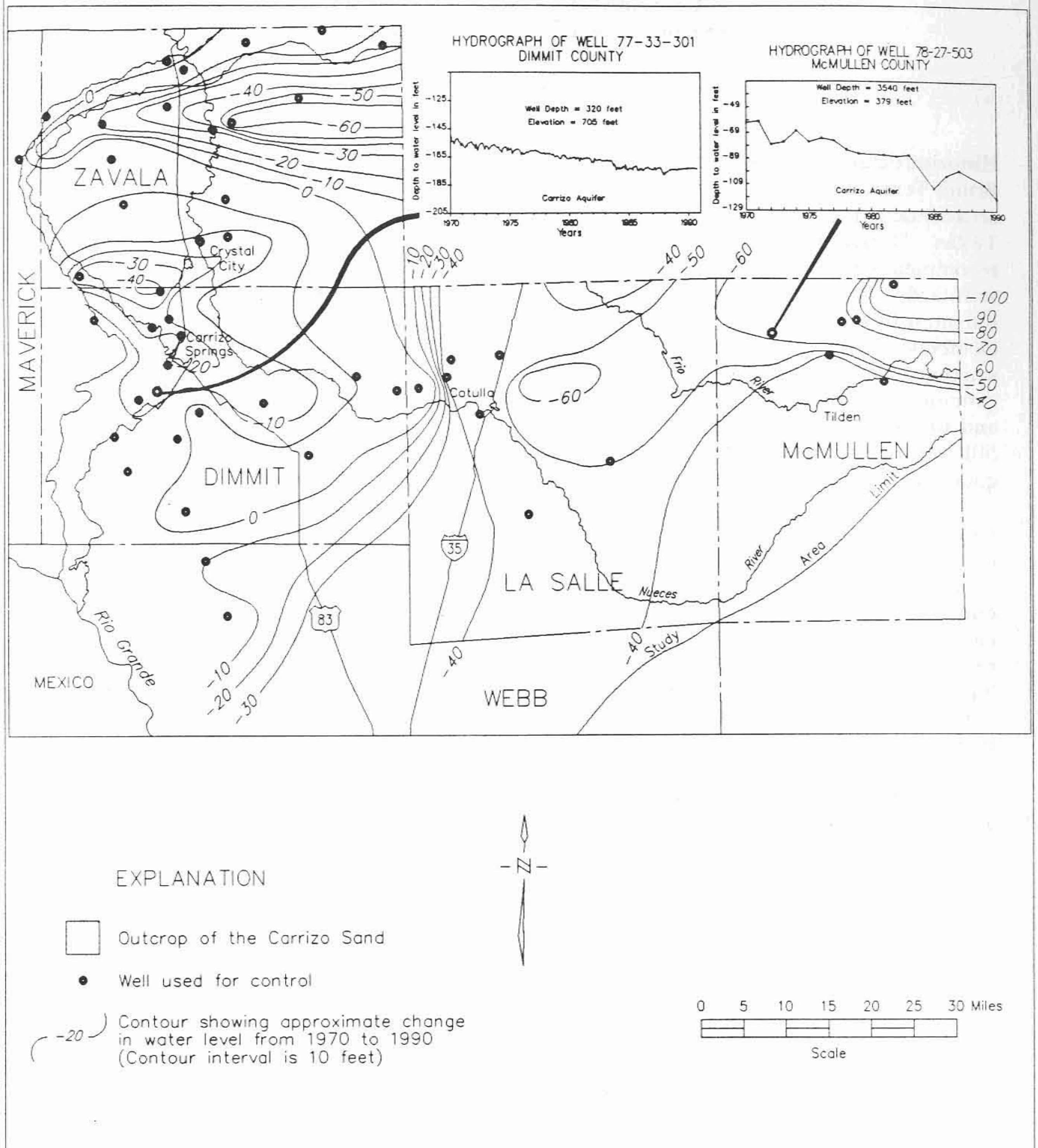


Figure 1

Water-level change map in the Carrizo aquifer, 1970–1990, illustrating large water-level declines in Zavala, La Salle, and McMullen Counties.

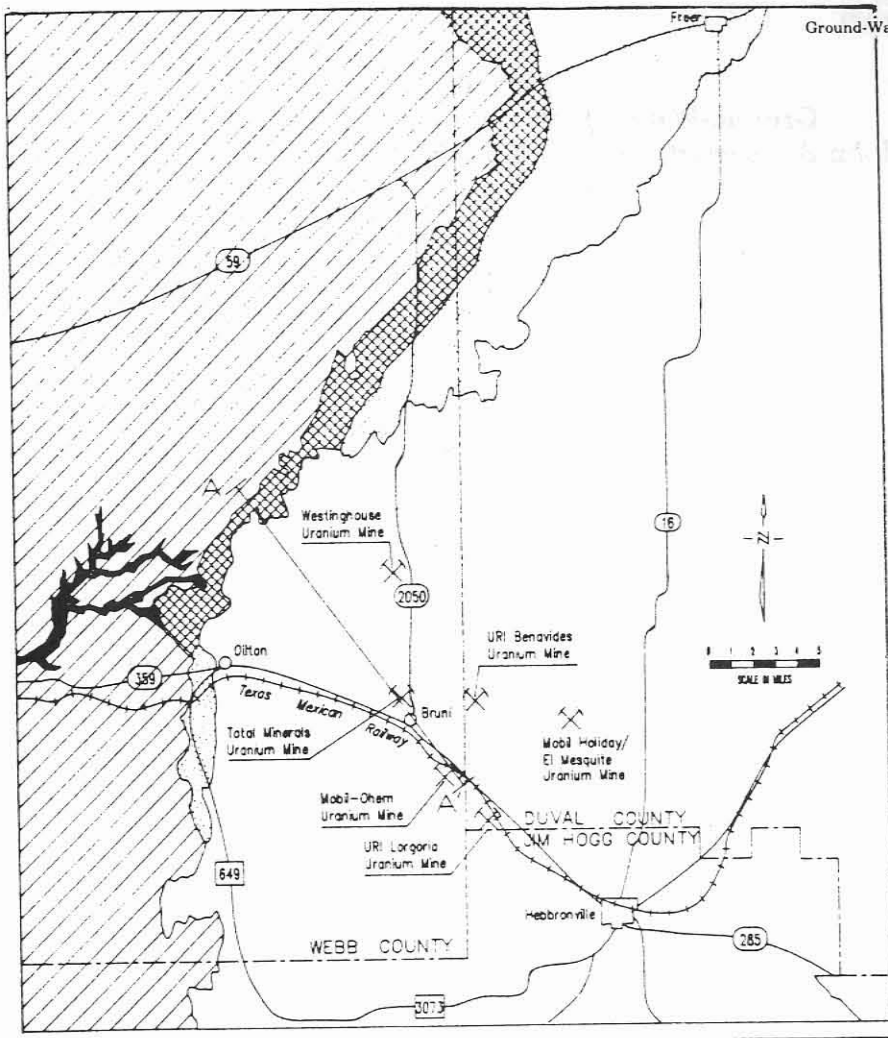
LP-209
Ground-Water Quality and Availability in and Around Bruni, Webb County, Texas
By Eric O. Adidas
March 1991

Historical data from shallow aquifers in and around Bruni, Texas, indicate that ground water in this area contains trace metal elements in excess of the Texas Department of Health (TDH) recommended limits for public drinking water standards. These elements include arsenic, selenium, iron, manganese, and some radioactive elements. A study was conducted to determine whether local uranium mining operations were contaminating or dewatering Tertiary aquifers and to recommend what procedures might be followed by the Bruni Water Works to ensure good-quality water.

Ground-water sample analyses reveal that Bruni water-supply wells have consistently yielded water with high arsenic, uranium, and daughter-product concentrations. Two domestic and two commercial-industrial water-supply wells have all reported arsenic concentrations two to three times higher than the acceptable standards set by the TDH. Domestic and school wells have also shown high levels of radium, radon gas, and arsenic.

Uranium and arsenic occur naturally within the water-producing interval in which the Bruni public-supply wells are completed, the same interval containing the uranium ore being mined by Total Minerals Company 1.5 miles north of Bruni (Fig. 1). As uranium and thorium constantly undergo radiochemical changes, they yield daughter products such as radium, radon gas, and bismuth which also naturally contaminate the aquifer. Their distribution and concentration characteristics do not indicate a plume of contamination from uranium mines in the area.

TWDB recommendations to alleviate these water-quality problems include: isolation of the interval producing acceptable-quality water from the interval containing uranium ore; installation of a corrosion inhibitor to reduce iron content; use of plastic casing when new wells are drilled; installation of a chlorinator and ion exchanger or reverse osmosis unit to reduce the concentrations of arsenic and other undesirable trace metals; and drilling of a third municipal-supply well to produce better-quality water to mix with the poorer-quality water presently being produced.



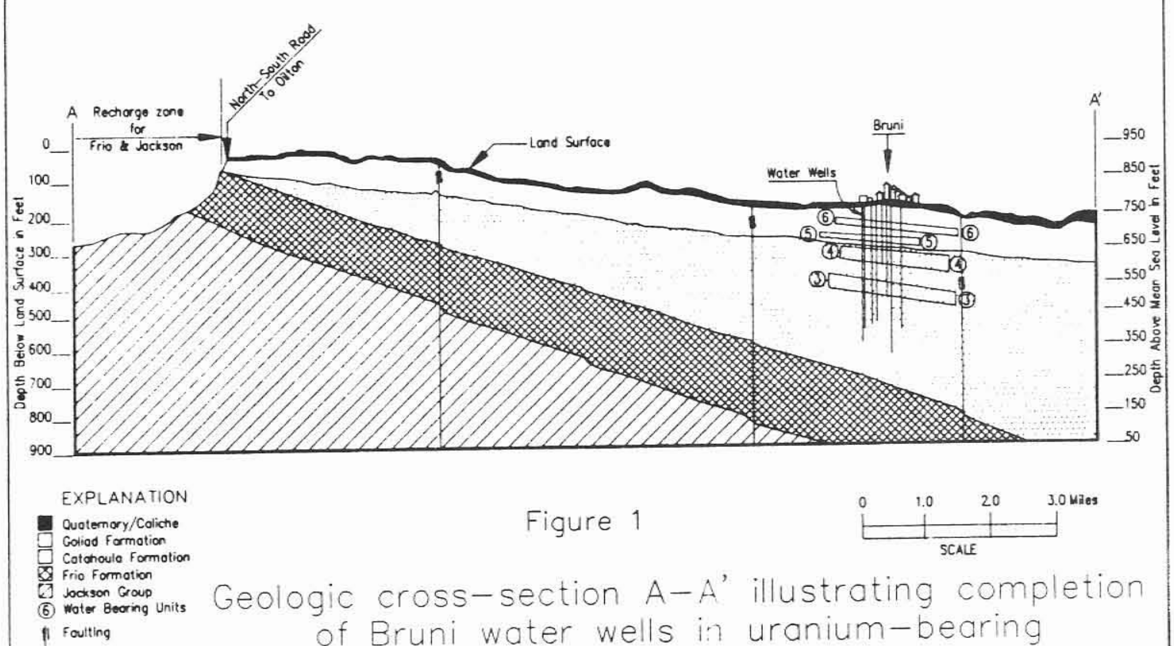


Figure 1

Geologic cross–section A–A' illustrating completion of Bruni water wells in uranium–bearing interval of the Catahoula Formation.

LP-210
Ground-Water Quality in Garden City, Texas
By John B. Ashworth, Phillip L. Nordstrom, and Rick Harston
September 1990

Garden City, the small, unincorporated community serving as the Glasscock County seat, relies on private water wells for its water supply and on septic systems for the disposal of sewage effluent. Approximately 104 wells are currently in use and 15 are abandoned or unused. Several of those wells are in a state of deterioration in which leakage of contaminants into the wells from the surface or near surface is possible. Virtually every home and many of the businesses have septic systems.

Water-quality analyses of samples taken from 28 wells indicate that the concentration of water wells and septic systems within the town has resulted in a degradation of the chemical quality of the underlying ground water. Although the ground-water quality is generally acceptable for human consumption, several samples from wells contained nitrate in excess of the TDH Maximum Contaminant Level (Fig. 1).

The primary solution to the problem of a contaminated or potentially contaminated aquifer would be the establishment of a municipal well field located outside the area of influence of concentrated human activities. As this option is not financially feasible, other suggestions that should be considered include: the establishment of a quality monitoring system in which every well is periodically tested for specific conductivity, nitrates, coliform bacteria, and other suspected contaminants; identification of contaminated wells and their remediation; elimination of all cesspools and replacement with properly installed septic tanks with adequate drain fields; proper plugging of all abandoned wells and/or capping of unused wells; and drilling of any new wells as far away from drain fields as possible.

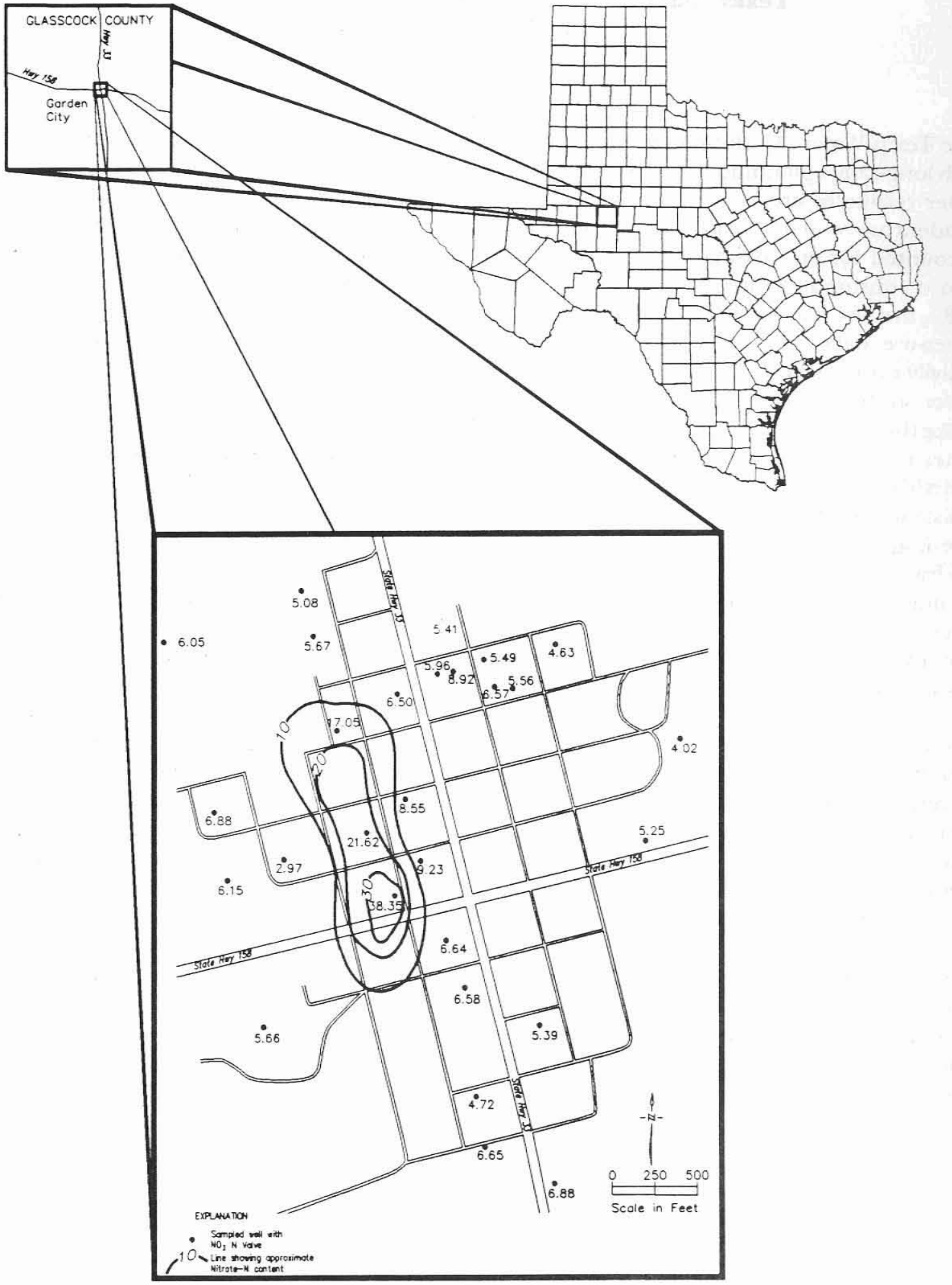


Figure 1

Map depicting location of wells with concentrations of nitrate-N in excess of the TDH standard of 10 mg/l.

LP-211
Ground-Water Programs and Studies of the Texas Water Development Board for Fiscal Years 1990-1991
By Ground Water Staff
October 1991

The Texas Water Development Board is charged with long-range planning to insure that the State's water resources are known and developed in a prudent and efficient manner. Ground-water use accounted for approximately 54 percent of the entire consumptive use of water in the State in 1989, the last year for which complete statewide water-use data are available. The Board relies heavily on data-collection activities and ground-water studies to insure that the data needed to make the proper decisions concerning the State's water resources are available. Public and private individuals and entities also rely on public assistance from the Ground Water Section when needing pertinent information prior to activities such as drilling or construction of municipal water facilities. This report describes the ground-water data collection and study activities conducted by the TWDB Ground Water Section staff during Fiscal Years 1990 and 1991.

Data-collection activities include: water-level monitoring, water-quality monitoring, and well development control. Data obtained from water-level observation wells reflect changes in the amount of water in underground storage, the depth to water, and the direction and rate of water movement. Excessive water-level declines may result in decreased well yields, increased pumping costs, abandonment of some wells, land surface subsidence, and encroachment. The objective of ground-water sampling is to determine the baseline characteristics and changes in the quality of ground water from selected aquifers. These changes may be natural or a result of human activities. The purpose of well development control is to maintain a current inventory of public supply, industrial, and irrigation well development in the state. Activities such as water well plotting, state-well numbering, geophysical logging, and computer graphics support the timely completion of ground-water data collection and study activities.

The TWDB Ground Water staff conducts ground-water investigations to determine the occurrence, availability, quantity, storage capacity, and quality of ground water needed to supply the future water needs of Texas. Detailed studies, the most comprehensive and complete type of investigation, provide quantitative data for use by individuals residing within the study area(s). Special studies are directed toward accomplishing a special objective or solving a problem in a particular county or region of the State; examples of these include a study of ground-water conditions in Garden City and construction of the Ogallala aquifer model (Fig. 1). A third type of study is devoted to critical areas, those areas in the State which are experiencing or are expected to experience critical ground-water problems within the next twenty years. The fourth type of investigation, the basic-data collection study, is conducted to supplement or expand ground-water data in the TWDB files and to support other investigations intended to evaluate the ground-water resources of a particular county or region of the State.

EXPLANATION

- 1 Pecos River Ground-Water Study
- 2 Garden City Study
- 3 Edwards Bad Water Line Study
- 4 Montgomery County Recharge Study
- 5 Edwards San Antonio Region Model Recalibration Study
- 6 Ogallala Model Study
- 7 Woodbine Model Study
- 8 Trinity Model Study
- 9 Gulf Coast Plain Model Study
- 10 Radioactivity in the Dockum Aquifer Study
- 11 Radioactivity in the Lower Gulf Coast Study
- 12 Aquifer Delination Criteria Study (not shown)

Figure 1

Map showing areas in which special ground-water studies were conducted in Fiscal Years 1990-1991.

LP-212
Delineation Criteria for the Major and Minor *Aquifer Maps of Texas*
By John B. Ashworth and Robert R. Flores
June 1991

An extensive revision of the major aquifer map (Fig. 1) and minor aquifer map of Texas was completed in 1990 by the Ground Water Section of the Texas Water Development Board (TWDB) for inclusion in the 1990 Texas Water Plan. Many of the previous delineations were made in the late sixties and early seventies. Since then, however, statewide geologic atlas coverage has been completed by the Bureau of Economic Geology (BEG) of The University of Texas, and numerous ground-water studies have been completed by the TWDB and other entities. Therefore, it seemed timely to redelineate the major and minor aquifers in Texas as part of the TWDB update of the Texas Water Plan. The level of detail with which the aquifers were delineated will aid in producing better estimates of recharge and ground-water availability for this and future Water Plan updates.

This report is intended to document the criteria and sources by which each aquifer was delineated. The selected references listed with each aquifer are only those that were specifically used in the delineations and do not necessarily represent the best overview of the aquifer.

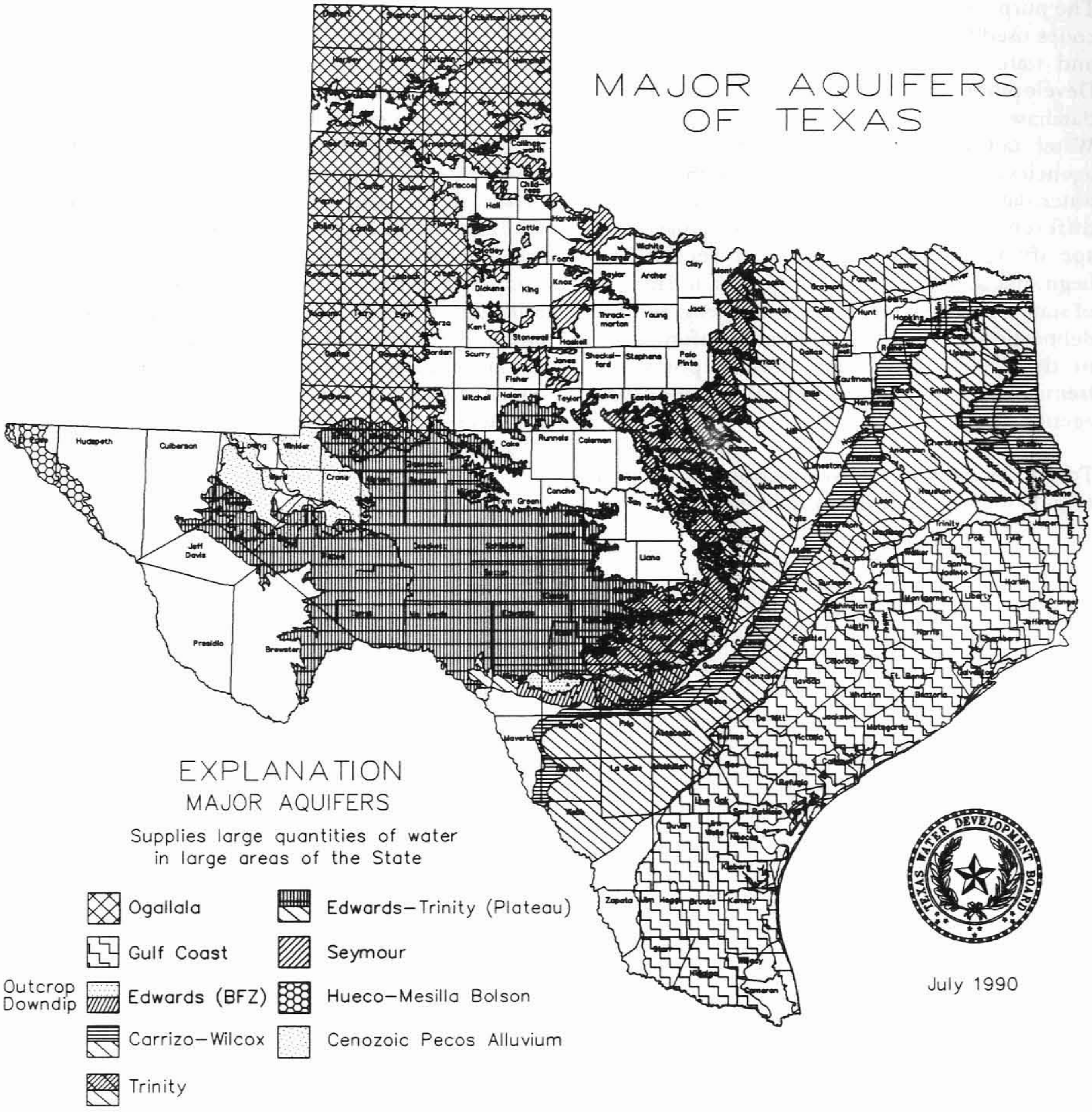
The surface extent (geologic outcrop) of each aquifer was digitized onto computer files from geologic atlas sheets published by the BEG and generally represents the recharge zone of each aquifer. Downdip boundaries delineate the extent of the aquifer which contains ground water whose dissolved solids concentrations will meet the primary use of the aquifer. The quality limit for most of the aquifers is 3,000 milligrams per liter (mg/l) dissolved solids. For a few aquifers, however, the limit is 1,000, 5,000, or 10,000 mg/l dissolved solids. Downdip quality boundaries were determined using a combination of sources including: geophysical logs, drillers' logs, water quality sample analyses (some of which were collected from test holes drilled by TWDB staff), results of ground-water studies conducted by TWDB staff and others, and previously published reports.

The aquifers were categorized as major or minor based on the quantity of water supplied by each in 1985, which reflects recent trends, and by their areal extent. The aquifers are defined as follows:

Major aquifer - supplies large quantities of water in large areas of the State.

Minor aquifer - supplies large quantities of water in small areas or relatively small quantities of water in large areas of the State.

The aquifers were then compiled and delineated on a 1:250,000 scale base map using computer graphics.


MAJOR AQUIFERS OF TEXAS
EXPLANATION
MAJOR AQUIFERS
Supplies large quantities of water in large areas of the State
Ogallala
Gulf Coast
Outcrop
Downdip
Edwards (BFZ)
Carrizo–Wilcox
Trinity
Edwards–Trinity (Plateau)
Seymour
Hueco–Mesilla Bolson
Cenozoic Pecos Alluvium
TEXAS WATER DEVELOPMENT BOARD
July 1990

UM-50
Ground-Water Data System Data Dictionary
By Phillip L. Nordstrom and Roger Quincy
Revised August 1991

The purpose of this manual is to standardize the codes used for input of well-record, water-level, and water-quality data into the Texas Water Development Board ground-water computer database. It is intended to be used by Ground Water staff and possibly be adopted by other state agencies and water entities involved with ground-water data collection activities. Currently twelve different report formats can be generated specifying counties, periods of record (or beginning and ending dates), aquifers, and ranges of state well numbers (allowing for geographical delineation across county lines) using information in the TWDB database. These reports are frequently requested by individuals outside of the agency.

Topics reviewed in the well-record data section (Fig. 1) include: state well numbers, county, river basin, latitude and longitude, reliability of location, owner and driller identification, well depth, well type, well construction data, casing screen setting, lift data, water use, date of record collected, reporting agency, and remarks. Topics in the water-level data section include: depth of water from LSD, date of visit, measuring agency, method of measuring, and remarks concerning water-level measuring. Topics in the water-quality section include: laboratory codes, dates of collection, sample number, collecting agency, analysis reliability remarks, aquifer/producing interval, and infrequent constituent data. Appendices list county composition of regions, county FIPS codes, aquifer codes, river basins and zones, well schedule remarks field statement sequence, and an abbreviated list of STORET codes.

Texas Water ~~Development~~ Board
Well Schedule

State Well No. 10 34 806 Previous Well No. P-84 County Parmer 369
River Basin Brazos 12 Zone 1 Region 04 Lat. 34 22 45 Long. 102 49 52 Source of Coords 1
Owner's Well No. 3 Location ___ 1/4, NW 1/4, Section 6, Block 14S, Survey 3E
TAEX #7
Owner Wayne Foster Driller W D Jones
Address ______ Tenant/Oper. ______
Date Drilled 03 13 1953 Depth 369 Source of Depth Datum D Altitude 4035 Source of Alt. Datum M
Aquifer Ogallala 121OGLL Well Type W User ______
Well Construction Method ______ Const. H Casing Material ______ S
Completion ______ P Screen Material ______ S
Lift Data Pump Mfr. ______ Type ______ T No. Stages ______
Bowls Diam. ______ in. Setting ______ ft. Column Diam. ______ in.
Motor Mfr. ______ Fuel or Power ______ L Horsepower 180.
Yield Flow ______ GPM Pump ______ GPM Meas., Rept., Est. ______ Date ______
Performance Test Date ______ Length of Test ______ Production ______ GPM
Static Level ____ ft. Pumping Level ____ ft. Drawdown ____ ft. Sp.Cap. ____ GPM/ft.
Quality (Remarks ______
Water Use Primary IRR I Secondary ______ Tertiary ______
Other Data Available Water Level M Water Quality Y Logs D Other Data ______

	Date	Meas.	
Water Levels	3 13 1953	140.	driller
		.	
		.	

Casing or Blank Pipe (C)
Well Screen or Slotted Zone (S)
Open Hole (O)
Cemented from __ to __

		Diam. (in.)	Setting (feet) From	To
1	C	16	0	279
2	S	16	279	369
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				

(20 max)

Recorded By HPUWCD#1 Date Record Collected or Updated 07 __ 1991 Reporting Agency 05

Remarks 1 2 3 4 5 6

Aquifer Ogallala
Well No. 10-34-806

960062 11/21/88

```
PERFORM:   Query  Next  Previous  Add  Update  Remove  Table  Screen  ...
Searches the active database table.          ** 1: welldata table**
State Well No.:[1034806]      Prev. Well No.:[P84      ]   County Code:[369]
Basin:          [12]          Zone:          [1]           Region No.: [04]
Latitude:       [342245]      Longitude:     [1024952]     Source of Coords:[1]

Well Owner:                [Wayne Foster          ]
                           [                      ]
Well Driller:              [W.D. Jones          ]
                           [                    ]
Date Drilled:[03][13][1953] Depth:[  369] Source of Depth:[D] Altitude:[ 4035]
Source of Alt. Datum:[M]    Aquifer Code:[121OGLL ]      Well Type:[W]
                            User Code:   [        ]

Type of Lift:[T]            Type of Power:[L]            Horsepower:[    180]
Primary Use: [I]            Secondary Use:[ ]            Tertiary Use: [ ]
Water Level: [M]  Water Quality: [Y]  Well Logs: [D     ] Other Data: [     ]

Date Collected or Updated: [07][  ][1991]     Reporting Agency: [05]
                      Well Schedule in File: [Y]

Construction Meth.:[H]  Completion:[P]  Casing Material:[S]  Screen Material:[S]

1 row(s) found
                                                            mm 11:10:15
==============================================================================
```

Figure 1

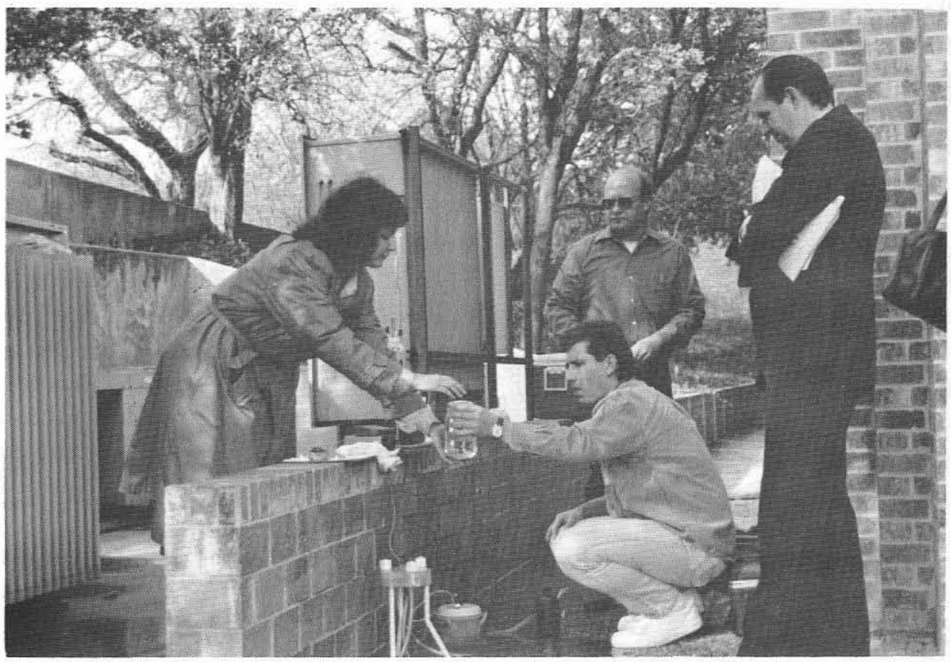
Information from well schedules can be entered into the well-record screen of the ground-water database to generate several different types of reports.

UM-51
A Field Manual for Ground Water Sampling
by Phillip L. Nordstrom and Barbara E. Beynon
Revised September 1991

The purpose of this manual is to standardize the Texas Water Development Board ground-water sampling program. It explains sample collection and chemical characterization procedure guidelines to be followed during any field sampling event by TWDB personnel or any other authorized party or agent. It should be emphasized that since the TWDB is not a regulatory agency, some methods may not meet EPA standards.

The sampling procedures and methods presented are a blend of those used in the references and may be revised as needs change or if better methods and procedures are developed. This manual supersedes all previous editions of TWDB ground-water sampling procedures.

Topics in this manual include well selection; equipment needed for ground-water sampling; recording field data; field analysis for unstable constituents (pH, temperature, specific conductance, oxidation reduction potential, alkalinity determination, and dissolved oxygen); filtering methods; and collection of samples (routine anions and cations, heavy/trace metals, nutrients, organics, radioactivity, radon, and stable isotopes).



Geologist Barbara Beynon and Engineering Technicians, Robert Ozment and John Asensio, demonstrate ground-water quality sampling procedures to TWDB Executive Administrator, Craig D. Pedersen.

Hydrologic Atlas No. 1
Water-Level Changes in the High Plains Aquifer of Texas, 1980-1990
By John B. Ashworth
1991

The High Plains aquifer of Texas is the southernmost extension of a regional aquifer which extends through eight states from the panhandle of Texas to South Dakota. The aquifer consists primarily of the Ogallala Formation but also includes other underlying, hydraulically-connected units in some areas. The water table, which regionally follows the surface topography, dips to the northeast, east, and the southeast at an average of about 15 feet per mile. In the vicinity of the Canadian River, however, ground-water movement is toward the river.

Approximately 40 percent of the Texas High Plains experienced a water-level rise during the preceding decade (Fig. 1). This rise was primarily the result of above-average precipitation and a decline in irrigation pumpage. The largest area of rise, in excess of 20 feet, occurred in Dawson and eastern Gaines Counties.

Water-level declines continue to occur in areas where pumpage is greater than recharge. Approximately 45 percent of the Texas High Plains experienced a water-level decline during the preceding decade. The largest area of decline was in the vicinity of the City of Amarillo well field in Carson County which has experienced up to 60 feet of decline over the past 10 years.

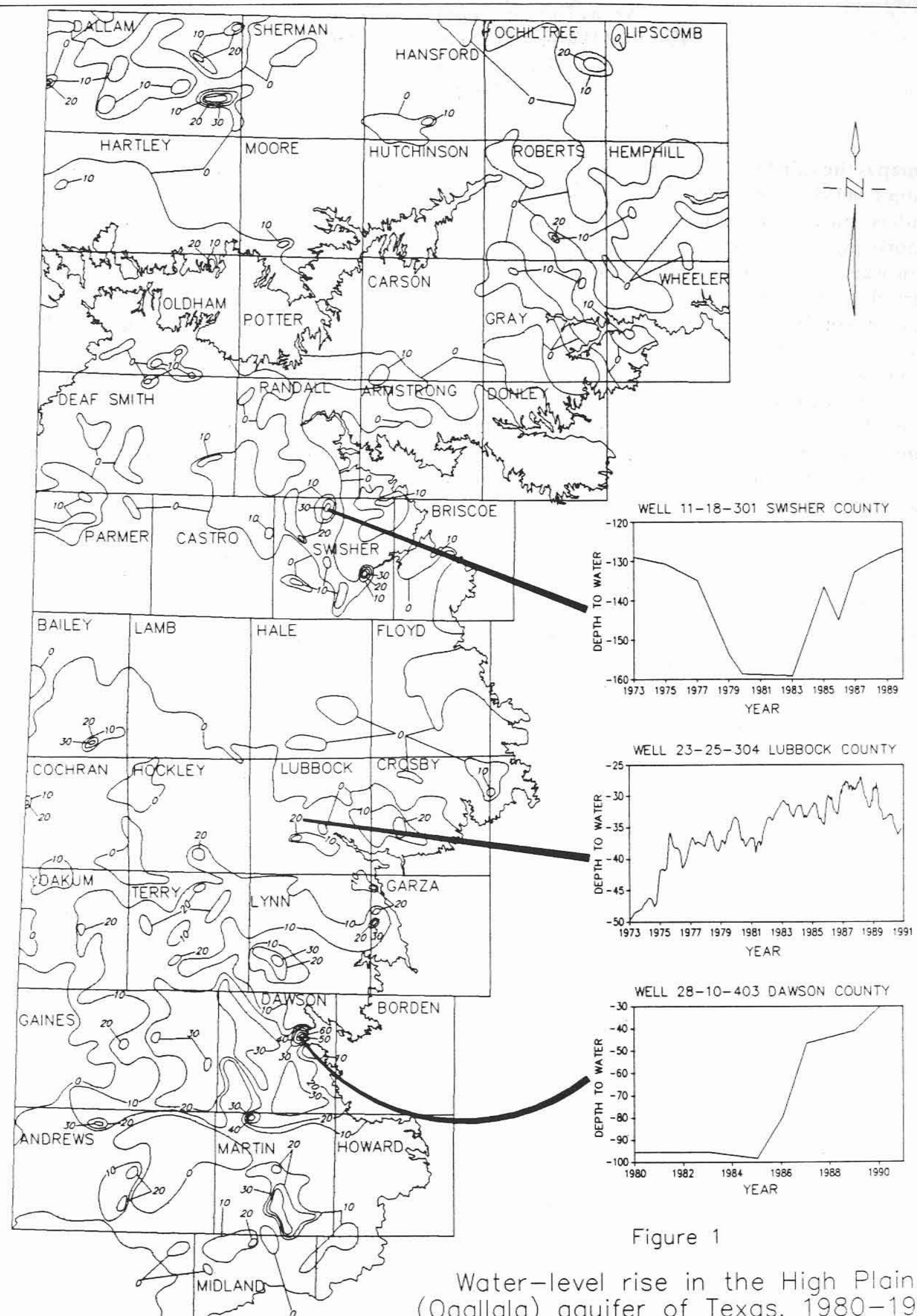


Figure 1

Water-level rise in the High Plains (Ogallala) aquifer of Texas, 1980-1990.

Hydrologic Atlas No. 2
Areas Experiencing Significant Ground-Water Level Decline, 1980-1990
By Janie Payne
1991

This map is the third in a series that depicts areas of water-level decline across the state (Fig. 1). Water-level measurements were made when wells were not being pumped in order to portray changes in static water levels. Contour intervals of 20 and 40 feet describe water-level declines in water-table, or unconfined, aquifers. A 20-foot decline under such conditions is more significant than the same decline in an artesian aquifer; therefore, larger contour intervals of 50 and 100 feet were used to illustrate declines in the artesian, or confined, aquifers where water exists under pressures greater than atmospheric. The portion of the map covering the High Plains was first published as Hydrologic Atlas No. 1 (Ashworth, 1991). The remainder of the map was prepared using measurements from 683 wells.

Aquifers that experienced water-table declines in the 1980-1990 decade include the Hueco and Mesilla bolsons in El Paso and Ciudad Juarez; the Ogallala in approximately 20 percent of the Texas High Plains; the Cenozoic Pecos Alluvium in a thin strip of irrigated land in Reeves County; the Middle Trinity (Hensell-Cow Creek aquifer) in the Kerrville/western Kendall County region; the Trinity in portions of Coryell, Bosque, and Somervell Counties in central Texas; the Wilcox in a small part of northwestern Van Zandt County; and the Gulf Coast (Chicot aquifer) in Fort Bend and western Harris County. Aquifers that experienced artesian declines include the Lower Trinity (Hosston aquifer) in Bandera County; the Carrizo in small portions of Zavala, Frio, and Atascosa Counties; the Trinity in much of north and central Texas; the Carrizo-Wilcox in Smith and Angelina Counties; and the Gulf Coast (Evangeline aquifer) around northwest Houston in Harris County. Localized cones of depression in areas not depicted on the map had no static water-level measurements for comparison.

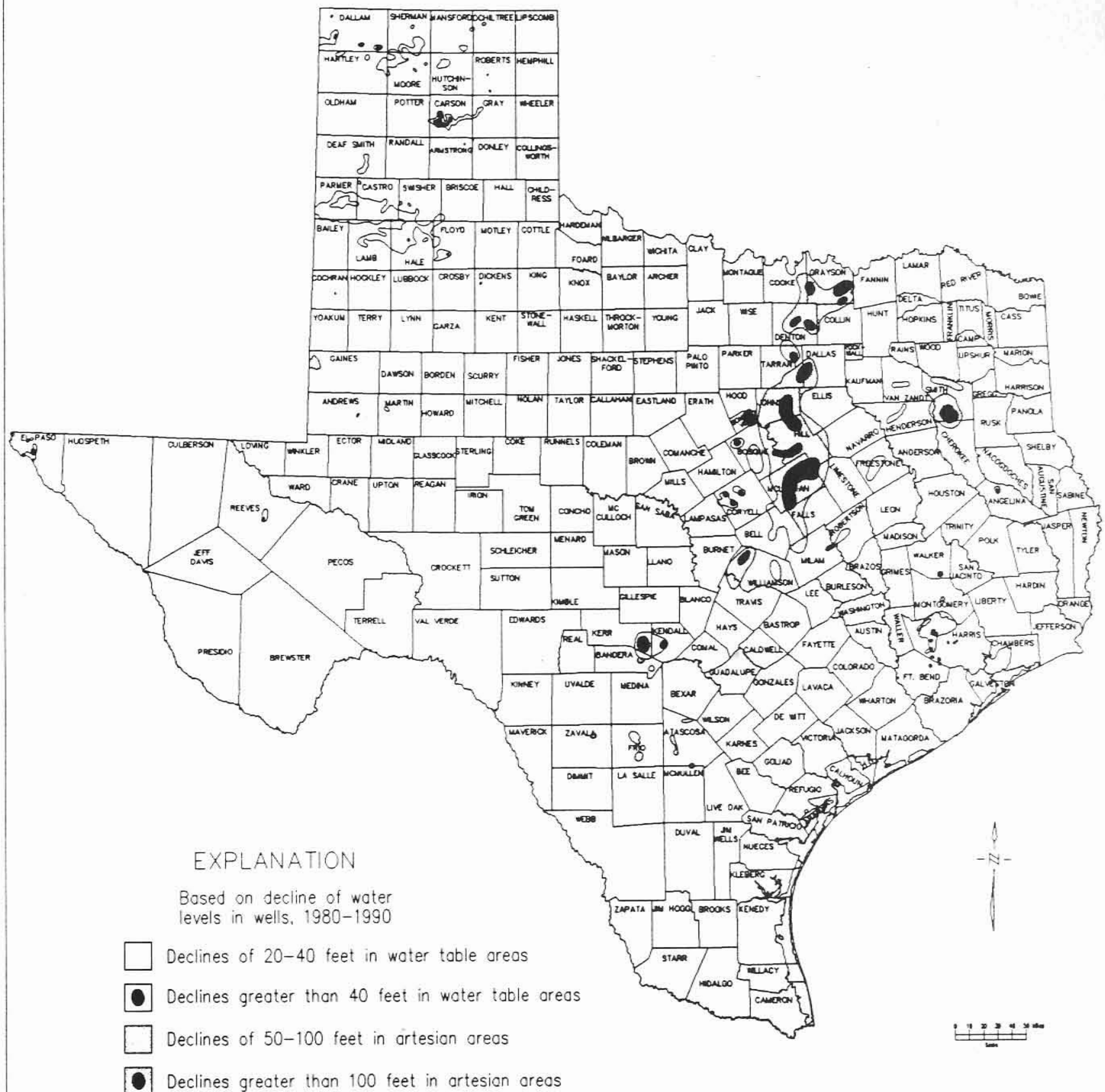


Figure 1

Areas experiencing significant ground–water level decline, 1980–1990.