Texas Water Development Board

LP-211

Ground Water Programs and Studies of the Texas Water Development Board for Fiscal Years 1990-1991

by
Ground Water Staff

October 1991

Texas Water Development Board

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Introduction

Ground water comprises a significant part of the total water resource of the State of Texas, accounting 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. Some areas in which the principal aquifers are being pumped at rates far exceeding natural recharge and whose depletion is causing adverse regional economic impact include:

The El Paso area -

Surface- and ground-water supplies in the region are shared by Texas, New Mexico, and Mexico. Ground water from the Hueco and Mesilla Bolson deposits are the primary source of municipal and industrial water for the El Paso-Juárez and surrounding areas. These aquifers are being depleted, and saline water is encroaching upon the fresh ground water remaining in storage.

The High Plains -

The Ogallala aquifer, the major source of municipal and irrigation water in the High Plains, is being overdrafted in several areas. As a result, ground water is becoming more difficult and expensive to obtain.

The Dallas-Fort Worth Metroplex and Waco areas -

Severely lowered water levels in the Trinity aquifer have created large regional cones of depression and the potential for quality deterioration of the ground water remaining in storage.

The San Antonio area and irrigated farmland west of the city -

Potentially serious overdrafts placed upon the Edwards (BFZ) aquifer have caused water shortages periodically resulting in reduced flows at Comal and San Marcos Springs and reduced baseflows of the rivers downstream.

The Houston area -

Extensive historical ground-water pumpage has caused widespread land subsidence, changes in the hydraulic characteristics of the aquifer, damage to structural surface developments, and some salt-water encroachment.

The Lower Rio Grande Valley and immediate Brownsville area -

The availability of good quality surface water is insufficient to meet the current and anticipated water-use demands. In addition, isolated occurrences of fresh to slightly-saline ground water are insufficient to supplement the surface-water supply during extended drought periods.

The continued use of the State's ground-water resources to satisfy the numerous beneficial purposes they serve depends on their availability and planned development. Such planning can only be accomplished if sufficient good-quality data needed to make these determinations are assimilated.

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. The Board relies heavily on data-collection activities and studies to insure that the data needed to make the proper decisions concerning the State's water resources are available. Most data collection involves ground-water monitoring conducted by Board personnel. Information is also obtained through cooperative agreements with the U.S. Geological Survey (USGS), the City of El Paso, and numerous underground water conservation districts. The purpose of this report is to describe the ground-water data collection and study activities conducted by the TWDB Ground Water Section staff during Fiscal Years 1990 and 1991 (FY 90 and FY 91).

Data-Collection Activities

In order to correctly assess the ground-water resources of the State's aquifers and to provide a ground-water database to the public, data must be collected and analyzed. These data are used to describe the occurrence and quality of ground water which supplies the needs of the water users in Texas. The objective of data-collection activities is to determine the quality, availability, and mode of occurrence of ground water and the storage capacity of the aquifers. Information concerning the geologic and hydrologic properties of underground water-bearing formations must be accurate to support rational planning, development, and management of these resources in conjunction with surface-water supplies. Current ground-water information is essential to properly evaluate the impact that development and related public or private activities will have on our environment.

Ground Water staff data-collection activities, such as monitoring changes in water levels, water quality, and well development, are essential in obtaining accurate information. Data-collection activities also include core-drilling, materials testing, geophysical logging, state well numbering, log plotting, data entry, database management, computer programming and modelling, computer graphics, public and interagency assistance, and ground-water problem solving.

Water-Level Monitoring

The Board maintains a network of water-level observation wells. Data from the network 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 of poor quality ground water.

Observation wells provide data needed to prepare water-level (potentiometric surface) or water-level change maps which reflect underground water conditions. Periodic measurements are made in each observation well at a time of year when water levels have recovered from the effects of pumping during the season of peak water demands. All updated water-level data are incorporated into the TWDB database. Water-level and water-level change maps in different areas of the State are demonstrated in three figures:

Figure 1 illustrates the following for the High Plains aquifer: (1) the approximate potentiometric surface in 1990; (2) areas experiencing water-level rise for the period 1980-90; and (3) areas experiencing water-level decline for the same period.

Figure 2 illustrates the changes in water levels in the Carrizo aquifer in the western portion of the Winter Garden area for the period 1970-90.

Figure 3 illustrates the approximate altitude of water levels in 1990 within the central portion of Carrizo-Wilcox aquifer, extending from the Guadalupe River northeastward to the Trinity River using water-level measurements made from 1947 through 1990.

Some of these maps show the effects long-term pronounced ground-water withdrawals have on water levels. Declines can result in greater pumping costs and water-quality deterioration as undesirable water is drawn toward pumping centers.

Continuous water-level recorders are operated in representative wells in localities where uninterrupted records of water-level changes are needed. Reports of water-level records and evaluations of those results are published periodically. Hydrographs from these recorders show long-term trends as demonstrated in Figure 4. This illustration of hydrographs from selected recorder wells located throughout the State shows that long-term water-level declines are occurring in many of the State's major aquifers.

During FY 91, the Board maintained 47 automatic water-level recorders in 42 counties with an additional 16 recorders maintained by the USGS and certain underground water conservation districts, as shown in Figure 4. Efforts are being directed toward evaluating sites where additional recorders should be located to insure that the best data possible are being collected.

The TWDB water-level observation well network currently consists of approximately 7,600 wells of which 5,000 are measured by Ground Water staff. The remaining 2,600 wells are measured by the underground water conservation districts, the USGS, and other cooperators. Cooperators measure observation wells within their areas, which may include counties or parts of counties within their jurisdiction, while the Board measures the remaining observation wells.

The number of water-level measurements obtained during FY 1990 and 1991 and their distribution by county are shown in Figure 5. The total number of water-level observation wells in the TWDB network and their distribution by county are shown in Figure 6. The approximate number of observation wells measured by the Board and other cooperating entities is listed below:

Entity	Number of Wells
High Plains Underground Water Conservation District No. 1 (Lubbock, Texas)	1,018
North Plains Groundwater Conservation District No. 2 (Dumas, Texas)	596
Panhandle Groundwater Conservation District No. 3 (White Deer, Texas)	199
Sandy Land Underground Water Conservation District (Plains, Texas)	57
Permian Basin Underground Water Conservation District (Stanton, Texas)	60
Glasscock County Underground Water District (Garden City, Texas)	56

Figure 5

Number of Water-Level Measurements Taken in Fiscal Years 1990 - 1991

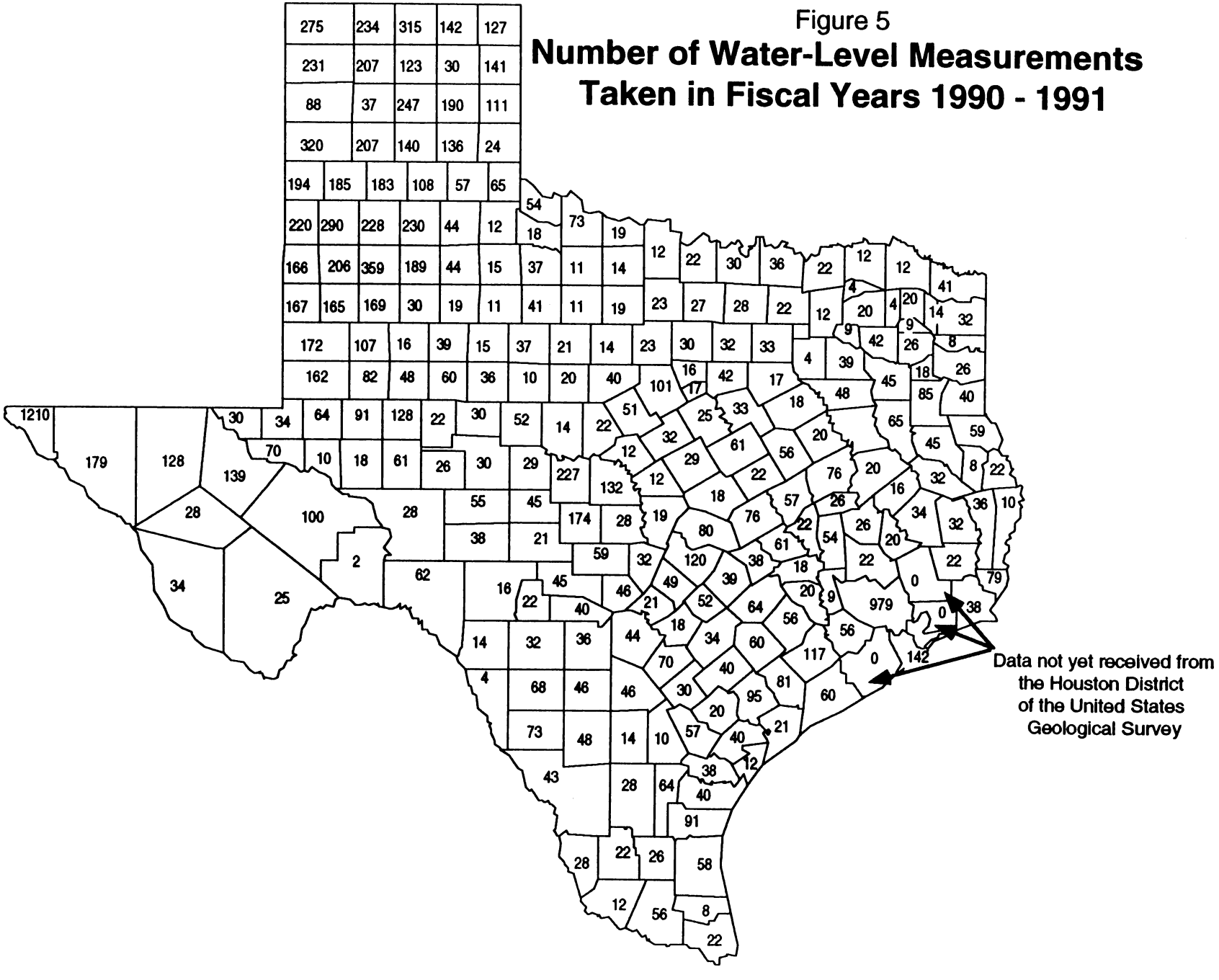
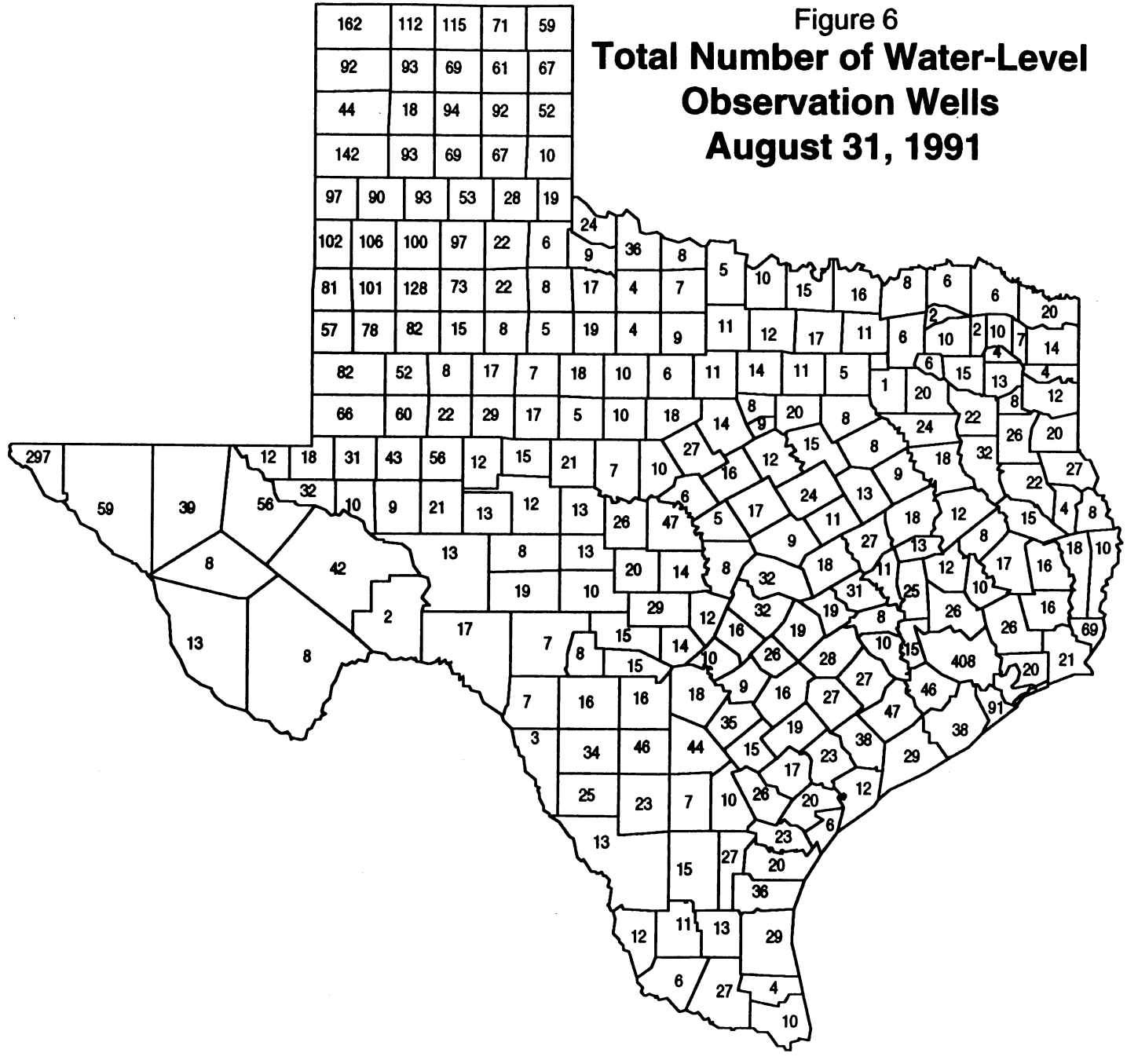


Figure 6

Total Number of Water-Level Observation Wells August 31, 1991



Entity	Number of Wells
Hill Country Underground Water Conservation District (Fredricksburg, Texas)	29
Edwards Underground Water District (San Antonio, Texas)	35
Evergreen Underground Water Conservation District (Jourdanton, Texas)	90
City of El Paso	145
U.S. Geological Survey	734
Texas Water Development Board	4,826
Total	**7,845**

Water-Quality Monitoring

The Board maintains a network of water-quality observation wells throughout the State from which water samples are periodically collected for chemical analysis in order to monitor changes which may occur in ground-water quality. These changes may be natural or a result of human activities. Board personnel evaluate the results of analyses to determine the frequency of resampling, identify ground-water quality problem areas, and provide a basis for determining where additional detailed ground-water quality studies are needed. The objective of ground-water sampling by the TWDB is to determine the baseline characteristics and changes in the quality of ground water from selected aquifers. Possible changes in water quality resulting from water-level decline; ground-water recharge; salt water encroachment; irrigation return flow; oil production activity; mining; leachate contamination from feedlots, dairies, and landfills; and industrial and agricultural activity were considered in determining areas and aquifers to be sampled. Figure 7 shows the areas where water-quality monitoring was completed during FY 90 and FY 91.

Water-quality monitoring observation wells in the TWDB network are selected annually from wells where quality information is needed. Prior to the Federal Safe Drinking Water Act, water samples were only analyzed for the anion and cation content. Since passage of the Act, samples are also analyzed for nutrients, certain organic constituents, heavy/trace metals, and radioactive elements. This has resulted in a dramatic increase in laboratory cost. In FY 91, $270,740 was spent for the analysis of water samples from 597 wells at an average cost of $454 per well.

The Texas Department of Health Environmental Laboratory analyzes the water samples under an interagency contract. Other laboratories may be used as needed. Water samples are routinely analyzed for dissolved constituents: anions, cations, nutrients, heavy metals, and radionuclides. Records of chemical analyses are stored in the TWDB database. Computer programs are used to facilitate retrieval of chemical-quality data for a particular well, aquifer, or geographical area. These programs help identify any significant changes or trends in water quality.

The number and distribution of wells for which the Board has water-quality analyses in the database are shown in Figure 8. Currently, there are more than 73,000 analyses of water samples from 44,011 sampled wells in the TWDB database. The total number and distribution of water-quality analyses retrievable from the database are illustrated in Figure 9.

Figure 7

Water-Quality Monitoring Completed During Fiscal Years 1990-1991

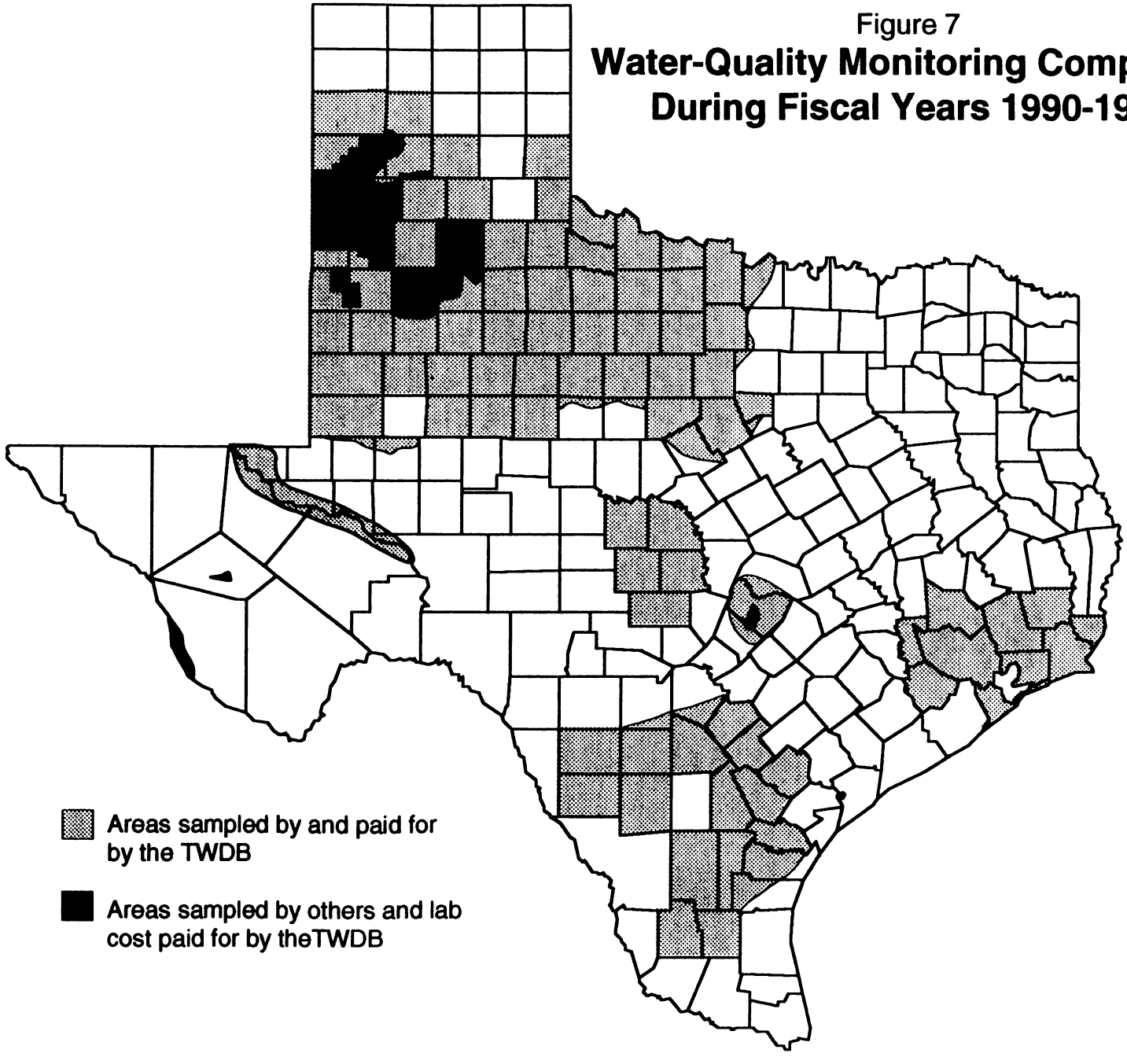


Figure 8

Wells Having Water-Quality Analyses August 31, 1991

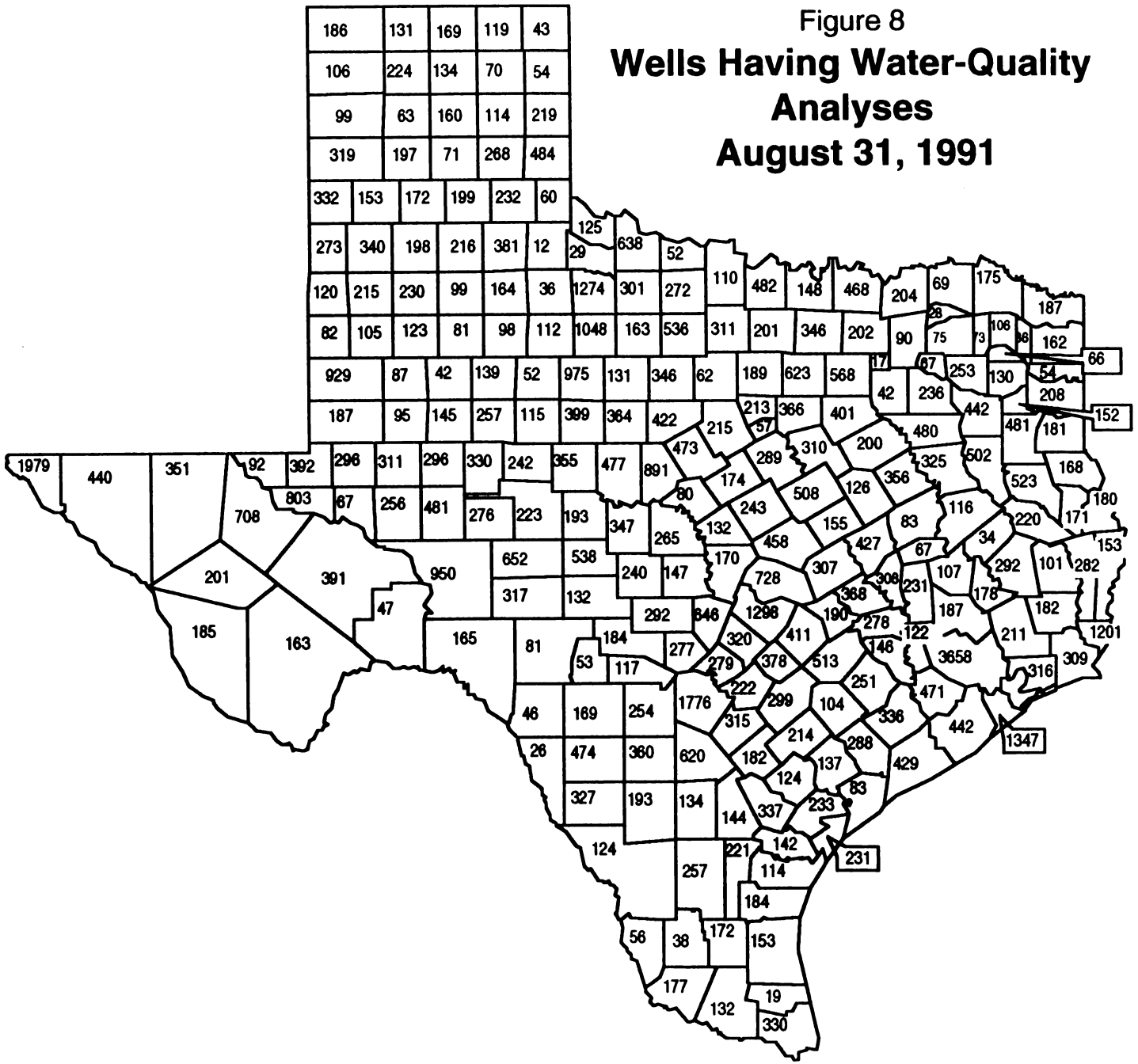
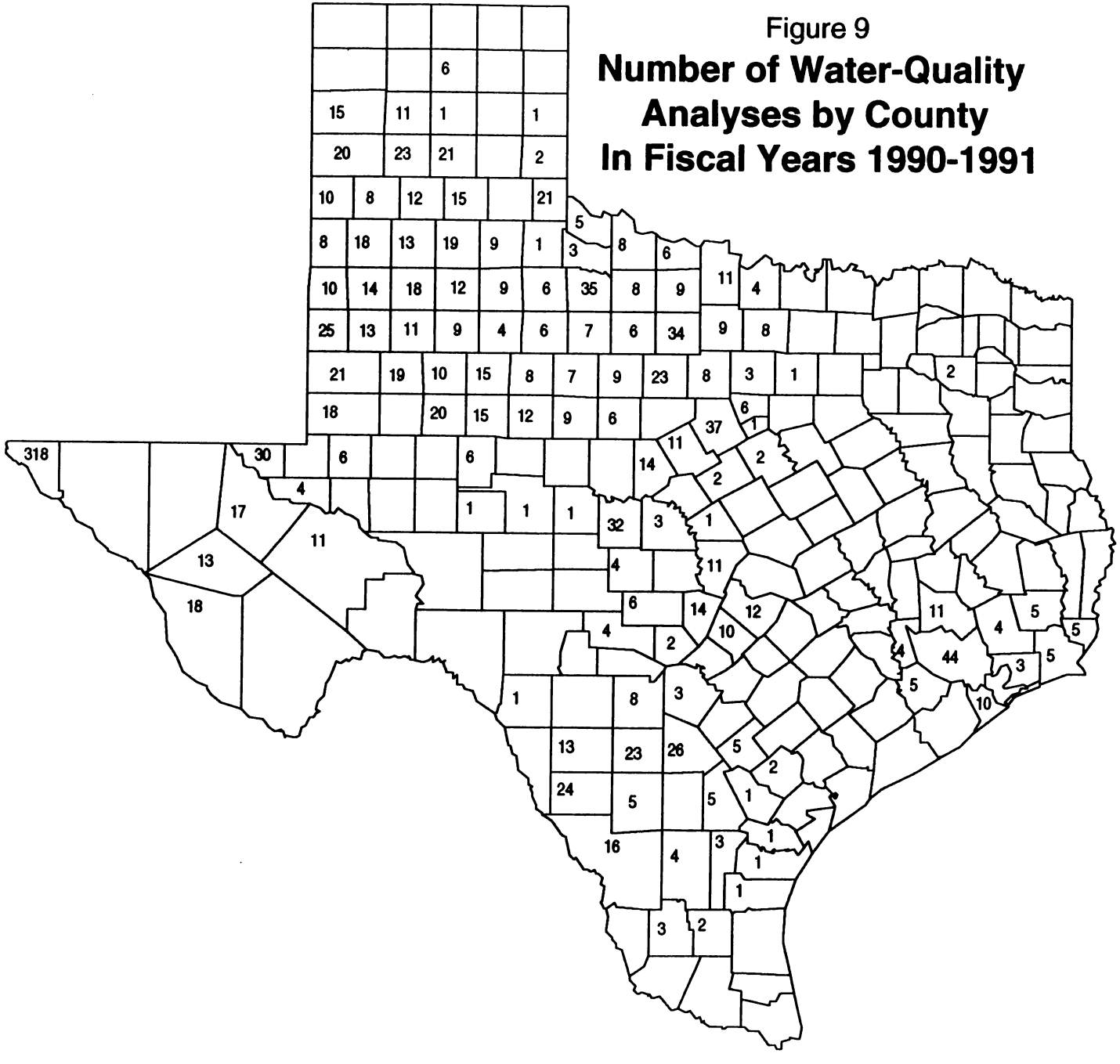


Figure 9

Number of Water-Quality Analyses by County In Fiscal Years 1990-1991



Well Development Control

The purpose of this activity is to maintain a current inventory of public supply, industrial, and irrigation well development in the state. TWDB personnel review drillers' logs submitted by licensed water well drillers and retain copies of high-capacity well reports. These assist the staff in locating and inventorying these wells in the field which allows the Board to remain abreast of significant well development and ground-water use throughout the State. This information is needed to determine the areas and extent of development for long-range water planning purposes. Regions experiencing significant development must be closely monitored to determine if ground-water availability is sufficient to meet the anticipated water requirements.

Support Functions

TWDB personnel conducting ground-water data collection and study activities receive assistance from other Section support functions. These functions, which are important to the timely completion of these activities, are as follows:

State Well Numbering

The Board devised a statewide well-numbering system to avoid duplication of records and to afford a means of convenient identification for wells, oil tests, and test holes. Ground Water personnel chose the system for its suitability for computer processing of the well data. The system is based on divisions of the State into numbered quadrangles formed by lines of latitude and longitude (1-degree) and by repeated subdivision of these into smaller quadrangles (7 $^1/_2$-minute and 2 $^1/_2$ -minute) that are also numbered. Thus every well is assigned a unique seven digit number indicating its approximate location. The Board maintains most state well numbers; but the USGS maintains well numbers in some instances, such as in the San Antonio and El Paso areas. TWDB staff assigned state well numbers to 2,424 newly inventoried wells during the biennium.

Historically the wells had been located on county-highway maps, but they are now maintained on more accurate topographic base maps. Permanent numbers are assigned to all wells that are field located and inventoried in connection with TWDB data-collection and study activities.

Water Well Drillers' Report Plotting

Water well drillers in Texas are required to be licensed and to file a Water Well Report with the State covering the drilling of all water wells and related test holes. Reports are also required for dewatering, monitoring, and injection wells. These reports contain information such as depth, location of cased and screened intervals, lithology encountered, water level, water quality, and other pertinent information.

TWDB personnel process reports submitted to the State by licensed water well drillers. This processing consists of separating the reports by county, reviewing the reports for completeness of information needed to identify and locate the wells, and assigning temporary coordinates to each well using the same criteria used in assigning permanent state well numbers. The coordinates are written on the lower right hand corner of the report to assist the public and staff in locating the wells on maps prior to being inventoried in the field. Copies are made of high-capacity well reports to assist staff in locating and inventorying these wells in the field.

More than 392,000 reports on file provide a valuable tool for use in detailed ground-water studies. They also serve as a useful reference to well owners and to well-service personnel when equipping, reworking, or servicing wells.

Approximately half of the 47,704 reports received in FY 90 and FY 91 were processed and assigned coordinates. The other half of the reports were for shallow monitoring wells in which the Board does not inventory at the present time. Figure 10 shows the number of drillers' logs received and filed in FY 90 and 91; while Figure 11 shows the total number of drillers' logs on file as of August 31, 1991.

Core-Drill Rig

Since 1969, the Board has operated a drilling rig to obtain subsurface data. The rig is used extensively to assist ground-water personnel conduct studies in areas where reliable data are lacking or supplemental data are needed.

When not involved in these activities, the rig is available for use at proposed dam sites, foundation sites, and other projects seeking financing from the TWDB Development Fund. The rig is also used to assist other governmental entities under appropriate agreements when their programs will provide information that is mutually beneficial.

Figure 12 illustrates the 68 projects in which the TWDB rig has been involved since 1969, including the six completed during FY 90 and 91. The numbers refer to the specific projects explained in detail in Table 1. The table lists the project dates, location, number of holes, total footage drilled or cored, and entity(s) involved in the projects. The hole depths drilled or cored by the rig ranged from 30 to 1,430 feet, and the number of holes drilled during each project varied from 1 to 44 holes.

Materials Testing Laboratory

The Board maintains a laboratory to perform a wide variety of tests for evaluating construction materials and to conduct basic research. The equipment, personnel, and procedures have been inspected and approved by the National Bureau of Standards. Laboratory personnel conduct tests to determine permeabilities, concrete batch design, and properties of soil cement and soil samples. They also perform consolidation tests, rock soundness tests, Atterberg limits (plasticity) tests, organic impurities tests, grain-size analyses, and other appropriate tests.

The laboratory is used to perform tests of cores and materials obtained from holes drilled for Ground-Water personnel conducting studies in areas where additional data are needed. Moreover, laboratory personnel may secure samples and perform field testing on Board funded projects; they may evaluate results from consultant laboratories to assure compliance with project plans and specifications; and personnel may test materials for other State and Federal agencies under appropriate agreements.

Geophysical Logging

Since 1968 the Board has operated a mobile geophysical logging unit to obtain subsurface data. Recorded responses indicate the physical properties and structure of geological formations below land surface and the presence of and depth to water. Ground Water staff use this information to conduct studies in areas where reliable data are lacking, where supplemental data are needed, and in projects involving the TWDB core-drill rig.

When not involved in these activities, the logging unit is available for use in evaluating the geological conditions near existing or proposed dam sites, foundation sites, embankments, and other projects seeking financing from the Board's Development Fund. The logging unit may also be utilized to assist other governmental entities under appropriate agreements if their programs will provide information that is mutually beneficial. Figure 13 shows the number and distribution of the 79 wells logged and corresponding portion of the total 182,165 feet logged during FY 90 and 91.

Figure 10

Water Well Drillers' Logs Received and Filed in Fiscal Years 1990 - 1991

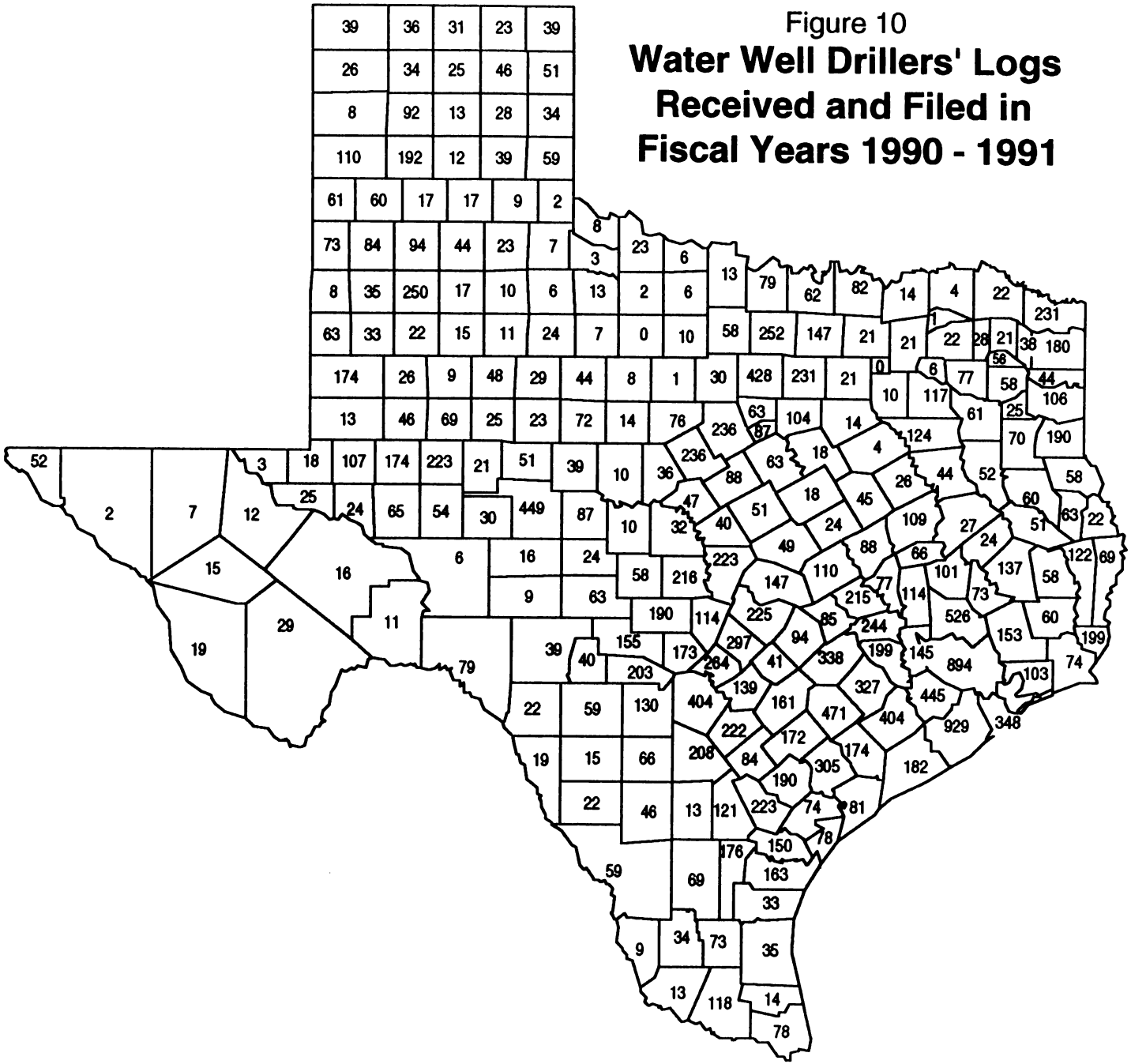


Figure 11

Total Water Well Drillers' Logs on File, August 31, 1991

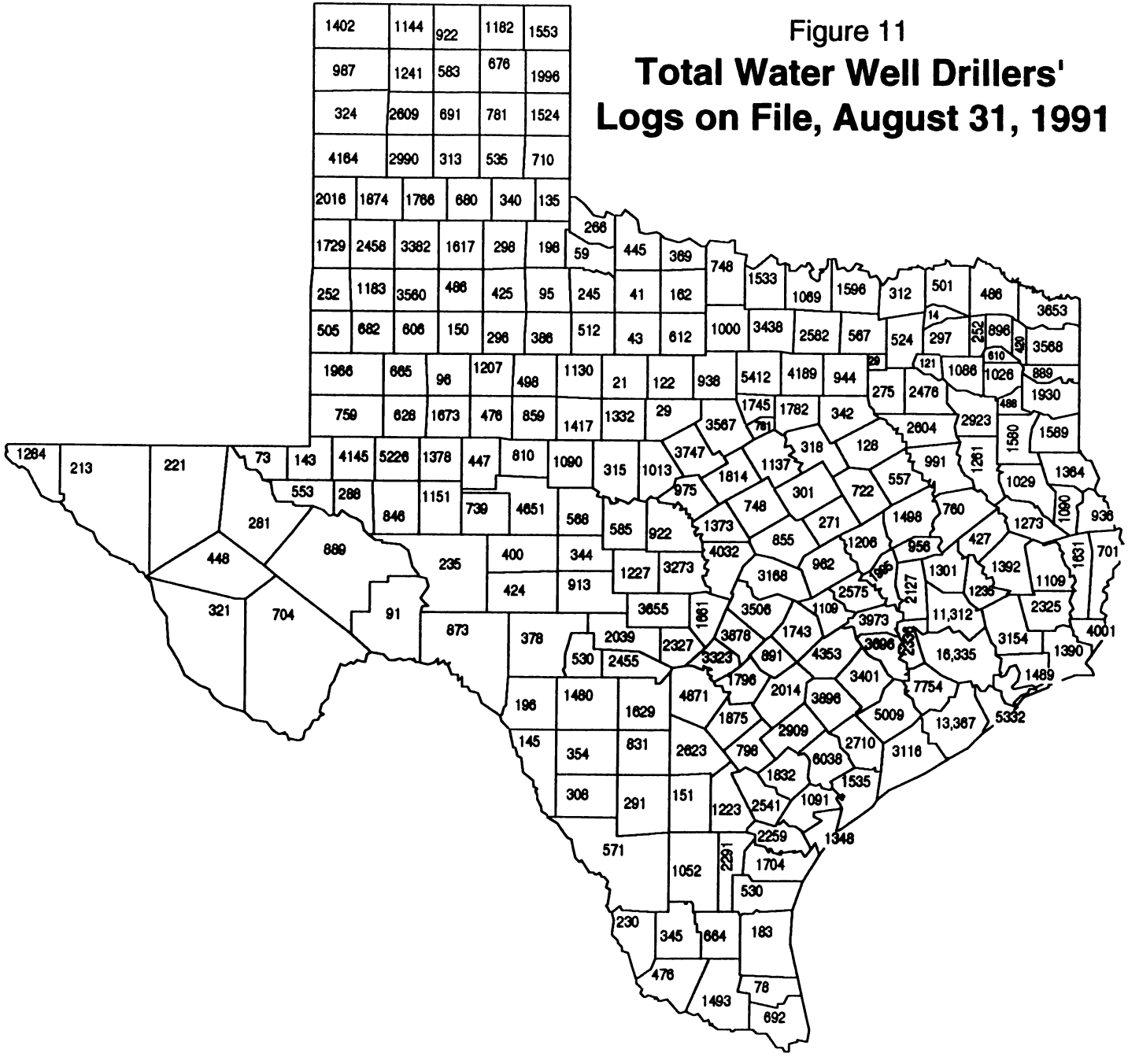
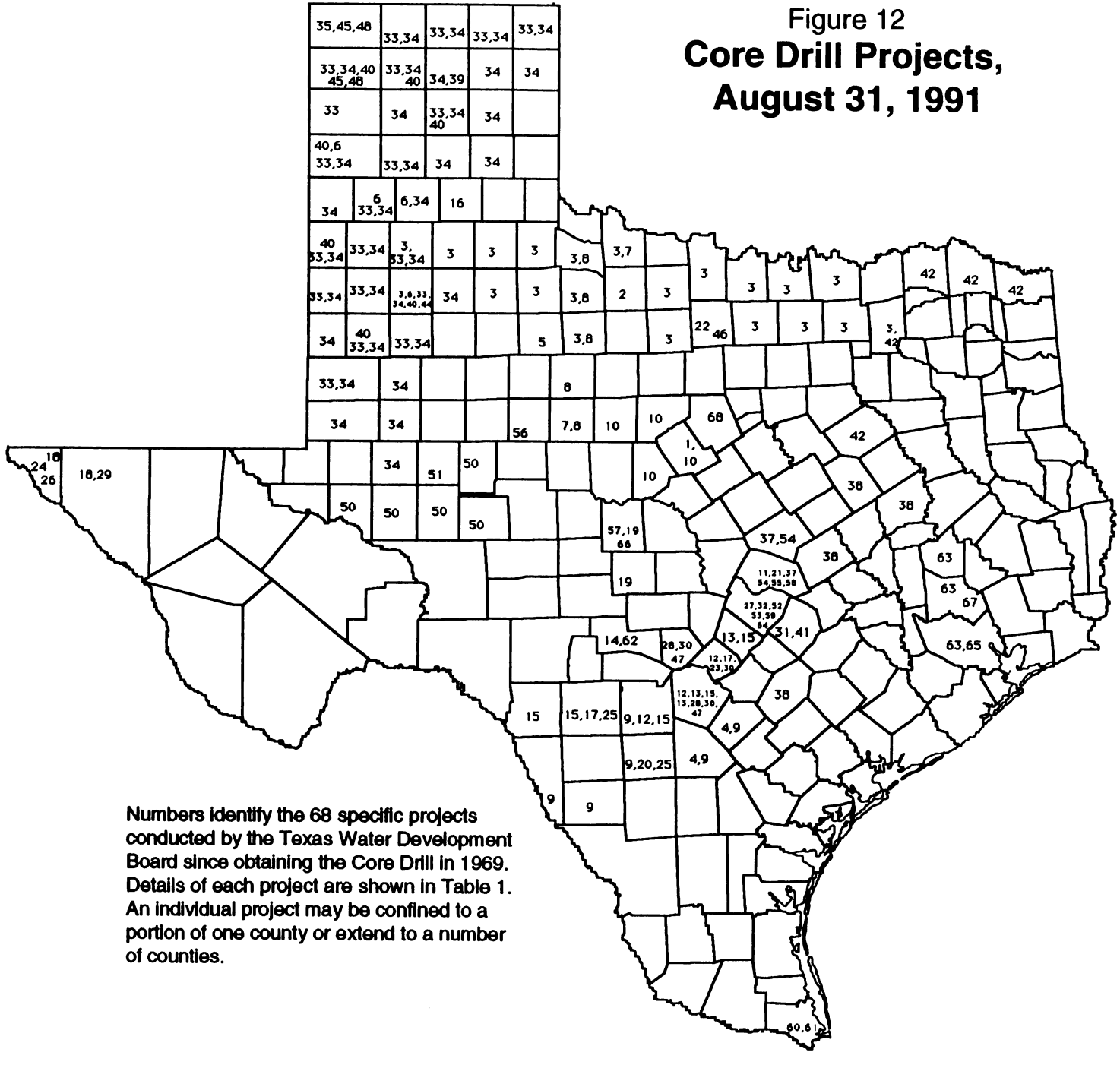


Figure 12

Core Drill Projects, August 31, 1991



Numbers identify the 68 specific projects conducted by the Texas Water Development Board since obtaining the Core Drill in 1969. Details of each project are shown in Table 1. An individual project may be confined to a portion of one county or extend to a number of counties.

Table 1. TWDB Core-Drill Projects, March 1969 to August 1991

Project #	Date	Project	Project For	Hole and Depth
1	3/69-4/69	Comanche County Study	TWDB-Ground Water Division	6 holes, 544 feet
2	6/69-7/69	Baylor County Study	TWDB-Ground Water Division	19 holes, 840.5 feet
3	8/69-11/69	Trans-Texas Canal Route Study	TWDB-Technical Review Division	29 holes, 2,298.5 feet
4	1/70-3/70	Carrizo-Wilcox Aquifer Study - Phase I	TWDB-Ground Water Division	6 holes, 2,133 feet
5	4/70-5/70	Upper Brazos River Salt Study	U.S. Army Corps of Engineers	6 holes, 1,060
6	5/70-9/70	High Plains Cattle Feedlot Study	Texas Tech University	37 holes, 3,409 feet
7	9/70-10/70	Wilbarger-Taylor County Study	TWDB-Ground Water Division	13 holes, 3,409 feet
8	10/70-11/70	Trans-Texas Canal Route Study	TWDB-Technical Review Division	8 holes, 595 feet
9	12/70-7/71	Carrizo-Wilcox Aquifer Study - Phase II	TWDB-Ground Water Division	13 holes, 3,738 feet
10	7/71-9/71	Antlers-Travis Peak Aquifer Study	TWDB-Ground Water Division	18 holes, 2,066 feet
11	10/71	MH-MR Leander Unit Dam	TWDB-Technical Review Division	27 holes, 2,066 feet
12	10/71-4/72	Edwards Aquifer Study - Phase I	TWDB-Ground Water Division	6 holes, 2,944 feet
13	5/72-1/73	Edwards Study, Phase I	USGS	4 holes, 3,084 feet
14	1/73	MH-MR Kerrville Unit Dam	TWDB-Technical Review Division	10 holes, 224.5
15	1/73-2/73 & 3/73-9/73	Edwards Aquifer Study - Phase II	TWDB-Ground Water Division	3 holes, 2,146 feet
16	3/73	Mackenzie Dam Construction Testing	TWDB-Technical Review Division	4 holes, 157 feet
17	10/73-4/74	Edwards Study, Phase II	USGS	3 holes 2,276 feet
18	5/74-7/74	El Paso Study	TWDB-Ground Water Division	4 holes, 1,400Division
19	8/74-12/74	Hickory Sand Delineation Study	TWDB-Ground Water Division	4 holes, 1,400 feet
20	1/75-11/75	Carrizo-Wilcox Aquifer Study	TWDB-Ground Water Division	2 holes, 2,012 feet
21	12/75	Cleaned out hole near Leander for Geophysical Division	TWDB-Ground Water Division	1 hole, 830 feet

Footage shown includes drilling and coring. Holes are routinely tested to determine potential yields, sampled for quality analysis, and followed by site clean-up and restoration

Table 1. TWDB Core-Drill Projects, March 1969 to August 1991

Project #	Date	Project	Project For	Hole and Depth
22	1/76-4/76	Jacksboro Ground Water Study	TWDB-Ground Water Division	3 holes, 1,529 feet
23	5/76	Cleaned out hole near New Braunfels for water testing	USGS	1 hole, 825 feet
24	5/76	El Paso Observation Wells	USGS	4 holes, 845 feet
25	6/76-7/76	Cleaned out two holes near Uvalde and Crystal City for testing	TWDB-Ground Water Division	2 holes, 1,681 feet
26	7/76-12/76 & 2/77	El Paso Ground Water Study and El Paso Water Improvement District #1	Bureau of Reclamation	6 holes, 4,049 feet
27	2/77	Landfill Disposal Site, Travis County	Texas Water Quality Board	3 holes, 45 feet
28	3/77-7/77	Glen Rose Aquifer Study	TWDB-Ground Water Division	2 holes, 1,460 feet
29	8/77-10/77	Sierra Blanca	Hudspeth County Water District #1	1 hole, 210 feet, 1 contract hole for 1,220 feet
30	10/77-3/78	Glen Rose Aquifer Study	TDWR-Data Collection & Evaluation Section	2 holes, 1,601 feet
31	3/78-6/78	Carrizo-Wilcox Aquifer Study	TDWR-Data Collection & Evaluation Section	3 holes, 1,416 feet
32	6/78-10/78	USGS Edwards Aquifer Study	USGS	4 holes, 1,286 feet
33	10/78-1/79	Ogallala Neutron Moisture Probe Test Sites	TDWR-Data Collection & Evaluation Section	44 holes, 1,320 feet
34	3/79-12/79	Ogallala Aquifer Stratigraphic Test Holes	TDWR-Data Collection & Evaluation Section	41 holes, 14,336 feet
35	3/80-5/80	Edwards Aquifer Study	TDWR-Data Collection & Evaluation Section	See 37 below
36	5/80	Westpoint Pepperell Iselin Mill Investigation	TDWR-Engineering & Technical Services Section	5 holes, 174 feet

Footage shown includes drilling and coring. Holes are routinely tested to determine potential yields, sampled for quality analysis, and followed by site clean-up and restoration

Table 1. TWDB Core-Drill Projects, March 1969 to August 1991

Project #	Date	Project	Project For	Hole and Depth
37	5/80-9/80	Edwards Aquifer Study	TDWR-Data Collection & Evaluation Section	20 holes, 1,882 feet
38	9/80-5/81	Carrizo-Wilcox Aquifer Study	TDWR-Data Collection & Evaluation Section	4 holes, 2,567 feet
39	6/81-9/81	Hazardous Waste Disposal Sites Investigation	TDWR-Enforcement & Field Operations Division	25 holes, 680 feet
40	9/81-3/82	Ogallala Secondary Recovery Study	High Plains Underground Water Conservation District #1	11 holes, 3,133 feet
41	3/82-6/82	Abandoned Lignite Mine Study	Texas Railroad Commission	10 holes, 1,079 feet
42	7/82-5/83	Blossom-Nacotoch Aquifer Study	TDWR-Data Collection & Evaluation Section	14 holes, 5,204 feet
43	6/83-9/83	Hidalgo Co. Underground Injection Study	TDWR-Permits Division	5 holes, 3,560 feet
44	9/83-10/83	Ogallala Secondary Recovery Study	High Plains Underground Water Conservation District #1	2 holes, 321 feet
45	10/83-12/83	Triassic Ground Water Study	TDWR-Data Collection & Evaluation Section	5 holes, 2,036 feet
46	2/84-4/84	Jack County Ground Water Study	TDWR-Data Collection & Evaluation Section	2 holes, 1,285 feet
47	5/84	Bexar & Kendall Counties clean-out observation wells	TDWR-Data Collection & Evaluation Section	2 holes, 1,601 feet
48	6/84-10/84	Triassic Ground Water Study	TDWR-Data Collection & Evaluation Section	9 holes, 5,031 feet
49	10/84	Borger Ground Water Pollution Study Tom Ware	TDWR-Data Collection & Evaluation Section	3 holes, 763 feet
50	10/84-6/85	Triassic Ground Water Study	TDWR-Data Collection & Evaluation Section	6 holes, 4,327 feet

Footage shown includes drilling and coring. Holes are routinely tested to determine potential yields, sampled for quality analysis, and followed by site clean-up and restoration

Table 1. TWDB Core-Drill Projects, March 1969 to August 1991

Project #	Date	Project	Project For	Hole and Depth
51	8/85-11/85	Glasscock Co. Triassic Test Hole Project	Glasscock County Underground Water Conservation District	3 holes, 2,202 feet
52	12/85-6/86	Edwards Aquifer Delineation Study	TWDB-Water Availability Data & Studies Section	4 holes, 3,207 feet
53	7/86-10/86	Attenuation of Pollutants of Edwards Aquifer Unsaturated Zone	USGS	8 holes, 681 feet
54	11/86-2/87	Effect of Georgetown Formation on Edwards Recharge Study in Williamson County	USGS	12 holes, 1,400 feet
55	3/87-6/87	Edwards Aquifer Delineation Study	TWDB-Water Availability Data & Studies Section	3 holes, 2,562
56	7/87-8/87	City of Sweetwater Well Field	City of Sweetwater	9 holes, 1,915 feet
57	9/87-10/87	Paleozoic Aquifer Study	TWDB-Water Availability Data & Studies Section	1 hole, 421 feet
58	12/87-1/88	Edwards Aquifer Delineation	TWDB-Water Availability Data & Studies Section	1 hole, 864 feet
59	2/88-8/88	TWDB - BRC Borehole Geophysical	TWDB-Water Availability Data & Studies Section	1 hole, 1,296 feet
60	11/88-1/89	PUB Well Field	Brownsville Public Service Board	9 holes, 3,384 feet
61	2/89-6/89	TWDB Special Test Hole Program	TWDB-Water Availability Data & Studies Section	4 holes, 3,354 feet
62	7/89-8/89	Aquifer Storage Recovery Feasibility Investigation	Upper Guadalupe River Authority	1 hole, 635 feet
63	9/89-10/89	Chicot Evangeline Aquifer USGS Recharge Study	USGS & Harris-Galveston Coastal Subsidence District	5 Holes, 2,085 feet
64	11/89	TWDB-BRC Borehole Geophysical Research Project	TWDB-Ground Water Section	6 Water Samples

Footage shown includes drilling and coring. Holes are routinely tested to determine potential yields, sampled for quality analysis, and followed by site clean-up and restoration

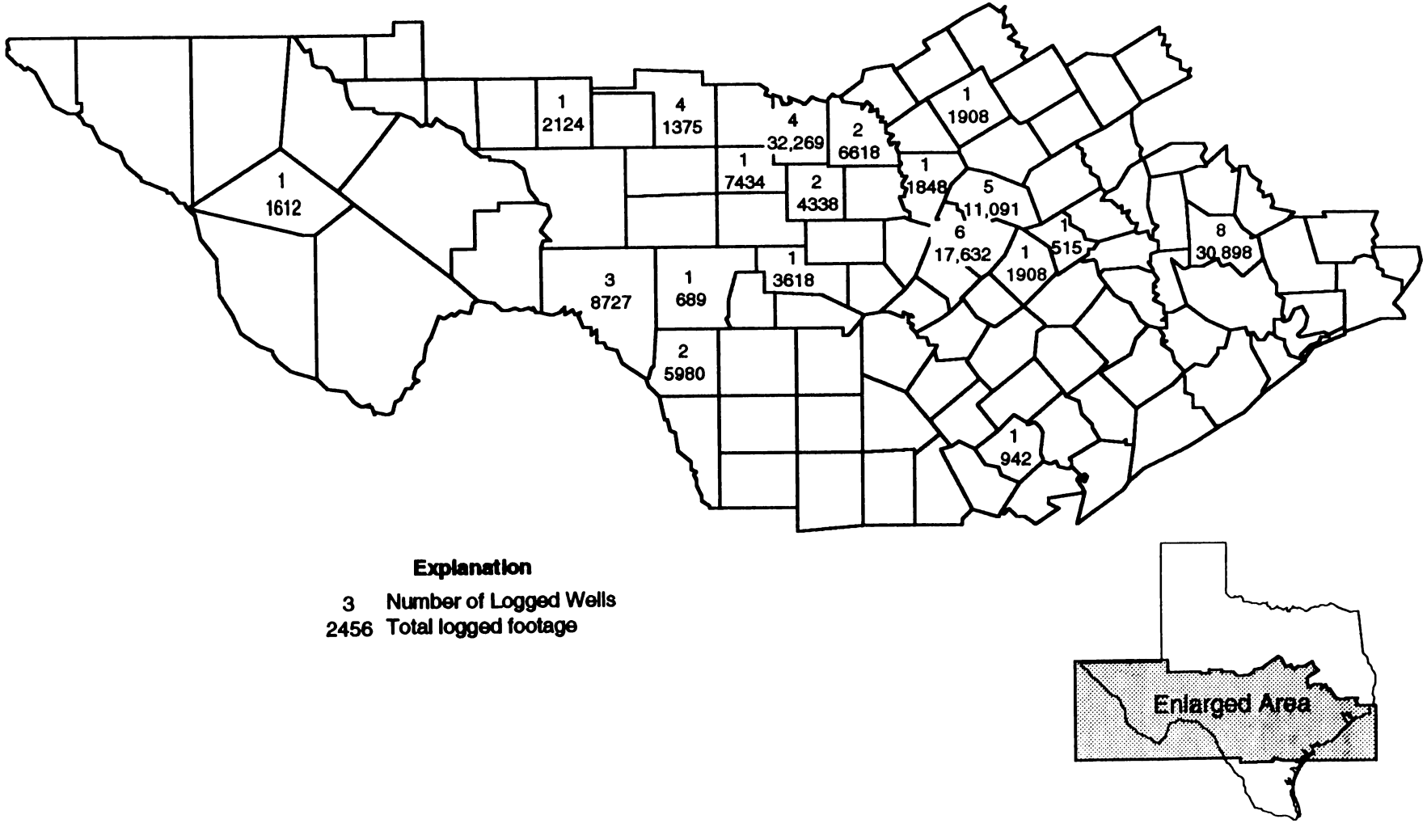
Table 1. TWDB Core-Drill Projects, March 1969 to August 1991

Project #	Date	Project	Project For	Hole and Depth
65	12/89-1/90	Growth Fault Effect on Ground Water Flow	University of Texas, USGS & Harris-Galveston Coastal Subsidence District	2 Holes, 1018 feet
66	2/90-1/91	Paleozoic Aquifer Study	TWDB-Ground Water Section	2 hole, 2,583 feet
67	2/91 - 8/91	Montgomery County Recharge Study	TWDB GW Section & San Jacinto River Authority	18 Holes 6,434 feet
68	4/91 - 6/91	Erath County Pollution Study	Tarleton Institute for Applied Research	20 Holes 364 feet

Footage shown includes drilling and coring. Holes are routinely tested to determine potential yields, sampled for quality analysis, and followed by site clean-up and restoration

Figure 13

Geophysical Logging Conducted in Fiscal Years 1990 - 1991



Data Entry

The Board recognized the need to incorporate the large quantities of hand or typewritten ground-water records collected over the years into a computer-compatible format allowing for easy storage and retrieval of these data. To accomplish this, the Board secured computer software capable of handling vast quantities of data and assigned personnel to design a program and input the records to form the ground-water database. The data are used by Board personnel to monitor and study ground-water conditions and to respond to inquiries from the public and other governmental entities.

Personnel added tens of thousands of ground-water records to the database in FY 90 and 91. Initial entry, involving input of data readily accessible from published reports, has been completed for the entire State. Following this, additional information must be added to the records from agency files and field notes; ultimately staff members are assigned to verify the accuracy of the data.

Computer Graphics

Results of the TWDB ground-water data collection and study activities are generally reported to the public in the form of ground-water publications (Reports and Limited Publications), brochures, and news releases. The publications consist of a text describing the geology, hydrology, quantity and quality of the ground-water resources, conclusions, and recommendations. The majority of reports contain tables providing additional basic information and illustrations supporting the conclusions and recommendations presented.

Prior to 1989, the illustrations were prepared manually. To improve and expedite the preparation of illustrations, staff attended computer-oriented graphics short courses and purchased hardware and software to perform these functions. Reports in progress containing hand-drawn illustrations were digitized and finalized using computer graphics. All subsequent illustrations have been prepared using computer graphics.

During the biennium, Ground Water personnel prepared approximately 1400 illustrations in connection with 30 ground-water studies. In addition, the major and minor aquifer maps were revised for inclusion in the 1990 Water Plan. Since publication of the original aquifer maps in the 1960s, numerous ground-water studies completed by Board personnel and others have provided the basis for changes in delineation, especially the down-dip limit of usable quality water, and in nomenclature. Aquifer outcrops were derived from the Geologic Atlas Series published by the Bureau of Economic Geology. The major and minor aquifer revisions were made (1:250,000 scale base) using computer graphics.

Public and Interagency Assistance

Public Assistance

Ground Water personnel responded to 5,918 public and interagency inquiries, during fiscal years 1990 - 1991, from sources such as private individuals seeking to obtain domestic water supplies, consultants, water well drillers needing pertinent information prior to drilling, and municipalities needing additional water due to increased population growth. The inquiries may be for basic ground-water data or for expertise concerning the availability, quantity, and quality of ground water for specific sites throughout the State. Some inquiries may require only a few minutes to complete whereas others may require several hours or days.

Interagency Assistance

The TWDB Planning staff is charged with evaluating the water resources of the State for long-range planning purposes. To accomplish this goal, Ground Water staff provide information on the occurrence, availability, quantity, and quality of ground water to meet specified planning periods.

The TWDB Development Fund staff receive numerous applications annually for financial assistance to fund water and waste-water projects. Ground Water staff review the applications to insure that the entity seeking financial assistance has sufficient good-quality water available to satisfy its projected water requirements during the loan repayment period. This review involves a complete assessment of the water resources at the proposed facility site. Most of these reviews require only a few hours to complete, although others may take days and could involve some field work. During the biennium, Ground Water staff reviewed 159 such applications.

Ground Water staff assists underground water conservation districts by providing (1) current and historical well data, (2) water-level and water-quality data, (3) geohydrologic expertise, and (4) personnel to conduct studies and/or test-hole drilling operations. In addition, the Ground Water staff assists managers of newly formed districts by providing all pertinent well data the Board has on file for the areas within their districts.

Ground-Water 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. Information about the geologic and hydrologic properties of underground water-bearing formations must be accurate to support rational planning, development, and management of these resources in conjunction with surface-water supplies. To accomplish this, the Board conducts ground-water investigations which are classified as (1) detailed studies, (2) special studies, (3) critical area studies, and (4) major basic data-collection studies.

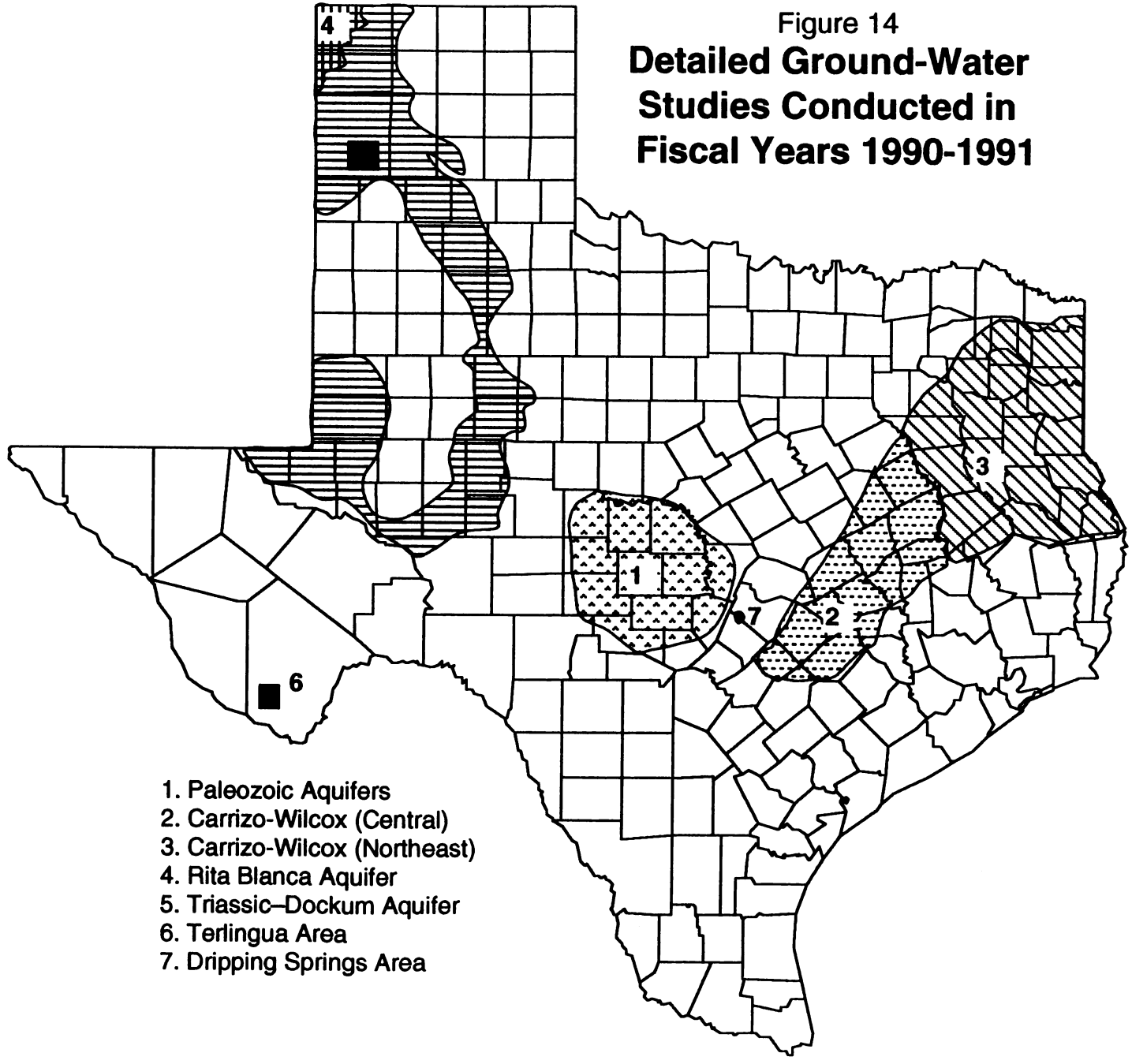
Detailed Studies

Detailed studies are the most comprehensive and complete type of investigation. These provide quantitative data for use by those involved in the planning and development of the State's water resources and for use by individuals residing within the study area(s).

Included in the scope of these investigations are the determination of the location and extent of fresh water-bearing formations, the chemical quality of the water, the amount of ground water being withdrawn, the effects of withdrawals upon water levels and water quality, the hydraulic characteristics of important water-bearing units, and an estimate of the amount of ground water available for development from each of the key aquifers. These investigations also include analysis of local or regional problems such as: encroachment of inferior-quality water into fresh water-bearing formations, subsidence of the land surface caused by major ground-water withdrawals, and the discharge of saline ground water into surface streams. The areas of the State in which detailed studies were conducted or in progress in FY 90 and 91 are shown in Figure 14 and are listed on the following pages.

Figure 14

Detailed Ground-Water Studies Conducted in Fiscal Years 1990-1991



1. Paleozoic Aquifers
2. Carrizo-Wilcox (Central)
3. Carrizo-Wilcox (Northeast)
4. Rita Blanca Aquifer
5. Triassic–Dockum Aquifer
6. Terlingua Area
7. Dripping Springs Area

Paleozoic Aquifer Study - A regional study of the Paleozoic aquifers in the Llano Uplift region of central Texas including all or parts of Blanco, Gillespie, Kendall, Kerr, Kimble, Mason, Llano, Burnet, Lampasas, Mills, Brown, San Saba, McCulloch, Menard, Concho, and Coleman Counties. Aquifers being studied are (from oldest to youngest) the Hickory, Mid-Cambrian, Ellenburger-San Saba, and Marble Falls. The study includes completion of monitor wells in the Paleozoic aquifers near Brady. These wells have not only helped to delineate the hydrological relationships of the aquifers under the stresses posed by pumpage in the irrigated outcrop area of the Hickory aquifer, but have also helped to investigate the source and occurrence of excessive radioactive elements within the aquifer. Finalization of the report has been delayed pending completion of the Water Plan related studies.

Carrizo-Wilcox (Central) Study - A comprehensive study of the ground-water resources of the Carrizo-Wilcox aquifer in central Texas including a digital model of the aquifer for use in predicting water-level responses to current and anticipated ground-water development. Study results will be presented in a two-volume report. The first volume, which presents the findings, conclusions, and recommendations of the study, has been published as TWDB Report 332. Basic data collected during the investigation are retained in the TWDB files for those wishing more detail than the report contains. The second volume, which will present results of the model study, has been delayed pending completion of Water Plan related studies.

Carrizo-Wilcox (Northeast) Study - A study of the ground-water resources of the Carrizo-Wilcox aquifer in northeast Texas which is a continuation of the Carrizo-Wilcox Study in central Texas. Field work for this study is in progress, but thus far the data collected have been used in Critical Area Studies. The study will be continued as part of the Water Plan related studies.

Rita Blanca Aquifer Study - A study to evaluate the ground-water resources of the Rita Blanca aquifer in Dallam and Hartley Counties in the northern Texas Panhandle including the Jurassic and Cretaceous water-bearing sediments. Field work has been completed, and preparation of the reports, tables, and manuscript has been initiated. Finalization of the report has been delayed pending completion of Water Plan related studies.

Triassic Aquifer Study - A study of the Triassic (Dockum) which occurs over much of the High Plains and Trans-Pecos region of Texas. These sediments contain moderate quantities of usable quality water and in places are hydrologically connected to the Ogallala and Edwards-Trinity (Plateau) aquifers. Field work has been completed, and preparation of the reports, tables and manuscript has been initiated. Finalization of the study has been delayed pending completion of Water Plan update related studies.

Ground-Water Evaluation in and Adjacent to Dripping Springs - This report presents the results of the TWDB study of the Trinity aquifer in the Dripping Springs area of Hays County. This study was conducted to compare current water-quality conditions to past conditions; to evaluate the potential for ground-water contamination in the area; and to recommend water-level and water-quality programs to monitor conditions in the area. The study was published as TWDB Report 322.

Hydrogeology of the Terlingua Area - This report presents the results of the TWDB study of the ground-water resources of the Terlingua area of Brewster County. The report attempts to determine if the ground-water availability can sustain the present and anticipated population growth of the area. The study was published as TWDB Report 323.

Special Studies

Special studies may have many of the same objectives as those of the detailed studies, but are directed toward accomplishing a special need or solving a problem in a particular county or region of the State. The areas where special studies were conducted or underway in FY 90-91 are shown in Figure 15 and are listed in the following section:

Ground-Water Conditions In Garden City, Texas - A study of the ground-water quality conditions underlying the community of Garden City which was conducted to determine the extent of contamination to the local drinking water source and the possible need for assistance from the Board in financing a water/waste-water project for the community. The study was completed and published as TWDB Report LP-210.

Test Well Drilling Investigation - Edwards (BFZ) Austin Region - A study to redefine the areal boundary of the down-dip extent of Edwards (BFZ)aquifer ground water containing less than 1,000 milligrams per liter (mg/l) dissolved solids, and less than 3,000 mg/l dissolved solids along the previously delineated "Bad Water Line" in Hays, Travis, and Williamson Counties. The study included test hole drilling, pump tests, and geophysical logging. The study was completed and published as TWDB Report 325.

Montgomery County Recharge Study - A study to determine the long term availability of ground water from the Gulf Coast aquifer which is being conducted cooperatively by the Board and the San Jacinto River Authority. Several test holes to better define recharge to the aquifer have been drilled, and recorders will be installed to monitor water levels. A model of the aquifer will be constructed to better simulate changes in storage based on proposed development of water resources to meet the needs of the area, and to facilitate planning.

Edwards (BFZ) Aquifer San Antonio Region Model - A study to revise the aquifer model constructed in connection with Report 239 published in October 1979. The revision is aimed at simulating the aquifer's response to change on a more realistic monthly basis instead of annually, as had been done in the previous model study. The model will be used to predict aquifer response to stress, especially during drought conditions, and to indicate what pumpage limitations might need to be imposed to insure that adequate flow occurs at Comal and San Marcos Springs to maintain their sensitive ecosystems.

Ogallala Aquifer Model - A study to revise the aquifer model constructed in connection with Report 288 published in May 1984. The revision was prompted because many of the projections of the original model did not occur. Information now available indicates a reduction in pumpage and additional recharge in the southern portion of the area, both of which will be incorporated into the present revision. Use of a multi-layer model is being considered for future revisions. Modelling of the aquifer has been completed and will be published in FY 92.

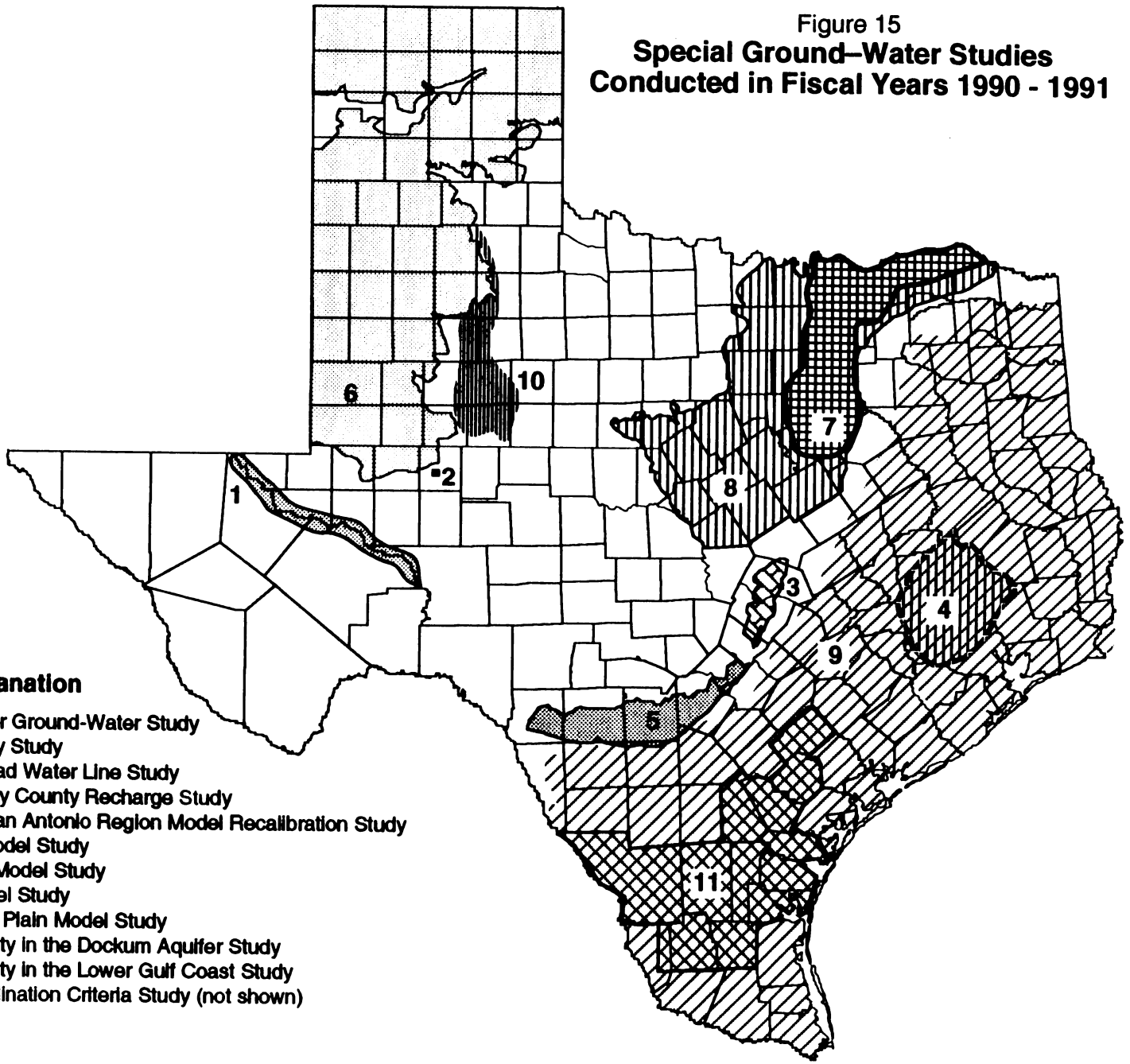
Woodbine Aquifer Study - A study of the Woodbine aquifer to assess the total volume of ground water in storage using a computer model analysis.

Trinity Aquifer(s) Study - A study of the Trinity aquifer(s) to assess the total volume of ground water in storage using a computer model analysis.

Gulf Coast Aquifer Study - A study of the Gulf Coast aquifer to assess the total volume of ground water in storage using a computer model analysis.

Figure 15

Special Ground–Water Studies Conducted in Fiscal Years 1990 - 1991



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)

Pecos River GW-SW Interface Study - A study to monitor the results of using surface water from the Pecos River to irrigate crops grown in the recharge area of the Cenozoic Pecos Alluvium. Pecos River water is high in both sulfates and chlorides, while ground water from the alluvium is predominately high in sulfates only. Wells will be sampled periodically to determine changes, if any, in ground-water quality. Analytical results are also provided to the Bureau of Reclamation for use in their study of the Red Bluff Power Control District Rehabilitation.

Occurrence of Radioactivity in Ground Water in the Dockum Aquifer - A study involving the sampling of 125 wells in the vicinity of the Dockum (Triassic Age) outcrop adjacent to the High Plains Escarpment. This study determined the amount of naturally occurring radioactive elements present in ground water pumped from the aquifer. A selected suite of heavy metals was also analyzed along with the major anions and cations. Results of this study will be incorporated into the Dockum study.

Occurrence of Radioactivity in Ground Water in the Lower Gulf Coast Aquifer - A study involving the sampling of 40 wells in 12 counties, 16 of which were located in Webb County. Ground-water samples were analyzed for 6 radioactive elements along with the major anions and cations. Results were provided to well owners and filed in the TWDB database.

Aquifer Delineation Criteria - A report detailing the criteria which are used to establish the boundaries of the re-delineated major and minor aquifers.

Major and Minor Aquifer Maps - An extensive revision of the major and minor aquifer maps of Texas. Aquifer outcrops were digitized for computer files from the Geologic Atlas maps published by the Bureau of Economic Geology.

Critical Area Studies

In 1985, the Sixty-ninth Texas Legislature enacted House Bill 2. This bill specifically directed the State water agency(s) to identify areas of the State which were experiencing or likely to experience critical ground-water problems within the next twenty years. Initially seventeen areas were identified as possibly having critical problems, but only ten areas were designated for study. Because one of the areas covered most of central Texas, it was subdivided into four areas, resulting in a total of thirteen areas designated for study. Two additional areas were designated for study following completion of the original thirteen.

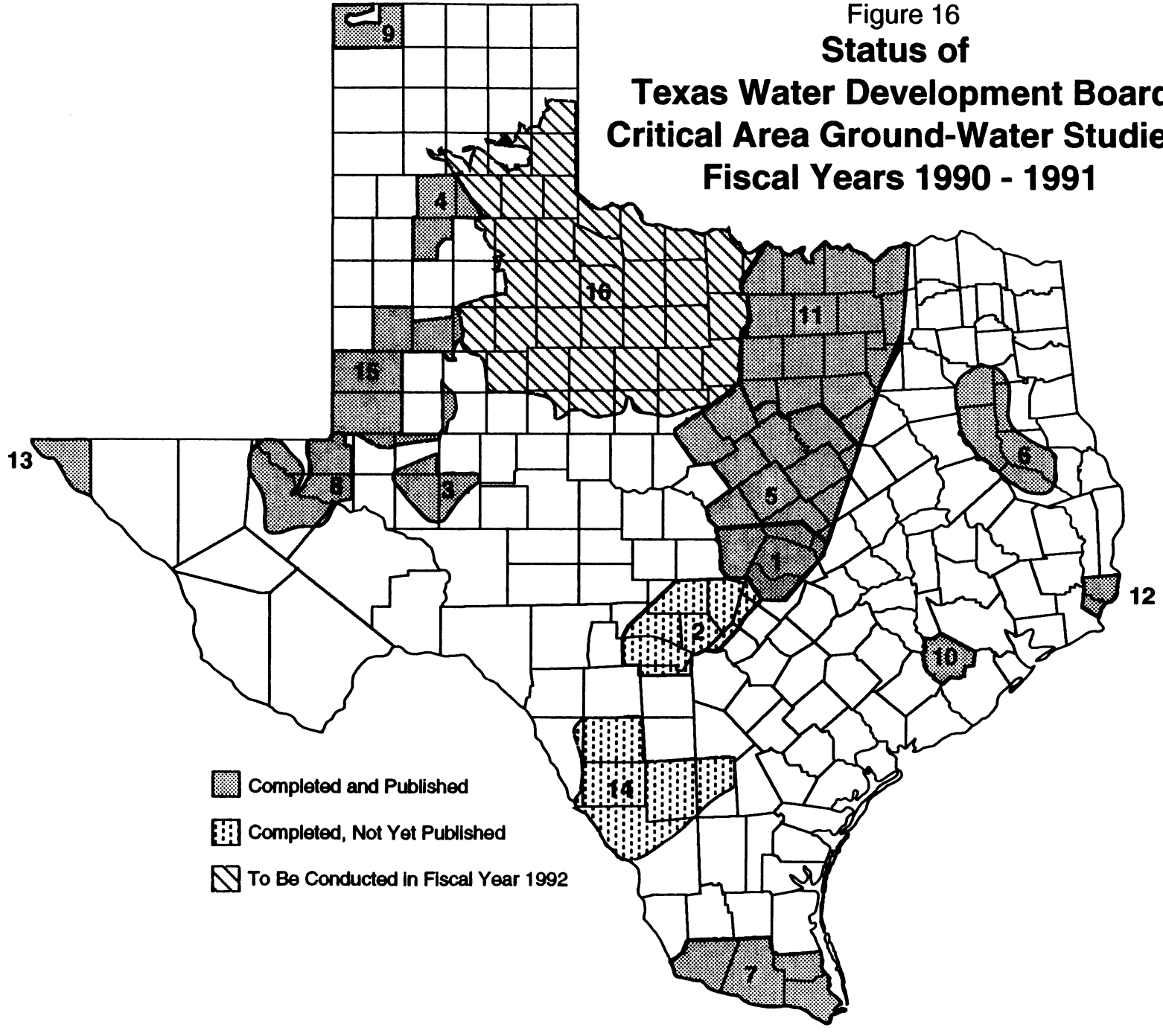
Critical Area Studies are designed to address special problems. These studies involve areas which are experiencing, or expected to experience, problems such as: overdrafts (resulting in water-level declines), saline-water encroachment, water-quality deterioration, susceptibility to pollution, and subsidence.

In FY 90 and 91, Ground Water staff presented the results of the thirteen area studies to the Texas Water Commission. Two previous studies were presented in FY 89. In addition, hearings have been held covering some of the areas to determine whether formation of an underground water conservation district might help solve or manage their problem(s). One additional area identified for study during the biennium will be officially initiated in FY 92. Figure 16 shows the status and locations of Critical Area studies as of August 31, 1991. The following list indicates the status of each Critical Area study:

Critical Study Area Number	Title	TWDB Report Number
1	Evaluation of Water Resources in Bell, Burnet, Travis, Williamson, and Parts of adjacent Counties, Texas	326
2	Evaluation of Ground-Water Resources in Bandera, Blanco, Gillespie, Kerr, Kendall, Medina, Comal, Hays, and Travis Counties	In Publication
3	Evaluation of Ground-Water Resources in Parts of Midland, Reagan, and Upton Counties, Texas	312 (FY 89)
4	Evaluation of Ground-Water Resources in Briscoe, Hale, and Swisher Counties, Texas	313 (FY 89)
5	Evaluation of Water Resources in Part of Central Texas	319
6	Evaluation of Ground-Water Resources in the Vicinity of the Cities of Henderson, Jacksonville, Kilgore, Lufkin, Nacogdoches, Rusk, and Tyler in East Texas	327
7	Evaluation of Ground-Water Resources in the Lower Rio Grande Valley, Texas	316
8	Evaluation of Ground-Water Resources in Parts of Loving, Pecos, Reeves, Ward, and Winkler Counties, Texas	317
9	Evaluation of Ground-Water Resources in Dallam County, Texas	315
10	Evaluation of Water Resources of Fort Bend County, Texas	321
11	Evaluation of Water Resources in Part of Central Texas	318
12	Evaluation of Water Resources of Orange and Eastern Jefferson Counties, Texas	320
13	Evaluation of Ground-Water Resources in El Paso County, Texas	324
14	Evaluation of Ground-Water Resources in the Winter Garden Area, Texas	334 (FY 92)
15	Evaluation of Ground-Water Resources in the Southern High Plains of Texas	330
16	Evaluation of Water Resources in Part of the Rolling Prairies Region of Texas	In Progress

Figure 16

Status of Texas Water Development Board Critical Area Ground-Water Studies, Fiscal Years 1990 - 1991



Basic Data-Collection Studies

Basic-data collection studies are 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. Often during the course of these investigations it becomes evident that additional work is needed. This may lead to a detailed investigation of all or portions of the area such as has been described under detailed studies.

Figure 17 shows areas of the State in which basic data-collection studies were conducted or in progress during FY 90 and 91. The status of each is explained in the following list.

Public Supply Well Inventory In The Texas Panhandle - A study consisting of an inventory of water wells which produce ground water for public supply use to the major entities in 48 counties in the Texas Panhandle. The data covering this large area will be compiled into two reports. They are intended to provide information concerning the regional water suppliers to the public and to assist Board staff in assessing applications for Development Fund financing of water and waste-water projects. The first report covering the Southern High Plains has been completed and published as TWDB Report 328. Field work covering the Northern High Plains is completed, and data are being assimilated into a report format.

Public Supply Well Inventory in Northeast Texas - A study consisting of an inventory of water wells which produce ground water for public supply use in the major entities in northeast Texas.

1980 - 1990 High Plains Aquifer Water-Level Change - An illustrated report containing three maps: 1990 contoured elevation of static water level; areas of 1980 - 1990 water-level rise; and areas of 1980 - 1990 water-level decline. This report has been published as TWDB Hydrologic Atlas No. 1.

Ground-Water Use in Victoria County - A field investigation to determine the concentration of wells and their use in Victoria County. These data will be used in the construction of the Gulf Coast aquifer model.

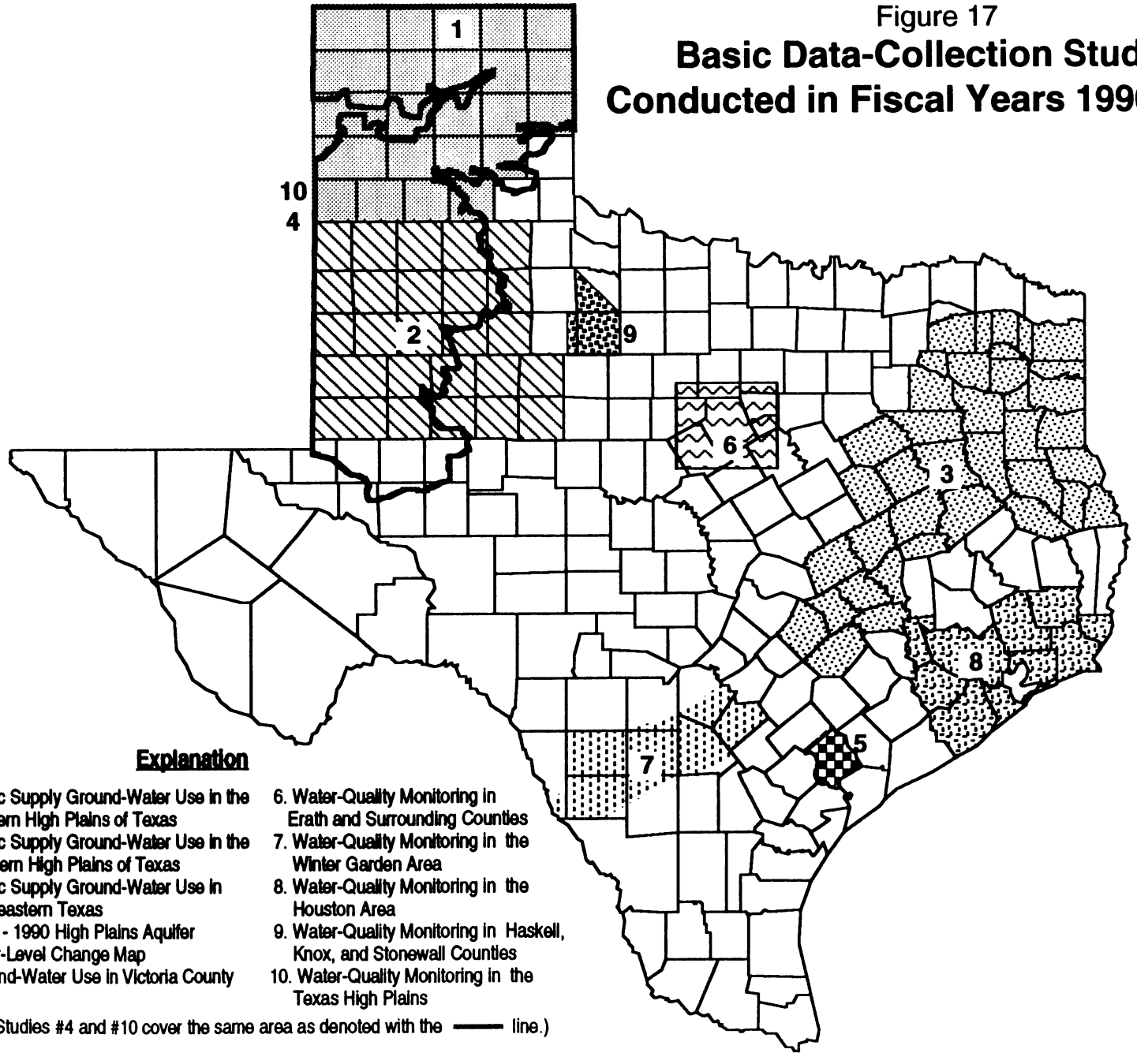
Results of Water-Quality Monitoring in Erath and Surrounding Counties - A study involving the routine sampling of 67 wells in an area of intense dairy operations which is also the focus of studies by several other entities. Most of the wells sampled were completed in the Antlers or Twin Mountains; some were completed in the Paluxy. These aquifers, all part of the major Trinity aquifer, were sampled for major anions and cations, metals, nitrates, insecticides, herbicides, and radioactivity. This study was completed and published as TWDB Report 331.

Results of Water Quality-Monitoring of the Carrizo-Wilcox Aquifer in the Winter Garden Area - A study conducted in cooperation with the Evergreen Underground Water Conservation District in which 119 TWDB observation wells were sampled for major anions and cations, metals, organic, and selected radioactive elements. 103 wells are completed in the Carrizo aquifer, with a representative number completed in the Queen City and Wilcox aquifers. This study was completed and will be published as Report 335 in FY 92.

Results of Water-Quality Monitoring of the Gulf Coast Aquifer in the Houston Area - A study of the ground-water quality from wells completed in the Gulf Coast aquifer primarily for organic constituents, radioactivity (including radon), and a complete suite of heavy metals. Results of the TWDB monitoring efforts were provided to the City of Houston, USGS, and participating well owners, and were included in the TWDB database.

Figure 17

Basic Data-Collection Studies Conducted in Fiscal Years 1990 - 1991



Explanation

1. Public Supply Ground-Water Use in the Northern High Plains of Texas
2. Public Supply Ground-Water Use in the Southern High Plains of Texas
3. Public Supply Ground-Water Use in Northeastern Texas
4. 1980 - 1990 High Plains Aquifer Water-Level Change Map
5. Ground-Water Use in Victoria County
6. Water-Quality Monitoring in Erath and Surrounding Counties
7. Water-Quality Monitoring in the Winter Garden Area
8. Water-Quality Monitoring in the Houston Area
9. Water-Quality Monitoring in Haskell, Knox, and Stonewall Counties
10. Water-Quality Monitoring in the Texas High Plains

(Note: Studies #4 and #10 cover the same area as denoted with the —— line.)

Results of Water-Quality Monitoring in Cooperation With the TDA in Parts of Haskell, Knox, and Stonewall Counties - A study conducted in cooperation with the Texas Department of Agriculture (TDA) in which a total of 47 wells completed in the Seymour aquifer were sampled by the Board for inorganic constituents in Haskell, Knox, and Stonewall Counties. Most of these same wells were also sampled by TDA personnel for pesticides. This combined agency effort provided a full suite of parameters indicative of the water-quality within the study area. This would have been cost-prohibitive if done independently. This study has been completed and will be published as Report 333 in FY 92.

Water-Quality Monitoring of the Ogallala Aquifer in the High Plains - A study conducted in cooperation with several underground water conservation districts and involving the sampling of wells for the major anions and cations, metals, nutrients, and radioactivity content of the ground water. The final well sampling for this project will occur in FY 92.

Ground-Water Data System Data Dictionary (UM-50) - This publication describes information available in the TWDB ground-water data system and instructions on how it can be retrieved.

A Field Manual For Ground Water Sampling (UM-51) - Originally published in FY 1990, the revised FY 91 publication describes the sampling program; equipment needed in the field; well-purging guidelines; procedures for determining ground-water sample temperature, specific conductance, pH, and alkalinity; procedures for sample collection of individual parameters; filtering methods; recording of field data; procedures for transporting or shipping samples; and the chain of custody.

Ground-Water Pumpage

The TWDB conducts a program to collect and maintain a comprehensive database on the use of water in the State. This program includes water-use data collection activities for (1) municipal and manufacturing uses, (2) mining and steam-electric generation uses, and (3) agricultural uses. These data are used by Board staff and others to evaluate current resources and to develop future water-supply requirements.

The total historical water used in 1974, 1977, 1980, 1984, 1985, 1986, 1987, 1988, and 1989 is given in Table 2. Areas experiencing water-level declines during the 1980 - 1990 decade are shown in Figure 18. In 1989, the last year for which complete statewide water-use data are available, 13.2 million acre-feet of water were used in Texas. Figure 19 shows the total water use for 1989 and its distribution by county. The amount of water-use by category that is supplied by surface and ground-water sources for the aforementioned years is also given in Table 2 and illustrated in Figure 20.

Of the total 13.2 million acre-feet (ac.ft.) of water used in 1989, approximately 54% (8,169,503 ac.ft.) was supplied by ground-water sources; of that amount, 76% was used for irrigation. Ground water also provided 45% of the total municipal water used that year.

Conclusions and Recommendations

Ground-water monitoring networks and studies are essential to accurately assess the resources of the State's aquifers. It is imperative that these activities be maintained to insure that the State's valuable ground-water resources are developed in a prudent and efficient manner, thereby securing the State's continued economic growth and the general welfare of its citizens. The Board recognizes this challenge and continues to support the efforts of the Ground Water staff to meet these goals.

Table 2

Historical Water Use, 1974 - 1989 (in acre-feet)

	Use	Municipal	Manufact.	Power	Irrigation	Mining	Livestock	State Total	Percent
1974	Ground	967,061	486,337	52,884	10,404,522	178,880	128,118	12,217,802	70
	Surface	964,374	1,112,631	148,212	2,680,553	48,156	167,500	5,121,426	30
	Total	1,931,435	1,598,968	201,096	13,085,075	227,036	295,618	17,339,228	
1977	Ground	1,138,526	396,874	45,046	9,156,391	198,821	124,964	11,060,622	68
	Surface	1,252,984	1,223,098	215,302	2,283,393	62,134	140,940	5,177,851	32
	Total	2,391,510	1,619,972	260,348	11,439,784	260,955	265,904	16,238,473	
1980	Ground	1,290,271	248,640	53,000	8,956,971	178,369	119,730	10,846,981	61
	Surface	1,522,911	1,271,352	274,138	3,749,377	60,707	124,279	7,005,683	39
	Total	2,813,182	1,519,992	327,138	12,706,348	239,076	244,009	17,852,664	
1984	Ground	1,412,910	238,253	54,324	6,899,829	115,736	124,743	8,845,795	58
	Surface	1,659,358	1,178,579	308,403	3,032,022	61,568	167,685	6,407,615	42
	Total	3,072,268	1,416,832	362,727	9,931,851	177,304	292,428	15,253,410	
1985	Ground	1,387,916	223,017	58,174	6,073,910	99,608	129,744	7,972,369	56
	Surface	1,694,805	1,204,725	333,435	2,686,597	77,771	162,955	6,160,288	44
	Total	3,082,721	1,427,742	391,609	8,760,507	177,379	292,699	14,132,657	
1986	Ground	1,387,594	217,443	50,707	5,288,367	80,644	119,235	7,143,990	55
	Surface	1,670,961	1,130,849	287,495	2,609,617	79,034	161,282	5,939,238	45
	Total	3,058,555	1,348,292	338,202	7,897,984	159,678	280,517	13,083,228	
1987	Ground	1,363,115	195,119	50,505	4,597,530	80,644	122,828	6,409,741	52
	Surface	1,677,949	1,171,434	274,814	2,657,073	79,034	155,070	6,015,374	48
	Total	3,041,064	1,366,553	325,319	7,254,603	159,678	277,898	12,425,115	
1988	Ground	1,426,842	204,318	49,592	5,065,515	103,616	100,348	6,950,786	50
	Surface	1,778,065	1,309,990	396,087	3,365,091	49,575	153,606	7,052,414	50
	Total	3,204,907	1,514,308	445,679	8,430,606	153,191	253,954	14,003,200	
1989	Ground	1,411,507	242,129	49,592	6,262,209	103,616	100,450	8,169,503	54
	Surface	1,734,548	1,296,626	396,087	3,277,429	49,575	152,859	6,907,124	46
	Total	3,146,055	1,538,755	445,679	9,539,638	153,191	253,309	15,076,627	

Municipal Use Excludes Reported Industrial Sales
Electrical Power Surface Water Use is Consumptive Use
Irrigation Surface Water Use for 1974-1977 is On-Farm Use
Surface Water Diversion Loss Estimates are Included After 1977

Figure 19

Water Use in 1989

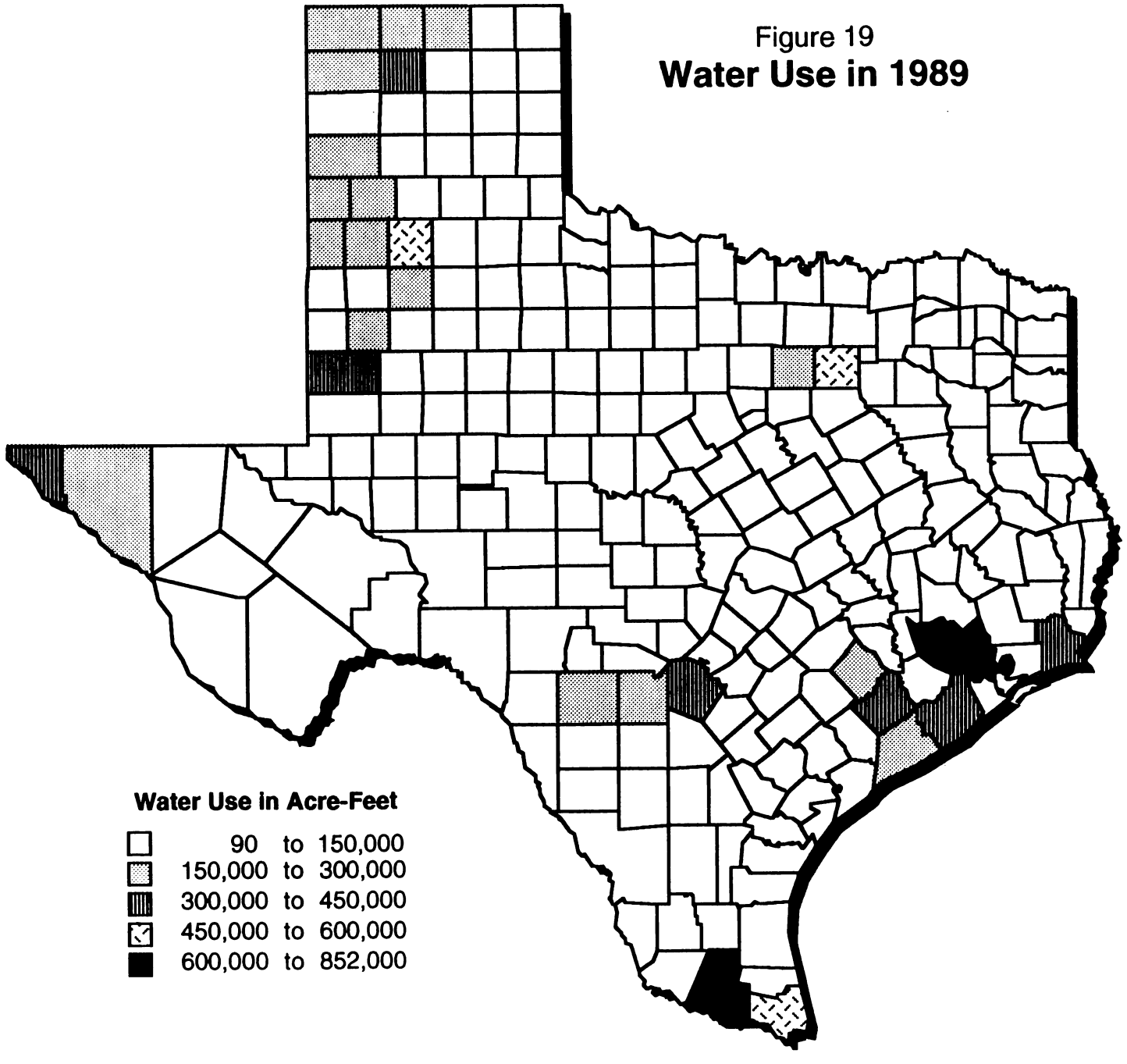
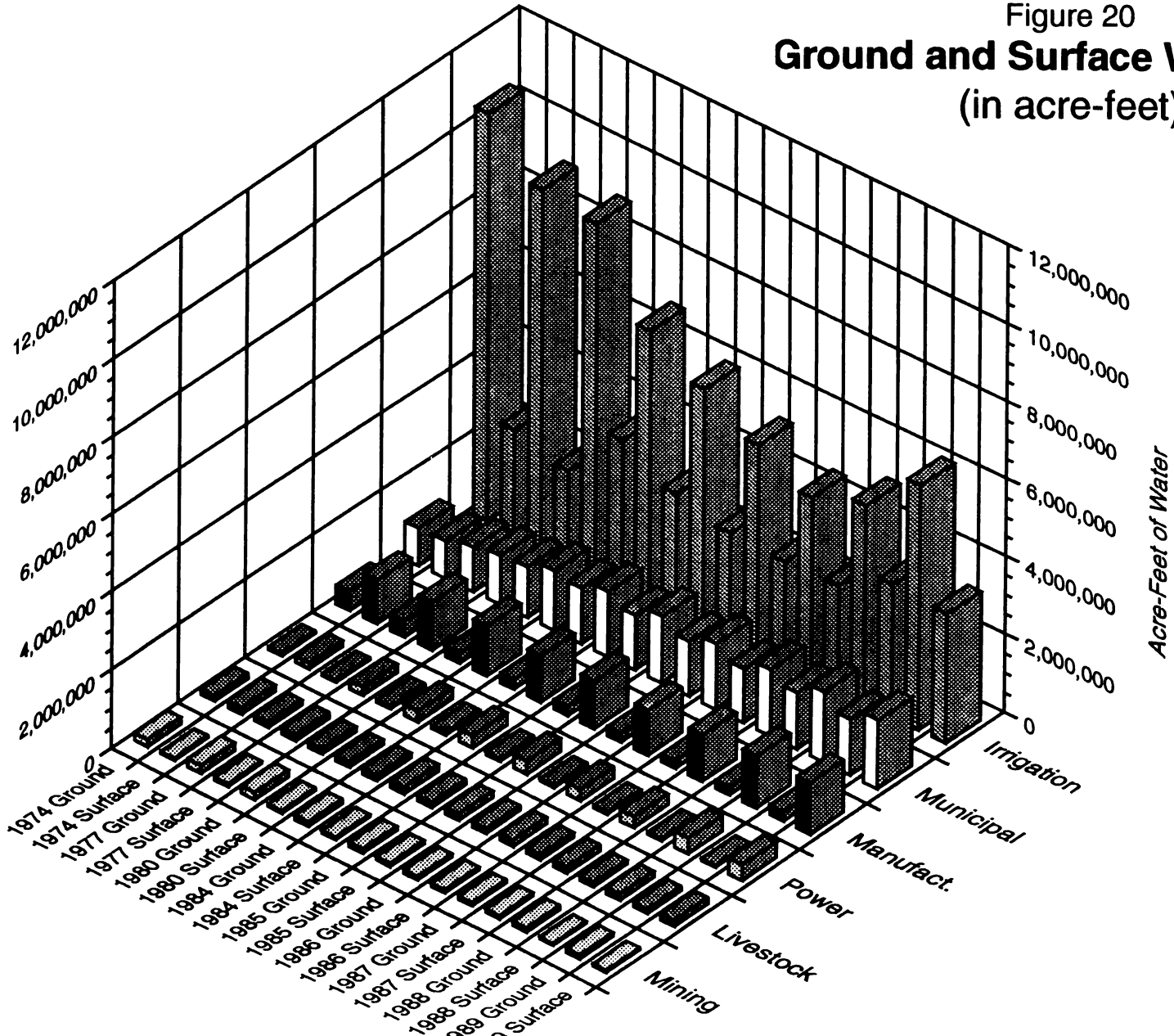


Figure 20

Ground and Surface Water Use
(in acre-feet)



Ground-Water Data Collection Activities

The TWDB maintains a network of 7,600 water-level and 6,000 water-quality observation wells. Despite this seemingly vast network, staff often lacks sufficient information to adequately determine the ground-water conditions within specific areas of the State; additional research and field work is frequently required to collect, compile, and evaluate the needed data. In areas lacking data, the TWDB Ground Water Section has the capability to drill test holes for the necessary information.

If monitoring networks are to provide the most reliable information possible, they must be continuously reviewed to determine if adequate coverage is being maintained. This can only be achieved, however, if funding to cover staff and travel expenses is continued and expanded. Sample analysis must include heavy metals, radioactivity, organic, and other constituents as needed. It is imperative that funding for chemical analysis, the most costly portion of this activity, be continued and even increased to cover any additional analysis costs.

The base-line quality of ground water present must be established; any long-term deterioration or short-term pronounced changes resulting from contamination must be monitored, described, and quantified. Further, the EPA will soon be initiating the State Ground-Water Protection Programs which will require all states to establish base-line parameters of all aquifers.

Ground-Water Study Activities

The role of the TWDB as the State's water-planning agency requires that the ground-water resources of the major and minor aquifers be known in sufficient detail to insure that the proper quantification, protection, and prudent management of these resources are accomplished. To achieve this end, ground-water availability estimates of all major and minor aquifers having substantial pumpage must be refined using digital computer models whenever possible. When coupled with the most recent pumpage determination and water-level changes, these estimates will help adjust the TWDB planning projections made prior to changes currently being experienced in some areas of the state as a result of the sluggish economy.

New areas which may experience critical ground-water problems must be identified and studied to determine the extent of the problem(s) and whether formation of underground water conservation districts might help solve or manage the problems. Areas expected to experience rapid and extensive population growth, such as the IH-35 corridor between San Antonio-Austin-Waco and the Dallas-Fort Worth Metroplex, must be studied in detail to insure that their water demands can and will be met.

Legislation

During the past legislative session, several bills were passed that will directly or indirectly influence the activities of the Ground Water staff, particularly House Bill 1458 and Senate Bills 856 and 1212. House Bill 1458 codifies the Texas Ground Water Protection Committee created in 1985 to coordinate state agency actions for protecting ground-water quality. The Executive Administrator of the Board serves as vice-chairman of the Committee. Several members of the Ground Water staff have been involved in the activities of the Committee since its inception. They have assisted in developing the Texas Ground-Water Protection Strategy and, most recently, in developing a State Pesticide Management Plan for the protection of ground water.

Senate Bill 856 concerns ground-water protection standards adopted and enforced by the Radiation Control Agency. Board personnel generally collect ground-water samples to be analyzed for their anion, cation, nitrate, nitrogen compound, and heavy metal content. Samples are also collected and analyzed for their radionuclide content in areas of known or suspected concentration, for example the

Llano Uplift area of central Texas. Data collected through these efforts will be made available to the Radiation Control Agency to assist in their work.

Senate Bill 1212 pertains to the creation, administration, and operation of underground water conservation districts. The Ground Water staff has assisted existing and newly established districts by providing basic water-well data and expertise on the geohydrologic conditions within their respective areas. The Board recognizes the importance of these entities in managing and developing the ground-water resources of their areas and encourages staff to assist these efforts whenever possible.

In summary, if the TWDB is to continue its role as the State's water-planning agency, it must respond to whatever challenges the future holds, and the Board must endeavor to see that the Legislature recognize the importance of this role. Only then will the Legislature allocate the funds necessary to maintain data-collection activities, water resource studies, and water and wastewater projects. Only then can Texas continue to be a leader in water-resource planning.

GROUND WATER SECTION

ADMINISTRATION

Alvarez
Cooper
Schultz

GW STUDIES

Area I (West Texas)	Area II (North Texas)	Area III (East Texas)	Area IV (South Texas)
Ashworth	Baker	Preston	Bluntzer
Peckham	Duffin	Thorkildsen	McCoy
Waterreus	Flores	Berryman	McElhaney
Coker	Bilberry	Moore	Derton

GW DATA

MONITORING	DATA BASE ANALYST	SWN LOG PROCESSING	PUBLIC INQUIRIES	DEVELOPMENT FUND
Nordstrom Beynon Jones Payne Mohr Zapata Ozment Winkelman Asensio Jones	Quincy	Adair Jones	Muller Back-up WT Peckham NT Flores ET Berryman ST McCoy	WT/Peckham/Ashworth NT Flores/Duffin ET Berryman/Preston ST McCoy/McElhaney

SUPPORT

GRAPHICS	CORE DRILL GEOPHYSICAL LOGGING
Hayes Gifford	Striegler Jones Connell Casarez Saldana Pilkinton Crim

Area 1 – West Texas

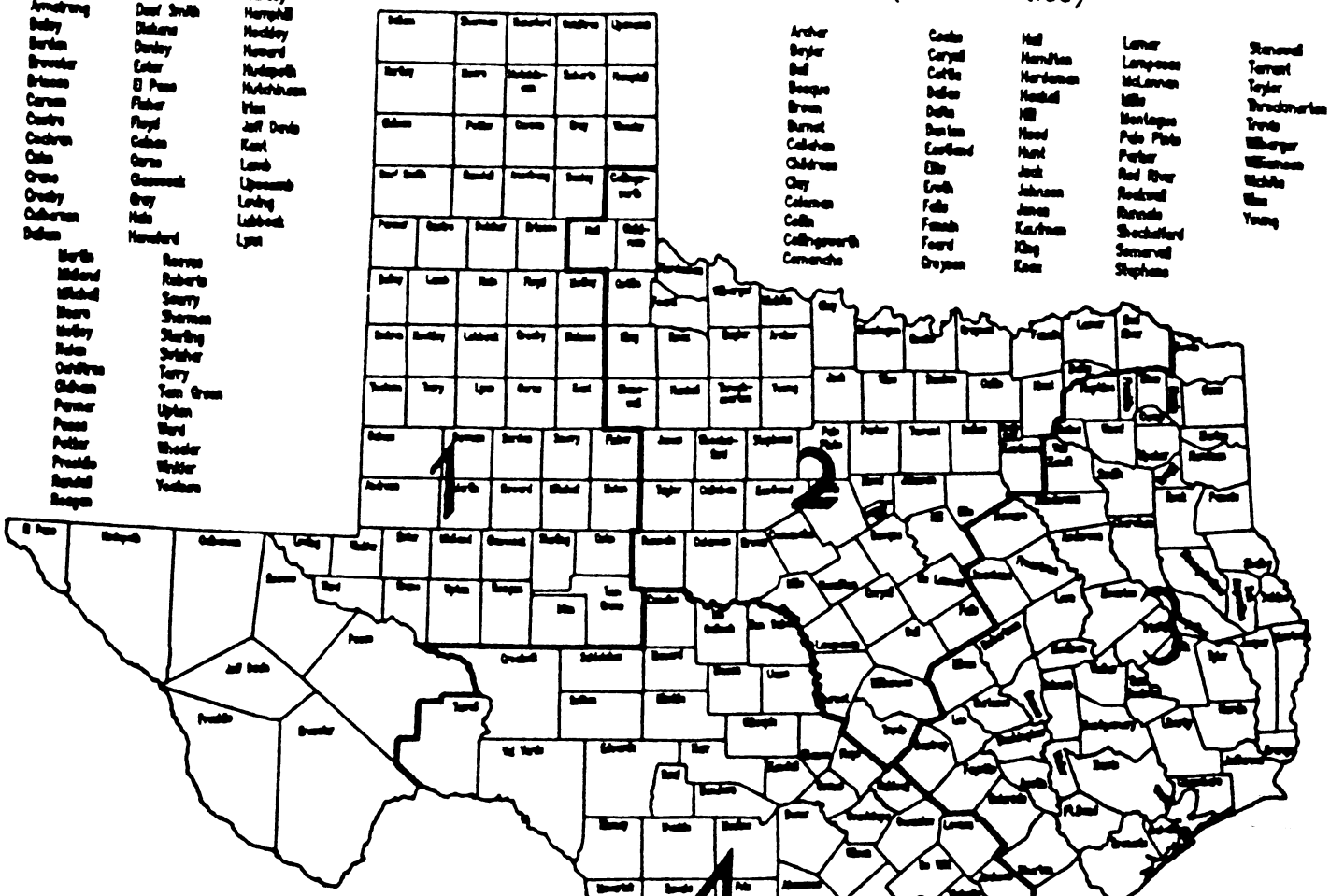
Ashworth
Peckham
Waterreus
Coker

(69 Counties)

Area 2 – North Texas

Baker
Flores
Duffin
Bilberry

(62 Counties)



Area 4 – South Texas

Bluntzer
McCoy
McElhaney
Derton

(61 Counties)

Area 3 – East Texas

Preston
Thorkildsen
Berryman
Moore

(62 Counties)