2008 State of Texas Water Quality Inventory
Groundwater Assessment
(March 19, 2008)

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SUMMARY

Texas' major and minor aquifers underlie approximately 76 percent of the state's surface area of 267,338 square miles (TWDB, 1995). Major aquifers are defined as producing large quantities of water in a comparatively large area of the state, whereas minor aquifers produce significant quantities of water within smaller geographic areas or small quantities in large geographic areas. Minor aquifers are very important as they may constitute the only significant source of water supply in some regions of the state. In 2003, these aquifers supplied 9.2 million acre-feet of groundwater, or about 59%, of all the water used by Texans for domestic, municipal, industrial, and agricultural purposes.

In 1989, the 71st Texas Legislature created the Texas Groundwater Protection Committee (Committee or TGPC) as a means to bridge the gap between existing state groundwater programs and to optimize water quality protection by improving coordination among agencies involved in groundwater activities. The Texas Commission on Environmental Quality (TCEQ) is designated as the lead agency of the TGPC. The Texas Water Development Board (TWDB) is designated as vice-chair of the Committee, and other members include as specified in the Texas Water Code, the Railroad Commission of Texas (RCT), Texas Department of State Health Services, Texas Department of Agriculture, Texas State Soil and Water Conservation Board, Texas Alliance of Groundwater Districts, Texas AgriLife Research, the Bureau of Economic Geology, and Texas Department of Licensing and Regulation.

TGPC member agencies provide data for the TGPC's groundwater quality inventory efforts. In 1996, the TGPC, through the partnership of two of its member agencies, the TCEQ and the TWDB, began this process by performing an inventory of the groundwater quality of one major, one minor, and two of Texas' local aquifer systems. This information was published in the TCEQ's State of Texas Water Quality Inventory 1996, addressing both surface water and groundwater quality (TCEQ, 1996). Additional aquifers were included in the report's subsequent years, and this edition marks the completion of the inventory for all thirty of the state's major and minor aquifers.

Information obtained from another of the Committee's reports, the annual Joint Groundwater Monitoring and Contamination Report, provides data on the "detrimental alteration of the naturally occurring physical, thermal, chemical, or biological quality of groundwater reasonably suspected of having been caused by the activities of entities under the jurisdiction of TGPC member agencies with groundwater protection responsibilities", which is Texas legislature's definition of contamination.

There were 5,576 documented groundwater contamination cases addressed in the 2006 (most recently published) joint report. Approximately 94 percent of the reported cases were under the jurisdiction of the TCEQ. The remainder of the cases were under the jurisdiction of the RCT and one groundwater conservation district which is a member of the Texas Alliance of Groundwater Districts. The vast majority of the cases documented under the jurisdiction of the TCEQ were identified through regulatory compliance monitoring, while the cases under the jurisdiction of the RCT and the groundwater conservation districts were identified from special

studies, investigations in response to complaints, or ambient groundwater quality monitoring activities (TGPC, 2006).

The most common contaminants reported in 2006 included gasoline, diesel, and other petroleum products, due to the large number of petroleum storage tank related cases in this report. Less common contaminants included volatile organic compounds (such as benzene, toluene, xylene, phenol, trichloroethylene, carbon tetrachloride, dichloroethylene, and naphthalene), pesticides (such as alachlor, atrazine, bromacil, dicamba, and prometon), creosote constituents, solvents, heavy metals, and sodium chloride (TGPC, 2006).

The 2008 groundwater inventory efforts show that ambient groundwater quality in Texas varies among the thirty study aquifers, but is generally good, with maximum contaminant level (MCL) exceedances occurring for some parameters (nitrate, sulfate, total dissolved solids, or others) in groundwater taken from a small percentage of water wells sampled throughout Texas. Fluoride (naturally occurring) appears as a secondary contaminant of concern sporadically throughout the wells sampled.

Groundwater contamination at regulated facilities occurs principally in heavily populated areas of the state, such as Houston, Dallas, Fort Worth, San Antonio and El Paso, primarily at petroleum storage tank facilities. TCEQ staff compiling data for the joint report have been obtaining geographic coordinates for contamination sites, but do not have a complete geographically referenced data set at this time. This precludes the possibility of any precise correlation between regulated facility sites with contamination and wells used for ambient data collection or public water supply system wells with impacts. Efforts to include this correlation in a subsequent inventory are still active.

Despite the lack of information for precise comparison of ambient water quality data to the occurrence of contamination sites, estimation methods currently in use suggest that a high concentration of regulated surface activity sites with groundwater contamination does not correlate with area-wide ambient groundwater degradation. This is understandable, given that contamination from most regulated surface activities tends to impact shallow, local water bearing zones that are separated from the major and minor aquifers.

OVERVIEW – GROUNDWATER RESOURCES

In 2003, Texans used 15.6 million acre-feet of water. Groundwater, a fundamental component of the state's water resources, supplied 9.2 million acre-feet, or about 59% of all the water used by Texans for domestic, municipal, industrial, and agricultural purposes.

The groundwater used by Texans is produced primarily from aquifers, underground layers of rock with water stored in pore spaces, cracks or voids. Major aquifers are defined as producing large quantities of water in a comparatively large area of the state, whereas minor aquifers produce significant quantities of water within smaller geographic areas or small quantities in large geographic areas. Minor aquifers are very important as they may constitute the only significant source of water supply in some regions of the state. The major and minor aquifers are composed of many rock types, including limestones, dolomites, sandstones, gypsum, alluvial gravels, and in some parts of the state, igneous rocks.

The nine major aquifers include the Carrizo-Wilcox aquifer, the Pecos Valley aquifer, the Edwards - Balcones Fault Zone aquifer, the Edwards-Trinity (Plateau) aquifer, the Gulf Coast aquifer, the Hueco-Mesilla Bolson, the Ogallala aquifer, the Seymour aquifer, and the Trinity aquifer. (Fig. 1)

The twenty-one minor aquifers that have been delineated within the state include the Blaine aquifer, the Blossom aquifer, the Bone Spring/Victorio Peak aquifer, the Brazos River Alluvium, the Capitan Reef Complex, the Dockum aquifer, the Ellenburger-San Saba aquifer, the Edwards-Trinity (High-Plains) aquifer, the Hickory aquifer, a group of igneous rocks in West Texas referred to as simply "Igneous", the Lipan aquifer, the Marble Falls aquifer, the Marathon aquifer, the Nacatoch aquifer, the Queen-City aquifer, the Rita Blanca aquifer, the Rustler aquifer, the Sparta aquifer, the West Texas Bolsons, the Woodbine aquifer, and the Yegua-Jackson aquifer. (Fig. 2)

Together, these major and minor aquifers underlie approximately 76 percent of the state's surface area of 267,338 square miles (TWDB, 1995). Other undifferentiated, local aquifers may represent the only source of groundwater where major or minor aquifers are absent. These local aquifers, which provide groundwater that is used for all purposes, vary in extent from very small to several hundred square miles (TWC, 1989).

Groundwater quality of these smaller groundwater sources is not directly addressed in this report, as they are too small and numerous to be characterized within the scope of this document.

Figure 1. Major Aquifers of Texas

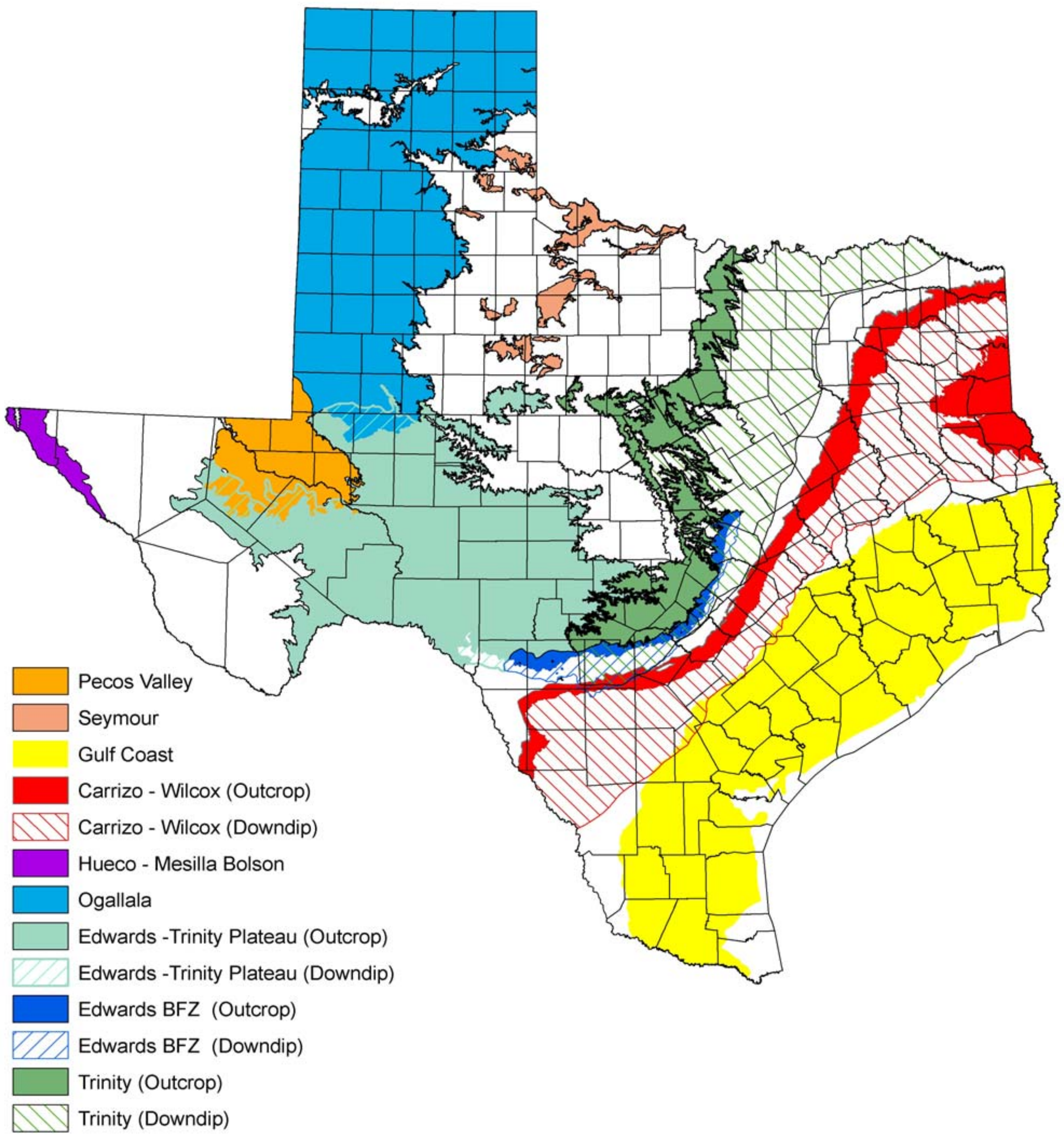
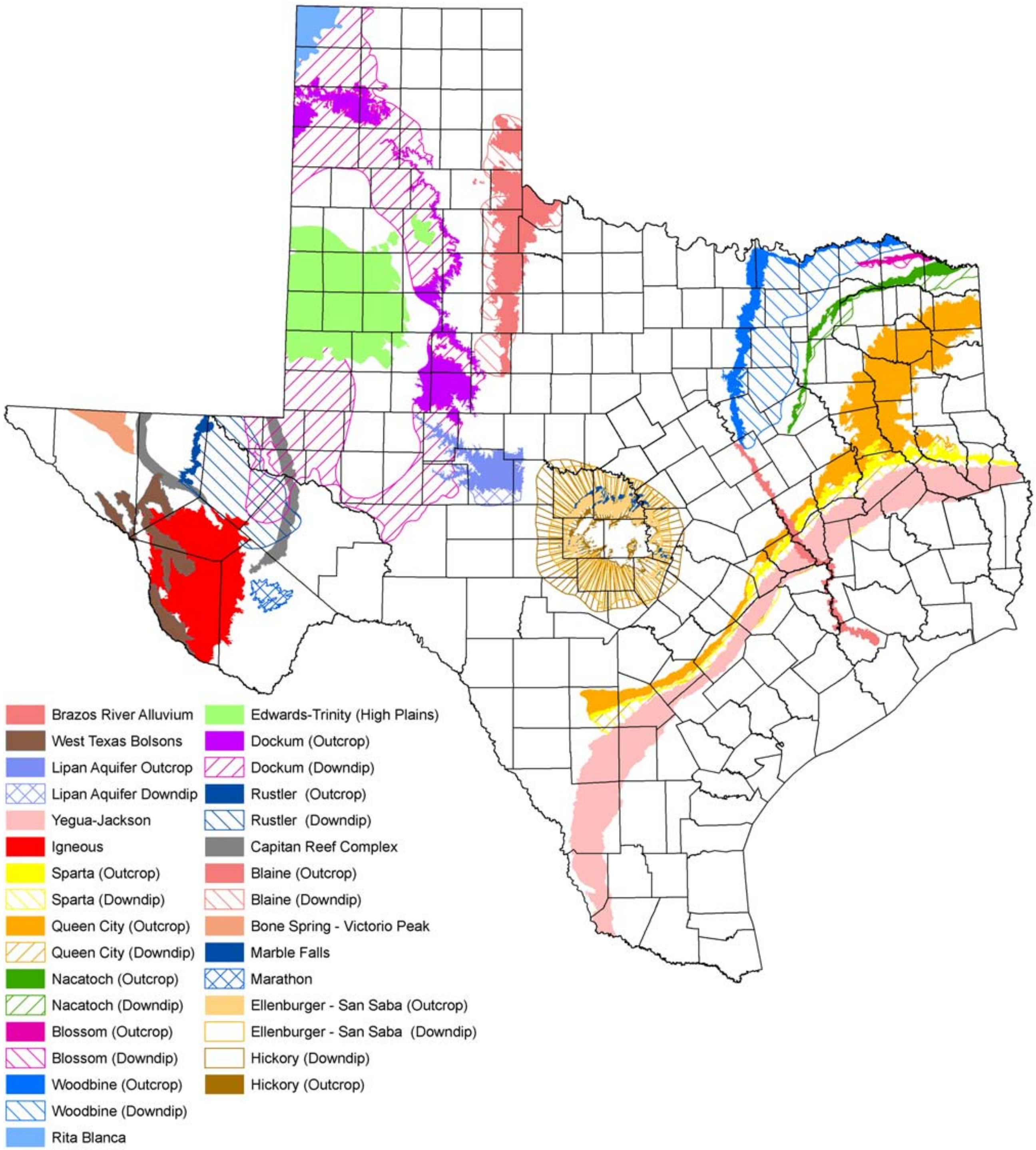


Figure 2. Minor Aquifers of Texas



About 79 percent of the groundwater used in 2003 was for irrigation, with the remainder being used for municipal supplies, rural and municipal domestic consumption, rural livestock, electric utility, and industry. Approximately 36 percent of municipal water is obtained from groundwater sources. Groundwater also provides a significant amount of the base flow for the state's rivers and streams, and is, therefore, of key importance to the maintenance of the state's environment and economy.

GROUNDWATER PROTECTION

Texas Groundwater Protection Committee

The Texas Groundwater Protection Committee was created by the 71st Texas Legislature in 1989 as a means to bridge gaps between existing state groundwater programs and to optimize water-quality protection by improving coordination among agencies involved in groundwater activities. state law codified in §§26.401 through 26.408 TWC established the TGPC; outlined the TGPC's powers, duties, and responsibilities; and established the state's groundwater protection policy.

The TGPC actively identifies opportunities to improve existing groundwater quality programs and promotes coordination between agencies. The TGPC also strives to improve or identify areas where new or existing programs could be enhanced to provide added protection. Major responsibilities of the TGPC are to:

- improve interagency coordination in the area of groundwater protection;
- develop and update a comprehensive groundwater protection strategy for the state;
- study and recommend to the Legislature groundwater protection programs for areas in which groundwater is not protected by current regulation;
- publish an interagency groundwater monitoring and contamination report;
- file with the governor, lieutenant governor, and speaker of the House of Representatives a report of the TGPC's activities during the biennium preceding each regular legislative session, including any recommendations for legislation for groundwater protection;
- advise the TCEQ on the development of agricultural chemical plans to prevent groundwater pollution; and
- develop the form and content of notices of groundwater contamination.

The TGPC's membership is composed of the following individuals or their designated representative:

- the executive director of the TCEQ;
- the executive administrator of the TWDB;
- the executive director of the Railroad Commission of Texas;
- the commissioner of Department of State Health Services;
- the deputy commissioner of the Department of Agriculture;
- the executive director of the Texas State Soil and Water Conservation Board;
- a representative selected by the Texas Alliance of Groundwater Districts;
- the director of the Texas AgriLife Research;
- the director of the Bureau of Economic Geology, University of Texas at Austin; and

- a representative of the Water Well Drillers and Water Well Pump Installers Program of the Texas Department of Licensing and Regulation selected by the executive director of the department.

The executive director of the TCEQ serves as the TGPC's chairman. The TCEQ is designated as the lead agency for the TGPC and administers the activities of the TGPC. The executive administrator of the TWDB.

The TGPC actively coordinates with federal agencies on groundwater protection issues that affect the state. The TGPC has worked with federal agencies on issues related to a comprehensive state groundwater protection program and the development of pesticide management plans for the prevention of groundwater contamination. In addition, the TGPC has regularly provided national level input to federal agencies on groundwater protection and program issues through the Ground Water Protection Council (an association of state groundwater and underground injection control program directors) and the State FIFRA Issues Research Evaluation Group (a group formed by state agricultural regulatory officials and EPA to discuss and evaluate pesticide matters affecting states), and other state and federal stakeholder and regulatory guidance groups.

The TGPC also works closely with the U.S. Geological Survey (USGS), the federal agency with responsibilities that include national level geologic mapping and hydrologic studies. Staff of the USGS has participated in various TGPC-sponsored projects, providing groundwater expertise and opportunities for state input in federally-sponsored research.

Descriptions of Groundwater Protection Programs

The groundwater protection programs of TGPC member agencies and organizations are described in this section. Detail summary of state groundwater protection programs are also referenced in Table 1.

Texas Commission on Environmental Quality

The TCEQ conducts regulatory groundwater protection programs that focus on both the prevention of contamination and the identification, assessment, and remediation of existing problems. The TCEQ implements these programs through education, voluntary action assistance, permitting, and enforcement. As the state lead agency for water quality protection, the TCEQ administers both state and federally mandated programs. Federal programs administered by the TCEQ include the Resource Conservation and Recovery Act (RCRA); the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA); the Clean Water Act (CWA); the Safe Drinking Water Act (SDWA); and the development of state management plans for prevention of pesticide contamination of groundwater under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).

TCEQ is responsible for:

- permitting facilities that store, process, and/or dispose of hazardous and nonhazardous industrial waste, and municipal solid waste and dispose of radioactive materials;

- overseeing the investigation and cleanup of hazardous waste and pollutants released into the environment, including the regulatory programs governing petroleum storage tanks (PSTs), hazardous and nonhazardous industrial waste sites, voluntary cleanups, innocent owner/operator certification, state brownfields initiatives, and Superfund activities;
- collecting and processing waste management data at both the state and national levels;
- the implementation of surface water quality management programs, the development and implementation of water quality standards, and permitting concentrated animal feeding operations, municipal and industrial wastewater treatment facilities, sludge disposal sites, and storm water run-off;
- providing technical support to promote effective and coordinated management of water resources in the state;
- field investigation of contamination complaints and the inspection of permitted and non-permitted facilities;
- the Edwards Aquifer Protection program, protecting the state's only Sole Source Aquifer;
- professional licensing and the on-site wastewater program; and
- ensuring that groundwater resources are protected during enforcement activities related to municipal solid waste, hazardous, and nonhazardous waste, petroleum storage tanks, agricultural and watershed management, water utilities, and public water supply programs.

Texas Water Development Board

The TWDB conducts an active groundwater resource assessment program. TWDB personnel have identified boundaries and various characteristics for all of the state's major and minor aquifers including water availability, recharge, and other geologic information. In addition, TWDB has identified the major entities using groundwater within each river basin, the aquifer(s) from which they pump, the quality of water being developed, and the quantity of water needed for a 50-year planning period. To accomplish this, TWDB collects data on the occurrence, availability, quality, and quantity of groundwater present and the current and projected demands on groundwater resources. The statewide groundwater level measurement program, groundwater quality sampling program, and groundwater studies are vital to the state's regional water planning efforts.

The purpose of the groundwater quality sampling program is to collect data to: 1) monitor changes, if any, in the quality of groundwater over time and 2) establish, as accurately as possible, the baseline quality of groundwater occurring naturally in the state's aquifers. TWDB conducts the groundwater quality monitoring program in accordance with procedures established in its Field Manual for Ground Water Sampling and by obtaining data collected by other entities also following these and similar procedures, such as groundwater conservation districts, the U.S. Geological Survey, and other state and federal agencies.

TWDB personnel process and store collected data by state well number in the TWDB groundwater database, including indicators of sample reliability, collecting entity, and analytical laboratory along with sample results. Because personnel identify wells with latitude and longitude, geographical information systems can spatially present water-quality data throughout the state. On occasion, the groundwater resource assessment program allows eligible entities to purchase water-quality lab equipment through agricultural conservation grants funded by the TWDB. Selected constituents reported by grant recipients are also included in the database.

Railroad Commission of Texas

The Railroad Commission of Texas (RCT) regulates the disposal of oil and gas wastes by injection (Statewide Rule 9), the injection of fluid for enhanced oil recovery (Statewide Rule 46), and the underground storage of hydrocarbons (Statewide Rules 95, 96, and 97). The RCT's Underground Injection Control Program for these categories of wells (Class II) is administered under authority issued by EPA under the Safe Drinking Water Act. The focus of the program is the protection of underground sources of drinking water.

Brine mining injection wells (Class III) are typical of solution mining wells. The RCT Class III Brine Mining Injection Well Program was approved on March 29, 2004. Since then, all active brine mining facilities were re-permitted per the provisions of Statewide Rule 81. A majority of brine mining facilities are required to monitor groundwater quality and submit groundwater-monitoring reports. Groundwater monitoring is not conducted at facilities where usable quality groundwater is not present, typically located on salt domes along the Gulf Coast.

Through the Statewide Rule 8 Water Protection Program, the RCT regulates the surface storage and disposal of oil and gas wastes and brine retention facilities associated with brine mining and underground hydrocarbon storage. Rule 8 requires permits for pits and disposal methods that are not specifically authorized by the rule. Many of the pit permits require liners and leak detection systems. Rule 8 permits may also contain groundwater monitoring requirements in certain circumstances.

The RCT also responds to citizen complaints regarding alleged groundwater contamination or alleged unauthorized activities that may endanger groundwater. RCT response may include investigation and sampling by the appropriate district office.

The Surface Mining and Reclamation Division (SMRD) of the RCT is authorized to enforce state laws and regulations consistent with the Texas Surface Coal Mining and Reclamation Act (Vernon's Texas Codes Annotated, Ch. 134, Texas Natural Resources Code) and the Texas Uranium Surface Mining and Reclamation Act (----, Ch. 131).

As part of the groundwater information required in the regulations, determination of the quality of subsurface water includes the analysis of common inorganic groundwater constituents plus certain trace metals. Monitoring plans for pre-mining, mining, and post-mining conditions are required, normally on a three-month basis, in order to track variations in water-quality parameters.

Monitoring by the RCT is generally conducted only during investigations for some specific reason, such as water-quality complaints. The RCT no longer maintains a laboratory, and chemical and physical analysis of samples collected by enforcement personnel are sent to a commercial laboratory under contract with the SMRD. Typically between 5 and 15 water-quality and quantity complaints are investigated annually by RCT field personnel. To date, investigations have not borne out any confirmed contamination cases.

Department of State Health Services

The Department of State Health Services (DSHS), formerly the Texas Department of Health, has limited involvement in groundwater protection, although it does provide services that are related to groundwater safety and public health concerns.

With regard to groundwater issues, the Community Hygiene Group in the Division of Regulatory Services acts primarily in a non-regulatory manner and serves in an advisory or public service role. If and when public health is impacted by groundwater contamination, the agency's response would focus on providing advice and assistance to the population affected. Since DSHS involvement in groundwater issues is primarily advisory, the agency assists in determining the problem and providing help to the affected public. Regulatory aspects and remediation requirements would, however, be the responsibility of other state and federal agencies, as appropriate.

Although there are no direct programs that relate to groundwater protection, DSHS does have programs that indirectly provide protection to the state's water resources. Under the Regulatory Licensing Unit, the Chemical Reporting Group administers and enforces Tier II reporting of hazardous substances and the Community Hygiene Group under the Inspections Unit enforces rules on Polychlorinated Biphenyls (PCBs) on behalf of the federal government. This federally funded program regulates the control and inventory of PCBs and enforces the cleanup of spills that sometimes involves groundwater monitoring. The Policy Standards and Quality Assurance Unit oversees programs for youth camps, childcare centers and investigates public health nuisance complaints.

The DSHS Laboratory Services Section performs chemical and microbiological analyses for any program at DSHS that needs water quality testing for its samples. For example, the laboratory routinely performs PCB analyses of surface and groundwater samples for the federal PCB program. The Laboratory Services Section also accepts water samples for routine microbiological analysis from the public for a fee.

DSHS offers support on an as-needed basis when issues arise regarding the potential contamination of drinking water, including drinking water that is produced from a groundwater source. In such cases, DSHS may provide analytical, toxicological and epidemiological support for the purpose of protecting the public health.

Texas Department of Agriculture

The Texas Department of Agriculture (TDA) has lead authority for pesticide regulation in Texas. The TDA recognizes certain pesticides as potential groundwater contaminants and has primary responsibility in preventing unreasonable risk to human health and the environment from the use of pesticides.

The agency conducts a variety of activities designed in part or entirely to reduce the potential of groundwater contamination by pesticides. These activities are described as follows.

Product Registration: All pesticide products sold and used in Texas must be registered with the TDA. This process ensures these products have met all EPA requirements for use.

Pesticide Label Compliance and Enforcement - The agency has responsibility and authority under the Texas Agricultural Code to enforce pesticide labels, which include use directions and precautions that directly or indirectly reduce the potential of groundwater contamination.

Pesticide Applicator Training - All prospective users of restricted-use or state-limited-use pesticides are required to obtain an applicator's license. This process includes training in the proper and legal use of pesticides, applicator testing, and continuing education.

Risk Assessment - The TDA maintains a program to assess the potential impacts of agricultural chemicals on human health and the environment, including groundwater quality. Pesticide-related water quality issues are directed by this program.

Structural Pest Control Service - Effective September 01, 2007, TDA assumed the duties of the Texas Structural Pest Control Board in the licensing and regulation of persons engaged in the business of structural pest control. The purpose of this program is to license all eligible applicators; continue to ensure technicians are licensed; ensure appropriate education standards for applicators; and ensure approved continuing education courses meet or exceed minimum standards. The program also provides education and awareness to the public concerning matters relating to pest control, with emphasis on integrated pest management (IPM) in Texas public schools. The major activities include providing education and information to the public and pest control industry through personal, written and electronic communication; as well as monitoring and inspecting public schools to ensure compliance with regulations regarding IPM, as well as monitoring compliance by pest control businesses.

Pesticide Management Plan for Prevention of Pesticide Contamination of Groundwater (PMP) - The TDA serves as co-chair of the PMP Task Force, under the authority of the Texas Groundwater Protection Committee, which is charged with developing the generic and pesticide-specific PMPs for Texas. These activities are conducted to ensure compliance with federal and state laws and regulations relating to the use of pesticides and the protection of groundwater resources. In addition, the TDA provides support and assistance in all state environmental projects where agricultural pesticides use and regulation are of concern.

Status of Groundwater Monitoring Programs - The TDA does not routinely conduct groundwater monitoring for pesticides. The agency relies on monitoring data generated by the TCEQ and TWDB to identify watersheds and pesticides of concern. In addition, monitoring data of federal, local, and private entities are also evaluated when available. At that point, the TDA may address the situation through any or all of its regulatory activities as well as coordinate preventative educational and best management efforts with other government, educational, and/or private entities. Although TDA does not routinely conduct groundwater monitoring for pesticides, the agency maintains a fully equipped laboratory located on the campus of Texas A&M University in College Station. The lab conducts pesticide residue analysis and pesticide product formulation analysis primarily to monitor product labeling, and to assist the department's efforts in enforcing pesticide laws and regulations.

Texas State Soil and Water Conservation Board

The Texas State Soil and Water Conservation Board (TSSWCB) was created in 1939 by the Texas Legislature to organize the state into soil and water conservation districts (SWCDs) and to serve as a centralized agency for communicating with other state and federal entities as well as the Texas Legislature.

Headquartered in Temple, Texas, the TSSWCB offers technical assistance to the states' 217 SWCDs and maintains regional offices in strategic locations in the state to help carry out the agency's water quality responsibilities. The TSSWCB is governed by a seven-member board composed of two Governor appointees and five landowners elected throughout Texas by more than 1,000 SWCD directors.

The TSSWCB is the lead agency for the planning, management and abatement of agricultural and silvicultural nonpoint source (NPS) pollution, and administers the Texas Brush Control Program. The TSSWCB has no statutory authority in the area of point source pollution, including misuse or accidents involving agricultural chemicals that are defined as point source pollution. The Board cooperates with the TDA and TCEQ in instances of point source agricultural chemical pollution.

The TSSWCB also works with other state and federal agencies on NPS issues as they relate to Water Quality Standards and Criteria, Total Maximum Daily Loads, and Coastal Zone Protection. The TSSWCB works to ensure SWCDs and local landowners are adequately represented in these matters that could have a significant impact on future conservation and utilization of natural resources.

The TSSWCB has authority to establish water quality management plans in areas that have developed, or have the potential to develop, agricultural or silvicultural nonpoint source water quality problems. This program provides, through local soil and water conservation districts, development, supervision and monitoring of individual water quality management plans for agricultural and silvicultural lands.

Besides their involvement in the abatement of nonpoint source pollution, the TSSWCB also helps to preserve groundwater resources with its Cost Share Program and Brush Control Program. The Cost Share Program funds up to 75 percent of the implementation costs for a Water Quality Management Plan which is developed and approved by the TSSWCB. This plan represents a commitment by the landowner to use the best management practices for their land uses available, as laid out in the plan, in order to protect their land and water resources from erosion, pesticide contamination, and over use. The Brush Control Program also protects groundwater resources by controlling invasive brush species which use large amounts of water. By controlling the brush in an area and restoring the native grasses, more water is available to recharge the aquifer below.

Texas Alliance of Groundwater Districts

The Texas Alliance of Groundwater Districts (TAGD) was formed on May 12, 1988. Its membership is restricted to groundwater conservation districts in Texas who have the powers and duties to manage groundwater as defined in Chapter 36 of the Texas Water Code. TAGD is organized exclusively for charitable, educational, or scientific purposes within the meaning of Section 501 (c) (3) of the Internal Revenue Code. As such it can accept tax exempt donations and use these donations to educate the public to the growing need for water conservation and groundwater protection.

The purpose of TAGD is to educate the public and further groundwater conservation and protection activities, and to provide a means of communication for the exchange of information between individual districts as well as the general public. The TAGD maintains contact with members of the private sector and various local, state, and federal officials and their agencies in order to obtain timely information on activities and issues relevant to groundwater districts. To date, there are 79 district members of the Texas Alliance of Groundwater Districts.

The districts are created by the Legislature or by the TCEQ with the purpose and responsibility of preserving and protecting groundwater. Groundwater districts can be created by one of four procedures: (1) special water districts can be established through action of the legislature; (2) districts can be created through a petitioning process filed with the TCEQ by property owners based on Section 36.013 of the Texas Water Code; (3) districts can be created in priority groundwater management areas through procedures initiated by the TCEQ; and (4) an alternative to create a new GCD is to add territory to an existing district, if an existing district is willing to accept the new territory. Districts are local or regional in their jurisdiction and have, for the most part, elected boards of directors. Among their legislatively granted authorities is the power to monitor groundwater quality. A number of districts also have the authority to bring civil court proceedings for injunctive relief against an entity causing groundwater contamination.

Texas AgriLife Research

AgriLife Research is the official agricultural research agency in Texas. Headquartered at Texas A&M University, AgriLife Research promotes food and fiber production that emphasizes water conservation and the protection of natural resources. AgriLife Research operates a system of 13 research centers which are located in the major land and natural resource regions of Texas. The Texas Water Resource Institute is an administrative unit of the AgriLife Research that guides internal water-related research.

Broad goals of the AgriLife Research groundwater research program are to protect, preserve, and efficiently use water resources, and to develop sustainable agricultural production systems. Groundwater programs of AgriLife Research stress the development of management strategies, technologies, and educational programs to support sustainable agriculture.

The AgriLife Research groundwater quality research focuses on reductions in chemical use; the control, fate, and transport of agricultural chemicals; and the remediation of contaminated groundwaters.

Major efforts are underway to develop strategies to manage brush species on rangelands to increase water yields and protect water quality; to manage livestock wastes from concentrated animal feeding operations to prevent water contamination; and to develop crop production technologies that produce high yields while minimizing the loss of pesticides, chemicals and nutrients into ground and surface-waters.

The following examples are of recent AgriLife Research groundwater related research activities:

- The fate and transport of atrazine in and through soils are under study in the Brazos River Basin. These soils are intensively farmed and may provide pathways for chemical transport to shallow alluvial aquifers;
- Rice water management strategies are being developed that lower pesticide needs, increase recycling and water conservation, and reduce risks of surface and groundwater contamination;
- Researchers are utilizing genetic engineering to identify genes in bacteria and fungi that have the potential to degrade groundwater contaminants;
- Research activities on animal waste management are now directed toward development of technologies to reduce phosphorus loading to soils and surface waters;
- Computer simulation models are being used to assess the impact of agricultural practices on the environment. For example, such models are now being used to identify cropping and chemical management strategies that may be appropriate for environmentally sensitive areas like the Seymour aquifer and the Texas Coastal Bend;
- Future professionals are trained through undergraduate and graduate education and research programs at Texas A&M University and other System Institutions. Many of AgriLife Research scientists at Texas A&M University in College Station also hold teaching appointments, thus providing the latest research results to students;
- AgriLife research efforts are complimented by the programs of the Texas AgriLife Extension Service. For example, AgriLife Extension specialists produce easy-to-read fact sheets and other publications for specific clientele, including agricultural producers. Other AgriLife Extension activities include field demonstrations and educational programs for youth and adults; and
- AgriLife Extension specialists are providing leadership in development of a video tape and education program on plugging abandoned wells to protect groundwater quality. Specialists are also providing technical leadership for development of pesticide-specific management plans for the state.

AgriLife Research has no regulatory monitoring authority. AgriLife Extension operates soil and water testing laboratories in College Station. The facilities provide information on potential groundwater quality problems to thousands of rural Texans. Results from the water tests are available in a database format so that water-quality trends can be identified.

Bureau of Economic Geology

The Bureau of Economic Geology (BEG), established in 1909, is a research entity of the University of Texas at Austin and functions as the state Geological Survey. The Bureau conducts basic and applied research projects, including environmental site assessment and investigations of ground-water resources and ground-water quality, in support of other state agency missions.

As part of sponsored-research projects, BEG staff measure ground-water quality and water levels in selected public and private wells. These projects cover many different parts of Texas. Most water-quality data collected in these studies consist of pH, temperature, conductivity, major and minor inorganic ions, total organic carbon, isotopes, and other constituents of interest. Data are used to interpret rates and modes of hydrologic processes and the source and movement of groundwater. Project-specific data are collected in data reports or topical reports. Periodically, the digitized data are compiled for inclusion in the TNRIS data system.

Texas Department of Licensing and Regulation

The need for identification and protection of the state's groundwater resources was recognized by the Legislature through the creation of the Water Well Drillers Board (Board) in 1965. In 1991, the 72nd Legislature expanded the Board's functions to include licensing and regulation of water well pump installers.

Senate Bill 1955 (75th Legislature, 1997) transferred the Water Well Driller Advisory Council and the Water Well Driller/Pump Installer Section from the Texas Natural Resource Conservation Commission to the Texas Department of Licensing and Regulation (TDLR) effective September 1, 1997.

The Water Well Driller/Pump Installer Section maintains communications with the Council, industry, various state agencies, and groundwater conservation districts and investigates all alleged violations of Chapters 1901 and 1902 of the Texas Occupations Code and 16 Texas Administrative Code Chapter 76 (Rules). The Section also investigates consumer complaints filed against water well drillers, pump installers, and performs compliance investigations of water, monitor, injection, and dewatering wells to insure compliance with well construction standards.

Investigations include, but are not limited to, surface completions, depth of annular cement, regulated distances from contamination sources and property lines, abandoned and deteriorated water wells, and licensing requirements. In addition, rules requiring isolation of zones containing undesirable or poor quality water are enforced to prevent commingling with and degradation of fresh water zones.

The TDLR's Water Well Driller/Pump Installer Section staff also administers the Abandoned Well Notification Program. Chapters 1901 and 1902 of the Texas

Occupations Code authorize this function. Investigations are conducted and landowners are notified that within one-hundred eighty (180) days of notification, the abandoned and/or deteriorated water well must be plugged, completed, or capped in accordance with 16 Texas Administrative Code Chapter 76 specifications.

Violations of Chapters 1901 and 1902 of the Texas Occupations Code and the Rules are enforced by the TDLR's Enforcement Division through TDLR orders requiring administrative penalties and corrective actions or referral to the Office of the Attorney General. Investigations that involve groundwater contamination are referred to the appropriate state agency with jurisdiction for the activity believed to be the cause of the contamination.

Table 1. Summary of State Groundwater Protection Programs

Programs or Activities	Check (X)	Implementation Status	Responsible State Agency
Active SARA Title III Program	X	fully established	TCEQ*
Ambient Groundwater Monitoring System	X	fully established	TWDB
Aquifer Vulnerability Assessment	X	continuing efforts	TCEQ*
Aquifer Mapping	X	fully established	TWDB
Aquifer Characterization	X	fully established	TWDB
Comprehensive Data Management System	X	under development	TGPC*
Core Comprehensive State Groundwater Protection Program (CSGWPP)	X	under development	TGPC*
Groundwater Best Management Practices	X	under development	TGPC*
Groundwater Legislative Goal	X	fully established	TCEQ*
Groundwater Classification	X	fully established	TGPC*
Groundwater Quality Standards	X	fully established	TCEQ
Interagency Coordination for Groundwater Protection Initiatives	X	fully established	TGPC*
Municipal Solid Waste Program (Subtitle D Primacy)	X	fully established	TCEQ
Nonpoint Source Controls/Agricultural & Silvicultural	X	continuing efforts	TSSWCB
Nonpoint Source Controls/All Others	X	continuing efforts	TCEQ
Pesticide State Management Plan (Generic)	X	received EPA concurrence	TGPC*
Pesticide Specific Regulation Programs	X	fully established	TDA
Pollution Prevention Program	X	fully established	All Agencies
Radioactive Waste Disposal Program	X	fully established	TCEQ
Resource Conservation and Recovery Act (RCRA) Primacy	X	fully established	TCEQ
State Hydrocarbon Exploration/Production Regulations	X	fully established	RCT
State Superfund	X	fully established	TCEQ
State Oilfield Cleanup Fund	X	fully established	RCT
State Petroleum Storage Tank Remediation Fund	X	fully established	TCEQ
State RCRA Program incorporating more stringent requirements than RCRA Primacy		not applicable	
State Septic System Regulations	X	fully established	TCEQ*
Surface Mining and Reclamation Regulations	X	fully established	RCT
Underground Storage Tank Installation Requirements	X	fully established	TCEQ

Summary of State Groundwater Protection Programs (cont.)

Programs or Activities	Check (X)	Implementation Status	Responsible State Agency
Underground Storage Tank Registration Program	X	fully established	TCEQ
Underground Injection Control Program/Industrial	X	fully established	TCEQ
Underground Injection Control Program/Oil & Gas	X	fully established	RCT
Vulnerability Assessment for Drinking Water/ Source Water Protection	X	fully established	TCEQ
Wellhead Protection Program (EPA-approved)	X	fully established	TCEQ
Wastewater Permits	X	fully established	TCEQ
Water Well Abandonment Regulations	X	fully established	TDLR
Water Well Installation Regulations	X	fully established	TDLR

NOTES:
TCEQ - Texas Commission on Environmental Quality
TGPC - Texas Groundwater Protection Committee
TDA - Texas Department of Agriculture
TDLR - Texas Department of Licensing and Regulation
TWDB - Texas Water Development Board
TSSWCB - Texas State Soil and Water Conservation Board
RCT - Railroad Commission of Texas

* Indicates responsibility for the program falls to more than one state agency.

GROUNDWATER PROTECTION POLICY

Section 26.401 TWC establishes the state's groundwater protection policy. The policy sets out nondegradation of the state's groundwater resources as the goal for all state programs. The policy recognizes the variability of the state's aquifers, the importance of maintaining water quality for existing and potential uses, the protection of the environment and the public health and welfare, and the maintenance and enhancement of the long-term economic health of the state. Further, the policy recognizes that groundwater contamination may result from many sources, including current and past oil and gas production and related practices, agricultural activities, industrial and manufacturing processes, commercial and business endeavors, domestic activities, and natural sources that may be influenced by, or may result from, human activities. The use of the best professional judgment by the responsible state agencies in attaining the goal and policy is also recognized.

The policy states that discharges of pollutants, disposal of wastes, and other regulated activities be conducted in a manner that will maintain present uses and not impair potential uses of groundwater or pose a public health hazard. The programs of the various state agencies are generally coordinated to attain this goal.

The state's policy on groundwater contamination is that the quality should be restored if feasible. Recognizing that in some cases it may not be technically possible or cost-effective to clean groundwater to its original quality, the TGPC recommends an approach that focuses on protection of groundwater for its highest quality use related to human health and the environment, while addressing the costs of available remediation technologies.

Groundwater Classification System

The TGPC and its member agencies recognize that groundwater classification is an important tool to be used in the implementation of the state's groundwater protection policy. Through classification, the groundwater in the state can be categorized and protection or restoration measures can then be specified by member agencies according to the quality and present or potential use of the groundwater.

The TGPC has developed a Groundwater Classification System for use by state agencies. Four groundwater classes are defined based on quality as determined by total dissolved solids (TDS) content. The names and concentration ranges are based on traditional nomenclature associated with each class. Fresh groundwater is classified as having a TDS concentration range from zero to 1,000 milligrams per liter (mg/L); slightly saline groundwater, a TDS concentration range from 1,000 to 3,000 mg/L; moderately saline groundwater, a TDS concentration range from 3,000 to 10,000 mg/L; and very saline groundwater to brine, a TDS concentration greater than 10,000 mg/L. Quality also determines usability; however, it is implicit in the classification that a water-bearing zone must be able to produce sufficient quantities of water to meet its intended use.

The Groundwater Classification System is applicable to all groundwater in the state. In assigning a classification, the member agencies attempt to use the natural quality of the groundwater that is unaffected by discharges of pollutants from human activities. All usable and potentially usable groundwater is subject to the same protection provided by the state's groundwater protection policy. Starting with the nondegradation goal, protection or restoration measures can be varied according to the response level set by the classification so long as the following conditions are met:

- Current groundwater uses are not impaired;
- Potential groundwater uses are not impaired;
- A public health hazard is not created; and
- The quality of groundwater is restored if feasible.

In determining protection or restoration measures, an agency considers all present or potential beneficial uses of groundwater of a given quality. Generally, drinking water for human consumption would require the highest degree of groundwater protection or restoration. Protection for this use will also be protective of all other current or potential uses. These considerations facilitated defining two response levels for purposes of assigning protection or restoration measures that are commensurate with the potential to impact human health and the environment.

- Level I response for the fresh, slightly saline and moderately saline classes should be based on the current or potential use as a human drinking water supply.
- Level II response for the very saline to brine class should be based on indirect exposure (i.e., by means other than drinking) or no human consumption.

In specifying a protection or restoration measure, member agencies should apply best professional judgment on a case-by-case basis. Evaluations to be made include, but are not limited to, such factors as productivity, the availability of alternate sources of water, background concentrations of naturally occurring constituents, the effects of constituents on usability, traditional and potential beneficial uses of the water, economic and technical feasibility of treatment, and projected needs for and types of impacts on these groundwaters.

The classification system is intended to be implemented by member agencies as an integral part of their groundwater protection programs. In addition to its response-setting function, the classification system fosters consistency among the various programs.

State Groundwater Protection Strategy

In evaluating the states' activities under the groundwater protection strategy initiative begun in the early 1980s, the EPA concluded that additional efforts were needed to protect the nation's groundwater, and that groundwater protection programs were a patchwork of federal, state, and local efforts that focus on individual sources of contamination rather than protection of the resource as a whole. During fiscal years 1992 and 1993, the EPA published draft guidance for the development of comprehensive state groundwater protection programs (CSGWPP). The CSGWPP guidance encourages the states to further their efforts in developing existing programs into a more comprehensive approach. The final guidance was published early in 1993.

The TGPC is charged with developing a comprehensive strategy that coordinates the activities of all the participating agencies and documents what needs to be done to protect groundwater in the State of Texas. The Committee addressed this duty directly in 1988 through the formal publication of the *Texas Ground Water Protection Strategy*. Since that time, there have been several efforts to describe changes to the groundwater protection programs and authorities of state agencies with respect to groundwater, in the *Texas Ground Water Protection Profiles*, 1991, and later in the various editions of the annual *Joint Groundwater Monitoring and Contamination Report*. There have been many changes in agencies and the programs that they administer since 1988. The more recent publications have focused on the water quality aspects of various programs rather than the state strategy for groundwater protection.

Recognizing the changes that have occurred since the state's first groundwater protection strategy was developed, the TGPC decided in January 2001 to begin the process to update it. That process resulted in the document, *Texas Groundwater Protection Strategy*, TCEQ Publication No. AS-188, February 2003. The new *Strategy* is providing a road map for the current activities of the TGPC. The *Strategy* is divided into thematic sections designed to highlight the state's current protection efforts, and importantly, identify any gaps that may need to be filled among those programs.

The *Strategy*:

- details the state's groundwater protection goal as established by the Legislature;
- explains the statewide groundwater classification system and how the state identifies contamination and quantity issues;
- describes the roles and responsibilities of the various state agencies involved in groundwater protection and discusses the TGPC as a coordinating mechanism;
- provides examples of how the various state agencies implement groundwater protection programs through regulatory and non-regulatory models;
- explains how the local, state, and federal agencies coordinate management of groundwater data for the enhancement of groundwater protection;
- discusses the role that research plays in understanding groundwater's importance and the importance of coordinating research efforts;
- provides an overview of the groundwater public education efforts in the state;
- discusses public participation in establishing and implementing groundwater policy;
- lays out a planning process for updating the groundwater strategy;
- proposes for inclusion in the next Strategy an identification and raking of significant threats to the state's groundwater resource, consideration of the vulnerability of groundwater resources, and a prioritization of actions to address those threats; and
- provides recommendations and possible actions to protect groundwater.

AMBIENT GROUNDWATER MONITORING

As noted previously, the TWDB collects data on the state's aquifers which include the occurrence, availability, quality, and quantity of groundwater present and the current and projected demands on groundwater resources. This is done through the statewide groundwater level measurement program, groundwater quality sampling program, and groundwater studies.

Status of Groundwater Monitoring Programs. The TWDB sampled approximately 569 sites (wells and springs) in 2006. TWDB’s collection of these samples and analysis of additional samples from cooperative entities comprise the ambient groundwater quality sampling program. As cooperators continue to send in data, the actual number of analytical results obtained from sites sampled in 2006 will be greater. TWDB enters water-quality data collected under this program in its groundwater database, scans accompanying images for an image-file database, available on the TWDB’s Water, Information, Integration, and Dissemination internet-based mapping application (http://wiid.twdb.state.tx.us/ims/wwm_drl/viewer.htm), and files them in their Located Well Data file room. The sites have accurate latitude and longitude data for use with geographic information systems.

The TGPC relies upon ambient monitoring data available from the TWDB for state groundwater quality information. The TWDB maintains a database of ambient groundwater monitoring data for the state from over 51,000 water wells, and performs ambient groundwater monitoring on water wells in a particular number of Texas aquifers each year, so that all major and minor aquifers of the state are monitored approximately every five years. The TGPC’s groundwater quality inventory efforts correspond to the TWDB’s monitoring schedule. Ambient monitoring groundwater quality data for all major and minor aquifers used in this report are tabulated in Table 2. The TWDB has published detailed reports of some of its collected groundwater quality data in Hydrologic Atlases of certain individual aquifers (Ashworth, 1991; Payne, 1991; Hopkins, 1995; Hopkins, 1996a; Biri, 1996; Brown; 1996; Hopkins 1996b; Brown; 1997; and Brown; 1998).

Table 2. Ambient Monitoring Groundwater Quality Data
All Major and Minor Aquifers (1998 - 2007)

Parameter Groups	Maximum Contamination Limit (MCL[2])	Number of Wells			
		Total Wells Sampled	< MDL[1]	< MCL1 (other than <MDL[2])	≥MCL1
Primary Constituents (dissolved phase unless noted)					
Arsenic	10 µg/l	5069	3097	1548	424
Barium	2 mg/l	5120	571	4547	2
Cadmium	5 µg/l	5065	4988	77	0
Chromium	100 µg/l	5078	2459	2617	2
Fluoride[3]	4 mg/l	5578	174	5166	238
Mercury	2 µg/l	103	102	1	0
Nitrate (N)	10 mg/l	5647	1719	2316	1612
Selenium	50 µg/l	5081	3389	1605	87
Secondary Constituents (dissolved phase unless noted)					
Chloride	300 mg/l	5591	5	4794	792
Copper	1 mg/l	5080	2430	2649	1
Fluoride[3]	2 mg/l	5635	87	4387	1
Iron	0.3 mg/l	5169	3365	1170	634
Manganese	50 µg/l	5087	2069	2419	599
Sulfate	300 mg/l	5639	214	4564	861
Dissolved Solids	1000 mg/l	5636	0	4513	1123
Zinc	5 mg/l	5090	1449	3639	2
Radioactivity					
Gross Alpha	15 pCi/l	1133	0	1005	128

Notes:
1. MDL = Method Detection Limit. The MDL is the lowest analysis value available for a particular constituent analysis at a particular sampling event. The MDL is determined by the analyzing laboratory.
2. MCL = Maximum Contamination Level. The MCL of a particular constituent is the maximum analysis level for safe drinking water. MDL's for certain constituents at certain sampling events were greater than the MCL's, and analyses from those events were not utilized when counting samples less than or greater than particular MCL's.
3. Fluoride has a health based MCL as a primary drinking water standard, and a aesthetic based MCL as a secondary MCL.

REGULATORY MONITORING/GROUNDWATER CONTAMINATION

The groundwater monitoring programs of the participating agencies generally fall within one of three categories:

- regulatory agencies requiring or conducting monitoring to assure compliance with guidelines and regulations for the protection of groundwater from discharges of contaminants;
- agencies or entities conducting monitoring to assess ambient or existing groundwater quality conditions and to track changes in water quality over time; and
- agencies or entities conducting research activities related to groundwater resources and groundwater conservation.

Each regulatory agency which requires or conducts groundwater monitoring to assure compliance with guidelines and regulations to protect groundwater from discharges of contaminants has its own monitoring program requirements and procedures. Criteria used to assess the need for groundwater monitoring vary among the regulatory entities. Major sources of documented or potential groundwater contamination are tabulated in Table 3.

Data indicate that an estimated 52,455 monitor and water wells are being used for groundwater monitoring purposes at regulated facilities statewide in 2006. The majority of the facilities being monitored (approximately 99 percent) are under the jurisdiction of the TCEQ, with the remainder under the jurisdiction of the RCT, TAGD, and DSHS.

The TWDB and the member districts of the TAGD conduct groundwater monitoring to assess ambient groundwater quality conditions through the assessment of particular constituents to track changes in water quality over time. Monitoring program activities reported by the TWDB and participating organizations involved over 569 water wells in 2006.

Additionally, some monitoring programs are developed for water-quality assessment studies that target specific geographic areas, specific contaminants or constituents, or specific activities. Contamination cases discovered by these agencies or entities through groundwater studies or groundwater sampling programs are referred to the regulatory agency with appropriate jurisdiction.

The ambient groundwater monitoring network has historic limitations for the parameters that have been analyzed. There are very few historical analyses available for constituents that can generally be attributed to anthropogenic (man-induced) sources.

For example, there are limited analyses available for constituents such as volatile and synthetic organic compounds and certain heavy metals. Ambient monitoring has not traditionally targeted pesticides. Drinking water analyses conducted under the Safe Drinking Water Act (SDWA) include some pesticides in their suite of chemicals, however, this program targets “finished” water, not groundwater specifically. Analyses conducted under the United States Geological Survey (USGS) National Water Quality Assessment (NWQA) program also include pesticides in a wide range of constituents. TCEQ, TWDB, and members of TAGD have recently begun a cooperative program where ambient groundwater samples collected by TWDB and Groundwater Conservation District staff are analyzed by TCEQ staff for Atrazine and Metolachlor.

Table 3. Ten Major Sources of Documented/Potential Groundwater Contamination

Contaminant Source	Factors Considered in Selecting a Contaminant Source [1]	Contaminants [2]
Storage, Treatment, and Disposal Activities		
Storage tanks (underground)	A, B, C, D	D, C
Storage tanks (above ground)	A, B, C, D	D, C
Surface impoundments	A, F, D, C, G	D, G, H, A, B
Landfills	A, F, D, E, G	C, G, A, B, H
Septic systems	F, B, C, D, E, G	E, B, A
Agricultural Activities		
Unknown/not quantified	A, F, C, D, E, G	E, A, B
Other		
Abandoned wells	A, F, C, D, E, G	NA
Oil & Gas activities	F, C, D, E, G	D, G
Grandfathered sites/past practices	A, F, D, E, G	D, E, G, H, A, B
Natural sources	F, E, G, I	G, F, E, H

1. Factors Considered for Selection
   - A. Documented from mandatory reporting
   - B. Size of population at risk
   - C. Location of the sources relative to drinking water sources
   - D. Number and/or size of contaminant sources
   - E. Hydrogeologic sensitivity
   - F. Potential from state and other findings
   - G. Geographic distribution/occurrence
   - H. Human health and/or environmental risk (toxicity)
   - I. Other criteria (described in narrative)

2. Contaminants
   - A. Inorganic compounds
   - B. Organic compounds
   - C. Halogenated solvents
   - D. Petroleum compounds
   - E. Nitrate
   - F. Fluoride
   - G. Salinity/brine
   - H. Metals

In general, the waste disposal programs — primarily the TCEQ's Office of Permitting, Remediation and Registration and the RCT — are monitoring existing, permitted facilities. Groundwater monitoring requirements have been established for the petroleum storage tank, industrial and hazardous waste, municipal waste, underground injection control, and enforcement programs. Initiatives in the municipal and industrial wastewater permitting program have required groundwater monitoring at facilities where activities pose a higher risk to groundwater quality. Additionally, permits required for surface storage and disposal of oil and gas waste and brine retention ensure the protection of groundwater by requiring pond liners, leak detection systems, groundwater monitoring, or a combination of these methods.

In the drinking water program, public water supply wells are also regulated by the TCEQ's Office of Permitting, Remediation and Registration. Public water systems receive sufficient monitoring to ensure that violations of drinking water standards are detected and addressed before water is distributed to consumers.

Currently, there is no state program for monitoring domestic wells, though some groundwater conservation districts do have programs that routinely monitor private water wells for ambient conditions or suspected contamination. The TDLR is responsible for oversight of licensed water well drillers, responding to complaints, and routinely checking compliance with TDLR rules.

Table 4. Statewide Documented Groundwater Contamination Cases by Agency/Activity Status, 2006

Agency/Division	Total Cases (2006)[1]	New Cases (2006)[2]	Activity Status Code[3]							
			0	1	2	3	4	5	6	None
Texas Commission on Environmental Quality										
/Remediation Division - Corrective Action Program	569	53	5	21	219	76	78	191	21	1
/Remediation Division - Dry Cleaners Remediation	68	26	0	1	94	0	0	1	0	0
/Remediation Division - Petroleum Storage Tanks Program	3,465	255	0	810	1,511	0	439	0	705	0
/Remediation Division - Superfund Cleanup Program	69	8`	0	8	52	34	24	108	7	0
/Remediation Division - Superfund Site Discovery & Assessment	16	5	1	2	6	0	0	0	1	0
/Remediation Division - Voluntary Cleanup Program	708	82	107	104	236	49	85	84	44	0
/Remediation Division -Voluntary Cleanup/Innocent Landowner	185	70	28	135	0	0	0	0	22	0
/Remediation Division - Voluntary Cleanup Program - Brownfields Site Assessment	8	3	4	1	2	0	0	0	1	0
/Enforcement Division	4	0	0	1	2	0	0	0	1	0
/Field Operations Division	4	3	0	0	4	0	0	0	0	0
/Water Supply Division /GW Planning and Assessment	48	0	0	3	2	0	0	0	43	0
/Water Supply Division/Public Drinking Water Section	12	11		0	0	0	0	0	11	0
/Waste Permits Division - Industrial and Hazardous Waste	6	4	0	3	1	8	0	0	0	0
/Waste Permits Division - Municipal Solid Waste Section	46	3	1	1	21	0	18	17	0	0
/Water Quality Division	13	0	0	1	6	0	5	6	0	0
/Radioactive Materials Division	2	0	0	0	2	0	0	0	0	0
Subtotal	5,223	523	146	1,091	2,158	168	649	407	855	1
Railroad Commission of Texas/Oil and Gas Division	351	25	0	25	13	53	123	101	29	0
Department of State Health Services	1	0	0	0	0	0	0	0	0	0
Texas Alliance of Groundwater Districts	1	0	1	0	0	0	0	0	0	0
Total	5,576	548	292	1,116	2,172	221	773	508	884	1

Notes: 1. Total number of groundwater contamination cases documented or under enforcement during calender year 2004.
2. Number of new cases documented or under enforcement during calender year 2004.
3. Activity Status Codes: 0—No Activity; 1—Contamination Confirmed; 2—Ongoing Investigation; 3—Corrective Action Planning; 4—Corrective Action Implementation; 5—Monitoring Action; 6—Action Completed Facilities may have more than one Activity Status Code.

Table 5. Groundwater Contamination Summary / Selected Major and Minor Aquifers Outcrops (2006)

Source Type	Documented Groundwater Contamination Present in Reporting Area	Number of Sites With Confirmed Groundwater Contamination	Site Activity Status						Contaminants
			Contamination Confirmation	**Ongoing Investigation**	**Corrective Action Planning**	**Corrective Action Implemented**	**Monitoring of Corrective Action**	**Action Completed**	
NPL	Yes	50	4	12	6	3	26	1	VOCs, chromium benzene, TCE, high explosives,
CERCLIS (non-NPL)	Yes	14	3	5		1		7	
DOD/DOE	Yes	9		4	1	1	4		benzene, TCE, high explosives, chromium
LUST*	Yes	2,194	311	1,074	19	374		434	gasoline, diesel, waste oil, jet fuel, BTEX, TPH
RCRA Corrective Action	Yes	372	12	145	77	108	134	11	VOCs, BTEX, TPH, chromium, lead
Underground Injection	No								
State Sites*	Yes	46	2	14	5	6	6	10	
Nonpoint Sources	Yes	35	1					34	pesticides, nitrate, arsenic
Oil/Gas Activities	Yes	351†	24	14	53	125	108	28	VOCs, NaCl, crude oil, natural gas, HCL, sulfates, chromium
Totals		3,071	357	1268	161	617	278	525	

NPL - National Priority List
DOE - Department of Energy
LUST - Leaking Underground Storage Tanks
CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOD - Department of Defense
RCRA - Resource Conservation and Recovery Act

*These sites may be combined with NPL and RCRA sites
† Site Activity Status for the entire state

GROUNDWATER ASSESSMENT

The methodology and limitations of this groundwater assessment are provided in this section.

Methodology Used in the Preparation of this Report

The TGPC member agencies provide data for the TGPC's groundwater quality inventorying efforts. In 1996, the TGPC, through the partnership of two of its member agencies, the TCEQ and the TWDB, began this process by performing an inventory of the groundwater quality of one major, one minor, and two of Texas' local aquifer systems. This information was published in the TCEQ's State of Texas Water Quality Inventory 1996, addressing both surface water and groundwater quality (TCEQ, 1996).

EPA representatives requested that the 1998 report update emphasize the spatial and graphical representation of the most recent available groundwater quality data, with maps showing examples of groundwater quality in wells located in the selected aquifers. Subsequent reports in 2000 and 2002 continued this spatial and graphical representation through all 21 minor and 9 major aquifers. Ambient nitrate concentrations for the each selected aquifer was represented with a map showing the locations of water wells sampled by the TWDB from 1994 to 1996, from 1996 to 1997, or 1998 to 2002 showing nitrate analyses exceeding EPA drinking water standards (10 mg/l).

However, this approach focused only on one constituent of concern for each of the 30 delineated aquifers in the state, and did not provide as complete a picture of the condition of the state's aquifers as is desired. Consequently, this report presents a broader range of constituents, pointing to specific aquifers and areas of the state where there may be some concerns with the quality of groundwater.

Ambient groundwater data from 1999 through 2007 was selected for use in the preparation of this report. Standard anion and cation analysis was sorted by aquifer identification number from "aquifer id" field in the database, and the data was then transferred into smaller aquifer-specific .dbf files for use in Geographic Information System (GIS) projects. The constituents available for each of the aquifers included calcium, magnesium, silica, sodium, potassium, sulfate, chloride, nitrate and total dissolved solids (TDS).

Infrequent analysis was sorted by constituent on a statewide basis, and again saved as .dbf files for use in GIS applications. The constituents available from the infrequent analysis data included arsenic, barium, boron, cadmium, chromium, copper, iron, manganese, selenium, and zinc. Radionuclides were sorted on a statewide basis from the ambient groundwater data as Gross Alpha and Gross Beta

It is important to note here that for all of the constituents of interest, the data was sorted and culled to eliminate duplicate values for any given well, giving a "snapshot" of the most current concentration values available. Concentrations illustrated in previous reports may have changed at specific sampling sites.

With each of the constituents, the GIS files were used to illustrate concentrations above an accepted regulatory value, usually a Maximum Contaminant Level as established by the U. S. Environmental Protection Agency, and a discussion of the findings follows in the Groundwater Concerns/Issues section of this report.

What percentage of wells with concentrations above the MCL constitute a "concern" for TCEQ? In this report, no specific percentage was used, rather, staff examined the data and weighed the numbers of samples, the extent of the aquifer, the demand in or use of the aquifer, and the distribution of the concentrations to give a "ranking" to the relative importance of the concentration data. GIS generated maps are included for select aquifers in the Groundwater Concerns/Issues section of this report to illustrate the spatial distribution of concentrations that have "ranked" as a higher concern.

As an example of this process, the Marathon aquifer has nitrate values exceeding the MCL in 75% of the water wells sampled. The Ogallala, on the other hand, has nitrate values that exceed the MCL in only 43% of the wells sampled. Staff has determined that the situation in the Ogallala aquifer is of greater concern than the situation in the Marathon aquifer, because only four wells were sampled in the Marathon aquifer, as opposed to 1,012 in the Ogallala. Three of the wells sampled in the Marathon showed nitrate values in excess of the MCL, while 439 wells in the Ogallala showed similar results. This, coupled with the high demand for water in the Ogallala, and the spatial distribution of the high nitrate values (being more concentrated in a specific region of the aquifer) generates greater concern for the Ogallala than for the Marathon.

Limitations

Data from the TWDB's ambient groundwater quality database contains a large amount of data collected over a span of several decades. Quantitative laboratory methods used to analyze water samples have changed over time, and even in recent years, analysis may be done by a lab, or by Hach "kits". Consequently, the data is not directly comparable without qualification.

Additionally, wells are sampled on a cycle, and there may be several intervening years between sample events. Aquifer conditions due to drought, seasonal variation or local flow directions are not considered in the sampling program. Analytical results, even if comparable by consistent lab methods, may still not be comparable over time due to cyclical variation in aquifer conditions.

This analysis is intended as a "reconnaissance" of potential problem areas for the purpose of this inventory, so variability of results from different methods of analysis is not considered, nor is cyclical variation due to aquifer conditions. Again, this report is intended to present a "snapshot" of Texas' groundwater quality conditions for each of the major and minor aquifers.

While Maximum Contaminant Levels for drinking water are based on "total" values for a constituent, the greatest amount of data available is for "dissolved" concentrations. In this report, "dissolved" concentrations were used, except for mercury, and as a general rule, "dissolved" concentrations are slightly lower than the "total" values in most instances. The tables and maps may portray a slightly better situation in terms of groundwater quality than actually exists in the field, however, they nonetheless serve to illustrate the need for concern for certain areas and constituents.

Gross Alpha values are used as an indicator for naturally occurring radioactive elements. If the value for Gross Alpha exceeds 15 pCi/l at a public drinking water system, then additional analysis is required to determine the source, generally radium or uranium. Gross Beta was shown on quality tables in the past, but this has been discontinued with this report, as Gross Beta is more of an indicator of man-made radioactive constituents, and there are only two or three sites in the state where this analysis would be considered applicable.

TCEQ was entered with the Bureau of Economic Geology, Jackson School of Geosciences, University of Texas at Austin to study nitrate loading to Texas aquifers, relate nitrate contamination to potential sources and assess the distribution of processes that mitigate nitrate contamination. The study is summarized at the end of this report. A special study on the occurrence of Arsenic in the Gulf Coast Aquifer is underway.

The lack of sophistication in the assessment methodology for this report is also a limitation. Basically, analysis of the data is an "eyeball" approach to character water quality, however, as an indicator of potential problems, and a "reconnaissance" of areas of concern, this approach is adequate, given the size of the state and the volume of data available.

Readers should bear in mind that this report is a quality inventory, and that the various limitations should restrict the conclusions that can be drawn from this data. This report may be used, however, to give guidance to researchers for future investigations to better characterize aquifer quality. Similarly, water resource planners, water suppliers and regulators could use this report to add a water quality component to their future planning efforts. Research on the occurrence and distribution of arsenic, for example are already underway to obtain more precise data on the aquifers where this constituent occur in high concentrations, and to attempt to ascertain potential sources of the constituents.

AMBIENT GROUNDWATER MONITORING TABULATED AQUIFER DATA

Table 6. Ambient Monitoring Groundwater Quality Data
Pecos Valley Aquifer (1999 - 2004)

Parameter Groups	Maximum Contamination Limit (MCL)	Number of Wells			
		Total Wells Sampled	< MDL	< MCL (other than <MDL)	≥ MCL
Primary Constituents (dissolved phase unless noted)					
Arsenic	10 µg/l	129	62	54	13
Barium	2 mg/l	129	0	129	0
Cadmium	5 µg/l	129	128	1	0
Chromium	100 µg/l	129	51	78	0
Fluoride	4 mg/l	140	0	137	3
Mercury	2 µg/l	0	0	0	0
Nitrate (N)	10 mg/l	140	20	59	61
Selenium	50 µg/l	129	49	77	3
Secondary Constituents (dissolved phase unless noted)					
Chloride	300 mg/l	140	0	69	71
Copper	1 mg/l	129	60	69	0
Fluoride	2 mg/l	140	0	105	35
Iron	0.3 mg/l	131	73	31	27
Manganese	50 µg/l	129	42	65	22
Sulfate	300 mg/l	140	0	46	94
Dissolved Solids	1000 mg/l	140	0	45	95
Zinc	5 mg/l	129	29	100	0
Radioactivity					
Gross Alpha	15 pCi/l	1	0	1	0

Notes:
1. MDL = Method Detection Limit. The MDL is the lowest analysis value available for a particular constituent analysis at a particular sampling event. The MDL is determined by the analyzing laboratory.
2. MCL = Maximum Contamination Level. The MCL of a particular constituent is the maximum analysis level for safe drinking water. MDL's for certain constituents at certain sampling events were greater than the MCL's, and analyses from those events were not utilized when counting samples less than or greater than particular MCL's.

Table 7. Ambient Monitoring Groundwater Quality Data
Edwards-Trinity (Plateau) Aquifer (1999 - 2007)

Parameter Groups	Maximum Contamination Limit (MCL)	Number of Wells			
		Total Wells Sampled	< MDL	< MCL (other than <MDL)	≥ MCL
Primary Constituents (dissolved phase unless noted)					
Arsenic	10 µg/l	664	539	114	11
Barium	2 mg/l	664	552	112	0
Cadmium	5 µg/l	662	657	5	0
Chromium	100 µg/l	665	178	487	0
Fluoride	4 mg/l	678	0	676	2
Mercury	2 µg/l	0	0	0	0
Nitrate (N)	10 mg/l	678	412	250	
Selenium	50 µg/l	664	412	250	2
Secondary Constituents (dissolved phase unless noted)					
Chloride	300 mg/l	678	2	300	76
Copper	1 mg/l	664	163	501	0
Fluoride	2 mg/l	678	0	582	96
Iron	0.3 mg/l	676	312	304	60
Manganese	50 µg/l	667	325	311	31
Sulfate	300 mg/l	678	1	491	186
Dissolved Solids	1000 mg/l	678	0	508	170
Zinc	5 mg/l	664	34	630	0
Radioactivity					
Gross Alpha	15 pCi/l	3	0	2	1

Notes:
1. MDL = Method Detection Limit. The MDL is the lowest analysis value available for a particular constituent analysis at a particular sampling event. The MDL is determined by the analyzing laboratory.
2. MCL = Maximum Contamination Level. The MCL of a particular constituent is the maximum analysis level for safe drinking water. MDL's for certain constituents at certain sampling events were greater than the MCL's, and analyses from those events were not utilized when counting samples less than or greater than particular MCL's.

Table 8. Ambient Monitoring Groundwater Quality Data
Ogallala Aquifer (1999 - 2006)

Parameter Groups	Maximum Contamination Limit (MCL)	Number of Wells			
		Total Wells Sampled	< MDL	< MCL (other than <MDL)	≥ MCL
Primary Constituents (dissolved phase unless noted)					
Arsenic	10 µg/l	1123	183	720	220
Barium	2 mg/l	1124	0	1123	1
Cadmium	5 µg/l	1123	1122	1	0
Chromium	100 µg/l	1123	361	760	2
Fluoride	4 mg/l	1465	0	1282	183
Mercury	2 µg/l	99	99	0	0
Nitrate (N)	10 mg/l	1465	10	754	701
Selenium	50 µg/l	1123	434	650	39
Secondary Constituents (dissolved phase unless noted)					
Chloride	300 mg/l	1414	0	1276	138
Copper	1 mg/l	1124	533	591	0
Fluoride	2 mg/l	1465	0	746	719
Iron	0.3 mg/l	1190	1123	56	11
Manganese	50 µg/l	1123	791	289	43
Sulfate	300 mg/l	1465	1	1285	179
Dissolved Solids	1000 mg/l	1465	0	1261	204
Zinc	5 mg/l	1123	361	762	0
Radioactivity					
Gross Alpha	15 pCi/l	134	0	128	6

Notes:

1. MDL = Method Detection Limit. The MDL is the lowest analysis value available for a particular constituent analysis at a particular sampling event. The MDL is determined by the analyzing laboratory.
2. MCL = Maximum Contamination Level. The MCL of a particular constituent is the maximum analysis level for safe drinking water. MDL's for certain constituents at certain sampling events were greater than the MCL's, and analyses from those events were not utilized when counting samples less than or greater than particular MCL's.

Table 9 . Ambient Monitoring Groundwater Quality Data
Capitan Reef Complex Aquifer (1999 - 2004)

Parameter Groups	Maximum Contamination Limit (MCL)	Number of Wells			
		Total Wells Sampled	< MDL	< MCL (other than <MDL)	≥ MCL
Primary Constituents (dissolved phase unless noted)					
Arsenic	10 µg/l	18	14	4	0
Barium	2 mg/l	18	0	18	0
Cadmium	5 µg/l	18	18	0	0
Chromium	100 µg/l	18	12	6	0
Fluoride	4 mg/l	17	0	17	0
Mercury	2 µg/l	0	0	0	0
Nitrate (N)	10 mg/l	18	8	9	1
Selenium	50 µg/l	18	9	9	0
Secondary Constituents (dissolved phase unless noted)					
Chloride	300 mg/l	19	0	13	6
Copper	1 mg/l	18	9	9	0
Fluoride	2 mg/l	17	0	12	5
Iron	0.3 mg/l	17	8	6	3
Manganese	50 µg/l	18	7	7	4
Sulfate	300 mg/l	19	0	5	14
Dissolved Solids	1000 mg/l	17	0	7	10
Zinc	5 mg/l	18	0	18	0
Radioactivity					
Gross Alpha	15 pCi/l	0	0	0	0

Notes:
1. MDL = Method Detection Limit. The MDL is the lowest analysis value available for a particular constituent analysis at a particular sampling event. The MDL is determined by the analyzing laboratory.
2. MCL = Maximum Contamination Level. The MCL of a particular constituent is the maximum analysis level for safe drinking water. MDL's for certain constituents at certain sampling events were greater than the MCL's, and analyses from those events were not utilized when counting samples less than or greater than particular MCL's.

Table 10. Ambient Monitoring Groundwater Quality Data
Ellenberger – San Saba Aquifer (2001 - 2006)

Parameter Groups	**Maximum Contamination Limit (MCL)**	**Number of Wells**			
		Total Wells Sampled	**< MDL**	**< MCL (other than <MDL)**	**≥ MCL**
Primary Constituents (dissolved phase unless noted)					
Arsenic	10 µg/l	54	49	5	0
Barium	2 mg/l	54	0	54	0
Cadmium	5 µg/l	54	0	54	0
Chromium	100 µg/l	54	34	20	0
Fluoride	4 mg/l	55	0	51	4
Mercury	2 µg/l	0	0	0	0
Nitrate (N)	10 mg/l	55	11	40	14
Selenium	50 µg/l	54	49	4	1
Secondary Constituents (dissolved phase unless noted)					
Chloride	300 mg/l	55	0	50	5
Copper	1 mg/l	54	21	33	0
Fluoride	2 mg/l	55	0	51	4
Iron	0.3 mg/l	54	41	3	10
Manganese	50 µg/l	54	31	22	1
Sulfate	300 mg/l	55	3	51	1
Dissolved Solids	1000 mg/l	55	0	49	6
Zinc	5 mg/l	54	19	35	0
Radioactivity					
Gross Alpha	15 pCi/l	51	0	42	9

Notes:
1. MDL = Method Detection Limit. The MDL is the lowest analysis value available for a particular constituent analysis at a particular sampling event. The MDL is determined by the analyzing laboratory.
2. MCL = Maximum Contamination Level. The MCL of a particular constituent is the maximum analysis level for safe drinking water. MDL's for certain constituents at certain sampling events were greater than the MCL's, and analyses from those events were not utilized when counting samples less than or greater than particular MCL's.

Table 11. Ambient Monitoring Groundwater Quality Data
Hickory Aquifer (2001 - 2006)

Parameter Groups	Maximum Contamination Limit (MCL)	Number of Wells			
		Total Wells Sampled	**< MDL**	**< MCL (other than <MDL)**	**≥ MCL**
Primary Constituents (dissolved phase unless noted)					
Arsenic	10 µg/l	63	54	8	1
Barium	2 mg/l	63	0	63	0
Cadmium	5 µg/l	63	63	0	0
Chromium	100 µg/l	63	48	15	0
Fluoride	4 mg/l	63	0	61	2
Mercury	2 µg/l	0	0	0	0
Nitrate (N)	10 mg/l	63	21	24	18
Selenium	50 µg/l	63	59	4	0
Secondary Constituents (dissolved phase unless noted)					
Chloride	300 mg/l	63	0	60	3
Copper	1 mg/l	63	26	37	0
Fluoride	2 mg/l	63	0	60	3
Iron	0.3 mg/l	63	45	8	10
Manganese	50 µg/l	63	25	32	6
Sulfate	300 mg/l	63	0	62	1
Dissolved Solids	1000 mg/l	63	0	60	3
Zinc	5 mg/l	63	14	49	0
Radioactivity					
Gross Alpha	15 pCi/l	59	0	37	22

Notes:

1. MDL = Method Detection Limit. The MDL is the lowest analysis value available for a particular constituent analysis at a particular sampling event. The MDL is determined by the analyzing laboratory.
2. MCL = Maximum Contamination Level. The MCL of a particular constituent is the maximum analysis level for safe drinking water. MDL's for certain constituents at certain sampling events were greater than the MCL's, and analyses from those events were not utilized when counting samples less than or greater than particular MCL's.

Table 12. Ambient Monitoring Groundwater Quality Data
Marble Falls Aquifer (2001 - 2004)

Parameter Groups	Maximum Contamination Limit (MCL)	Number of Wells			
		Total Wells Sampled	< MDL	< MCL (other than <MDL)	≥ MCL
Primary Constituents (dissolved phase unless noted)					
Arsenic	10 µg/l	2	2	0	0
Barium	2 mg/l	2	0	2	0
Cadmium	5 µg/l	2	2	0	0
Chromium	100 µg/l	2	2	0	0
Fluoride	4 mg/l	1	0	0	0
Mercury	2 µg/l	0	0	0	0
Nitrate (N)	10 mg/l	1	0	1	0
Selenium	50 µg/l	2	2	0	0
Secondary Constituents (dissolved phase unless noted)					
Chloride	300 mg/l	1	0	1	0
Copper	1 mg/l	2	1	1	0
Fluoride	2 mg/l	1	0	1	0
Iron	0.3 mg/l	2	2	0	0
Manganese	50 µg/l	2	2	0	0
Sulfate	300 mg/l	1	0	1	0
Dissolved Solids	1000 mg/l	1	0	1	0
Zinc	5 mg/l	2	1	1	0
Radioactivity					
Gross Alpha	15 pCi/l	2	0	2	0

Notes:

1. MDL = Method Detection Limit. The MDL is the lowest analysis value available for a particular constituent analysis at a particular sampling event. The MDL is determined by the analyzing laboratory.
2. MCL = Maximum Contamination Level. The MCL of a particular constituent is the maximum analysis level for safe drinking water. MDL's for certain constituents at certain sampling events were greater than the MCL's, and analyses from those events were not utilized when counting samples less than or greater than particular MCL's.

Table 13. Ambient Monitoring Groundwater Quality Data
Rita Blanca Aquifer (2001 - 2004)

Parameter Groups	Maximum Contamination Limit (MCL)	Number of Wells			
		Total Wells Sampled	< MDL	< MCL (other than <MDL)	≥ MCL
Primary Constituents (dissolved phase unless noted)					
Arsenic	10 µg/l	9	4	4	1
Barium	2 mg/l	9	0	9	0
Cadmium	5 µg/l	9	9	0	0
Chromium	100 µg/l	9	8	1	0
Fluoride	4 mg/l	8	0	8	0
Mercury	2 µg/l	0	0	0	0
Nitrate (N)	10 mg/l	8	1	5	2
Selenium	50 µg/l	9	8	1	0
Secondary Constituents (dissolved phase unless noted)					
Chloride	300 mg/l	8	0	8	0
Copper	1 mg/l	9	3	6	0
Fluoride	2 mg/l	8	0	8	0
Iron	0.3 mg/l	9	8	0	1
Manganese	50 µg/l	9	6	2	1
Sulfate	300 mg/l	8	0	8	0
Dissolved Solids	1000 mg/l	8	0	8	0
Zinc	5 mg/l	9	4	5	0
Radioactivity					
Gross Alpha	15 pCi/l	8	0	8	0

Notes:
1. MDL = Method Detection Limit. The MDL is the lowest analysis value available for a particular constituent analysis at a particular sampling event. The MDL is determined by the analyzing laboratory.
2. MCL = Maximum Contamination Level. The MCL of a particular constituent is the maximum analysis level for safe drinking water. MDL's for certain constituents at certain sampling events were greater than the MCL's, and analyses from those events were not utilized when counting samples less than or greater than particular MCL's.

Table 14. Ambient Monitoring Groundwater Quality Data
Rustler Aquifer (1999 - 2004)

Parameter Groups	Maximum Contamination Limit (MCL)	Number of Wells			
		Total Wells Sampled	< MDL	< MCL (other than <MDL)	≥ MCL
Primary Constituents (dissolved phase unless noted)					
Arsenic	10 µg/l	18	16	2	0
Barium	2 mg/l	18	0	18	0
Cadmium	5 µg/l	17	17	0	0
Chromium	100 µg/l	18	16	2	0
Fluoride	4 mg/l	18	0	18	0
Mercury	2 µg/l	0	0	0	0
Nitrate (N)	10 mg/l	18	9	2	7
Selenium	50 µg/l	18	11	7	0
Secondary Constituents (dissolved phase unless noted)					
Chloride	300 mg/l	18	0	13	5
Copper	1 mg/l	18	16	2	0
Fluoride	2 mg/l	18	0	7	11
Iron	0.3 mg/l	18	5	11	2
Manganese	50 µg/l	17	3	14	0
Sulfate	300 mg/l	18	0	0	18
Dissolved Solids	1000 mg/l	18	0	2	16
Zinc	5 mg/l	18	7	11	0
Radioactivity					
Gross Alpha	15 pCi/l	0	0	0	0

Notes:

1. MDL = Method Detection Limit. The MDL is the lowest analysis value available for a particular constituent analysis at a particular sampling event. The MDL is determined by the analyzing laboratory.
2. MCL = Maximum Contamination Level. The MCL of a particular constituent is the maximum analysis level for safe drinking water. MDL's for certain constituents at certain sampling events were greater than the MCL's, and analyses from those events were not utilized when counting samples less than or greater than particular MCL's.

Table 15. Ambient Monitoring Groundwater Quality Data
Gulf Coast Aquifer (1998 - 2006)

Parameter Groups	Maximum Contamination Limit (MCL)	Number of Wells			
		Total Wells Sampled	< MDL	< MCL (other than <MDL)	≥ MCL
Primary Constituents (dissolved phase unless noted)					
Arsenic	10 µg/l	828	415	282	131
Barium	2 mg/l	828	0	827	1
Cadmium	5 µg/l	828	828	0	0
Chromium	100 µg/l	825	545	280	0
Fluoride	4 mg/l	893	15	873	5
Mercury	2 µg/l	0	0	0	0
Nitrate (N)	10 mg/l	893	467	295	131
Selenium	50 µg/l	828	634	187	7
Secondary Constituents (dissolved phase unless noted)					
Chloride	300 mg/l	893	0	664	229
Copper	1 mg/l	828	470	358	0
Fluoride	2 mg/l	893	15	828	50
Iron	0.3 mg/l	831	464	236	131
Manganese	50 µg/l	828	218	412	198
Sulfate	300 mg/l	893	98	712	83
Dissolved Solids	1000 mg/l	893	0	690	203
Zinc	5 mg/l	828	264	564	0
Radioactivity					
Gross Alpha	15 pCi/l	621	0	569	52

Notes:
1. MDL = Method Detection Limit. The MDL is the lowest analysis value available for a particular constituent analysis at a particular sampling event. The MDL is determined by the analyzing laboratory.
2. MCL = Maximum Contamination Level. The MCL of a particular constituent is the maximum analysis level for safe drinking water. MDL's for certain constituents at certain sampling events were greater than the MCL's, and analyses from those events were not utilized when counting samples less than or greater than particular MCL's.

Table 16. Ambient Monitoring Groundwater Quality Data
Seymour Aquifer (1999 - 2006)

Parameter Groups	Maximum Contamination Limit (MCL)	Number of Wells			
		Total Wells Sampled	< MDL	< MCL (other than <MDL)	≥ MCL
Primary Constituents (dissolved phase unless noted)					
Arsenic	10 µg/l	91	37	52	2
Barium	2 mg/l	91	0	91	0
Cadmium	5 µg/l	91	91	0	0
Chromium	100 µg/l	91	44	47	0
Fluoride	4 mg/l	91	0	57	0
Mercury	2 µg/l	0	0	0	0
Nitrate (N)	10 mg/l	91	0	8	83
Selenium	50 µg/l	91	24	65	2
Secondary Constituents (dissolved phase unless noted)					
Chloride	300 mg/l	91	0	81	10
Copper	1 mg/l	91	2	89	0
Fluoride	2 mg/l	91	0	85	6
Iron	0.3 mg/l	91	85	5	1
Manganese	50 µg/l	91	69	20	2
Sulfate	300 mg/l	91	0	75	16
Dissolved Solids	1000 mg/l	91	0	66	25
Zinc	5 mg/l	91	14	87	0
Radioactivity					
Gross Alpha	15 pCi/l	9	0	9	0

Notes:
1. MDL = Method Detection Limit. The MDL is the lowest analysis value available for a particular constituent analysis at a particular sampling event. The MDL is determined by the analyzing laboratory.
2. MCL = Maximum Contamination Level. The MCL of a particular constituent is the maximum analysis level for safe drinking water. MDL's for certain constituents at certain sampling events were greater than the MCL's, and analyses from those events were not utilized when counting samples less than or greater than particular MCL's.

Table 17. Ambient Monitoring Groundwater Quality Data
Blaine Aquifer (2001 - 2006)

Parameter Groups	**Maximum Contamination Limit (MCL)**	**Number of Wells**			
		Total Wells Sampled	**< MDL**	**< MCL (other than <MDL)**	**≥ MCL**
Primary Constituents (dissolved phase unless noted)					
Arsenic	10 µg/l	34	21	12	1
Barium	2 mg/l	34	0	34	0
Cadmium	5 µg/l	34	33	1	0
Chromium	100 µg/l	34	24	10	0
Fluoride	4 mg/l	34	0	34	0
Mercury	2 µg/l	0	0	0	0
Nitrate (N)	10 mg/l	34	2	10	22
Selenium	50 µg/l	34	6	22	6
Secondary Constituents (dissolved phase unless noted)					
Chloride	300 mg/l	34	0	25	9
Copper	1 mg/l	34	3	31	0
Fluoride	2 mg/l	31	0	34	0
Iron	0.3 mg/l	34	21	11	2
Manganese	50 µg/l	34	10	23	1
Sulfate	300 mg/l	34	0	1	33
Dissolved Solids	1000 mg/l	34	0	1	33
Zinc	5 mg/l	34	0	34	0
Radioactivity					
Gross Alpha	15 pCi/l	8	0	8	0

Notes:

1. MDL = Method Detection Limit. The MDL is the lowest analysis value available for a particular constituent analysis at a particular sampling event. The MDL is determined by the analyzing laboratory.
2. MCL = Maximum Contamination Level. The MCL of a particular constituent is the maximum analysis level for safe drinking water. MDL's for certain constituents at certain sampling events were greater than the MCL's, and analyses from those events were not utilized when counting samples less than or greater than particular MCL's.

Table 18. Ambient Monitoring Groundwater Quality Data
Woodbine Aquifer (1999 - 2006)

Parameter Groups	Maximum Contamination Limit (MCL)	Number of Wells			
		Total Wells Sampled	< MDL	< MCL (other than <MDL)	≥ MCL
Primary Constituents (dissolved phase unless noted)					
Arsenic	10 μg/l	73	69	4	0
Barium	2 mg/l	73	3	70	0
Cadmium	5 μg/l	73	73	0	0
Chromium	100 μg/l	73	32	41	0
Fluoride	4 mg/l	73	2	68	3
Mercury	2 μg/l	0	0	0	0
Nitrate (N)	10 mg/l	73	72	1	0
Selenium	50 μg/l	73	70	3	0
Secondary Constituents (dissolved phase unless noted)					
Chloride	300 mg/l	73	0	72	1
Copper	1 mg/l	73	29	44	0
Fluoride	2 mg/l	73	2	56	15
Iron	0.3 mg/l	73	46	19	8
Manganese	50 μg/l	73	9	58	6
Sulfate	300 mg/l	73	0	57	16
Dissolved Solids	1000 mg/l	73	0	55	18
Zinc	5 mg/l	73	43	30	0
Radioactivity					
Gross Alpha	15 pCi/l	10	0	10	0

Notes:
1. MDL = Method Detection Limit. The MDL is the lowest analysis value available for a particular constituent analysis at a particular sampling event. The MDL is determined by the analyzing laboratory.
2. MCL = Maximum Contamination Level. The MCL of a particular constituent is the maximum analysis level for safe drinking water. MDL's for certain constituents at certain sampling events were greater than the MCL's, and analyses from those events were not utilized when counting samples less than or greater than particular MCL's.

Table 19. Ambient Monitoring Groundwater Quality Data
Blossom Aquifer (2000 - 2006)

Parameter Groups	Maximum Contamination Limit (MCL)	Number of Wells			
		Total Wells Sampled	< MDL	< MCL (other than <MDL)	≥ MCL
Primary Constituents (dissolved phase unless noted)					
Arsenic	10 µg/l	11	11	0	0
Barium	2 mg/l	18	0	18	0
Cadmium	5 µg/l	18	18	0	0
Chromium	100 µg/l	18	8	10	0
Fluoride	4 mg/l	18	1	17	0
Mercury	2 µg/l	0	0	0	0
Nitrate (N)	10 mg/l	18	12	4	2
Selenium	50 µg/l	18	8	10	0
Secondary Constituents (dissolved phase unless noted)					
Chloride	300 mg/l	18	0	16	2
Copper	1 mg/l	18	9	9	0
Fluoride	2 mg/l	18	1	17	0
Iron	0.3 mg/l	18	12	4	2
Manganese	50 µg/l	18	1	14	3
Sulfate	300 mg/l	18	0	15	3
Dissolved Solids	1000 mg/l	18	0	12	6
Zinc	5 mg/l	18	6	12	0
Radioactivity					
Gross Alpha	15 pCi/l	3	0	3	0

Notes:
1. MDL = Method Detection Limit. The MDL is the lowest analysis value available for a particular constituent analysis at a particular sampling event. The MDL is determined by the analyzing laboratory.
2. MCL = Maximum Contamination Level. The MCL of a particular constituent is the maximum analysis level for safe drinking water. MDL's for certain constituents at certain sampling events were greater than the MCL's, and analyses from those events were not utilized when counting samples less than or greater than particular MCL's.

Table 20. Ambient Monitoring Groundwater Quality Data
Nacatoch Aquifer (1999 - 2006)

Parameter Groups	**Maximum Contamination Limit (MCL)**	**Number of Wells**			
		Total Wells Sampled	**< MDL**	**< MCL (other than <MDL)**	**≥ MCL**
Primary Constituents (dissolved phase unless noted)					
Arsenic	10 µg/l	22	17	5	0
Barium	2 mg/l	22	0	22	0
Cadmium	5 µg/l	22	22	0	0
Chromium	100 µg/l	22	14	8	0
Fluoride	4 mg/l	23	0	23	0
Mercury	2 µg/l	0	0	0	0
Nitrate (N)	10 mg/l	23	19	4	0
Selenium	50 µg/l	22	15	7	0
Secondary Constituents (dissolved phase unless noted)					
Chloride	300 mg/l	27	0	22	5
Copper	1 mg/l	22	7	15	0
Fluoride	2 mg/l	23	0	17	6
Iron	0.3 mg/l	22	13	7	2
Manganese	50 µg/l	22	11	10	1
Sulfate	300 mg/l	23	4	17	3
Dissolved Solids	1000 mg/l	23	0	16	7
Zinc	5 mg/l	22	10	12	0
Radioactivity					
Gross Alpha	15 pCi/l	8	0	8	0

Notes:
1. MDL = Method Detection Limit. The MDL is the lowest analysis value available for a particular constituent analysis at a particular sampling event. The MDL is determined by the analyzing laboratory.
2. MCL = Maximum Contamination Level. The MCL of a particular constituent is the maximum analysis level for safe drinking water. MDL's for certain constituents at certain sampling events were greater than the MCL's, and analyses from those events were not utilized when counting samples less than or greater than particular MCL's.

Table 21. Ambient Monitoring Groundwater Quality Data
Lipan Aquifer (2001 - 2005)

Parameter Groups	Maximum Contamination Limit (MCL)	Number of Wells			
		Total Wells Sampled	< MDL	< MCL (other than <MDL)	≥ MCL
Primary Constituents (dissolved phase unless noted)					
Arsenic	10 μg/l	24	3	21	0
Barium	2 mg/l	24	0	24	0
Cadmium	5 μg/l	24	24	0	0
Chromium	100 μg/l	24	24	0	0
Fluoride	4 mg/l	24	0	24	0
Mercury	2 μg/l	0	0	0	0
Nitrate (N)	10 mg/l	24	0	6	18
Selenium	50 μg/l	24	5	18	1
Secondary Constituents (dissolved phase unless noted)					
Chloride	300 mg/l	24	0	13	11
Copper	1 mg/l	24	0	24	0
Fluoride	2 mg/l	24	0	24	0
Iron	0.3 mg/l	24	23	1	0
Manganese	50 μg/l	24	17	7	0
Sulfate	300 mg/l	24	0	19	5
Dissolved Solids	1000 mg/l	24	0	10	14
Zinc	5 mg/l	24	1	23	0
Radioactivity					
Gross Alpha	15 pCi/l	18	0	18	0

Notes:
1. MDL = Method Detection Limit. The MDL is the lowest analysis value available for a particular constituent analysis at a particular sampling event. The MDL is determined by the analyzing laboratory.
2. MCL = Maximum Contamination Level. The MCL of a particular constituent is the maximum analysis level for safe drinking water. MDL's for certain constituents at certain sampling events were greater than the MCL's, and analyses from those events were not utilized when counting samples less than or greater than particular MCL's.

Table 22. Ambient Monitoring Groundwater Quality Data
Hueco – Mesilla Bolson Aquifer (1999 - 2004)

Parameter Groups	Maximum Contamination Limit (MCL)	Number of Wells			
		Total Wells Sampled	< MDL	< MCL (other than <MDL)	≥ MCL
Primary Constituents (dissolved phase unless noted)					
Arsenic	10 µg/l	16	1	8	7
Barium	2 mg/l	17	1	16	0
Cadmium	5 µg/l	16	16	0	0
Chromium	100 µg/l	16	3	13	0
Fluoride	4 mg/l	148	0	146	2
Mercury	2 µg/l	0	0	0	0
Nitrate (N)	10 mg/l	148	9	93	46
Selenium	50 µg/l	16	8	8	0
Secondary Constituents (dissolved phase unless noted)					
Chloride	300 mg/l	148	0	101	47
Copper	1 mg/l	16	8	8	0
Fluoride	2 mg/l	148	0	146	2
Iron	0.3 mg/l	16	9	7	0
Manganese	50 µg/l	16	1	13	2
Sulfate	300 mg/l	148	0	137	11
Dissolved Solids	1000 mg/l	148	0	124	24
Zinc	5 mg/l	16	3	13	0
Radioactivity					
Gross Alpha	15 pCi/l	0	0	0	0

Notes:
1. MDL = Method Detection Limit. The MDL is the lowest analysis value available for a particular constituent analysis at a particular sampling event. The MDL is determined by the analyzing laboratory.
2. MCL = Maximum Contamination Level. The MCL of a particular constituent is the maximum analysis level for safe drinking water. MDL's for certain constituents at certain sampling events were greater than the MCL's, and analyses from those events were not utilized when counting samples less than or greater than particular MCL's.

Table 23. Ambient Monitoring Groundwater Quality Data
Bone Spring – Victorio Peak Aquifer (2001)

Parameter Groups	Maximum Contamination Limit (MCL)	Number of Wells			
		Total Wells Sampled	< MDL	< MCL (other than <MDL)	≥ MCL
Primary Constituents (dissolved phase unless noted)					
Arsenic	10 µg/l	12	12	0	0
Barium	2 mg/l	12	0	12	0
Cadmium	5 µg/l	12	12	0	0
Chromium	100 µg/l	12	6	6	0
Fluoride	4 mg/l	11	0	11	0
Mercury	2 µg/l	0	0	0	0
Nitrate (N)	10 mg/l	11	0	6	5
Selenium	50 µg/l	12	0	12	0
Secondary Constituents (dissolved phase unless noted)					
Chloride	300 mg/l	11	0	2	9
Copper	1 mg/l	11	1	10	0
Fluoride	2 mg/l	11	0	9	2
Iron	0.3 mg/l	12	11	1	0
Manganese	50 µg/l	12	10	2	0
Sulfate	300 mg/l	11	0	0	11
Dissolved Solids	1000 mg/l	11	0	0	11
Zinc	5 mg/l	12	1	10	1
Radioactivity					
Gross Alpha	15 pCi/l	0	0	0	0

Notes:
1. MDL = Method Detection Limit. The MDL is the lowest analysis value available for a particular constituent analysis at a particular sampling event. The MDL is determined by the analyzing laboratory.
2. MCL = Maximum Contamination Level. The MCL of a particular constituent is the maximum analysis level for safe drinking water. MDL's for certain constituents at certain sampling events were greater than the MCL's, and analyses from those events were not utilized when counting samples less than or greater than particular MCL's.

Table 24. Ambient Monitoring Groundwater Quality Data
Carrizo – Wilcox Aquifer (1998 - 2006)

Parameter Groups	**Maximum Contamination Limit (MCL)**	**Number of Wells**			
		Total Wells Sampled	**< MDL**	**< MCL (other than <MDL)**	**≥ MCL**
Primary Constituents (dissolved phase unless noted)					
Arsenic	10 µg/l	704	653	51	0
Barium	2 mg/l	704	1	703	0
Cadmium	5 µg/l	697	688	9	0
Chromium	100 µg/l	704	229	475	0
Fluoride	4 mg/l	718	38	672	8
Mercury	2 µg/l	4	3	1	0
Nitrate (N)	10 mg/l	718	604	94	20
Selenium	50 µg/l	704	635	60	9
Secondary Constituents (dissolved phase unless noted)					
Chloride	300 mg/l	718	1	670	47
Copper	1 mg/l	704	660	44	0
Fluoride	2 mg/l	718	38	656	24
Iron	0.3 mg/l	708	307	204	197
Manganese	50 µg/l	708	58	506	144
Sulfate	300 mg/l	718	86	607	25
Dissolved Solids	1000 mg/l	718	0	653	65
Zinc	5 mg/l	704	333	371	0
Radioactivity					
Gross Alpha	15 pCi/l	29	0	28	1

Notes:
1. MDL = Method Detection Limit. The MDL is the lowest analysis value available for a particular constituent analysis at a particular sampling event. The MDL is determined by the analyzing laboratory.
2. MCL = Maximum Contamination Level. The MCL of a particular constituent is the maximum analysis level for safe drinking water. MDL's for certain constituents at certain sampling events were greater than the MCL's, and analyses from those events were not utilized when counting samples less than or greater than particular MCL's.

Table 25. Ambient Monitoring Groundwater Quality Data
Edwards (Balcones Fault Zone) (2003 - 2006)

Parameter Groups	**Maximum Contamination Limit (MCL)**	**Number of Wells**			
		Total Wells Sampled	**< MDL**	**< MCL (other than <MDL)**	**≥ MCL**
Primary Constituents (dissolved phase unless noted)					
Arsenic	10 µg/l	198	178	16	4
Barium	2 mg/l	198	1	197	0
Cadmium	5 µg/l	198	198	0	0
Chromium	100 µg/l	198	130	68	0
Fluoride	4 mg/l	204	0	201	3
Mercury	2 µg/l	0	0	0	0
Nitrate (N)	10 mg/l	204	17	148	39
Selenium	50 µg/l	198	176	15	7
Secondary Constituents (dissolved phase unless noted)					
Chloride	300 mg/l	204	0	196	8
Copper	1 mg/l	198	81	117	0
Fluoride	2 mg/l	204	0	184	20
Iron	0.3 mg/l	198	175	14	9
Manganese	50 µg/l	198	164	29	5
Sulfate	300 mg/l	204	0	192	12
Dissolved Solids	1000 mg/l	204	0	193	11
Zinc	5 mg/l	198	82	116	0
Radioactivity					
Gross Alpha	15 pCi/l	29	0	28	1

Notes:
1. MDL = Method Detection Limit. The MDL is the lowest analysis value available for a particular constituent analysis at a particular sampling event. The MDL is determined by the analyzing laboratory.
2. MCL = Maximum Contamination Level. The MCL of a particular constituent is the maximum analysis level for safe drinking water. MDL’s for certain constituents at certain sampling events were greater than the MCL’s, and analyses from those events were not utilized when counting samples less than or greater than particular MCL’s.

Table 26. Ambient Monitoring Groundwater Quality Data
Trinity Aquifer (2002 - 2006)

Parameter Groups	Maximum Contamination Limit (MCL)	Number of Wells			
		Total Wells Sampled	< MDL	< MCL (other than <MDL)	≥ MCL
Primary Constituents (dissolved phase unless noted)					
Arsenic	10 µg/l	394	359	30	5
Barium	2 mg/l	394	0	394	0
Cadmium	5 µg/l	394	394	0	0
Chromium	100 µg/l	394	394	0	0
Fluoride	4 mg/l	394	1	383	10
Mercury	2 µg/l	0	0	0	0
Nitrate (N)	10 mg/l	394	201	136	57
Selenium	50 µg/l	394	336	57	1
Secondary Constituents (dissolved phase unless noted)					
Chloride	300 mg/l	394	1	372	21
Copper	1 mg/l	394	115	279	0
Fluoride	2 mg/l	394	1	337	56
Iron	0.3 mg/l	394	293	67	34
Manganese	50 µg/l	394	130	252	12
Sulfate	300 mg/l	394	0	356	38
Dissolved Solids	1000 mg/l	394	0	339	55
Zinc	5 mg/l	394	97	297	0
Radioactivity					
Gross Alpha	15 pCi/l	12	0	11	1

Notes:

1. MDL = Method Detection Limit. The MDL is the lowest analysis value available for a particular constituent analysis at a particular sampling event. The MDL is determined by the analyzing laboratory.
2. MCL = Maximum Contamination Level. The MCL of a particular constituent is the maximum analysis level for safe drinking water. MDL's for certain constituents at certain sampling events were greater than the MCL's, and analyses from those events were not utilized when counting samples less than or greater than particular MCL's.

Table 27. Ambient Monitoring Groundwater Quality Data
Brazos River Alluvium Aquifer (1999 - 2004)

Parameter Groups	**Maximum Contamination Limit (MCL)**	**Number of Wells**			
		Total Wells Sampled	**< MDL**	**< MCL (other than <MDL)**	**≥ MCL**
Primary Constituents (dissolved phase unless noted)					
Arsenic	10 µg/l	18	12	5	0
Barium	2 mg/l	16	0	16	0
Cadmium	5 µg/l	16	16	0	0
Chromium	100 µg/l	16	9	7	0
Fluoride	4 mg/l	16	0	16	0
Mercury	2 µg/l	0	0	0	0
Nitrate (N)	10 mg/l	16	6	7	3
Selenium	50 µg/l	16	12	4	0
Secondary Constituents (dissolved phase unless noted)					
Chloride	300 mg/l	16	0	13	3
Copper	1 mg/l	16	12	4	0
Fluoride	2 mg/l	16	0	16	0
Iron	0.3 mg/l	16	6	3	7
Manganese	50 µg/l	16	2	3	11
Sulfate	300 mg/l	16	1	11	4
Dissolved Solids	1000 mg/l	16	0	10	6
Zinc	5 mg/l	16	5	11	0
Radioactivity					
Gross Alpha	15 pCi/l	0	0	0	0

Notes:

1. MDL = Method Detection Limit. The MDL is the lowest analysis value available for a particular constituent analysis at a particular sampling event. The MDL is determined by the analyzing laboratory.
2. MCL = Maximum Contamination Level. The MCL of a particular constituent is the maximum analysis level for safe drinking water. MDL's for certain constituents at certain sampling events were greater than the MCL's, and analyses from those events were not utilized when counting samples less than or greater than particular MCL's.

Table 28. Ambient Monitoring Groundwater Quality Data
Dockum Aquifer (2000 - 2004)

Parameter Groups	Maximum Contamination Limit (MCL)	Number of Wells			
		Total Wells Sampled	< MDL	< MCL (other than < MDL)	≥ MCL
Primary Constituents (dissolved phase unless noted)					
Arsenic	10 µg/l	157	66	84	7
Barium	2 mg/l	162	5	157	0
Cadmium	5 µg/l	157	157	0	0
Chromium	100 µg/l	162	59	103	0
Fluoride	4 mg/l	110	3	105	2
Mercury	2 µg/l	0	0	0	0
Nitrate (N)	10 mg/l	110	31	49	30
Selenium	50 µg/l	162	74	85	3
Secondary Constituents (dissolved phase unless noted)					
Chloride	300 mg/l	110	1	90	19
Copper	1 mg/l	162	52	110	0
Fluoride	2 mg/l	110	3	61	46
Iron	0.3 mg/l	163	97	40	26
Manganese	50 µg/l	162	57	81	24
Sulfate	300 mg/l	110	0	79	31
Dissolved Solids	1000 mg/l	110	0	74	36
Zinc	5 mg/l	162	31	131	0
Radioactivity					
Gross Alpha	15 pCi/l	79	0	48	31

Notes:
1. MDL = Method Detection Limit. The MDL is the lowest analysis value available for a particular constituent analysis at a particular sampling event. The MDL is determined by the analyzing laboratory.
2. MCL = Maximum Contamination Level. The MCL of a particular constituent is the maximum analysis level for safe drinking water. MDL's for certain constituents at certain sampling events were greater than the MCL's, and analyses from those events were not utilized when counting samples less than or greater than particular MCL's.

Table 29. Ambient Monitoring Groundwater Quality Data
Edwards – Trinity (High Plains) Aquifer (2000 - 2004)

Parameter Groups	Maximum Contamination Limit (MCL)	Number of Wells			
		Total Wells Sampled	< MDL	< MCL (other than <MDL)	≥ MCL
Primary Constituents (dissolved phase unless noted)					
Arsenic	10 µg/l	11	3	7	1
Barium	2 mg/l	11	0	11	0
Cadmium	5 µg/l	11	11	0	0
Chromium	100 µg/l	11	6	5	0
Fluoride	4 mg/l	10	0	8	2
Mercury	2 µg/l	0	0	0	0
Nitrate (N)	10 mg/l	11	2	3	6
Selenium	50 µg/l	11	3	8	0
Secondary Constituents (dissolved phase unless noted)					
Chloride	300 mg/l	11	0	8	3
Copper	1 mg/l	11	3	8	0
Fluoride	2 mg/l	10	0	5	5
Iron	0.3 mg/l	11	9	2	0
Manganese	50 µg/l	11	6	5	0
Sulfate	300 mg/l	11	0	9	2
Dissolved Solids	1000 mg/l	11	0	6	5
Zinc	5 mg/l	11	3	8	0
Radioactivity					
Gross Alpha	15 pCi/l	0	0	0	0

Notes:

1. MDL = Method Detection Limit. The MDL is the lowest analysis value available for a particular constituent analysis at a particular sampling event. The MDL is determined by the analyzing laboratory.
2. MCL = Maximum Contamination Level. The MCL of a particular constituent is the maximum analysis level for safe drinking water. MDL's for certain constituents at certain sampling events were greater than the MCL's, and analyses from those events were not utilized when counting samples less than or greater than particular MCL's.

Table 30. Ambient Monitoring Groundwater Quality Data
Igneous Aquifer (1999 - 2005)

Parameter Groups	Maximum Contamination Limit (MCL)	Number of Wells			
		Total Wells Sampled	< MDL	< MCL (other than <MDL)	≥ MCL
Primary Constituents (dissolved phase unless noted)					
Arsenic	10 μg/l	33	22	5	5
Barium	2 mg/l	34	6	28	0
Cadmium	5 μg/l	33	33	0	0
Chromium	100 μg/l	33	24	9	0
Fluoride	4 mg/l	55	1	54	0
Mercury	2 μg/l	0	0	0	0
Nitrate (N)	10 mg/l	55	3	46	6
Selenium	50 μg/l	33	30	3	0
Secondary Constituents (dissolved phase unless noted)					
Chloride	300 mg/l	55	0	54	1
Copper	1 mg/l	33	20	13	0
Fluoride	2 mg/l	55	1	41	13
Iron	0.3 mg/l	33	27	3	3
Manganese	50 μg/l	33	22	10	1
Sulfate	300 mg/l	55	0	53	2
Dissolved Solids	1000 mg/l	55	0	54	1
Zinc	5 mg/l	33	10	23	0
Radioactivity					
Gross Alpha	15 pCi/l	17	0	16	1

Notes:

1. MDL = Method Detection Limit. The MDL is the lowest analysis value available for a particular constituent analysis at a particular sampling event. The MDL is determined by the analyzing laboratory.
2. MCL = Maximum Contamination Level. The MCL of a particular constituent is the maximum analysis level for safe drinking water. MDL's for certain constituents at certain sampling events were greater than the MCL's, and analyses from those events were not utilized when counting samples less than or greater than particular MCL's.

Table 31. Ambient Monitoring Groundwater Quality Data
Marathon Aquifer (1998)

Parameter Groups	Maximum Contamination Limit (MCL)	Number of Wells			
		Total Wells Sampled	< MDL	< MCL (other than <MDL)	≥ MCL
Primary Constituents (dissolved phase unless noted)					
Arsenic	10 µg/l	4	4	0	0
Barium	2 mg/l	4	0	4	0
Cadmium	5 µg/l	4	4	0	0
Chromium	100 µg/l	4	2	2	0
Fluoride	4 mg/l	4	0	4	0
Mercury	2 µg/l	0	0	0	0
Nitrate (N)	10 mg/l	4	0	1	3
Selenium	50 µg/l	4	0	4	0
Secondary Constituents (dissolved phase unless noted)					
Chloride	300 mg/l	4	0	4	0
Copper	1 mg/l	4	1	3	0
Fluoride	2 mg/l	4	0	4	0
Iron	0.3 mg/l	4	0	4	0
Manganese	50 µg/l	4	2	2	0
Sulfate	300 mg/l	4	0	4	0
Dissolved Solids	1000 mg/l	4	0	4	0
Zinc	5 mg/l	4	0	4	0
Radioactivity					
Gross Alpha	15 pCi/l	0	0	0	0

Notes:
1. MDL = Method Detection Limit. The MDL is the lowest analysis value available for a particular constituent analysis at a particular sampling event. The MDL is determined by the analyzing laboratory.
2. MCL = Maximum Contamination Level. The MCL of a particular constituent is the maximum analysis level for safe drinking water. MDL's for certain constituents at certain sampling events were greater than the MCL's, and analyses from those events were not utilized when counting samples less than or greater than particular MCL's.

Table 32. Ambient Monitoring Groundwater Quality Data
Queen City Aquifer (1999 - 2006)

Parameter Groups	Maximum Contamination Limit (MCL)	Number of Wells			
		Total Wells Sampled	< MDL	< MCL (other than <MDL)	≥ MCL
Primary Constituents (dissolved phase unless noted)					
Arsenic	10 µg/l	119	115	4	0
Barium	2 mg/l	119	0	155	0
Cadmium	5 µg/l	119	118	1	0
Chromium	100 µg/l	119	81	38	0
Fluoride	4 mg/l	119	19	100	0
Mercury	2 µg/l	0	0	0	0
Nitrate (N)	10 mg/l	119	55	54	10
Selenium	50 µg/l	119	114	5	0
Secondary Constituents (dissolved phase unless noted)					
Chloride	300 mg/l	119	0	111	8
Copper	1 mg/l	119	52	66	1
Fluoride	2 mg/l	119	19	97	3
Iron	0.3 mg/l	119	56	28	35
Manganese	50 µg/l	119	6	86	27
Sulfate	300 mg/l	119	5	105	9
Dissolved Solids	1000 mg/l	119	0	103	16
Zinc	5 mg/l	119	22	96	1
Radioactivity					
Gross Alpha	15 pCi/l	1	0	1	0

Notes:
1. MDL = Method Detection Limit. The MDL is the lowest analysis value available for a particular constituent analysis at a particular sampling event. The MDL is determined by the analyzing laboratory.
2. MCL = Maximum Contamination Level. The MCL of a particular constituent is the maximum analysis level for safe drinking water. MDL's for certain constituents at certain sampling events were greater than the MCL's, and analyses from those events were not utilized when counting samples less than or greater than particular MCL's.

Table 33. Ambient Monitoring Groundwater Quality Data
Sparta Aquifer (2002 - 2006)

Parameter Groups	**Maximum Contamination Limit (MCL)**	**Number of Wells**			
		Total Wells Sampled	**< MDL**	**< MCL (other than <MDL)**	**≥ MCL**
Primary Constituents (dissolved phase unless noted)					
Arsenic	10 µg/l	59	56	2	1
Barium	2 mg/l	59	0	59	0
Cadmium	5 µg/l	59	59	0	0
Chromium	100 µg/l	59	39	20	0
Fluoride	4 mg/l	60	2	58	0
Mercury	2 µg/l	0	0	0	0
Nitrate (N)	10 mg/l	60	35	25	0
Selenium	50 µg/l	59	55	2	2
Secondary Constituents (dissolved phase unless noted)					
Chloride	300 mg/l	60	0	46	14
Copper	1 mg/l	59	31	28	0
Fluoride	2 mg/l	60	2	56	2
Iron	0.3 mg/l	59	23	19	17
Manganese	50 µg/l	59	5	45	9
Sulfate	300 mg/l	60	3	42	15
Dissolved Solids	1000 mg/l	60	0	41	19
Zinc	5 mg/l	59	17	42	0
Radioactivity					
Gross Alpha	15 pCi/l	0	0	0	0

Notes:
1. MDL = Method Detection Limit. The MDL is the lowest analysis value available for a particular constituent analysis at a particular sampling event. The MDL is determined by the analyzing laboratory.
2. MCL = Maximum Contamination Level. The MCL of a particular constituent is the maximum analysis level for safe drinking water. MDL's for certain constituents at certain sampling events were greater than the MCL's, and analyses from those events were not utilized when counting samples less than or greater than particular MCL's.

Table 34. Ambient Monitoring Groundwater Quality Data
West Texas Bolsons Aquifer (1999 - 2005)

Parameter Groups	**Maximum Contamination Limit (MCL)**	**Number of Wells**			
		Total Wells Sampled	**< MDL**	**< MCL (other than <MDL)**	**≥ MCL**
Primary Constituents (dissolved phase unless noted)					
Arsenic	10 µg/l	67	22	33	12
Barium	2 mg/l	68	2	66	0
Cadmium	5 µg/l	67	66	1	0
Chromium	100 µg/l	67	22	45	0
Fluoride	4 mg/l	70	0	61	9
Mercury	2 µg/l	0	0	0	0
Nitrate (N)	10 mg/l	70	0	56	14
Selenium	50 µg/l	68	50	18	0
Secondary Constituents (dissolved phase unless noted)					
Chloride	300 mg/l	70	0	64	6
Copper	1 mg/l	67	19	48	0
Fluoride	2 mg/l	70	0	37	33
Iron	0.3 mg/l	68	21	44	3
Manganese	50 µg/l	68	34	31	3
Sulfate	300 mg/l	70	0	55	15
Dissolved Solids	1000 mg/l	70	0	55	15
Zinc	5 mg/l	67	11	56	0
Radioactivity					
Gross Alpha	15 pCi/l	18	0	16	2

Notes:
1. MDL = Method Detection Limit. The MDL is the lowest analysis value available for a particular constituent analysis at a particular sampling event. The MDL is determined by the analyzing laboratory.
2. MCL = Maximum Contamination Level. The MCL of a particular constituent is the maximum analysis level for safe drinking water. MDL's for certain constituents at certain sampling events were greater than the MCL's, and analyses from those events were not utilized when counting samples less than or greater than particular MCL's.

Table 35. Ambient Monitoring Groundwater Quality Data
Yegua Jackson Aquifer (2002 - 2005)

Parameter Groups	Maximum Contamination Limit (MCL)	Number of Wells			
		Total Wells Sampled	< MDL	< MCL (other than <MDL)	≥ MCL
Primary Constituents (dissolved phase unless noted)					
Arsenic	10 µg/l	115	97	16	2
Barium	2 mg/l	115	0	115	0
Cadmium	5 µg/l	115	111	4	0
Chromium	100 µg/l	115	54	61	0
Fluoride	4 mg/l	115	5	110	0
Mercury	2 µg/l	0	0	0	0
Nitrate (N)	10 mg/l	115	69	44	2
Selenium	50 µg/l	115	101	10	4
Secondary Constituents (dissolved phase unless noted)					
Chloride	300 mg/l	115	0	80	35
Copper	1 mg/l	115	23	92	0
Fluoride	2 mg/l	115	5	105	5
Iron	0.3 mg/l	115	50	32	33
Manganese	50 µg/l	115	5	68	42
Sulfate	300 mg/l	115	12	69	34
Dissolved Solids	1000 mg/l	115	0	66	49
Zinc	5 mg/l	115	27	88	0
Radioactivity					
Gross Alpha	15 pCi/l	13	0	12	1

Notes:

1. MDL = Method Detection Limit. The MDL is the lowest analysis value available for a particular constituent analysis at a particular sampling event. The MDL is determined by the analyzing laboratory.
2. MCL = Maximum Contamination Level. The MCL of a particular constituent is the maximum analysis level for safe drinking water. MDL's for certain constituents at certain sampling events were greater than the MCL's, and analyses from those events were not utilized when counting samples less than or greater than particular MCL's.

Regulatory Monitoring/Groundwater Contamination

Table 36. Groundwater Contamination Summary
Pecos Valley Aquifer Outcrop (2006)

Source Type	Documented Groundwater Contamination Present in Reporting Area	Number of Sites With Confirmed Groundwater Contamination	Site Activity Status						Contaminants
			Contamination Confirmation	Ongoing Investigation	Corrective Action Planning	Corrective Action Implemented	Monitoring of Corrective Action	Action Completed	
NPL	No								
CERCLIS (non-NPL)	No								
DOD/DOE	No								
LUST	Yes	36	2	11	0	12	0	11	Gasoline, Diesel, Waste Oil, Jet Fuel, BTEX, TPH
RCRA Corrective Action	Yes	2	0	0	0	2	1	0	VOCs, BTEX, TPH, Chromium, Lead
Underground Injection	No								
State Sites*	No								
Non-point Sources	No								
Oil/Gas Activities	Yes								VOCs, NaCl, Crude Oil, HCL, Sulfates, Chromium
Totals		38	2	11	0	14	1	11	

NPL - National Priority List
DOE - Department of Energy
LUST - Leaking Underground Storage Tanks
*These sites may be combined with NPL sites

CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOD - Department of Defense
RCRA - Resource Conservation and Recovery Act

Table 37. Groundwater Contamination Summary
Edwards – Trinity (Plateau) Aquifer Outcrop (2006)

Source Type	Documented Groundwater Contamination Present in Reporting Area	Number of Sites With Confirmed Groundwater Contamination	Site Activity Status						Contaminants
			Contamination Confirmation	Ongoing Investigation	Corrective Action Planning	Corrective Action Implemented	Monitoring of Corrective Action	Action Completed	
NPL	Yes	2		1			1		Chromium
CERCLIS (non-NPL)	No								
DOD/DOE	No								
LUST	Yes	91	8	38	0	26	0	19	Gasoline, Diesel, Waste Oil, Jet Fuel, BTEX, TPH
RCRA Corrective Action	Yes	21	1	5	4	4	9	2	VOCs, BTEX, TPH, Chromium, Lead
Underground Injection	No								
State Sites*	Yes	4	1	1	0	0	0	0	Arsenic, Metals, PCE, Chlorobenzene
Non-point Sources	No								
Oil/Gas Activities	Yes								
Totals		118	10	45	4	30	10	21	

NPL - National Priority List
DOE - Department of Energy
LUST - Leaking Underground Storage Tanks
*These sites may be combined with NPL sites

CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOD - Department of Defense
RCRA - Resource Conservation and Recovery Act

Table 38. Groundwater Contamination Summary
Ogallala Aquifer Outcrop (2006)

Source Type	Documented Groundwater Contamination Present in Reporting Area	Number of Sites With Confirmed Groundwater Contamination	Site Activity Status						Contaminants
			Contamination Confirmation	Ongoing Investigation	Corrective Action Planning	Corrective Action Implemented	Monitoring of Corrective Action	Action Completed	
NPL	Yes	5	0	1	1	0	4	0	Carbon Tetrachloride, Metals, Atrazine
CERCLIS (non-NPL)	Yes	7	2	4	0	0	0	1	Metals, TCE
DOD/DOE	Yes								Benzene, High Explosives, Chromium
LUST	Yes	366	21	149	0	122	0	74	Gasoline, Diesel, Waste Oil, Jet Fuel, BTEX, TPH
RCRA Corrective Action	Yes	49	1	19	15	11	16	2	VOCs, BTEX, TPH, Chromium , Lead
Underground Injection	No								
State Sites*	Yes	4	1	1	0	2	1	0	Pesticide, Arsenic, VOCs
Non-point Sources	No	20	1	0	0	0	0	19	
Oil/Gas Activities	Yes								VOCs, NaCl, Crude Oil, Natural Gas, HCL, Sulfates
Totals		451	27	174	16	135	21	96	

NPL - National Priority List
DOE - Department of Energy
LUST - Leaking Underground Storage Tanks
*These sites may be combined with NPL sites

CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOD - Department of Defense
RCRA - Resource Conservation and Recovery Act

Table 39. Groundwater Contamination Summary
Capitan Reef Complex Aquifer Outcrop (2006)

Source Type	Documented Groundwater Contamination Present in Reporting Area	Number of Sites With Confirmed Groundwater Contamination	Site Activity Status						Contaminants
			Contamination Confirmation	Ongoing Investigation	Corrective Action Planning	Corrective Action Implemented	Monitoring of Corrective Action	Action Completed	
NPL	No								
CERCLIS (non-NPL)	No								
DOD/DOE	No								
LUST	Yes	6	0	2	0	0	0	4	Gasoline, Diesel, Waste Oil
RCRA Corrective Action	Yes								
Underground Injection	No								
State Sites*	No								
Non-point Sources	No								
Oil/Gas Activities	Yes								
Totals		6	0	2	0	0	0	4	

NPL - National Priority List
DOE - Department of Energy
LUST - Leaking Underground Storage Tanks
*These sites may be combined with NPL sites

CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOD - Department of Defense
RCRA - Resource Conservation and Recovery Act

Table 40. Groundwater Contamination Summary
Ellenberger – San Saba Aquifer Outcrop (2006)

Source Type	Documented Groundwater Contamination Present in Reporting Area	Number of Sites With Confirmed Groundwater Contamination	Site Activity Status						Contaminants
			Contamination Confirmation	Ongoing Investigation	Corrective Action Planning	Corrective Action Implemented	Monitoring of Corrective Action	Action Completed	
NPL	No								
CERCLIS (non-NPL)	No								
DOD/DOE	No								
LUST	No								
RCRA Corrective Action	No								
Underground Injection	No								
State Sites*	No								
Non-point Sources	No								
Oil/Gas Activities	No								
Totals									

NPL - National Priority List
DOE - Department of Energy
LUST - Leaking Underground Storage Tanks
*These sites may be combined with NPL sites

CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOD - Department of Defense
RCRA - Resource Conservation and Recovery Act

Table 41. Groundwater Contamination Summary
Hickory Aquifer Outcrop (2006)

Source Type	Documented Groundwater Contamination Present in Reporting Area	Number of Sites With Confirmed Groundwater Contamination	Site Activity Status						Contaminants
			Contamination Confirmation	Ongoing Investigation	Corrective Action Planning	Corrective Action Implemented	Monitoring of Corrective Action	Action Completed	
NPL	No								
CERCLIS (non-NPL)	No								
DOD/DOE	No								
LUST	Yes	2	0	0	0	0	0	2	Gasoline, Waste Oil
RCRA Corrective Action	No								
Underground Injection	No								
State Sites*	No								
Non-point Sources	No								
Oil/Gas Activities	No								
Totals		2	0	0	0	0	0	2	

NPL - National Priority List
DOE - Department of Energy
LUST - Leaking Underground Storage Tanks
*These sites may be combined with NPL sites

CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOD - Department of Defense
RCRA - Resource Conservation and Recovery Act

Table 42. Groundwater Contamination Summary
Marble Falls Aquifer Outcrop (2006)

Source Type	Documented Groundwater Contamination Present in Reporting Area	Number of Sites With Confirmed Groundwater Contamination	Site Activity Status						Contaminants
			Contamination Confirmation	Ongoing Investigation	Corrective Action Planning	Corrective Action Implemented	Monitoring of Corrective Action	Action Completed	
NPL	No								
CERCLIS (non-NPL)	No								
DOD/DOE	No								
LUST	No								
RCRA Corrective Action	No								
Underground Injection	No								
State Sites*	No								
Non-point Sources	No								
Oil/Gas Activities	No								
Totals									

NPL - National Priority List
DOE - Department of Energy
LUST - Leaking Underground Storage Tanks
*These sites may be combined with NPL sites

CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOD - Department of Defense
RCRA - Resource Conservation and Recovery Act

Table 43. Groundwater Contamination Summary
Rita Blanca Aquifer Outcrop (2006)

Source Type	Documented Groundwater Contamination Present in Reporting Area	Number of Sites With Confirmed Groundwater Contamination	Site Activity Status						Contaminants
			Contamination Confirmation	Ongoing Investigation	Corrective Action Planning	Corrective Action Implemented	Monitoring of Corrective Action	Action Completed	
NPL	No								
CERCLIS (non-NPL)	No								
DOD/DOE	No								
LUST	No								
RCRA Corrective Action	No								
Underground Injection	No								
State Sites*	No								
Non-point Sources	No								
Oil/Gas Activities	No								
Totals									

NPL - National Priority List
DOE - Department of Energy
LUST - Leaking Underground Storage Tanks
*These sites may be combined with NPL sites

CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOD - Department of Defense
RCRA - Resource Conservation and Recovery Act

Table 44. Groundwater Contamination Summary
Rustler Aquifer Outcrop (2006)

Source Type	Documented Groundwater Contamination Present in Reporting Area	Number of Sites With Confirmed Groundwater Contamination	Site Activity Status						Contaminants
			Contamination Confirmation	Ongoing Investigation	Corrective Action Planning	Corrective Action Implemented	Monitoring of Corrective Action	Action Completed	
NPL	No								
CERCLIS (non-NPL)	No								
DOD/DOE	No								
LUST	No								
RCRA Corrective Action	No								
Underground Injection	No								
State Sites*	No								
Non-point Sources	No								
Oil/Gas Activities	No								
Totals									

NPL - National Priority List
DOE - Department of Energy
LUST - Leaking Underground Storage Tanks
*These sites may be combined with NPL sites

CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOD - Department of Defense
RCRA - Resource Conservation and Recovery Act

Table 45. Groundwater Contamination Summary
Gulf Coast Aquifer Outcrop (2006)

Source Type	Documented Groundwater Contamination Present in Reporting Area	Number of Sites With Confirmed Groundwater Contamination	Site Activity Status						Contaminants
			Contamination Confirmation	Ongoing Investigation	Corrective Action Planning	Corrective Action Implemented	Monitoring of Corrective Action	Action Completed	
NPL	Yes	33	3	8	2	3	17	1	Metal, VOC, Arsenic, Organic chemicals
CERCLIS (non-NPL)	Yes	6	1	1	0	0	0	6	Metals, VOC, Arsenic, Organic chemicals
DOD/DOE	No								
LUST	Yes	1013	203	490	0	107	0	213	Gasoline, Diesel, Waste Oil, Jet Fuel, BTEX, TPH
RCRA Corrective Action	Yes	198	6	79	47	65	77	4	DDT, Dieldrin, Methylparathion
Underground Injection	No								
State Sites*	Yes	14	0	7	4	2	3	0	Organic Chemicals, Creosote, pH, Epichlorohydrin, DCE
Non-point Sources	No								
Oil/Gas Activities	Yes								Chloride, TDS, Crude
Totals		1264	213	585	53	177	97	224	

NPL - National Priority List
DOE - Department of Energy
LUST - Leaking Underground Storage Tanks
*These sites may be combined with NPL sites

CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOD - Department of Defense
RCRA - Resource Conservation and Recovery Act

Table 46. Groundwater Contamination Summary
Seymour Aquifer Outcrop (2006)

Source Type	Documented Groundwater Contamination Present in Reporting Area	Number of Sites With Confirmed Groundwater Contamination	Site Activity Status						Contaminants
			Contamination Confirmation	Ongoing Investigation	Corrective Action Planning	Corrective Action Implemented	Monitoring of Corrective Action	Action Completed	
NPL	No								
CERCLIS (non-NPL)	No								
DOD/DOE	Yes	1	0	1	0	0	0	0	Volatiles
LUST	Yes	79	5	48	0	19	0	7	Gasoline, Diesel, Waste Oil
RCRA Corrective Action	Yes	5	0	3	2	1	1	0	Metals, VOC's
Underground Injection	No								
State Sites*	No								Metals
Non-point Sources	Yes	15	0	0	0	0	0	15	Atrazine, Dicamba, Prometon, Propazine
Oil/Gas Activities	Yes								Oil, Salt
Totals		100	5	52	2	20	1	22	

NPL - National Priority List
DOE - Department of Energy
LUST - Leaking Underground Storage Tanks
*These sites may be combined with NPL sites

CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOD - Department of Defense
RCRA - Resource Conservation and Recovery Act

Table 47. Groundwater Contamination Summary
Blaine Aquifer Outcrop (2006)

Source Type	Documented Groundwater Contamination Present in Reporting Area	Number of Sites With Confirmed Groundwater Contamination	Site Activity Status						Contaminants
			Contamination Confirmation	Ongoing Investigation	Corrective Action Planning	Corrective Action Implemented	Monitoring of Corrective Action	Action Completed	
NPL	No								
CERCLIS (non-NPL)	No								
DOD/DOE	No								
LUST	Yes	15	2	11	0	1	0	1	Gasoline, Diesel, BTEX, TPH
RCRA Corrective Action	No								
Underground Injection	No								
State Sites*	No								
Non-point Sources	No								
Oil/Gas Activities	No								
Totals		15	2	11	0	1	0	1	

NPL - National Priority List
DOE - Department of Energy
LUST - Leaking Underground Storage Tanks
*These sites may be combined with NPL sites

CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOD - Department of Defense
RCRA - Resource Conservation and Recovery Act

Table 48. Groundwater Contamination Summary
Woodbine Aquifer Outcrop (2006)

Source Type	Documented Groundwater Contamination Present in Reporting Area	Number of Sites With Confirmed Groundwater Contamination	Site Activity Status						Contaminants
			Contamination Confirmation	Ongoing Investigation	Corrective Action Planning	Corrective Action Implemented	Monitoring of Corrective Action	Action Completed	
NPL	No								
CERCLIS (non-NPL)	No								
DOD/DOE	No								
LUST	Yes	72	14	37	0	6	0	15	Gasoline, Diesel, Waste Oil, Jet Fuel, BTEX, TPH
RCRA Corrective Action	Yes	8	2	3	2	2	3	0	BTEX, TPH, VOC's, Lead, Arsenic, MTBE, Cadmium, Chrome, TCE
Underground Injection	No								
State Sites*	Yes	2	0	0	0	1	1	0	Chromium, Arsenic, Lead, TCE
Non-point Sources	No								
Oil/Gas Activities	No								
Totals		82	16	40	2	9	4	15	

NPL - National Priority List
DOE - Department of Energy
LUST - Leaking Underground Storage Tanks
*These sites may be combined with NPL sites

CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOD - Department of Defense
RCRA - Resource Conservation and Recovery Act

Table 49. Groundwater Contamination Summary
Blossom Aquifer Outcrop (2006)

Source Type	Documented Groundwater Contamination Present in Reporting Area	Number of Sites With Confirmed Groundwater Contamination	Site Activity Status						Contaminants
			Contamination Confirmation	Ongoing Investigation	Corrective Action Planning	Corrective Action Implemented	Monitoring of Corrective Action	Action Completed	
NPL	No								
CERCLIS (non-NPL)	No								
DOD/DOE	No								
LUST	Yes	9	2	4	0	0	0	3	Gasoline, BTEX, TPH
RCRA Corrective Action	No								
Underground Injection	No								
State Sites*	No								
Non-point Sources	No								
Oil/Gas Activities	No								
Totals		9	2	4	0	0	0	3	

NPL - National Priority List
DOE - Department of Energy
LUST - Leaking Underground Storage Tanks
*These sites may be combined with NPL sites

CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOD - Department of Defense
RCRA - Resource Conservation and Recovery Act

Table 50. Groundwater Contamination Summary
Nacatoch Aquifer Outcrop (2006)

Source Type	Documented Groundwater Contamination Present in Reporting Area	Number of Sites With Confirmed Groundwater Contamination	Site Activity Status						Contaminants
			Contamination Confirmation	Ongoing Investigation	Corrective Action Planning	Corrective Action Implemented	Monitoring of Corrective Action	Action Completed	
NPL	No								
CERCLIS (non-NPL)	No								
DOD/DOE	No								
LUST	Yes	14	3	6	0	0	0	5	Gasoine, Diesel, Waste Oil, BTEX, TPH
RCRA Corrective Action	Yes	1	0	0	1	0	0	0	Metals, BTEX, TCE
Underground Injection	No								
State Sites*	No								
Non-point Sources	No								
Oil/Gas Activities	No								
Totals		15	3	6	1	0	0	5	

NPL - National Priority List
DOE - Department of Energy
LUST - Leaking Underground Storage Tanks
*These sites may be combined with NPL sites

CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOD - Department of Defense
RCRA - Resource Conservation and Recovery Act

Table 51. Groundwater Contamination Summary
Lipan Aquifer Outcrop (2006)

Source Type	Documented Groundwater Contamination Present in Reporting Area	Number of Sites With Confirmed Groundwater Contamination	Site Activity Status						Contaminants
			Contamination Confirmation	Ongoing Investigation	Corrective Action Planning	Corrective Action Implemented	Monitoring of Corrective Action	Action Completed	
NPL	No								
CERCLIS (non-NPL)	Yes	1	0	0	0	1	0	0	PCB Oil
DOD/DOE	Yes	1	0	1	0	0	0	0	Carbon Tetrachloride
LUST	Yes	31	1	22	0	4	0	4	Gasoline, Diesel
RCRA Corrective Action	Yes	4	0	2	2	0	1	0	Methylene Chloride, Metal, Chlorinated Hydrocarbons
Underground Injection	No								
State Sites*	No								
Non-point Sources	No								
Oil/Gas Activities	Yes								
Totals		37	1	25	2	5	1	4	

NPL - National Priority List
DOE - Department of Energy
LUST - Leaking Underground Storage Tanks
*These sites may be combined with NPL sites

CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOD - Department of Defense
RCRA - Resource Conservation and Recovery Act

Table 52. Groundwater Contamination Summary
Hueco – Mesilla Bolsons Aquifer Outcrop (2006)

Source Type	Documented Groundwater Contamination Present in Reporting Area	Number of Sites With Confirmed Groundwater Contamination	Site Activity Status						Contaminants
			Contamination Confirmation	Ongoing Investigation	Corrective Action Planning	Corrective Action Implemented	Monitoring of Corrective Action	Action Completed	
NPL	No								
CERCLIS (non-NPL)	No								
DOD/DOE	No								
LUST	Yes	69	5	48	0	19	0	7	Gasoline, Diesel
RCRA Corrective Action	Yes	9	0	5	1	1	2	0	Plating Solutions, Paint, Mercury, Chromium
Underground Injection	No								
State Sites*	No								
Non-point Sources	No								
Oil/Gas Activities	No								
Totals		78	5	53	1	20	2	7	

NPL - National Priority List
DOE - Department of Energy
LUST - Leaking Underground Storage Tanks
*These sites may be combined with NPL sites

CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOD - Department of Defense
RCRA - Resource Conservation and Recovery Act

Table 53. Groundwater Contamination Summary
Bone Spring - Victorio Aquifer Outcrop (2006)

Source Type	Documented Groundwater Contamination Present in Reporting Area	Number of Sites With Confirmed Groundwater Contamination	Site Activity Status						Contaminants
			Contamination Confirmation	Ongoing Investigation	Corrective Action Planning	Corrective Action Implemented	Monitoring of Corrective Action	Action Completed	
NPL	No								
CERCLIS (non-NPL)	No								
DOD/DOE	No								
LUST	No								
RCRA Corrective Action	No								
Underground Injection	No								
State Sites*	No								
Non-point Sources	No								
Oil/Gas Activities	No								
Totals									

NPL - National Priority List
DOE - Department of Energy
LUST - Leaking Underground Storage Tanks
*These sites may be combined with NPL sites

CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOD - Department of Defense
RCRA - Resource Conservation and Recovery Act

Table 54. Groundwater Contamination Summary
Carrizo - Wilcox Aquifer Outcrop (2006)

Source Type	Documented Groundwater Contamination Present in Reporting Area	Number of Sites With Confirmed Groundwater Contamination	Site Activity Status						Contaminants
			Contamination Confirmation	Ongoing Investigation	Corrective Action Planning	Corrective Action Implemented	Monitoring of Corrective Action	Action Completed	
NPL	Yes	6	0	0	2	0	4	0	Dioxins, Coal Tar, Metals, VOC's
CERCLIS (non-NPL)	No								
DOD/DOE	Yes	4	0	1	1	0	2	0	Explosives, Nitrate, Metals, Volatiles, Methylene Chloride
LUST	Yes	79	5	48	0	19	0	6	Gasoline, Diesel, Waste Oil
RCRA Corrective Action	Yes	17	1	7	3	4	5	0	Chlorinated Solvents, Boron, Selenium, TCE, Acetone, Chromium, Organic Chemicals
Underground Injection	No								
State Sites*	Yes	2	0	2	0	0	0	0	VOC's, Chlorinated Solvents
Non-point Sources	No								
Oil/Gas Activities	Yes								
Totals		108	6	58	6	23	11	6	

NPL - National Priority List
DOE - Department of Energy
LUST - Leaking Underground Storage Tanks
*These sites may be combined with NPL sites

CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOD - Department of Defense
RCRA - Resource Conservation and Recovery Act

Table 55. Groundwater Contamination Summary
Edwards Balcones Fault Zone (BFZ) Aquifer Outcrop (2006)

Source Type	Documented Groundwater Contamination Present in Reporting Area	Number of Sites With Confirmed Groundwater Contamination	Site Activity Status						Contaminants
			Contamination Confirmation	Ongoing Investigation	Corrective Action Planning	Corrective Action Implemented	Monitoring of Corrective Action	Action Completed	
NPL	No								
CERCLIS (non-NPL)	No								
DOD/DOE	Yes	3	0	1	0	1	2	0	Solvents, Chlorinated Hydrocarbons
LUST	Yes	8	2	2	0	2	0	2	Gasoline, Diesel, Waste Oil
RCRA Corrective Action	Yes	1	0	1	0	0	0	0	Pesticides
Underground Injection	No								
State Sites*	No								
Non-point Sources	No								
Oil/Gas Activities	No								
Totals		12	2	4	0	3	2	2	

NPL - National Priority List
DOE - Department of Energy
LUST - Leaking Underground Storage Tanks
*These sites may be combined with NPL sites

CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOD - Department of Defense
RCRA - Resource Conservation and Recovery Act

Table 56. Groundwater Contamination Summary
Trinity Aquifer Outcrop (2006)

Source Type	Documented Groundwater Contamination Present in Reporting Area	Number of Sites With Confirmed Groundwater Contamination	Site Activity Status						Contaminants
			Contamination Confirmation	Ongoing Investigation	Corrective Action Planning	Corrective Action Implemented	Monitoring of Corrective Action	Action Completed	
NPL	No								
CERCLIS (non-NPL)	No								
DOD/DOE	No								
LUST	Yes	94	12	45	0	17	0	20	Gasoline, Diesel, Waste Oil
RCRA Corrective Action	Yes	8	0	2	4	5	5	0	TPH, BTEX, Gasoline, Metals
Underground Injection	No								
State Sites*	Yes	5	0	3	1	0	0	1	VOC's, Ammonia, Barium
Non-point Sources	No								
Oil/Gas Activities	Yes								
Totals		107	12	50	5	22	5	21	

NPL - National Priority List
DOE - Department of Energy
LUST - Leaking Underground Storage Tanks
*These sites may be combined with NPL sites

CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOD - Department of Defense
RCRA - Resource Conservation and Recovery Act

Table 57. Groundwater Contamination Summary
Brazos River Alluvium Aquifer Outcrop (2006)

Source Type	Documented Groundwater Contamination Present in Reporting Area	Number of Sites With Confirmed Groundwater Contamination	Site Activity Status						Contaminants
			Contamination Confirmation	Ongoing Investigation	Corrective Action Planning	Corrective Action Implemented	Monitoring of Corrective Action	Action Completed	
NPL	No								
CERCLIS (non-NPL)	No								
DOD/DOE	No								
LUST	Yes	15	1	7	0	1	0	6	Gasoline, Diesel, Waste Oil
RCRA Corrective Action	Yes	7	0	3	2	3	1	0	Metals, Chromium, TPH, VOC's
Underground Injection	No								
State Sites*	No								
Non-point Sources	No								
Oil/Gas Activities	Yes								
Totals		23	1	10	2	4	2	6	

NPL - National Priority List
DOE - Department of Energy
LUST - Leaking Underground Storage Tanks
*These sites may be combined with NPL sites

CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOD - Department of Defense
RCRA - Resource Conservation and Recovery Act

Table 58. Groundwater Contamination Summary
Dockum Aquifer Outcrop (2006)

Source Type	Documented Groundwater Contamination Present in Reporting Area	Number of Sites With Confirmed Groundwater Contamination	Site Activity Status						Contaminants
			Contamination Confirmation	Ongoing Investigation	Corrective Action Planning	Corrective Action Implemented	Monitoring of Corrective Action	Action Completed	
NPL	No								
CERCLIS (non-NPL)	No								
DOD/DOE	No								
LUST	No								
RCRA Corrective Action	No								
Underground Injection	No								
State Sites*	No								
Non-point Sources	No								
Oil/Gas Activities	No								
Totals									

NPL - National Priority List
DOE - Department of Energy
LUST - Leaking Underground Storage Tanks
*These sites may be combined with NPL sites

CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOD - Department of Defense
RCRA - Resource Conservation and Recovery Act

Table 59. Groundwater Contamination Summary
Edwards – Trinity High Plains Aquifer Outcrop (2006)

Source Type	Documented Groundwater Contamination Present in Reporting Area	Number of Sites With Confirmed Groundwater Contamination	Site Activity Status						Contaminants
			Contamination Confirmation	Ongoing Investigation	Corrective Action Planning	Corrective Action Implemented	Monitoring of Corrective Action	Action Completed	
NPL	No								
CERCLIS (non-NPL)	No								
DOD/DOE	No								
LUST	No								
RCRA Corrective Action	No								
Underground Injection	No								
State Sites*	No								
Non-point Sources	No								
Oil/Gas Activities	No								
Totals									

NPL - National Priority List
DOE - Department of Energy
LUST - Leaking Underground Storage Tanks
*These sites may be combined with NPL sites

CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOD - Department of Defense
RCRA - Resource Conservation and Recovery Act

Table 60. Groundwater Contamination Summary
Igneous Aquifer Outcrop (2006)

Source Type	Documented Groundwater Contamination Present in Reporting Area	Number of Sites With Confirmed Groundwater Contamination	Site Activity Status						Contaminants
			Contamination Confirmation	Ongoing Investigation	Corrective Action Planning	Corrective Action Implemented	Monitoring of Corrective Action	Action Completed	
NPL	No								
CERCLIS (non-NPL)	No								
DOD/DOE	No								
LUST	No								
RCRA Corrective Action	No								
Underground Injection	No								
State Sites*	No								
Non-point Sources	No								
Oil/Gas Activities	No								
Totals									

NPL - National Priority List
DOE - Department of Energy
LUST - Leaking Underground Storage Tanks
*These sites may be combined with NPL sites

CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOD - Department of Defense
RCRA - Resource Conservation and Recovery Act

Table 61. Groundwater Contamination Summary
Marathon Aquifer Outcrop (2006)

Source Type	Documented Groundwater Contamination Present in Reporting Area	Number of Sites With Confirmed Groundwater Contamination	Site Activity Status						Contaminants
			Contamination Confirmation	Ongoing Investigation	Corrective Action Planning	Corrective Action Implemented	Monitoring of Corrective Action	Action Completed	
NPL	No								
CERCLIS (non-NPL)	No								
DOD/DOE	No								
LUST	No								
RCRA Corrective Action	No								
Underground Injection	No								
State Sites*	No								
Non-point Sources	No								
Oil/Gas Activities	No								
Totals									

NPL - National Priority List
DOE - Department of Energy
LUST - Leaking Underground Storage Tanks
*These sites may be combined with NPL sites

CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOD - Department of Defense
RCRA - Resource Conservation and Recovery Act

Table 62. Groundwater Contamination Summary
Queen City Aquifer Outcrop (2006)

Source Type	Documented Groundwater Contamination Present in Reporting Area	Number of Sites With Confirmed Groundwater Contamination	Site Activity Status						Contaminants
			Contamination Confirmation	Ongoing Investigation	Corrective Action Planning	Corrective Action Implemented	Monitoring of Corrective Action	Action Completed	
NPL	Yes	4	1	2	1	0	0	0	Benzene, Metal, TCE
CERCLIS (non-NPL)	No								
DOD/DOE	No								
LUST	Yes	141	14	78	0	24	0	25	Gasoline, Diesel, Waste Oil
RCRA Corrective Action	Yes	25	1	7	8	6	5	3	Creosote, BTEX, Solvents,
Underground Injection	No								
State Sites*	No								
Non-point Sources	No								
Oil/Gas Activities	Yes								
Totals		170	16	87	9	30	5	28	

NPL - National Priority List
DOE - Department of Energy
LUST - Leaking Underground Storage Tanks
*These sites may be combined with NPL sites

CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOD - Department of Defense
RCRA - Resource Conservation and Recovery Act

Table 63. Groundwater Contamination Summary
Sparta Aquifer Outcrop (2006)

Source Type	Documented Groundwater Contamination Present in Reporting Area	Number of Sites With Confirmed Groundwater Contamination	Site Activity Status						Contaminants
			Contamination Confirmation	Ongoing Investigation	Corrective Action Planning	Corrective Action Implemented	Monitoring of Corrective Action	Action Completed	
NPL	No								
CERCLIS (non-NPL)	No								
DOD/DOE	No								
LUST	Yes	8	3	4	0	0	0	1	Gasoline, Diesel
RCRA Corrective Action	Yes	3	0	0	1	2	0	0	Nitrate, Chlorinated Solvents
Underground Injection	No								
State Sites*	No								
Non-point Sources	No								
Oil/Gas Activities	Yes								
Totals		11	3	4	1	2	0	1	

NPL - National Priority List
DOE - Department of Energy
LUST - Leaking Underground Storage Tanks
*These sites may be combined with NPL sites

CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOD - Department of Defense
RCRA - Resource Conservation and Recovery Act

Table 64. Groundwater Contamination Summary
West Texas Bolsons Aquifer Outcrop (2006)

Source Type	Documented Groundwater Contamination Present in Reporting Area	Number of Sites With Confirmed Groundwater Contamination	Site Activity Status						Contaminants
			Contamination Confirmation	Ongoing Investigation	Corrective Action Planning	Corrective Action Implemented	Monitoring of Corrective Action	Action Completed	
NPL	No								
CERCLIS (non-NPL)	No								
DOD/DOE	No								
LUST	No								
RCRA Corrective Action	No								
Underground Injection	No								
State Sites*	No								
Non-point Sources	No								
Oil/Gas Activities	No								
Totals									

NPL - National Priority List
DOE - Department of Energy
LUST - Leaking Underground Storage Tanks
*These sites may be combined with NPL sites

CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOD - Department of Defense
RCRA - Resource Conservation and Recovery Act

Table 65. Groundwater Contamination Summary
Yegua - Jackson Aquifer Outcrop (2006)

Source Type	Documented Groundwater Contamination Present in Reporting Area	Number of Sites With Confirmed Groundwater Contamination	Site Activity Status						Contaminants
			Contamination Confirmation	Ongoing Investigation	Corrective Action Planning	Corrective Action Implemented	Monitoring of Corrective Action	Action Completed	
NPL	No								
CERCLIS (non-NPL)	No								
DOD/DOE	No								
LUST	Yes	46	8	24	0	5	0	9	Gasoline, Diesel, Waste Oil
RCRA Corrective Action	Yes	14	0	9	4	2	3	0	Herbicides/Pesticides, Arsenic, PCP, Acetone, VOC's, Metals
Underground Injection	No								
State Sites*	No								
Non-point Sources	No								
Oil/Gas Activities	No								
Totals		60	8	33	4	7	3	9	

NPL - National Priority List
DOE - Department of Energy
LUST - Leaking Underground Storage Tanks
*These sites may be combined with NPL sites

CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOD - Department of Defense
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GROUNDWATER CONCERNS/ISSUES

Apparent groundwater concerns and issues that have been identified are discussed in this section.

Analysis of Nitrate Contamination in Groundwater in Texas

Nitrate is the most widespread groundwater contaminant in the U.S. (Nolan et al., 2002). High nitrate concentrations in groundwater can have adverse health impacts. Methemoglobinemia in infants is a potentially fatal disease and results from low oxygen levels in the blood caused by ingestion of high nitrate groundwater (Spalding and Exner, 1993). Increased risk of non-Hodgkin's lymphoma has been related to nitrate concentrations ≥4 mg N/L in community water supply wells in Nebraska (Ward et al., 1996). Toxicological studies indicate that multi-contaminant exposure may have a much greater impact on health than exposure to single pure contaminants because of additive or synergistic interactions among compounds (Squillace et al., 2002). Adverse health impacts are much greater for mixtures of nitrate and pesticides (Porter et al., 1999) and suggest that the MCL for nitrate may be reduced in the future, which would greatly affect water availability in Texas. Nitrate concentrations ≥2 mg/L in groundwater are considered to be impacted by human activities (Mueller and Helsel, 1996). High groundwater nitrate concentrations can also have adverse impacts on water quality of streams and estuaries by causing eutrophication and algal blooms (e.g. Mississippi River and Gulf of Mexico, Chesapeake Bay) (Donner and Kucharik, 2003; Jordan et al., 1997).

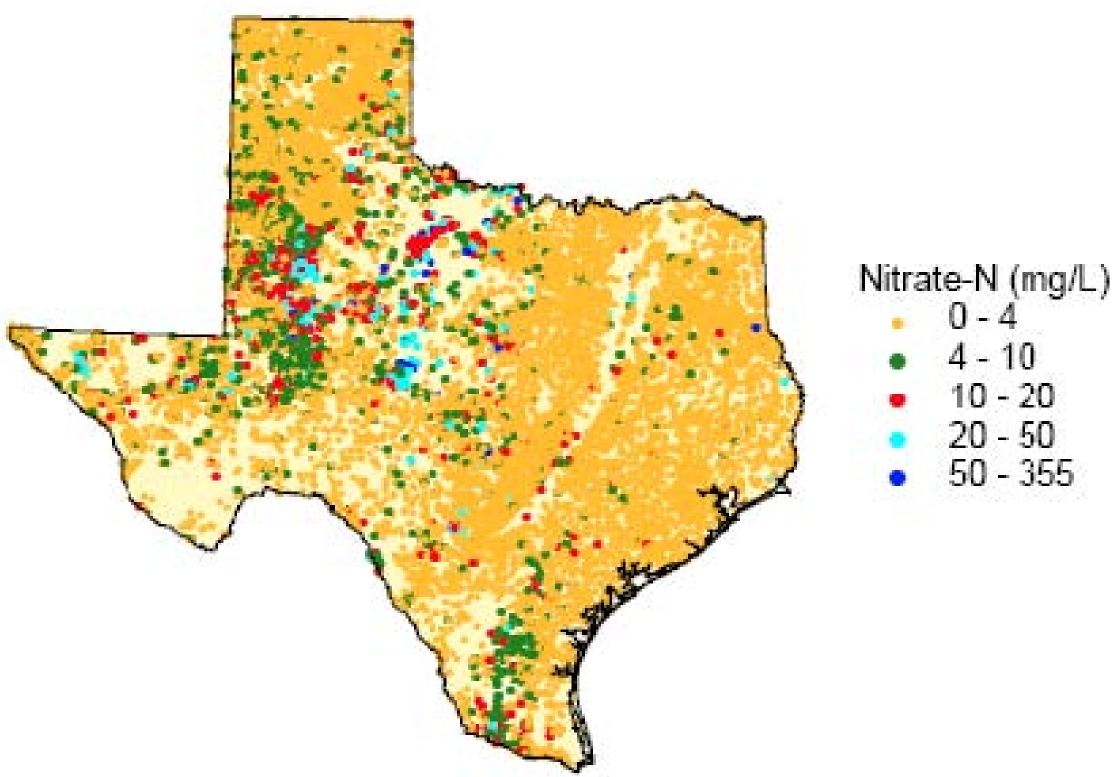
Nitrate is highly soluble in water and is not prone to ion exchange (Stumm and Morgan, 1996). The anionic form of nitrate does not sorb onto clay particles which are also negatively charged under normal pH conditions. Nitrate also cannot be lost through volatilization because it is nonvolatile. The high solubility and mobility of nitrate results in nitrate being readily leached through the soil zone to underlying aquifers. Nitrate is not affected by chlorination, the most common method of treating most public water. It can be removed from water by reverse osmosis, although this is an expensive process. Additional treatment technologies include ion exchange and denitrification (Kapoor and Viraraghavan, 1997). Commonly water supply companies try to reduce nitrate concentrations by blending water with groundwater/or surface water that contains low nitrate concentrations. Another water treatment option involves extending wells to greater depths where nitrate concentrations are often lower (McMahon et al., 2003).

Potential sources of nitrate contamination in groundwater include atmospheric deposition, natural sources, inorganic fertilizer, organic fertilizer or manure, concentrated animal feeding operations (CAFOs), barnyards, septic tanks, and leaking sewer systems.

Bureau of Economic Geology, Jackson School of Geosciences, University of Texas at Austin entered into a cooperative agreement with the TCEQ to characterize nitrate reservoirs beneath natural ecosystems and irrigated and rainfed agricultural ecosystems in areas of high groundwater nitrate contamination in the Seymour, southern High Plains, and southern Gulf Coast aquifers.

According to the study, profiles were drilled beneath natural (24), and irrigated (22) and nonirrigated (44) ecosystems in the Seymour, southern High Plains (Ogallala), and southern Gulf Coast aquifers. Nitrate levels beneath natural rangeland ecosystems were generally low in the different aquifer regions (median 48.7 kg/ha, range 4.3 to 1035 kg/ha); however, nitrate accumulations were much higher at depth beneath cultivated areas which reflect precultivation rangeland conditions (median 392 kg/ha, range 8.0 to 1727 kg/ha). These data suggest that nitrate accumulations under current rangeland conditions may not be typical of those beneath rangeland conditions prior to cultivation. Nitrate accumulations beneath rainfed agriculture are moderate (median 80.3 kg/ha, range 0.4 to 1657 kg/ha), because of generally low to moderate fertilizer application rates added to pristine precipitation. In contrast, nitrate accumulations beneath irrigated agriculture are generally high (median 276 kg/ha, range 3.7 to 4677 kg/ha). In the southern High Plains, high levels of nitrate beneath irrigated areas are attributed to lack of flushing associated with deficit irrigation and therefore, may represent a threat of soil salinisation rather than groundwater contamination. High groundwater nitrate contamination prior to fertilization and irrigation in the Seymour aquifer, low to moderate fertilizer application rates, and low to moderate unsaturated zone nitrate accumulations indicate that high groundwater contamination may be related to natural nitrate sources prior to irrigation and to irrigation recycling. High groundwater nitrate contamination in the High Plains is restricted to the southern part of the southern High Plains where the water table is shallow (~82 ft) and saturated thickness is low (~45 ft). Nitrate loading is moderate to high in this region and nitrate reservoirs in the unsaturated zone are high in deep profiles representing rangeland conditions prior to cultivation. Large nitrate accumulations in irrigated areas reflect evapotranspirative concentration caused by a lack of flushing related to deficit irrigation. Groundwater nitrate contamination may increase in the future if these nitrate reservoirs are mobilized. Insufficient data are available for the southern Gulf Coast to evaluate spatial and temporal trends. Unsaturated zone data are extremely useful in linking surface loading with groundwater nitrate levels and developing a comprehensive understanding of controls and timing of groundwater nitrate contamination.

Figure 3 shows the statewide distribution of nitrate contamination in groundwater in Texas.



Other Constituents of Concern in the selected Texas aquifers

Specific concerns for the Ogallala and Gulf Coast aquifers, and radionuclide concerns are described in this section.

Ogallala Aquifer

Concentrations above the MCL for nitrate are present throughout the extent of the aquifer. Higher Concentrations of Nitrate are found especially in the Southern part of High Plains region. Special concern is warranted for ambient conditions that exceed 100 mg/l in Borden, Dawson, Lubbock, Lynn, Martin, Andrews and Midland counties. These sites are represented by red dots in Figure 4. The figure illustrates the distribution of nitrates in the aquifer.

The Ogallala aquifer showed areas of concern with respect to arsenic as well. Arsenic values below 10 micrograms per liter are illustrated by green dots in Figure 5. Yellow dots and red dots in the figure represent sites with ambient values at or above 10 micrograms per liter, the MCL that became effective in January 2006 in Texas. Special concern is warranted for ambient conditions that exceed 50ug/l in Glasscok, Dawson, Borden, Terry, and Yoakum counties.

There are also concern with fluoride concentrations in the Ogallala, particularly in the same general areas that exhibit higher nitrate and arsenic concentrations. Ninety-nine percent of the wells sampled in Crosby, Floyd, Hockley, Lynn, and Terry counties exceed the secondary MCL for fluoride of 2 mg/l. In Hockley, Lubbock, Lynn and Terry counties, over half of the wells tested exceed the primary MCL of 4.0 mg/l. Wells sampled in Andrews, Armstrong, Briscoe, Cochran, Dallam, Gaines, Hale, Parmer and Randall counties also show detections above both the primary and secondary MCLs for fluoride. Figure 6 shows the distribution of fluoride contamination in the Ogallala aquifer.

Figure 4. Distribution of Nitrate in the Ogallala Aquifer

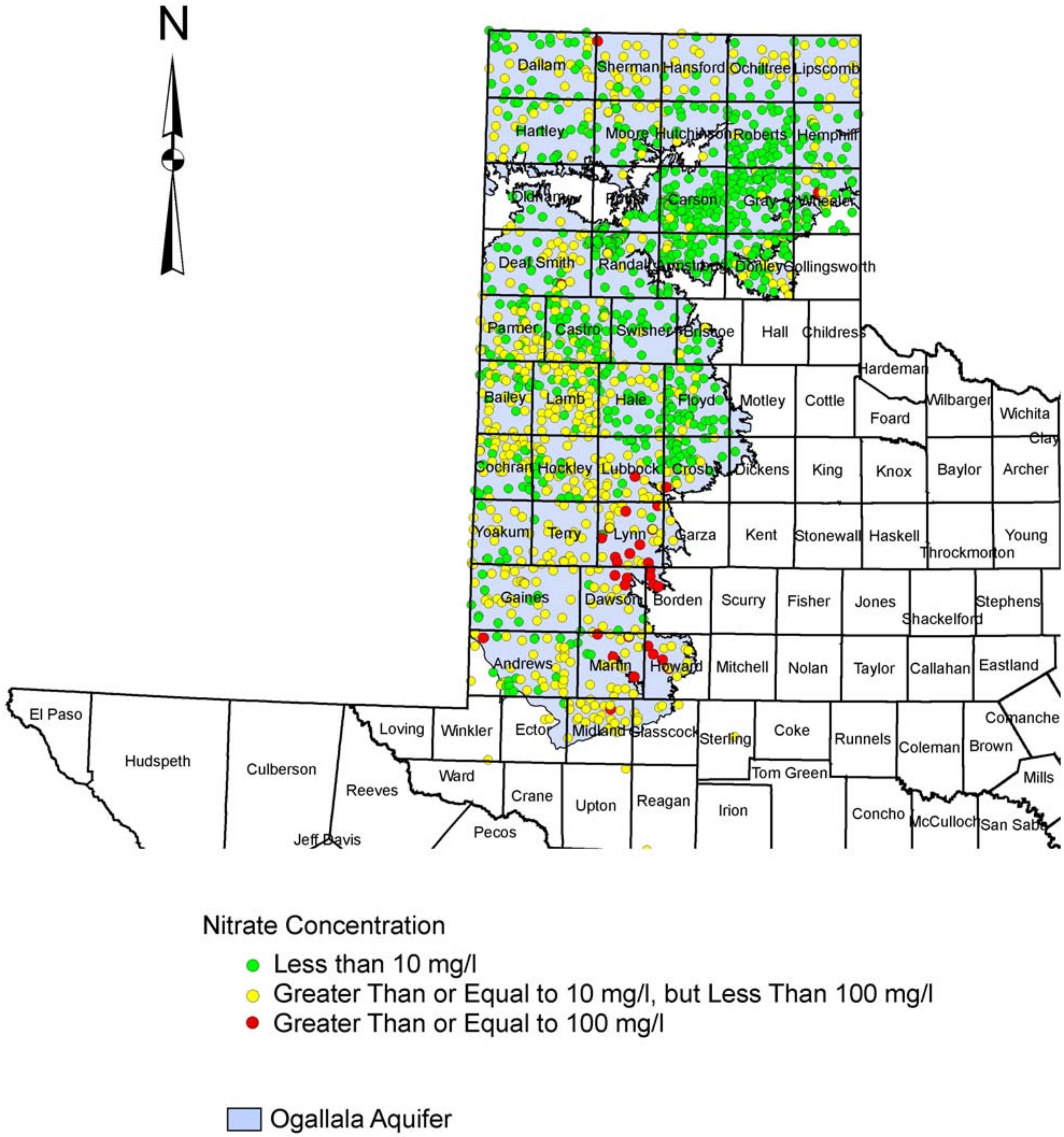


Figure 5. Distribution of Arsenic in the Ogallala Aquifer

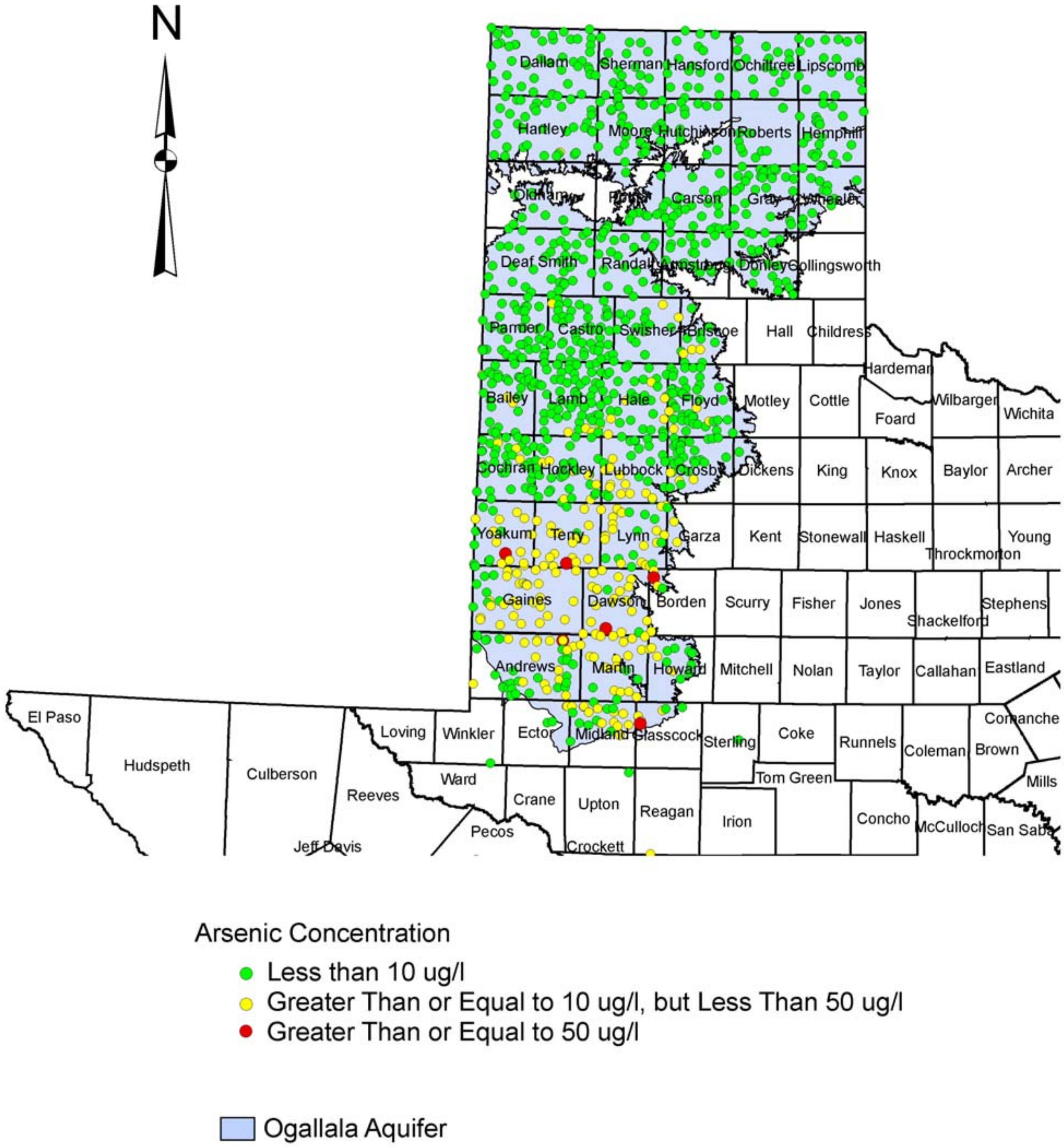
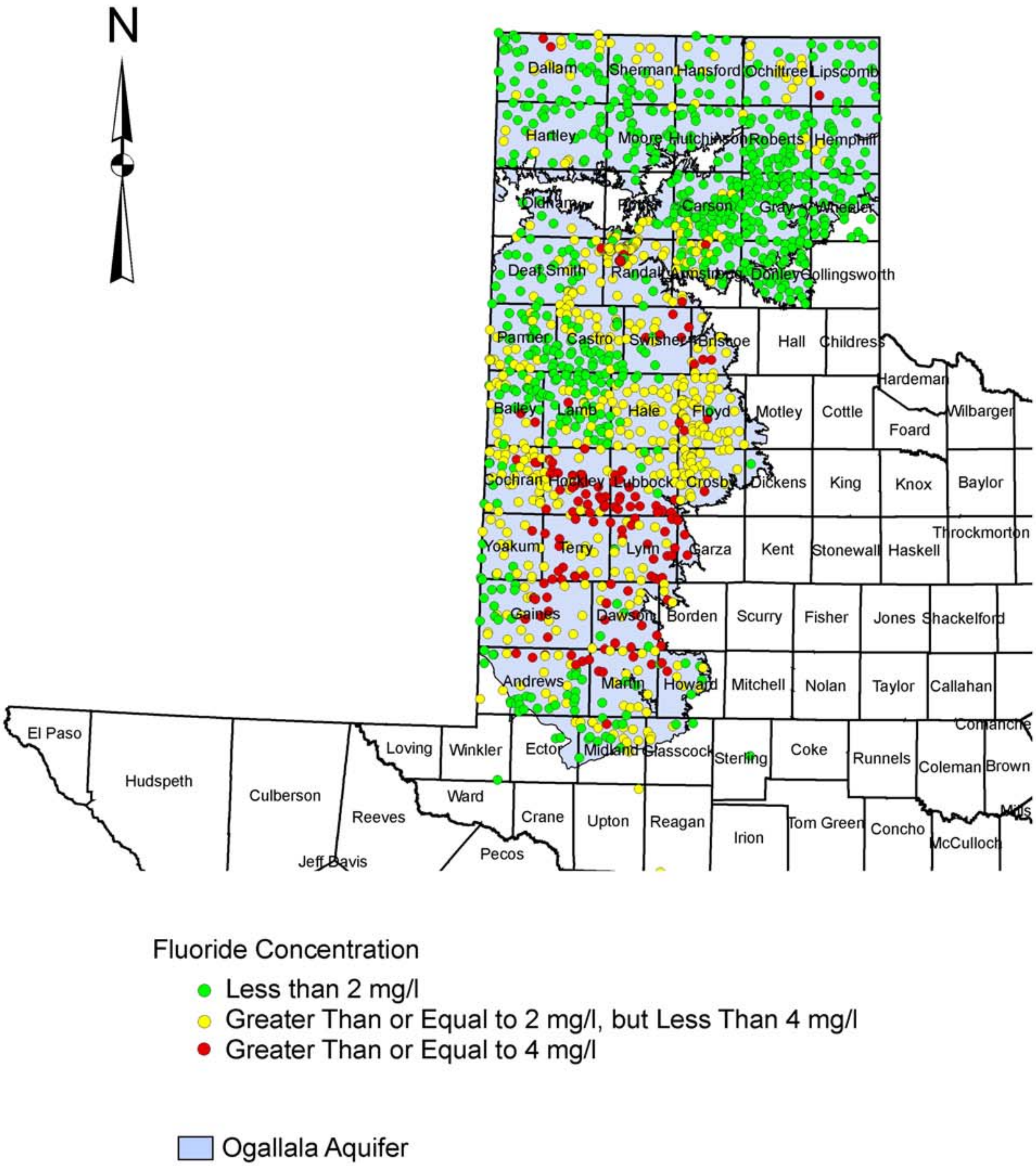


Figure.6. Distribution of Fluoride in the Ogallala Aquifer



Gulf Coast Aquifer:

The distribution of nitrates in the Gulf Cast aquifer is not as widely distributed as in the Ogallala aquifer. Concentrations above the primary MCL of 10 milligrams per liter for nitrate are present in far south Texas, mainly the counties of Hidalgo, Starr, Jim Hogg, Brooks, Duval, Jim Wells, Kleberg, Webb, McMullen, Live Oak, Bee, and Karnes. Also, De Witt, Victoria, Calhoun, Wharton, Fort Bend, Liberty, Gonzales, and Hardin counties have detections of nitrate above the MCL, though the occurrence of values exceeding the MCL is substantially less frequent than the previously listed counties. Figure 7 depicts concentrations that exceed the MCL, represented with yellow and red dots. Ambient conditions indicated that the highest concentrations exceeding 100 mg/l are found in Star County.

As with the Ogallala aquifer, the Gulf Coast aquifer shares some concern over the presence of arsenic. In Figure 8, arsenic values below 10 micrograms per liter are represented by green dots; yellow and red dots represent sites with ambient values at or above MCL of 10 micrograms per liter. Thirty-two counties have concentrations of arsenic exceeding the MCL in more than 25% of the wells sampled. Five counties, Starr, Webb, Jim Hogg, Duval and Karnes have a total of eight wells exceeded 50 micrograms per liter.

Figure 7. Distribution of Nitrate in the Gulf Coast Aquifer

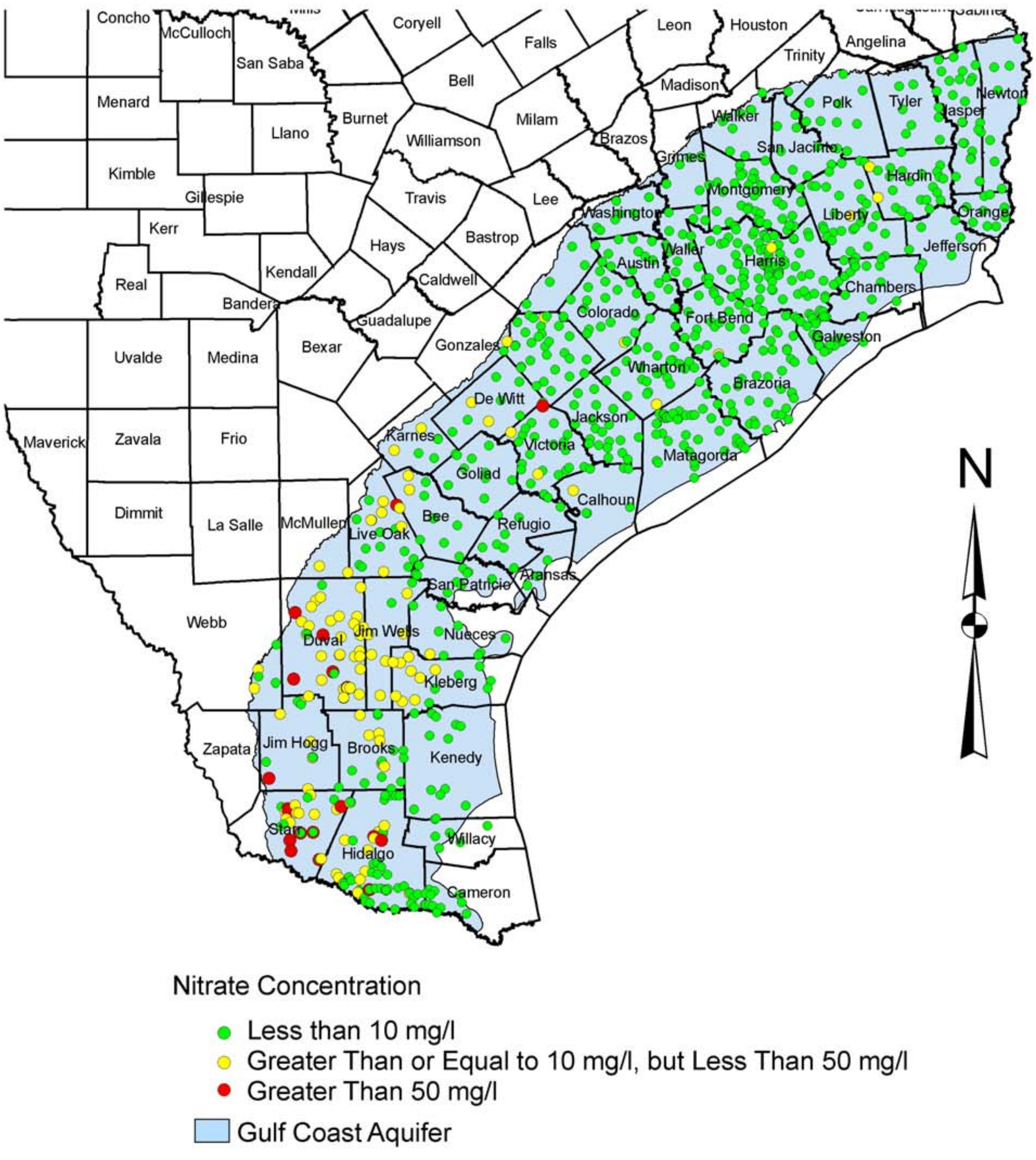
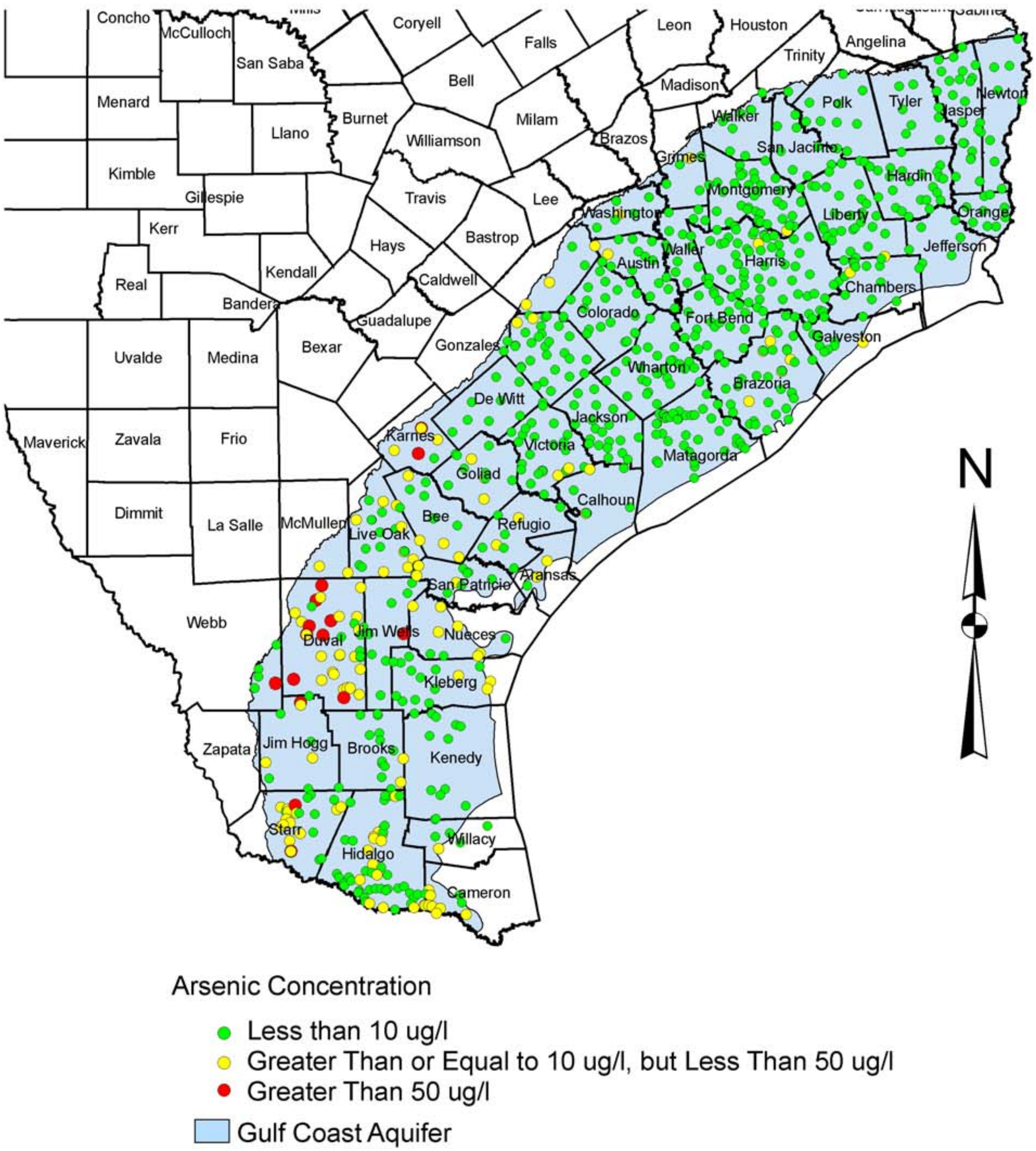


Figure 8. Distribution of Arsenic in the Gulf Coast Aquifer



Radionuclides

Radioactive elements such as uranium and thorium are found naturally in rocks and mineral in the earth's crust in varying amounts. Uranium and thorium slowly transform into radium and radon over millions of years through the release of energy.

The ionizing radiation emitted by radium is alpha and beta radiation. Alpha particles move slowly but cannot penetrate skin. Beta particles can penetrate skin but only through the surficial layer. If radium is ingested, however, especially dissolved in water, then the emitted alpha and beta particle radiation can come into contact with, ionize, and damage internal cell tissue. Radium in drinking water is known to increase cancer risk, primarily bone and sinus cancers.

Depending on their chemical properties, radionuclides may accumulate in some drinking water supplies over time, ultimately reaching concentrations that mandate some concern.

Most drinking water sources have very low levels of naturally occurring radionuclides, that are generally not present in sufficient concentrations to pose a serious public health threat.

Alpha radiation is measured in picocuries per liter (pCi/L). The EPA has set a maximum contaminant level of 15 pci/liter for adjusted gross alpha. Gross alpha is the total alpha counts minus alpha counts from uranium and radon. Figure 9 shows the distribution of alpha particle activity in the selected state aquifers.

Figure 9. Distribution of alpha particle activity in the selected state aquifers.