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Texas Groundwater Protection Strategy

Prepared by the
Texas Groundwater Protection Committee

Contributing State Agencies and Organizations

Texas Commission on Environmental Quality

Texas Water Development Board

Railroad Commission of Texas

Texas Department of Health

Texas Department of Agriculture

Texas State Soil and Water Conservation Board

Texas Alliance of Groundwater Districts

Texas Agricultural Experiment Station

Bureau of Economic Geology

Texas Department of Licensing and Regulation

Artesian well at San Leon, Galveston County, Texas 1891.
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www.tgpc.state.tx.us

Committee Membership:

Texas Commission on Environmental Quality
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INTRODUCTION

One of Texas' most valued natural resources is its ground and surface water resources. In 1999, groundwater provided approximately 58 percent of the water used in the state, and it is a fundamental component of the state's water supply. In addition, groundwater provides a significant amount of the base flow for the state's rivers and streams, and is, therefore, important to the maintenance of the state's environment and economy.

The state Legislature recognized the importance of groundwater when, in 1989, it created the Texas Groundwater Protection Committee (TGPC), and charged the committee to *" . . . develop and update a comprehensive groundwater protection strategy for the state that provides guidelines for the prevention of contamination and for the conservation of groundwater and that provides for the coordination of the groundwater protection activities of the agencies represented on the committee . . .."* (Water Code Section 26.405(2)).

The TGPC is composed of nine state agencies and the Texas Alliance of Groundwater Districts (TAGD). Members of the TGPC represent the primary state agencies and groundwater districts entrusted by the Legislature with the conservation, protection — and where necessary — the remediation of groundwater.

The state's first groundwater protection strategy was published in January 1988 and the TGPC has not revised it until now. However, the TGPC has undertaken several efforts to describe the groundwater protection program and responsibilities of state agencies including documents such as the *Texas Ground Water Protection Profiles, 1991,* and later in each annual *Joint Groundwater Monitoring and Contamination Report*.[1] In addition, the TGPC has worked on an unpublished Comprehensive Groundwater Protection Plan, a nonmandatory U.S. Environmental Protection Agency effort, which was the basis for this document.

Since the strategy was first published, the nature and extent of the state's water quality and quantity programs have changed dramatically. For example, in the water quality program area, the Leaking Underground Storage Tank program was in its infancy with a total of 954 confirmed cases. In 2001, there were 5,540 active leaking underground storage tank cases and 6,122 cases in which clean up had been completed.

[1]Documents are available from the Texas Commission on Environmental Quality publications website at http://www.tceq.state.tx.us/AC/comm_exec/forms_pubs/

Similarly, the state has found new ways to address the issues of water conservation and supply. The Legislature, recognizing the need to address long-term water supply in new ways, created a stakeholder-based regional and state water planning effort. Also among the changes to water supply and conservation efforts has been the growth of locally controlled groundwater districts that can regulate groundwater pumpage and well spacing to help ensure continued and equitable groundwater supply and distribution.

Acknowledging the changes that have occurred since the publication of the state's first groundwater protection strategy, the TGPC decided in January 2001 to begin the process to update it. That process has resulted in this document, *Texas Groundwater Protection Strategy (2003).*

In developing the current *Strategy*, the TGPC recognized that the state has many successful groundwater programs spread across local and state governmental agencies and research institutions. Therefore, a key component of this *Strategy* documents how the current regulatory, outreach, and research programs work to protect groundwater resources.

The second component identifies protection gaps in program implementation or coordination. TGPC believes that this approach to developing the strategy, grounded firmly within the existing policy and programmatic directions given by the Legislature, will result in a document that sets realistic objectives for success and provides a road map for action over the next five years (the TGPC's short-term planning horizon).

The TGPC acknowledges that this *Strategy* does not contain a prioritized analysis of whether the state's groundwater quality resources are adequately protected for current and future uses. As part of the ongoing development of the next *Strategy*, the TGPC intends to conduct an analysis to identify and rank threats to groundwater quality (taking into consideration the vulnerability of groundwater resources and using available data) and to prioritize possible actions that address those threats. Such an analysis would provide a valuable tool to both TGPC member agencies and the Legislature in setting groundwater policy for the state.

The TGPC, as part of its outreach activities, requested public comment on the draft *Texas Groundwater Protection Strategy* in the December 13, 2002 *Texas Register*. The deadline for submission of comments was January 17, 2003. Three sets of comments were received. A summary of those comments and the TGPC's responses can be found in Appendix 3.

The strategy described in this document:

- details the state's groundwater protection goal as established by the Legislature;
- explains the statewide groundwater classification system and how the state goes about identifying contamination;
- 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 carry out groundwater protection programs through regulatory and nonregulatory 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 ranking 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.

CHAPTER I: THE POLICY FRAMEWORK FOR GROUNDWATER PROTECTION

Three overarching principles guide state groundwater management: (1) the policy of nondegradation of groundwater quality established in the state's Groundwater Goal and Policy (TWC Section 26.401); (2) stakeholder and regionally based planning for ground and surface water that is the cornerstone of the state's water planning effort; and (3) local control of groundwater quantity management through groundwater conservation districts.

The State Groundwater Protection Goal

In establishing the State's groundwater protection goal (see Figure 1.1) the Legislature recognized the need to protect the state's groundwater resources from contamination and degradation while simultaneously maintaining existing and potential uses. The goal acknowledges the variability of the state's aquifers and emphasizes protection of public health and the environment, while maintaining the long-term economic health of the state.

Further, the goal 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 goal also recognizes the use of the best professional judgement by the responsible state agencies in attaining the goal and policies.

Importantly, the goal states that nondegradation does not mean zero-contaminant discharge. Discharges of pollutants, disposal of wastes, and other regulated activities must 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 required to generally meet this goal and implement the state's policy.

Figure 1.1

Texas Groundwater Protection Goal

TWC Section 26.401.

Legislative Findings:

(a) The Legislature finds that: (1) in order to safeguard present and future groundwater supplies, usable and potentially usable groundwater must be protected and maintained; (2) protection of the environment and public health and welfare requires that groundwater be kept reasonably free of contaminants that interfere with present and potential uses of groundwater; (3) 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; 4) the various existing and potential groundwater uses are important to the state economy; and (5) aquifers vary both in their potential for beneficial use and in their susceptibility to contamination.

(b) The Legislature determines that, consistent with the protection of the public health and welfare, the propagation and protection of terrestrial and aquatic life, the protection of the environment, the operation of existing industries, and the maintenance and enhancement of the long-term economic health of the state, it is the goal of groundwater policy in this state that the existing quality of groundwater not be degraded. This goal of nondegradation does not mean zero-contaminant discharge.

(c) It is the policy of this state that: (1) discharges of pollutants, disposal of wastes, or other activities subject to regulation by state agencies be conducted in a manner that will maintain present uses and not impair potential uses of groundwater or pose a public health hazard; and (2) the quality of groundwater be restored if feasible.

(d) The Legislature recognizes the important role of the use of the best professional judgment of the responsible state agencies in attaining the groundwater goal and policy of this state.

Added by Acts 1989, 71st Leg., ch. 768, Sec. 1, effective September. 1, 1989.

State Water Planning Process

Regional and stakeholder-based water planning is the second overarching principle guiding the management of groundwater in Texas. There is a long history of water planning in Texas due to the frequency of droughts and the demands of economic development. Population growth and competition for existing supplies underline the importance and need for comprehensive water planning. State law establishes the mandate for water planning (both ground and surface water) and charges the Texas Water Development Board (TWDB) with its implementation.

The State's water planning process is based on Regional Water Plans developed by stakeholder-based Regional Water Planning Groups. The State Water Plan also includes the input of the state's natural resource protection agencies: the Texas Commission on Environmental Quality, the Texas Parks and Wildlife Department, and the Texas Department of Agriculture.

The State Water Plan is prepared on a five-year cycle with the most recent plan, *Water for Texas - 2002*, adopted by the TWDB in December 2001. The 2002 State Water Plan is the result of three years of efforts by 16 Regional Water Planning Groups, regional representatives, nearly 900 public meetings and hearings, and the combined efforts of the state's natural resource management agencies. It also provides for detailed water management over the next 50 years. The plan identifies all water user groups in the state, records the projected water demand for each user group over the 50-year planning period, indicates whether the user group needs additional water in the future, and provides water management strategies to meet the projected need.

Groundwater Conservation and Management

Figure 1.2

State Water Plan

TWC Section 16.051

The State Water Plan shall provide for the orderly development, management, and conservation of water resources and preparation for and response to drought conditions, in order that sufficient water will be available at a reasonable cost to ensure public health, safety, and welfare; further economic development; and protect the agricultural and natural resources of the entire state.

The third principle guiding groundwater policy implementation in Texas is local control of groundwater withdrawal. Thus, Texas state law treats groundwater conservation and management differently than surface water management.

Courts have applied the "rule of capture" for landowners' damage claims arising from the withdrawal of groundwater. The doctrine and its interpretation provide that groundwater captured by a well and delivered to the surface is the property of the landowner with only a few limitations. The courts have also recognized the authority granted by the Texas Constitution to the state to conserve and protect natural resources.

Balancing landowner interests and the finite nature of groundwater resources, the Legislature in 1949 set out a mechanism for local management of groundwater. Local groundwater conservation districts could be created subject to local initiative with voter confirmation for taxing authority. The Legislature further empowered districts through Senate Bill 1 (75th Legislature, 1997) and Senate Bill 2 (77th Legislature, 2001) strengthening the mechanisms for management of groundwater. The TWC Section 36.0015 (see Figure 1.3) states that groundwater conservation districts are the state's preferred method of groundwater management.

As of February 2003, 80 groundwater conservation districts have been established in Texas covering all or parts of 119 counties. Another nine districts have been created by the Legislature that await voter confirmation

Figure 1.3

Purpose of Groundwater Conservation Districts

TWC Section 36.0015

Groundwater Conservation Districts: Purpose

In order to provide for the conservation, preservation, protection, recharging, and prevention of waste of groundwater, and of groundwater reservoirs or their subdivisions, and to control subsidence caused by withdrawal of water from those groundwater reservoirs or their subdivisions, consistent with the objectives of Section 59, Article XVI, Texas Constitution, groundwater conservation districts may be created as provided by this chapter. Groundwater conservation districts created as provided by this chapter are the state's preferred method of groundwater management.

elections. State law empowers these districts to adopt and carry out management plans, rules, and permits for the conservation, preservation, and protection of groundwater and the prevention of the waste of groundwater in their jurisdiction. Fifty-one districts have adopted management plans that set out the goals of the individual districts consistent with state law and the regional and state water plans.

CHAPTER II: CHARACTERIZING THE STATE'S GROUNDWATER RESOURCES

In order to carry out the goals and policy of the state for conservation and protection of groundwater (Chapter I), it is essential to understand the occurrence and movement of groundwater and its uses. It is equally important to assess or gauge the usability of water resources based on quality considerations. The state's policy addresses protection of water quality to preserve present and potential uses and the cleanup of groundwater which may have become contaminated. The work of state agencies including protection and corrective action measures are based on scientific principles, standards and measures.

Assessing the occurrence of groundwater includes many facets. Generally, the occurrence of groundwater can be described through maps or through delineation of the surface and subsurface extent of groundwater present in distinct geologic units. Once identified, further study and characterization are required to understand the effects of pumpage and the movement of contaminants.

Groundwater can be described by the type of use (for example, municipal or irrigation), volume of use, and location of the use. The usability of groundwater depends to a great degree on the quality of the water. Determination of water quality is necessary to estimate the amount of groundwater available for use and to track impacts to water quality that might affect the current or future use of the water.

Aquifers vary both in their potential for beneficial use and in their susceptibility to contamination. Comparative processes are used to assess aquifers in order to implement a protection policy and to provide for restoration where feasible. The goals of groundwater protection and restoration can be facilitated by classifications of groundwater or aquifers based on water quality, on use, yield or availability and on vulnerability. Texas uses a number of the mechanisms discussed in this chapter — groundwater classification systems and standards, facility and contamination inventories, and key identifiers such as aquifer maps — to characterize groundwater.

Aquifer Mapping

Groundwater is water that occurs beneath the land surface in porous or fractured rock and sediments. Aquifers are distinct geologic units that contain a significant amount of retrievable water with generally similar quality and hydrologic characteristics. Aquifer mapping identifies the boundaries of specific aquifers based on their geologic and hydrologic characteristics.

The state is committed to mapping and characterizing its groundwater resources. Primary responsibilities and efforts for mapping are carried out by the Texas Water Development Board (TWDB) through its water planning activities; and by the Bureau of Economic Geology, as the state's geological survey. Since mapping aquifers requires significant technical resources and effort, priorities have been established based on their significance as a source of supply.

Major and Minor Aquifer Delineations

The TWDB is authorized by the Texas Water Code to conduct studies and mapping of water resources in the state. The TWDB has identified the state's aquifers, and delineated the boundaries of major and minor aquifers based on yields and significance of aquifer production. The maps are published and periodically revised. The most recent publication is TWDB Report 345, *Aquifers of Texas*.[2]

Figure 2.1

Major and Minor Aquifers

A major aquifer is generally defined as supplying large quantities of water in large areas of the state.

Minor aquifers typically supply large quantities of water in small areas or relatively small quantities in large areas.

These maps depict the extent of each aquifer, including its recharge zone, where it occurs below ground, and where it is exposed at the surface. In mapping the underground extent of the aquifer, a water quality boundary is generally used. For most aquifers, a dissolved solids concentration of 3,000 milligrams per liter is used to mark the boundary of usable quality water. The boundary of the Edwards Aquifer is defined by a dissolved solids concentration of 1,000 milligrams per liter.

Groundwater Management Area Designations

From a conservation and management perspective, aquifer mapping is necessary to identify the manageable units of an aquifer. A manageable unit is one where pumping outside the area does not affect the water resource within the area. It is also important to identify areas that are experiencing critical problems associated with the overpumping of groundwater. Chapter 35 of the Water Code provides for the delineation

[2]The report is available from the Texas Water Development Board website at http://www.twdb.state.tx.us/publications/pub.htm

and designation of ***Groundwater Management Areas*** (GMAs) and ***Priority Groundwater Management Areas*** (PGMAs). The delineations of these areas are the responsibility, respectively, of the TWDB and the TCEQ.

A ***Groundwater Management Area*** is an area of the state that has been identified by the TWDB as suitable for the management of groundwater resources. The purpose for designation of a GMA is twofold. A GMA must be designated before a Groundwater Conservation District (GCD) can be created administratively by the TCEQ in response to a landowner district-creation petition. In addition, GCDs that are located in a common GMA are required to coordinate groundwater management planning for conservation of the common groundwater resources.

A ***Priority Groundwater Management Area*** is defined as an area designated and mapped by the TCEQ that is experiencing or is expected to experience (within the immediately following 25-year period) critical groundwater problems, including shortages of surface water or groundwater, land subsidence resulting from groundwater withdrawal, and contamination of groundwater supplies. Landowners in a designated PGMA are provided the opportunity to establish a GCD in a designated PGMA; however, if no such action is taken, the TCEQ is required to establish a GCD to address identified critical groundwater problems.

Groundwater Classification and Standards

A water quality classification system can be used to identify which aquifers have usable quality waters and to compare aquifers. Standards can be employed to assess which constituents and concentrations pose risks of impairing the use of the water or to assess usability at a specific location. Water quality standards can be used to describe a set of characteristics of water, such as a measured concentration of dissolved solids to describe salinity. Standards are also used for individual constituents to identify a concentration that has a negative or positive impact on the use of the water. Classifications and standards can be employed in both water quality protection programs and remediation programs.

Groundwater Classification System

The TGPC has developed a water quality classification system for groundwater that guides the state's groundwater protection programs. Under the groundwater classification system, four classes are defined based on quality as determined by Total Dissolved Solids (TDS) content (Appendix 1). TDS is constituents in groundwater dissolved from the surrounding rock. Through classification, groundwater can be categorized, and protection or restoration decisions can be made by state agencies according to the water quality and present or potential use of the groundwater.

It is implicit in the classification system that a water-bearing zone must be able to produce sufficient quantities of water to meet its intended use. In assigning a classification, agencies endeavor to use the natural quality of the groundwater that is unaffected by discharges of pollutants from human activities.

A general classification employing dissolved solids or salinity can identify groundwater that is to be protected from degradation and subject to the use of protective measures for specific activities. Examples include surface casing and cementing requirements for oil and gas production wells for aquifers with dissolved solids concentrations of less than 3,000 milligrams per liter.

The classification system is implemented by TGPC-member agencies as an integral part of their groundwater programs. The system serves as a common basis among the various programs to foster regulatory consistency. It is also used as a mapping tool to delineate specific areas in need of more detailed groundwater quality management. The classification system has been used previously to define usable quality groundwater for both protection purposes and as a planning tool to identify the availability of groundwater for future or potential use.

Groundwater Standards

Since the legislatively mandated goal of nondegradation guides groundwater programs, the state has not developed standards for pollutant discharge to groundwater. However, the state has developed surface water quality standards applicable for certain water bodies that are protective of groundwater affected by surface water. Additionally, for the recharge zone of the Edward Aquifer, the state has developed water quality protection measures that specify groundwater recharge as a “designated use” in the state’s surface water quality standards.

Risk-Based Cleanup Standards

A risk-based approach to environmental remediation takes into consideration the actual or reasonable potential for public and environmental exposure to contaminants in the determination of the timing, type, and degree of site remediation. Risk assessment is the process used to quantify the potential adverse effects to human health due to exposure to chemicals. A risk assessment process was first proposed by the National Academy of Sciences (NAS) in the 1983 publication *Risk Assessment in the Federal Government: Managing the Process*. The basic process proposed by the NAS is the foundation for most published risk assessment guidance documents developed by state and federal regulatory agencies and has been used to guide risk-based approaches in Texas.

The state's policy requires that groundwater be kept reasonably free of contaminants that would interfere with present uses or impair future uses, and that the quality of groundwater be restored if feasible. Risk-based remediation provides a scientifically-based approach that can address both restoration and feasibility. While a statewide risk-based cleanup policy has not been implemented, the TCEQ has developed an approach that focuses on protection of groundwater uses. The program focuses on the ability to manage and prevent exposure of humans and the environment to chemicals of concern. The Railroad Commission of Texas also uses a remediation approach that provides risk-based options.

The TCEQ, which has primary jurisdiction for the regulatory protection of groundwater and is responsible for overseeing 97 percent of the state's documented groundwater contamination cases currently under investigation, is implementing a risk-based approach in setting cleanup levels that is based on sound science, flexibility, and common sense. The TCEQ Texas Risk Reduction Program (TRRP) regulates the cleanup and management of hazardous wastes and substances, referred to as chemicals of concern (COCs). The TRRP sets out requirements for how to determine whether releases or closures pose unacceptable risk. If they do, the program defines requirements for what must be done to reduce the risk of exposure, prevent pollution, or protect natural resources.

The TRRP rule appears in 30 TAC Chapter 350 and became effective on September 23, 1999. On May 1, 2000, TRRP became mandatory for all remediation activities except petroleum storage tanks (PST). The rule becomes effective for the new PST cases on September 1, 2003. Risk-based corrective action ensures protection of human health and the environment while making response actions more economically feasible than cleanup to naturally occurring background levels.

The state's policy on groundwater contamination provides that water quality be restored if feasible. The determination of feasibility examines the adequacy of remediation or groundwater cleanup technologies, the economic costs of remediating contaminated groundwater to its original condition, and the ability to manage and prevent exposure to contamination.

Technical feasibility issues include the ability to completely withdraw the affected groundwater and the ability to remove or treat all contaminants to background concentrations. Economic feasibility includes issues such as the high cost of sophisticated treatment technologies and the long time periods required to retrieve the affected groundwater for treatment.

In many cases contaminated groundwater cannot be restored to its original quality, and significant costs are incurred at many sites in the recovery and treatment of groundwater. It may not be technically possible or cost-effective in all cases to clean up groundwater to its original quality. In

most cases, sites are remediated to human health or ecological risk-based standards. Natural attenuation is frequently relied on as a groundwater restoration or control mechanism.

Contamination of groundwater by oil and gas activities is approached on a case-by-case basis by the Railroad Commission of Texas (RCT). In environmental remediation cases, the RCT looks first to the responsible operator or person whose operations have caused the contamination. The majority of these cleanups result from violations of RCT's statewide rules for groundwater and surface water protection. Cleanup options available for these sites include:

- cleanup to background;
- cleanup to conservative risk-based levels (for example, TCEQ TRRP Tier 1, Texas Surface Water Quality Standards, Federal Drinking Water Standards, EPA Soil Screening Criteria, and others.); and
- risk-assessment driven cleanup utilizing site-specific considerations and data.

Regardless of ultimate closure options, when groundwater is contaminated, free-phase hydrocarbons are expected to be removed; and full delineation of contamination in all directions is performed. For the purpose of establishing consistency for groundwater, RCT staff may use as guidance the TRRP groundwater resource classification system that is based on the Texas Groundwater Protection Committee's classification (Appendix 1). The RCT gives additional consideration to low-yielding formations from which windmill pumps are able to provide water for stock.

Aquifer Vulnerability Assessment

Vulnerability of an aquifer to contamination has two components: the environmental pathway that a contaminant would take to reach the groundwater, and the source and type of contaminants that result from activities conducted above the aquifer. Aquifer vulnerability is related to the physical, hydrological and biological characteristics of the soil, the unsaturated (non–water-producing) upper portion of the aquifer and the water-bearing portion. Characteristics such as permeability and processes such as natural attenuation affect the movement and alteration of contaminants. These characteristics vary greatly among aquifers in Texas, such that aquifers have different vulnerabilities to contamination. Different parts of the same aquifer may have different vulnerabilities.

The potential for impact on an aquifer is dependent on what activities are occurring above an aquifer or in its recharge zone. An inventory of activities can be identified that have impacted an aquifer. Such contamination inventories should include locational information for the source and assessment of the likely risk of contaminant release.

State agencies, primarily the TCEQ, have utilized a number of aquifer vulnerability assessment methods to facilitate groundwater quality protection. These methods generally involve the identification of specific aquifer and environmental characteristics, evaluation of aquifers for the identified characteristics, and mapping of aquifer areas according to relative or comparative vulnerability. The examples that follow, DRASTIC, the state pesticide management plan, and the Edwards Aquifer Program, show a range in scope from more general guidance to specific regulatory approach.

DRASTIC

Vulnerability mapping of the state's aquifers was begun by the Texas Water Commission (predecessor of the TCEQ) in 1987. DRASTIC, a methodology for delineating sensitivity to groundwater pollution, was developed in the mid-1980's by the combined efforts of the National Water Well Association and the Robert S. Kerr Environmental Research Laboratory to serve as a tool in groundwater assessment. DRASTIC mapping was undertaken as an attempt to classify Texas aquifers according to their pollution potential. The objective was to develop two maps, one depicting general vulnerability to groundwater pollution from point sources and the other specifically aimed at groundwater pollution from certain agricultural, or nonpoint source practices. TCEQ's DRASTIC maps are intended as guidance for program planning and priority setting.

Figure 2.2

DRASTIC

D - **D**epth to water

R - annual **R**echarge

A - **A**quifer media

S - **S**oil media

T - **T**opography

I - vadose zone **I**mpact

C - hydraulic **C**onductivity

DRASTIC is a systematic process for assessing the groundwater pollution potential of hydrogeologic settings. Hydrogeologic settings are delineated based on seven parameters, which are used to develop a single index number for each setting. The parameters used in the DRASTIC system are a combination of geologic, hydrologic, geomorphologic, and meteorologic factors that describe physical characteristics of the hydrogeologic setting.

Pesticide Management Plan

The *Texas State Management Plan for Prevention of Pesticide Contamination of Groundwater* (SFR-070/01) was prepared for the TCEQ by participating members of the TGPC in 2000. The plan includes a method of vulnerability assessment targeted specifically at pesticides. The approach is a stepwise analysis that will be used in the development of a vulnerability map necessary for the planning of pesticide monitoring activities. The analysis involves a three-step process, with each taking into consideration a different aspect of vulnerability. An optional fourth step would be used if further focusing was needed. The levels of analysis are soils evaluation, pesticide use demarcation, aquifer permeability evaluation, and, if needed, detailed aquifer vulnerability.

Edwards Aquifer

The unique vulnerability of the Edwards Aquifer to contamination is generally accepted, based on its karstic and permeable recharge zone with significant percolation of surface waters. In 1989, the Texas Water Commission, a predecessor agency to the TCEQ, conducted statewide mapping and assessment to classify the relative vulnerability of all the major and minor aquifers in the state to manmade contamination. The agency used the DRASTIC system to determine relative vulnerability.

Because of its hydrogeologic character, the Edwards Aquifer ranked as the most vulnerable major aquifer in the state to manmade contamination. It is considered to be more susceptible to pollution from contaminants deposited on or flowing over the recharge zone than other aquifers in the state.

An example of how the state sets priority based on groundwater characteristics is reflected in the effort to protect the Edwards Aquifer. This aquifer has been recognized by both state and federal law as needing special protection because of its vulnerability to contamination and its importance as a high-quality water supply. Currently, over 1.7 million people in 11 counties rely upon the aquifer to meet their water supply needs. The TCEQ and its predecessor agencies have administered special water quality protection rules, 30 TAC Chapter 213, for the aquifer for approximately 31 years. The regulation of activities that can affect the quality of water recharging the aquifer protects the existing and potential uses of this water resource.

Facility and Contaminant Source Inventory

The potential for contamination and hence the vulnerability of groundwater resources is also related to the types of activities and any resulting contaminant releases that may reach an aquifer. Assessing vulnerability can be enhanced with knowledge of activities, facilities, potential sources of contamination, and actual cases of contamination affecting an aquifer. Inventories, such as databases and maps, provide information linking human activities to the vulnerable areas of aquifers.

Three types of inventories are often used to assess vulnerability: facility inventories, actual contamination cases, and inventories of potential sources of contamination. Facility inventories are files and databases maintained by regulatory agencies for activities that are permitted, registered, or part of a regulatory program.

Contamination Cases

An inventory of active groundwater contamination cases for Texas is maintained by the Texas Groundwater Protection Committee (TGPC), which is required by state law (TWC Section 26.405) to publish an annual joint groundwater monitoring and contamination report for all agencies represented on the TGPC. Further, state law (TWC Section 26.406) requires that each state agency "having responsibilities related to the protection of groundwater maintain a public file of all documented cases of groundwater contamination that are reasonably suspected of having been caused by activities regulated by the agency." All agencies on the committee are charged with compiling the contamination information.

Regulatory agencies that contribute to the report are the Texas Commission on Environmental Quality, the Texas Department of Agriculture, the Railroad Commission of Texas, the Texas Alliance of Groundwater District members, and the Texas Department of Licensing and Regulation. The contamination report has been published and distributed to the public and stakeholders annually since 1991.

State law requires that the report describe the current status of groundwater monitoring programs being conducted by the state agencies, describe each case of groundwater contamination documented in the previous year, and indicate the enforcement action. As an indication of the report's importance, the Legislature gave the TGPC rulemaking authority to develop report guidelines. A copy of the committee's rule can be found in Appendix 2.

Source Water Assessment Program (SWAP)

An inventory of potential sources of contamination depicted on an aquifer map is a more detailed and useful inventory than a listing of facilities. Such an effort was begun at the Texas Water Commission, a predecessor of TCEQ, with wellhead protection delineations and inventories in the late 1980s and with the establishment of the Texas Wellhead Protection Program in 1990. This early work focused on public water supply (PWS) wells and nearby sources of potential contamination.

Aquifer information was evaluated to establish or delineate a vulnerable area or wellhead protection area around the public water supply, and potential sources of contamination within the wellhead protection area were identified and mapped. Cities and other public water supply entities are encouraged to educate the public about contaminant sources and best management practices directed at preventing releases.

TCEQ has developed a new program, the Source Water Assessment Program, which expands the Wellhead Protection Program and includes public water supply surface water sources. The new program, which is currently in the inventory stage, will address all PWS systems in the state, develop geographically accurate electronic data for potential sources of contamination, and provide an assessment of vulnerability. Because SWAP is an electronic, geographically based data system, other groundwater protection program areas will be able to use the assessments in permitting and remediation efforts.

CHAPTER III: ROLES AND RESPONSIBILITIES IN PROTECTING GROUNDWATER

The State's Groundwater Protection Policy recognizes the importance of the role of state agencies in implementing the policy and attaining the goal of groundwater protection. The roles of the various state agencies are set out by their enabling legislation, which directs them to address specific program areas. Coordination of agencies with programs relevant to the protection and conservation of groundwater resources is necessary to focus attention on groundwater as a resource, to improve program implementation, and to prevent duplication of efforts. Coordination of groundwater activities requires that the roles and responsibilities of participating agencies and entities be clearly defined.

This chapter identifies agencies and organizations involved in groundwater protection and conservation activities and describes the general functions of these entities. Activities of state agencies and universities, local groundwater districts and the Texas Alliance of Groundwater Districts, local and regional authorities, and federal agencies are discussed. The chapter also includes a brief discussion of groundwater coordination with neighboring states and the Republic of Mexico. Additional information on the programs of participating agencies and organizations is presented in Chapter IV, "Program Implementation" and in Tables 1 through 6, which appear in that chapter.

The Texas Groundwater Protection Committee

The Texas Groundwater Protection Committee was created by the 71st Texas Legislature in 1989 as a means to bridge gaps among existing state groundwater programs and to optimize water quality protection by improving coordination among agencies involved in groundwater activities. House Bill 1458 (codified as Sections 26.401 through 26.407 of the TWC) established the committee and outlined its powers, duties, and responsibilities. The state law that set out the Groundwater Protection Policy also provides for the role of the Texas Groundwater Protection Committee as a coordinating mechanism for the protection of groundwater resources.

The committee actively seeks to implement this policy and responsibility by identifying opportunities to improve existing groundwater programs and by promoting coordination among agencies. The committee also strives to improve or identify areas where new or existing programs could be enhanced to provide additional protection. Major responsibilities of the committee are:

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

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

- the executive director of the Texas Commission on Environmental Quality;
- the executive administrator of the Texas Water Development Board;
- a representative selected by the Railroad Commission of Texas;
- the commissioner of health of the Texas Department of Health;
- the deputy commissioner of the Texas 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 Agricultural Experiment Station;
- the director of the Bureau of Economic Geology, University of Texas at Austin; and
- a representative of the Department of Licensing and Regulation.

The Texas Commission on Environmental Quality is designated as the lead agency for the TGPC, with the commission's executive director designated as the committee's chairman. The executive administrator of the Texas Water Development Board is designated as the committee's vice-chairman.

The TGPC holds quarterly and special meetings and maintains mailing lists, meeting records, and report files. In addition to the public notification of meetings in the *Texas Register*, a notice of quarterly meetings, including the proposed meeting agenda, is provided to all individuals on the TGPC's mailing list. Meeting notices are also posted on the TGPC's Internet web site. The quarterly meetings serve as a forum for presenting information and discussing groundwater protection and conservation issues. Action is taken on business items within the scope of the Committee's mandate and functions.

Regularly scheduled items on the TGPC's agenda include subcommittee reports, presentations and roundtable discussions, business, information exchange, announcements, and public comment. Various agencies and groups give presentations to the TGPC on groundwater-related activities and initiatives. The presentations and information exchange serve to broaden interagency awareness of the many groundwater activities and initiatives under way in the state and provide the opportunity for coordination among participating groups. The TGPC agendas also include a section for public comment, which provides an opportunity for the public and water stakeholders to raise issues or comment on pending issues related to groundwater.

Subcommittees and work groups are formed by the TGPC to carry out its required function and to address specific issues. The subcommittees address specific groundwater-related issues in areas of program development and coordination. The public and stakeholders are encouraged to fully participate and serve in the subcommittee process. At its meetings, the TGPC considers the findings and recommendations of the subcommittees, and after holding discussion, takes action as it finds appropriate.

The TGPC has formed standing subcommittees for preparation of the biennial report to the Legislature, for preparation of the annual joint groundwater contamination report, to address coordination and planning for agricultural chemical management plans, to encourage the closure of abandoned water wells, and to coordinate data management.

Roles and Responsibilities of State Agencies and Organizations

Texas Commission on Environmental Quality

The Texas Commission on Environmental Quality (TCEQ) has the responsibility for the majority of the state's environmental and water quality regulatory programs. The TCEQ implements a variety of programs which address groundwater protection and focus on both prevention of contamination and remediation of existing problems. The major areas of jurisdiction affecting groundwater include the wastewater and storm water permitting, the Edwards Aquifer program, the Petroleum Storage Tank (PST) program, underground injection control, surface water rights permitting, the oversight of public drinking water systems, the on-site waste water program, solid and hazardous waste disposal and remediation programs.

As the state lead agency for water resources and environmental protection, the TCEQ administers both state and federally mandated programs. Federal programs include the Resource Conservation and Recovery Act for the management of municipal and industrial wastes; the Comprehensive Environmental Response, Compensation, and Liability Act or Superfund cleanup program; the Clean Water Act for managing pollutant releases to state waters; the Safe Drinking Water Act for the protection of public drinking water supplies; and the development of pesticide management plans for groundwater under the Federal Insecticide, Fungicide, and Rodenticide Act. TCEQ has responsibilities and authorities under state law provided in the Texas Water Code and the Texas Health and Safety Code for a number of programs addressing water resource management, waste management, and environmental protection.

The TCEQ is headed by a three-member commission and organized into major functional program areas. The Office of Permitting, Registration, and Remediation is responsible for permitting facility operations which include provisions for the prevention of groundwater impacts and for remediation and corrective action to address groundwater contamination. The Office of Compliance and Enforcement is responsible for assuring that regulated entities comply with permits and agency rules including provisions related to groundwater quality protection through: a network of agency regional offices; facility inspections; enforcement proceedings; and professional licensing. The Office of Environmental Policy, Analysis and Assessment is responsible for the functions of environmental assessment, program planning, the development of policy and regulations, and provides support to the TGPC. Outreach and technical assistance are responsibilities in each of the program areas directed to specific stakeholder and regulated communities. TCEQ also had outreach programs targeting small business and local government technical assistance.

Texas Water Development Board

The Texas Water Development Board (TWDB), created in 1957, is the state agency responsible for statewide water planning, collection and maintenance of water resource information, and administration of financial assistance programs for water supply, water quality, flood control and agricultural water conservation projects. The TWDB is responsible for the development of the State Water Plan to provide for the orderly development, management and conservation of the state's water resources. TWDB provides support to regional water planning groups for the development of regional water plans that serve as the bases for the State Water Plan.

The TWDB, in support of its water planning and data collection responsibilities, conducts an active groundwater resource assessment program. The TWDB conducts studies to assess the State's aquifers, including occurrence, availability, quality and quantity of groundwater present. Major groundwater-using entities and current and projected demands on groundwater resources are also identified. The TWDB conducts statewide groundwater level measurements and groundwater quality sampling programs as a part of its assessment effort. The groundwater quality sampling program permits the TWDB to 1) monitor changes, if any, in the ambient quality of groundwater over time; and 2) establish, as accurately as possible, the baseline quality of groundwater occurring naturally in the State's aquifers.

As a significant part of the water planning process, the TWDB supports a Groundwater Availability Model (GAM) Program, an initiative to develop state-of-the-art, publicly available numerical groundwater flow models. GAMs provide reliable information on groundwater availability in Texas to ensure adequacy of supplies or recognition of inadequacy of supplies throughout the State Water Plan's 50-year planning horizon. The TWDB plans to have all nine of the state's major aquifers modeled by October 2004, while work continues on the minor minor aquifers.

Railroad Commission of Texas

The Railroad Commission of Texas (RCT) regulatory authority includes oil and gas exploration and production, surface mining and mine reclamation, and pipelines. Oil and gas-related environmental regulations under the RCT include well drilling and completion; well plugging; surface storage, treatment, and disposal of oil and gas wastes; oil spill response; management of hazardous oil and gas wastes; disposal of nonhazardous oil and gas wastes by injection; underground injection of fluids for enhanced recovery of hydrocarbons; underground hydrocarbon

storage; solution mining of brine; and site remediation of the aforementioned activities. The RCT offers technical guidance through its oil and gas waste minimization program. Environmental activities related to surface mining include surface coal and uranium mine operations, and mine land abandonment. Pipeline regulations are primarily safety regulations, although the routes of new pipelines are reviewed for environmental risk.

Permits to drill oil, gas, and related wells are issued only after the applicant has submitted a letter from the TCEQ that provides information on the depth of usable quality groundwater. The information is used to ensure that the well is constructed and cemented in a manner that protects groundwater. Similarly, the information is used to ensure that during plugging operations plugs are set to isolate and protect groundwater. Knowledge of the presence of shallow groundwater and the recharge areas of aquifers is vital to the regulation of surface storage and disposal of oil and gas wastes. Underground injection, hydrocarbon storage, and brine mining are primarily groundwater protection regulations federally delegated under the Safe Drinking Water Act. The RCT requires remediation of sites contaminated by oil and gas exploration, production, disposal, and pipeline operations to prevent groundwater contamination or to mitigate groundwater contamination. Remediation projects include operator-initiated clean-up and state-funded clean-ups, if no responsible party exists. Oil spills must be reported, managed and remediated in accordance with state regulations.

The Site Remediation Section of the RCT is responsible for the state-funded cleanup of abandoned oil field pollution sites (State-Funded Cleanup Program) and the oversight and monitoring of complex pollution cleanups conducted by responsible operators (Operator Cleanup Program). In addition, the Site Remediation Section administers the Voluntary Cleanup Program for contaminated property over which the RCT has jurisdiction. The goal of these programs is to control or cleanup oil and gas waste or other materials that are causing or likely to cause the pollution of surface or subsurface water, to ensure human health and safety and to protect the environment.

A groundwater impact assessment is performed as part of surface coal mining permitting process. Permits contain plans to protect the groundwater resources in the area of the permit. Groundwater may be removed during the mining activities; however, if those activities adversely impact a used groundwater resource, then the impacts must be mitigated. Abandoned mines are closed to protect natural resources and the public.

Texas Department of Health

The Texas Department of Health (TDH) 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 Bureau of Environmental Health (BEH) within the agency acts primarily in a nonregulatory manner and serves in an advisory or public service role. If and when public health is determined to have been impacted by groundwater contamination, the agency's response would focus on providing advice and assistance to the population affected. Since TDH's involvement in groundwater issues is primarily advisory, the agency would assist 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, the BEH does have programs that indirectly provide protection to the state's water resources. Under the Product Safety Division, the Hazard Communications Branch administers and enforces Tier II reporting of hazardous substances. Under the Toxic Substances Control Division, the Toxic Substances Control Act (TSCA) Program enforces rules on PCB's (polychlorinated biphenyls) on behalf of the federal government. This federally funded program regulates the control and inventory of PCB's and enforces the cleanup of spills that sometimes involves groundwater monitoring. The General Sanitation Division includes programs for youth camps, childcare centers and investigates public health nuisance complaints.

The Texas Department of Health, Bureau of Radiation Control (BRC) regulates radioactive materials, including uranium recovery and radioactive waste disposal. The BRC monitors groundwater for radionuclides on a routine basis at several facilities. As needed, the BRC will sample groundwater as a result of an incident, complaint, or situation that leads BRC to believe there may be groundwater contamination.

The TDH, Environmental Sciences Division laboratory performs chemical and microbiological analyses for any program at the TDH which 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 TDH, Bureau of Laboratories also accepts water samples for routine microbiological analysis from the public for a fee.

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:

- *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.
- *Pesticide Management Plan for Prevention of Pesticide Contamination of Groundwater (PMP)* - The TDA serves as 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. Although TDA does not routinely conduct groundwater monitoring for pesticides, the agency maintains a fully equipped laboratory located at Texas A&M University. 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.

The use of weather-modification technology is being evaluated in the state as mandated by the Legislature. Ten rain-enhancement projects are now operating in Texas, covering some 51 million acres from the Caprock in the Texas High Plains to the coastal prairies south of San Antonio and the lower Rio Grande basin. These projects are designed to be integral parts of a long-term, water-management strategy by water conservation districts and other water-management authorities to replenish fresh-water sup plies in aquifers and reservoirs, as well as to help meet the water needs of agriculture, industry, and municipalities.

The Legislature established the Prescribed Burning Board (PBB) and directed its administration through the Texas Department of Agriculture. The PBB sets standards for prescribed burning; coordinates training, certification, and recertification of burn managers; and sets minimum insurance requirements for prescribed burn managers. Prescribed burning is a standardized, accepted rangeland management practice. The controlled application of fire is utilized to meet a variety of objectives. An important use is to conserve water resources by mitigating the undesirable impact of vegetation requiring intensive water consumption. These mandated programs are augmented by TDA's initiatives in riparian invasive species control efforts. Staff address regulatory issues; provide technical expertise on human health, environmental, endangered species as well as other nontarget effects by pesticides; and facilitate coordination of invasive species control projects.

Texas State Soil and Water Conservation Board

The Texas State Soil and Water Conservation Board (TSSWCB) is the lead agency for abatement of agricultural and silvicultural nonpoint source pollution. The TSSWCB uses its resources to educate and encourage farmers and ranchers in the importance of proper use of agricultural chemicals. 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.

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.

Besides their involvement in the abatement of nonpoint source pollution, the Board also helps to preserve groundwater resources with its Cost Share Program and Brush Control Program. The Cost Share Program provides funding to pay for 75 percent of the implementation costs for a Water Quality Management Plan which is developed and approved by the Board. 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. This program has been very successful in areas, restoring seeps and springs that had been dormant for decades due to the invasion of brush species.

Texas Alliance of Groundwater Districts

The Texas Alliance of Groundwater Districts (TAGD), formerly the Texas Groundwater Conservation Districts Alliance, 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 TWC. TAGD is organized exclusively for charitable, educational, or scientific purposes within the meaning of Section 501(c)(3) of the Internal Revenue Code.

The TAGD was formed to further the purposes of groundwater conservation and protection activities. TAGD provides a means of communication and exchange of information between individual groundwater conservation districts on issues ranging from the day-to-day operation of local groundwater management to statewide groundwater resource policy issues. Members of TAGD are part of a network in which valuable technical and operational experience is available to members and the interested public. TAGD maintains contact with members of the private sector and various elected, local, state, and federal officials, providing them with timely information on activities and issues relevant to groundwater management. Members of TAGD also serve on various local, state, and federal agency committees and subcommittees, providing input and information on behalf of member districts. In April 2002, there were 49 district members of the TAGD.

Texas Agricultural Experiment Station

The Texas Agricultural Experiment Station (TAES) is the official agricultural research agency in Texas. TAES has no regulatory authority. Headquartered at Texas A&M University, TAES promotes food and fiber production while emphasizing water conservation and the protection of natural resources. TAES operates a system of 14 research centers which are located in the major land and natural resource regions of Texas. The Texas Water Resources Institute is an administrative unit of TAES that guides internal water-related research. The main function of TAES is research into development of management strategies and basic understanding of contaminant removal from water resources and movement of contaminants through aquifers.

Broad goals of the TAES groundwater research program are to protect, preserve, and efficiently use water resources, and to develop sustainable agricultural production systems. Groundwater programs of TAES stress the development of management strategies, technologies, and educational programs to support sustainable agriculture. TAES 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 solid and liquid wastes from livestock production and processing to prevent water contamination; to develop crop production technologies that produce high yields while minimizing the loss of pesticides, chemicals and nutrients into ground and surface waters; and, to manage contaminants produced during industrial and urban activities.

TAES also trains future professionals through undergraduate and graduate education and research programs at Texas A&M University and other System institutions. Many TAES researchers at Texas A&M University in College Station also hold teaching appointments, thus providing the latest research results to students.

TAES research efforts are complemented by the programs of the Texas Cooperative Extension, also a component of the Texas A&M University System. Texas Cooperative Extension conducts educational programs on management strategies and best management practices to protect

groundwater resources. Extension specialists produce easy-to-read fact sheets and other publications for specific clientele, including agricultural producers. Other Extension activities include field demonstrations and educational programs for youth and adults. The Texas Cooperative Extension has no regulatory authority.

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 BEG conducts basic and applied research projects related to water resources and contaminant transport in support of other state and federal agencies. It is not a regulatory agency and has no groundwater protection regulatory programs but supports the agencies that fulfill these functions.

The BEG serves as a valuable resource for geologic maps and reports that provide the framework for many environmental studies. The state geological mapping program focuses on developing maps of different geologic units and works with other state agencies to identify priority areas related to environmental issues. The core repository at the BEG contains an extensive collection of cores from many of the geologic units in the state. One of the strengths of environmental studies conducted by the BEG is the integration of geology and hydrology.

Groundwater resources are the focus of several studies conducted by the BEG. Groundwater models have been developed by BEG scientists of many of the major aquifers in the state, including the northern Ogallala, Trinity, Carrizo-Wilcox, Edwards (Barton Springs segment), and Gulf Coast aquifers. Some of these are currently being developed as part of the Groundwater Availability Modeling program directed by the Texas Water Development Board.

The BEG also has unique capabilities in unsaturated zone hydrology include physical, chemical, and isotopic analysis and modeling. The unsaturated zone is extremely important because many contaminants originate near the land surface and have to be transported through the unsaturated zone to reach the water table. In addition, groundwater recharge generally occurs through the unsaturated zone and is a critical issue for assessing groundwater availability in the state. Examples of previous studies in unsaturated zone hydrology include characterization of water fluxes related to proposed low-level radioactive waste disposal sites, quantification of contaminant transport related to the U.S. Department of Energy's Pantex Plant, and estimation of recharge for groundwater modeling studies.

The BEG has conducted many studies evaluating contaminant transport in the state. Examples of the types of studies include delineation of salinity contamination related to oil and gas production activities for the Railroad Commission of Texas, assessment of transport processes at the DOE Pantex Plant, and evaluation of benzene plumes related to underground fuel tanks. Results of the benzene plume study were extremely valuable for TCEQ in developing remediation protocols with respect to leaking petroleum storage tanks.

One of the missions of the BEG is public outreach. In its role as the State Geological Survey, the BEG responds to questions and requests for information from other institutions and the public. The BEG participates in many public education programs, including efforts to engage kindergarten through 12th grade students and teachers in scientific discovery. The BEG has been actively involved in organizing and promoting Earth Science Week, celebrated both nationally and internationally, which highlights the ways the earth sciences affect our daily lives and features an annual career fair.

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. The Board had the responsibilities of determining qualifications for licensure of all persons drilling water wells and enforcing standards of conduct and well completion through the revocation or suspension of licenses and assessment of administrative penalties. Legislation adopted by the 69th Legislature required that the drillers of Class V injection wells (geothermal heat-loops) be licensed by the Board after September 1, 1985. Also, the 70th Legislature required that the Board license drillers of monitoring and de-watering wells after January 1, 1988, and it strengthened the state's authority to require the plugging of abandoned and deteriorated water wells. In 1991, the 72nd Legislature expanded the Board's functions to include licensing and regulation of water well pump installers.

The Water Well Driller/Pump Installer Program, now within the Texas Department of Licensing and Regulation (TDLR), maintains an advisory council, the Water Well Drillers Advisory Council, and investigates all alleged violations of Chapters 32 and 33 of the TWC and Title 16, TAC Chapter 76 (Water Well Drillers and Pump Installers Rules). The program also investigates consumer complaints filed against regulated well drillers, pump installers, and inspects wells to ensure compliance with well construction standards.

Investigations include, but are not limited to, surface completions, depth of annular cement, regulated distances from contamination sources, and licensing requirements. Surface completions and depth of annular cement footage of wells are closely inspected to assure the prevention of groundwater contamination from surface runoff. 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.

Violations of Chapters 32 and 33 of the TWC and the Water Well Drillers and Pump Installers Rules are enforced by the TDLR (some with recommendations from the advisory council) through TDLR orders requiring administrative penalties and corrective actions or referral to the Attorney General's office. 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. When groundwater contamination has been confirmed, the TDLR contacts the licensed drillers by letter with specific instructions on how to complete wells in the area to avoid further contamination.

Abandoned and/or deteriorated wells are reported to the TDLR by drillers, pump installers, and neighbors who discover them. The TDLR contacts the landowner by letter to notify them of the requirement to plug or bring the well into compliance not later than 180 days from the time of the notice. Only licensed water well drillers, licensed pump installers, or the landowner whose property contains an abandoned and/or deteriorated well may plug or bring the well into compliance. All must submit a State of Texas Plugging Report to the TDLR no later than 30 days after the well is plugged or capped. Information is available, from the TDLR and the TGPC, to landowners wishing to plug their own wells.

At the end of February, there were 1831 licensed professionals including drillers, pump installers, and apprentices regulated by the Water Well Driller/Pump Installer Program. During Fiscal Year 2001, there were 381 investigations and 196 inspections conducted by the Water Well Driller/Pump Installer Program with all documented violations either remediated or in the enforcement process.

Local and Regional Governments and Agencies

Groundwater Conservation Districts

Groundwater conservation districts (GCDs) are a form of local governments authorized by the Texas Constitution. GCDs are created through the Legislature or through the TCEQ in response to a petition from area landowners. GCDs have the purpose and duty of preserving, conserving, and protecting groundwater. State law provides that

groundwater conservation districts are the state's preferred method of groundwater management. Groundwater conservation districts have the authority to develop management plans, adopt and enforce rules, require well permits, monitor groundwater quality and quantity and provide public education. As of February 2003, there were 80 established groundwater districts in the state.

Regional Authorities and Planning Groups

There are several types of regional authorities authorized by state law which directly address water resource issues and may maintain data or administer programs related to groundwater. This group of entities includes River Authorities and Regional Water Planning Groups. The primary purpose of a river authority is to manage surface water within their defined boundaries, associated with one of the state's major river basins. Several river authorities administer on-site wastewater or septic tank regulatory programs, designed to prevent both surface and groundwater pollution.

The Texas Water Development Board (TWDB), implementing state law (Senate Bill 1, 75th Legislature, 1997), divided the state into 16 regional water planning areas each represented by a regional water planning group (RWPG). RWPGs are composed of a variety of individuals representing interests comprising the region, including the public, counties, municipalities, industries, agricultural interests, environmental interests, small business, electric generating utilities, river authorities, water districts, and water utilities. Each RWPG is responsible for preparing and adopting a regional water plan for their area. State law requires that regional plans be updated every five years. A RWPG may hire consultants to assist with developing the engineering, socioeconomic, hydrological, environmental, legal and institutional components of the regional water plans. A RWPG must provide for public input in the planning process, hold public meetings and furnish a draft report of the plan for public review and comment. State law requires that each regional water plan address the needs of all water users and suppliers, except certain political subdivisions that decide not to participate.

Counties and Cities

Cities and counties are the primary units of local government in Texas. While most groundwater protection and conservation programs are administered through state agencies or groundwater conservation districts, there are several important functions that can be administered at the local government level. Cities through their ordinance authority to protect the public welfare may initiate water resource protection programs which can include groundwater data collection or land use regulation to protect water

quality. County authority is limited to two primary areas of water resource protection. Counties and cities may receive delegation from the state through TCEQ to implement the on-site wastewater or septic tank regulatory program. Counties and cities may also require a demonstration of groundwater availability for certain land subdivisions subject to plat approval under state law in the format defined in 30 TAC Chapter 230.

Federal Agency Partners

United States Environmental Protection Agency

The TGPC actively coordinates with the United States Environmental Protection Agency (EPA) and other federal agencies on groundwater protection issues. The TGPC has taken leadership initiative with federal agencies on the development of the state's groundwater protection strategy and the development of a pesticide management plan for the prevention of groundwater contamination. Since 1985, EPA grants administered under Section 106 of the Clean Water Act have funded coordination of groundwater protection activities of federal and federally-delegated regulatory programs, and the development of a groundwater protection strategy.

EPA coordinates and/or helps fund much of nation's environmental science, research, education and assessment efforts. EPA works closely with other federal agencies, state and local governments, and Indian tribes to develop and enforce regulations under existing environmental laws. More than a dozen major statutes or laws form the legal basis for EPA's programs.

EPA is responsible for researching and setting national standards for a variety of environmental programs and delegates to states and tribes responsibility for issuing permits, and monitoring and enforcing compliance. Where national standards are not met, EPA can issue sanctions and take other steps to assist the states and tribes in reaching the desired levels of environmental quality. EPA also works with industries and all levels of government in a wide variety of voluntary pollution prevention programs and energy conservation efforts.

United States Geological Survey

The TGPC 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 have participated in various TGPC-sponsored projects, providing groundwater expertise and opportunities for state input in federally-sponsored research.

The USGS is the federal government's primary source of data on the quantity and quality of the Nation's water resources, its principal civilian map making agency, and its primary provider of information on natural hazards and mineral, energy, and biological resources. The USGS makes scientific information available equally to all interested parties.

In Texas, the Water Resources Division of the USGS monitors, assesses, and conducts research pertaining to the State's surface and groundwater resources. Most of these activities are funded cooperatively with over 80 local, state, and federal agencies. The USGS has a significant presence in Texas with offices in Austin, San Antonio, Houston, Ft. Worth, Wichita Falls, and San Angelo. The Las Cruces, NM, office collects data and conducts studies in the El Paso region of west Texas.

The USGS is a source of hydrologic, water-quality, geologic, and geographic data for the state's groundwater resources. For selected aquifers in Texas, data are available that define the depth to groundwater, aquifer hydraulic properties, aquifer recharge and discharge areas and rates, and groundwater use. Chemical analysis of groundwater samples, including pesticides analyses, also are available for selected wells and springs monitored by the USGS. USGS data and interpretative results are made available to the public in a variety of publications. Data in digital form also can be obtained from the Survey's database. For Texas, the USGS has placed a vast amount of hydrologic data and information on the worldwide web. The Texas USGS website at **http://txwww.cr.usgs.gov** provides public access to the data and information.

The Texas USGS website also contains regularly updated information describing its data-collection programs, current studies, and links to other on-line sources of natural-resources information. The USGS library in Austin, Texas maintains reference material on-line, which includes bibliographic references, report abstracts, and the entire contents of selected recent publications.

Other Federal Agencies

The TGPC and its members agencies have cooperative relationships with other federal agencies. The work and support of these agencies contributes to the protection and remediation of groundwater resource in the state. These agencies collect and share environmental, management practices and programmatic data; provide information and guidance; conduct and support environmental- related research; provide funding and programmatic support and provide training and technical assistance to the state.

Cooperating federal agencies include:

- United States Department of Agriculture (USDA);
- United States Department of Energy (DOE);
- United States Department of Defense (DOD); and,
- United States Department of the Interior, Bureau of Reclamation (BOR).

Coordination in National and Interstate Groundwater Protection Efforts

Interstate Cooperation

The TGPC and its members agencies coordinate groundwater protection efforts, particularly the development of national policy positions, through membership in national organizations such as American Water Works Association; Association of State Drinking Water Administrators; Association for State and Interstate Water Pollution Control Administrators; Environmental Council of the States (ECOS); the Ground Water Protection Council; and the State FIFRA [the Federal Insecticide, Fungicide, and Rodenticide Act] Issues Research Evaluation Group, a group formed by state agricultural regulatory officials and EPA to discuss and evaluate pesticide matters affecting states.

Texas shares borders and water resources with the states of Arkansas, Louisiana, New Mexico, and Oklahoma. A number of river basins extend along or across these political boundaries. Major groundwater resources — including the High Plains-Ogallala, the Carrizo-Wilcox, and the Gulf Coast Aquifers — are shared with neighboring states. Interstate Compacts have been established between Texas and neighboring states for several of the river basins to coordinate surface water supply and availability issues.

With regard to water quality, TCEQ, working through EPA Region 6, coordinates cross-border activities with the states through regularly scheduled state-EPA meetings. These meetings, held twice per year, provide an opportunity for data exchange and coordination of activities.

Often specific programs develop state-to-state relationships based on specific needs. For example, the PST program coordinates with other states in the rare instances that a contaminated underground storage tank site affects the groundwater of a neighboring state.

On a much broader basis, the TCEQ Source Water Assessment Protection Program participates in the Rio Grande Watershed Interstate Coordination Team, sponsored by EPA and coordinated by the State of Colorado. This coordination team establishes lines of communication among states along the Rio Grande River for exchange of water quality data, information on each state's approaches to the various Source Water Assessment and Protection Program (SWAP) elements, and how the various states can work together in concert to protect the Rio Grande. TCEQ participates in a series of interstate meetings and conferences; exchanges data with bordering states; and produces GIS maps of the source water protection areas in each river basin.

Cooperation with Mexico

The unique border region shared by the United States and Mexico provides challenges and opportunities to the region's states and local communities. Four Mexican states are adjacent to the Texas border: Chihuahua, Coahuila, Nuevo León, and Tamaulipas. In addition to the shared boundary of the Rio Grande/Rio Bravo, groundwater resources of several major and minor aquifers are shared. Most notable is the Hueco Bolson used by both the city of El Paso and Ciudad Juárez.

Activities with respect to Mexico are coordinated through the International Boundary and Water Commission (IBWC). The IBWC was created more than a century ago by the governments of the United States and Mexico to apply the provisions of various boundary and water treaties, and to settle differences arising from such applications through a joint international commission located at the border. The IBWC's jurisdiction extends along the U.S.-Mexico boundary, and inland into both countries where they may have international boundary and water projects. The IBWC has encouraged and coordinated the establishment of cooperative relationships with federal, state, and local agencies, both in the U.S. and in Mexico, in carrying out its border projects and activities.

Through the *Transboundary Aquifers and Binational Ground-Water Data Base* (IBWC, January 1998) study of aquifers in the El Paso/Ciudad Juárez area, groundwater data from the U.S. and Mexico have been integrated into one database. The groundwater databases were provided by the Texas Water Development Board and New Mexico State Water Resources Research Institute for the U.S. side, and by the Comisión Nacional del Agua, Junta Municipal de Agua y Saneamiento, Ciudad Juárez, and Instituto Nacional de Estadística, Geografía e Informática for the Mexican side. The data exchanged includes land use, well data (construction, ownership, well use, and so on.), core descriptions, groundwater levels in wells, results of groundwater quality analyses, and pumping records.

Analysis

As noted in this chapter during the discussion of the Texas Water Development Board, the 2002 State Water Plan includes groundwater issues and recommendations in its highlights. The issues include groundwater depletion, lack of groundwater development and infrastructure, groundwater management, and water quality concerns. Groundwater is identified by the Regional Water Planning Groups (RWPGs) as a major source of water supplies needed to meet future water needs over the 50-year planning horizon.

In the State Water Plan's section on regional concerns, numerous recommendations were made by the RWPGs on the subjects of groundwater availability, groundwater management, and data collection and research. These recommendations indicate that planning region stakeholders have recognized groundwater issues that will affect future water use and availability, and that there is significant regional interest in addressing these problems.

Texas Groundwater Protection Committee (TGPC) members have responsibilities and interests in many of these issue areas. The TGPC could contribute to the discussion of these issues and assist in addressing or developing appropriate solutions. Communication and information are key factors in understanding the issues at the regional level, and in participating in the discussion of the issues. The strengthening of lines of communication and information sharing among the RWPGs and the TGPC is necessary to coordinate the state's groundwater protection strategy with the state's water supply planning efforts.

CHAPTER IV: PROGRAM IMPLEMENTATION

The state's groundwater protection efforts are implemented through three types of groundwater program activities: groundwater protection, groundwater remediation, and groundwater conservation. Various state agencies conduct programs to achieve the overall policy and goals that have been established by either state legislation or through the delegation to the state of federal programs.

Groundwater Protection

Groundwater protection is the first programmatic component that defines the state's efforts. Section 26.401 of the TWC sets out nondegradation of the state's groundwater resources as the goal for all state programs and asserts that groundwater be kept reasonably free of contaminants that interfere with the present and potential uses of groundwater. This effort and the programs that compose it are discussed later in this chapter in the section titled Groundwater Quality Protection Programs.

Groundwater Remediation

The second programmatic component of the state's efforts is groundwater remediation. Aquifers vary both in their potential for beneficial use and in their susceptibility to contamination. Once contamination has occurred, the goal of remediation programs is to restore the quality of groundwater if feasible. In some cases, it may not be technically possible or cost-effective to cleanup groundwater to its original quality. To provide flexibility in these instances, the state recognizes the important role of best professional judgment by the responsible state agencies, and their ability to assess the relative risk versus feasibility in achieving this remediation goal. The various groundwater remediation programs are discussed in the section titled Groundwater Quality Remediation Programs.

Groundwater Conservation

The final component of the triad of groundwater programs is conservation. Balancing landowner interests and the finite nature of groundwater resources, the Legislature in 1949 set out a mechanism for local management of groundwater. Locally controlled groundwater conservation districts are the state's preferred method of managing groundwater resources.

The Legislature has also stressed the importance and responsibility of groundwater conservation districts in developing and implementing comprehensive management plans to conserve and protect groundwater resources. Additionally, several groundwater conservation programs are implemented by state agencies. Groundwater conservation programs are discussed in the section titled Groundwater Conservation Programs.

Regulatory vs. Nonregulatory Programs

Each of the following sections of the three-component program is further subdivided into regulatory and nonregulatory programs. A regulatory program is one that is mandatory in order to conduct certain activities within the state, and penalties can result from noncompliance. A nonregulatory program is one in which participation is voluntary and may come about through incentives or education.

The last section in the chapter address gaps identified under this analysis and focuses on the lack of programs to assess groundwater quality in private/domestic wells.

Groundwater Quality Protection Programs

Regulatory Programs for the Protection of Groundwater

Many activities which could result in the contamination of groundwater, unless protective measures are in place to protect groundwater quality, have to be authorized by the state through regulatory programs (Table 1). Some of the regulatory programs require site specific permitting with compliance monitoring, issuing of general statewide permits and/or authorizations by rule, issuing geographic area specific registrations/authorizations, licensing and certification of specialists who conduct activities, issuing operation standards for activities, and tracking and classifying waste.

Table 1. Groundwater Quality PROTECTION — REGULATORY Programs

Agency	Program Type (if applicable) and Program Name
Texas Commission on Environmental Quality	***Permitting Programs***: ■Municipal Solid Waste ■Industrial and Hazardous Waste ■Underground Injection Control Permitting ■Wastewater Permitting ■Radioactive Waste Program ■On-Site Wastewater Permitting
	Installer Certification: ■Underground Storage Tank Contractor ■On-Site Wastewater
	Operator Certification: ■Leaking PST Corrective Action Specialist ■Corrective Action Project Manager ■Water Operator ■Wastewater Operator
	Other Programs: ■Low-Level Radioactive Waste Disposal ■Edwards Aquifer Protection ■Waste Handling/Tracking/Registration ■Underground Storage Tank Standards and Installation ■Public Drinking Water System Monitoring ■Public Drinking Water Source Water Assessment/Vulnerability Assessment Program
Texas Department of Licensing and Regulation	■Water Well Construction Standards ■Driller and Pump Installer Certification ■Undesirable Water and Constituent Reports/Drillers' Alerts ■Abandoned Well Closure
Texas Department of Health	■Noncommercial Pesticide Applicators Licensing ■Tier II Reporting ■Bureau of Radiation Control ■PCB Inspections
Texas Department of Agriculture	■Pesticide Applicator Licensing/Certification ■Pesticide Registration and Compliance
Railroad Commission of Texas	■Oil and Gas Well Permitting ■Oil and Gas Waste Haulers ■Management and Surface Disposal of Oil and Gas Waste ■Underground Injection Permitting/Testing ■Surface Mining and Reclamation ■Surface Mining Permitting and Groundwater Monitoring
Members of the Texas Alliance of Groundwater Districts	(Not all member districts have the same programs) ■Point Source Pollution Management

Permitting

Some programs permit activities on either a site-specific or statewide basis. Based upon the type of operation or waste, various disposal options are available. Disposal permits can contain construction or operating standards, groundwater compliance monitoring requirements, and self-reporting/record-keeping requirements. Types of disposal permits include permits for hazardous waste management facilities, underground injection wells, municipal solid waste facilities, wastewater treatment facilities, applying biosolids to farmland, and disposal of oil and gas wastes. Other site-specific permit programs address the potential contamination that can result from production of energy minerals such as surface mining of coal or uranium.

General Permits and Authorizations By Rule

Many activities in the state that have the potential to affect groundwater quality are authorized under general permits, rules, or product application labels. These include installation and registration standards for Petroleum Storage Tanks (PSTs), RCT statewide rules for oil and gas well permitting and production and for the storage and collection of brines associated with oil and gas, labels for pesticide use, on-site wastewater disposal permits, and injection of waste to underground sources of drinking water.

In developing these statewide or area-specific rules, the state promulgates standards that are protective of groundwater quality. For example, the Pesticide Registration program at TDA registers all EPA-approved pesticides distributed in Texas. The TDA identifies pesticides that may reach groundwater and enforces all label directions to mitigate potential adverse effects on human health and the environment.

Site Requirements

In some areas of the state where groundwater is extremely vulnerable to contamination, activities that are typically authorized by a "general permit" or rule require site-specific review and approval of the proposed activity. For example, installation standards for petroleum storage tanks are covered by a general authorization rule throughout the state, except over the Edwards Aquifer where specific construction standards for PSTs are required; installation can only take place after the TCEQ approves a site-specific petroleum storage tank plan.

In order to protect human health and to ensure high-quality drinking water, the TCEQ regulates public water supply systems. Many of these systems depend on groundwater as a primary or additional water source. The quality of treated water is monitored to ensure that drinking water standards for various contaminants are met by the systems. The federal Safe Drinking Water Act Amendments of 1996 requires all states to complete Source Water Assessments for all public water supply wells and intakes by the end of May 2003. The Texas Source Water Assessment Program utilizes numerous spatial databases of potential contaminant sources and provides a susceptibility rating of high, medium, or low for each public water system based on a list of 227 contaminants.

Licensing and Certification

Groundwater is also protected through the state's licensing and certification programs for individuals and businesses that conduct activities or provide services to others. These activities are required to be conducted in a manner that is protective of groundwater resources, and some are required to be performed according to specific construction standards set out in the licensing/certification programs. If these standards are not met, the person who is licensed/certified to conduct the activity is subject to fines and penalties, which can include revocation of the license/certification.

Licensing and certification standards are required for the installation of water wells, on-site wastewater systems, and petroleum storage tanks. For example, the TDLR licenses water well drillers and requires the drillers to use specific well construction and reporting standards. If a driller encounters undesirable groundwater when drilling a well, the well must be constructed so that the undesirable water cannot contaminate the well or surrounding groundwater aquifers.

Other licensing and certification programs focus on the operation standards for certain activities such as leaking PST corrective action specialists, water utility operators, wastewater operators, waste haulers, and pesticide applicators. The TDA licenses applicators using federal "restricted-use" and state "limited-use" pesticides and regulated herbicides in a number of agricultural and rural-use categories. The TDH certifies pesticide applicators for vector control (health-related pests) and only licenses government employees.

Waste Tracking and Minimization

Other programs prevent groundwater contamination through the proper handling, tracking, and disposal of waste. By tracking hazardous and nonhazardous waste from creation to disposal, midnight dumping of waste is prevented. Some of these programs also encouraging the voluntary minimization or recycling of waste. Industries, small businesses, and local and regional governments are encouraged to reduce the volume of pollution and waste generated through fees charged for the disposal of waste.

Nonregulatory Programs for the Protection of Groundwater

There are many nonregulatory groundwater quality protection programs which are conducted by various state agencies (Table 2). Some of these programs offer incentives such as technical assistance or financial assistance. Others focus on establishing plans to address potential groundwater contamination scenarios. Educational and outreach programs are also used to raise the awareness of the general or regulated public to specific issues. Still other agencies conduct groundwater monitoring or other basic research on topics related to prevention or permitting issues. Many programs incorporate some or all of these elements to promote groundwater quality protection.

Table 2. Groundwater Quality PROTECTION — NONREGULATORY Programs

Agency	Program Type (if applicable) and Program Name
Texas Commission on Environmental Quality	■Non-point Source Pollution Management Program ■Pollution Prevention ■Source Water Protection for Drinking Water Wells ■Small Business & Environmental Assistance ■Spill Response Planning ■Public Drinking Water System Technical Assistance ■Usable Quality Groundwater Recommendations for Oil and Gas Well Surface Casing ■Development of Low Level Radioactive Waste Management and Disposal Alternatives
Texas Department of Licensing and Regulation	■Closed Abandoned Water Well Database
Tx Agricultural Experiment Station/Tx Cooperative Extension Service	■ Water Quality Monitoring ■Educational Outreach ■Potential Contaminant Movement Modeling ■Dairy Waste Management ■Irrigation ■Water Conservation ■Pesticide Fate and Transport ■On-Site Wastewater Education ■Point and Non-Point Source Management Practices Education
Texas State Soil and Water Conservation Board	■ Cost Share Program ■Non-Point Source Program ■Water Quality Management Plans ■Educational Outreach
Bureau of Economic Geology	■Applied Research Project for Groundwater Protection Programs ■Landfill Covers Research ■Applied Research Related to Contaminant Plume Studies
Texas Water Development Board	■Groundwater Quality Monitoring/Database ■State Revolving Fund
Texas Department of Health	■Epidemiological and Toxic Substances Studies as Needed ■Public Health Warnings ■Analyses of Private Water Well Samples
Texas Department of Agriculture	■Pesticide Applicator Continuing Education ■Pesticide Residue Laboratory ■Pesticide Risk Assessment and Toxicology
Railroad Commission of Texas	■Water Protection Seminars ■Class II Injection Well Seminars ■Oil and Gas Waste Minimization
Members of the Texas Alliance of Groundwater Districts	(Not all member districts have the same programs) ■Water Well Sampling ■Non-point Source Pollution Management
Texas Groundwater Protection Committee	■Development of the State Pesticide Management Plan ■Abandoned Water Well Closure Educational Initiative

Technical Assistance Programs

Technical assistance programs conducted by the state agencies take many forms. Some provide assistance on reducing the generation of waste through pollution prevention programs. Others provide assistance to facilitate compliance with regulatory programs. For example, the oil and

gas exploration/production industry requests a recommendation from the TCEQ regarding the depth of usable quality groundwater. This number is used by the RCT to determine depth that surface casing for a well must be set to protect groundwater quality. Some programs provide technical services to the public. This includes both sampling of private domestic water wells and providing laboratory services to analyze the water samples.

Other technical assistance programs provide databases that can be used by others as they evaluate the potential impact of their actions on groundwater quality. For example, the TDLR, in a joint effort with the TWDB, has started a database on abandoned well closures. This database can be used to find well reports from wells all over the state and encourages the use of a Global Positioning System (GPS) to locate wells accurately.

Another example is the Texas Source Water Assessment Program (SWAP), which will utilize an assessment software developed through a partnership with the USGS. The inventories will be used to assess potential contaminant sources that pose a threat to public drinking water supplies. This information will be made available to the public, and can be used by local authorities/planners to assist them in protecting their drinking water sources from contamination.

Some nonregulatory programs provide financial assistance to the public to address nonpoint source pollution. These programs include both an urban component under the TCEQ and a rural agricultural/silviculture component under the TSSWCB. Other cost share programs are also available to provide financial assistance to agricultural producers to aid in the protection of groundwater quality through the TSSWCB. The TWDB provides financial assistance to water and wastewater operators which indirectly provides protection to groundwater by supporting the repair and expansion of infrastructure components.

Planning and Coordination

Many state agencies have developed plans for groundwater protection which address specific actions that could affect groundwater quality. These plans take many forms, such as water quality management plans developed by TSSWCB with individual farmers and the state Nonpoint Source Management Plan, both of which target funding to address identified problems. Other planning provides for the coordinated response to potential threats to groundwater quality or provides for contingency planning to respond to specific events. For example, the TGPC's development of the Texas State Management Plan for Prevention of Pesticide Contamination of Groundwater lays out the various roles, responsibilities, and coordination mechanisms for the state agencies having responsibilities in the protection of groundwater resources and the regulation of pesticides.

Educational and Outreach Program

Educational and outreach programs also provide information to the public on groundwater quality protection activities. This information includes continuing education for industry on how to comply with regulatory programs, such as Class II injection wells seminars sponsored by the RCT; these seminars cover the disposal of waste generated by oil and gas production. Other educational programs focus on specific issues and encourage compliance by affected parties.

For example, the TGPC has developed handbooks and videos on how to properly close an abandoned well and has supported demonstrations to illustrate the proper closure techniques. The minimization of waste generated by the oil and gas industry has been addressed by the RCT Oil and Gas Division's waste minimization program and has received national attention. The Interstate Oil and Gas Compact Commission, made up of oil producing states, adopted the state's waste minimization program manual as their own guide book.

Monitoring and Research Programs

Some nonregulatory protection programs monitor groundwater quality either as part of data gathering to characterize water quality in the state or to provide a service to the public, such as the private water well sampling and analyses performed by various groundwater conservation districts. For example, the TWDB and some member districts of the TAGD conduct groundwater monitoring to assess ambient groundwater quality conditions through the assessment of particular constituents in order to track changes in water quality over time. Additionally, some monitoring programs are developed for water-quality assessment studies that target specific geographic areas, specific contaminants or constituents, or specific activities.

Basic research is another type of nonregulatory protection program conducted by the state. Some research involves the study of hydrogeologic characteristics and contaminant migration to provide information to better regulate certain activities that have the potential to contaminate groundwater. Other research supports the development of various best management practices to prevent contamination of groundwater or to facilitate the remediation of groundwater.

Groundwater Quality Remediation Programs

Groundwater quality remediation programs are being implemented by several state agencies. Regulatory programs that provide for remediation of groundwater contamination consist of corrective action to assess contamination and restore groundwater quality, if feasible, and enforcement for noncompliance with rules, regulations, and standards. Other actions that facilitate the remediation of groundwater are nonregulatory.

Regulatory Programs for the Remediation of Groundwater

The state's policy requires that groundwater be kept reasonably free of contaminants that would interfere with present uses or impair future uses of groundwater. Regulatory programs that ensure the remediation of groundwater contamination require certain actions to be taken by those responsible for the contamination or by those responsible for cleaning it up (Table 3). The required actions include remediation at permitted and nonpermitted waste disposal facilities, at leaking petroleum storage tanks, and at superfund sites; oil field cleanup; and spill response. Other programs bring enforcement action against those who violate operating or construction standards and investigate complaints.

Table 3. Groundwater Quality REMEDIATION — REGULATORY Programs

Agency	Program Type (if applicable) and Program Name
Texas Commission on Environmental Quality	***Enforcement of Permitting Programs***: ■Municipal Solid Waste ■Industrial and Hazardous Waste ■Underground Injection Control Permitting ■Wastewater Permitting ■Radioactive Waste Program ■On-Site Wastewater Permitting
	Other Programs: ■Corrective Action ■Leaking Petroleum Storage Tank Remediation ■Site Assessment and Management ■Superfund ■Natural Resource Trustee Program ■Waste Water Permit Compliance ■Emergency Spill Response
Texas Department of Licensing and Regulation	■Enforcement of Water Well Construction Standards ■Consumer Complaint Investigations
Railroad Commission of Texas	***Oil Field and Abandoned Well Site Remediation:*** ■State-Funded Cleanup Program ■Operator Cleanup Program
	Enforcement: ■ Oil and Gas Inspections ■ Surface Mining Inspections ■Complaint Investigation ■Spill Response
Members of the Texas Alliance of Groundwater Districts	(Not all member districts have the same programs) ■Complaint Investigation

The state's policy affirms that groundwater quality should be restored if feasible. In implementing the feasibility determination, many remediation programs examine the current threats posed by the contamination, by the adequacy of remediation or groundwater cleanup technologies, and by the economic costs of remediating contaminated groundwater to its original condition. It may not be technically possible, feasible, or cost-effective to cleanup groundwater to its original quality.

Technical feasibility issues include the ability to completely withdraw the affected groundwater, the ability to control the contaminant plume so it does not pose a threat to the current groundwater uses, and the ability to remove or treat all contaminants to background concentrations.

Economic feasibilities include the high cost of sophisticated treatment technologies and the long time periods required to retrieve the affected groundwater for treatment. In many cases contaminated groundwater cannot be restored to its original quality, and significant costs are incurred at many sites in the recovery and treatment of groundwater.

The Risk-Based Approach

To address these feasibility issues, the TCEQ in its remediation programs has developed an approach which focuses on protection of groundwater for high-quality uses, including human health, and addresses the cost of available remediation technologies. The Texas Risk Reduction Program (TRRP) is a comprehensive program that addresses the investigation of contaminated sites, establishes reasonable standards for notice, provides flexibility in calculating site-specific cleanup levels, and sets forth appropriate response actions to address the environmental contamination.

The program is designed to provide a consistent corrective action process directed toward protection of human health and the environment balanced with the economic welfare of citizens in the state. The program uses a tiered approach incorporating risk assessment techniques to help focus investigations, to determine appropriate protective concentration levels, and to set reasonable response objectives that will protect human health and the environment.

The TRRP sets forth a groundwater resource classification system based on the TGPC statewide groundwater classification system (Appendix 1) and other factors including proximity to wells used for public drinking water systems, potential yield of groundwater formations, and the likelihood of the chemical of concern migrating from the contaminated site. The TRRP requires that a contaminated site undergo an “affected property assessment” to determine the extent of contamination.

If, as part of the affected property assessment, it is determined through a vertical soil analysis that groundwater is contaminated or is likely to be contaminated, then a groundwater assessment must be undertaken. Implicit in the groundwater assessment is an examination of various criteria including intrinsic sensitivity, hydrogeologic regimes and flow patterns, quantity and potential yield, current use, and interactions between ground and surface waters.

Other programs that examine various cleanup options for contaminated groundwater are conducted by the Site Remediation Section of the Railroad Commission of Texas (RCT). This section is responsible for the state-funded cleanup of abandoned oil field pollution sites (State-Funded Cleanup Program) and the oversight and monitoring of complex pollution cleanups conducted by responsible operators (Operator Cleanup Program).

With a combination of these programs, the remediation of groundwater contamination as a result of oil and gas exploration and production activities has become proactive to the point that historic pollution is diminishing and response to new releases is quicker and more effective.

Cleanup options available for these sites include:

- cleanup to background;
- cleanup to conservative risk-based levels (for example, TRRP Tier 1, Texas Surface Water Quality Standards, Federal Drinking Water Standards, and EPA Soil Screening Criteria); and
- risk-assessment-driven cleanup utilizing site-specific considerations and data.

Regardless of ultimate closure options, when groundwater is contaminated, free-phase hydrocarbons are expected to be removed; and full delineation of contamination in all directions is to be performed. For the purpose of establishing consistency, RCT staff may use as guidance the TRRP groundwater resource classification system (Appendix 1). This system is based on the Texas Groundwater Protection Committee's classification, with an additional consideration of low-yielding formations from which windmill pumps are able to provide water for stock.

The Process of Risk Assessment

This risk-based approach takes into consideration the actual or reasonable potential for public and environmental exposure to contaminants in the determination of the timing, type, and degree of site remediation. Risk assessment is the process used to quantify the potential adverse effects to human health due to exposure to chemicals. The risk assessment process consists of four steps: hazard identification, dose-response assessment, exposure assessment, and risk characterization.

The objective of hazard identification is to determine whether the available chemical-specific scientific data describe a causal relationship between exposure to the chemical and adverse human health effects. The dose-response assessment quantifies the relationship between the dose (amount of chemical that the organism is exposed to) and the response (adverse health effects). The objective of the exposure assessment is to analyze site-specific information to estimate the most likely dose to potential human receptors. The risk characterization uses information from the previous three steps to estimate adverse human health effects. The risk characterization answers the question "How much risk does the situation pose?"

Risk characterization is followed by the risk management step, which answers the question "What should be done with the risk that has been quantified?" Depending on the level of the risk, risk management may involve no action, engineering solutions such as soil and groundwater remediation, or institutional controls such as deed restrictions or limiting access to the site.

Nonregulatory Programs for Remediation of Groundwater

The use of the term "nonregulatory programs" in the context of remediation programs reflects the incentive-based programs that are available to address groundwater contamination. Two programs conducted by TCEQ fall into this category: the voluntary cleanup program and the innocent landowner program (Table 4). The RCT's new Voluntary Cleanup Program is also an incentive-based cleanup program.

Table 4. Groundwater Quality REMEDIATION — NONREGULATORY Programs

Agency	Program Type (if applicable) and Program Name
Texas Commission on Environmental Quality	■ Voluntary Cleanup ■ Innocent Owner/Operator
Railroad Commission of Texas	■ Voluntary Cleanup ■ Abandoned Mine Lands Reclamation

Voluntary Cleanup Programs

The purpose of the TCEQ's Texas Voluntary Cleanup Program is to provide a streamlined, incentive-based process for persons to pursue cleanup of contaminated properties. The administrative and technical requirements and conditions necessary for persons to voluntarily clean up sites under this program encourage lenders, developers, and prospective purchasers to clean up abandoned or underutilized properties. The program provides for a nonbinding voluntary cleanup agreement with the TCEQ, agreement by the TCEQ not to pursue enforcement action on sites that are being voluntarily remediated, and a release to non–responsible parties from liability to the State of Texas for cleanup of existing contamination in areas covered by the Certificate of Completion.

Under the TCEQ Voluntary Cleanup Program, sites are investigated to determine whether groundwater impacts have occurred. If groundwater contamination is verified, then the persons conducting the voluntary cleanup propose responses to address the contamination. The TCEQ assesses their proposal to ensure that the proposed remedy is capable of achieving the goals of the groundwater cleanup. Due to the voluntary nature of the program, some sites may withdraw from the program before completing restoration of the groundwater. Only sites that pose an

imminent threat to human health or the environment and withdraw before completion of the response are referred for potential enforcement action to compel the completion of any necessary responses.

The RCT's VCP was created by Senate Bill 310, 77th Legislature (2001), which amended Texas Natural Resources Code, Chapter 91, by adding new Subchapter O, specifically authorizing the RCT to establish a VCP that is self-funded through the collection of application and oversight fees. The purpose of the VCP is to provide an incentive to lenders, developers, owners, and operators to remediate soil and water environmentally impacted by activities over which the RCT exercises jurisdiction; the incentives consists of removing liability to the state from lenders, developers, owners, and operators who did not cause or contribute to contamination.

The VCP operates in a sequential fashion: (1) an application (with application fee of $1,000) and acceptance process; (2) nonbinding agreement execution process; (3) cleanup with RCT oversight process; and finally (4) RCT issuance of a VCP Certificate of Completion. Neither Subchapter O nor the VCP rules propose technical cleanup standards. Instead, the voluntary cleanup agreement will list all statutes, rules, and standards with which the participant must comply, including cleanup standards. These cleanup standards are generally developed on a site-specific basis to protect human health and the environment, including impacts to groundwater.

Innocent Owner/Operator Program

The TCEQ's Innocent Owner/Operator Program provides liability relief for owners or operators of property that has become contaminated as a result of a release or migration of contaminants from a source or sources not located on the owner's/operator's property. Also, a person who, after appropriate inquiry consistent with good commercial or customary practice, did not know or have reason to know of contamination on his property at the time the person acquired it is released from liability to the state. The program reviews the site investigation report to confirm, through the issuance of a certificate, that the person is an innocent owner or operator.

Groundwater Conservation Programs

Groundwater is and will continue to be a major source of water for Texas. Regional Water Planning Groups, set up under Senate Bill 1, 76th Legislature in 1999, estimate that 14.9 million acre-feet/year (AFY) of groundwater is available according to various management philosophies, including those that are the result of environmental constraints such as the federal Endangered Species Act. However, 6.1 million AFY currently cannot be used because of the absence of infrastructure to connect to or treat the water.

Many water management strategies focus on using this 6.1 million AFY and replacing the groundwater supply that is currently being used (1.5 million AFY). This groundwater will not be available in 2050 because of depletion of aquifers. Further, because of projected depletions of groundwater and because of water-quality problems (often due to naturally occurring constituents), groundwater supplies will be insufficient to meet some irrigation needs and the needs of some small cities.

Regulatory conservation programs are conducted under the jurisdiction of the Texas Commission on Environmental Quality, the Railroad Commission of Texas, some groundwater conservation districts, and the Texas Water Development Board. Other agencies implement a variety of groundwater conservation programs that are nonregulatory. These programs are implemented by the Texas Agricultural Experiment Station, the Texas Cooperative Extension, the Texas State Soil and Water Conservation Board, the University of Texas Bureau of Economic Geology, the Texas Water Development Board, the Texas Department of Agriculture, the Railroad Commission of Texas, the Texas Alliance of Groundwater Districts, and various groundwater conservation districts.

Regulatory Programs for Groundwater Conservation

Regulatory programs provide for the creation of groundwater conservation districts (GCDs), and for their oversight, development of a management plan, and coordination with other districts. The programs also regulate use of groundwater or remedy the effects of its use (Table 5).

Table 5. Groundwater CONSERVATION — REGULATORY Programs

Agency	Program Type (if applicable) and Program Name
Texas Commission on Environmental Quality	■Groundwater District Creation and Oversight ■Consideration of Groundwater Contribution in Surface Water Rights Permitting
Texas Water Development Board	■Groundwater Conservation District Management Plan Development Oversight ■Groundwater Management Area Designation/Groundwater District Coordination
Texas Department of Agriculture	■Prescribed Burn Board -- Burn Manager Licensing
Railroad Commission of Texas	■Enhanced Recovery Freshwater Injection Permits ■Surface Mining and Reclamation
Members of the Texas Alliance of Groundwater Districts	(Not all member districts have the same programs) ■Permitting for Drilling, Equipment or Completion of Water Wells ■Abandoned Well Closure ■Control Land Subsidence ■Well Spacing and Production

Groundwater Conservation Districts

As of Febraury 2003, 80 confirmed GCDs existed in Texas. Creation and control of groundwater development and use through local districts allows for flexibility to respond to the local conditions and needs. The statewide diversity of climatic conditions, water use patterns, population growth projections, and aquifer characteristics makes it difficult to formulate and administer uniform laws and regulations to govern the development and use of groundwater statewide. GCDs are charged with providing for the conservation, preservation, protection, recharge, and prevention of waste of the groundwater resources within their jurisdictions. GCDs have required duties that must be performed, as well as a number of individually authorized powers that may be invoked.

Authorities and Duties of Groundwater Conservation Districts. All GCDs can require permits for drilling, equipping, or completing wells that produce more than 25,000 gallons of water per day or for alterations to well size or well pumps. Some have been granted additional authority over well regulation. Some districts regulate well spacing and production, and some have programs to address abandoned well closures and land subsidence. Other optional duties of groundwater conservation districts include the ability to conserve, preserve, protect, recharge, and prevent waste of groundwater; establish sites for groundwater recharge; purchase, sell, transport, and distribute surface water or groundwater for any purpose; and require permits for transferring groundwater out of the district.

Oversight of GCDs. Some of the functions of a GCD are regulated by the TWDB and the TCEQ. The TWDB oversees development of management plans and TCEQ oversees their implementation. GCDs within the same Groundwater Management Area are required to coordinate their management plans. The TWDB designates the Groundwater Management Areas within the state. TCEQ — with the assistance of TWDB, TDA, and the Texas Parks and Wildlife Department — designates Priority Groundwater Management Areas (PGMAs) where critical water shortages are expected to occur within the next 25 years. The TCEQ encourages and/or creates groundwater conservation districts in these PGMAs.

Other Regulatory Conservation Programs

There are other regulatory groundwater conservation programs. For example, the RCT has regulatory programs that address groundwater use. The impact of surface coal mining operations on groundwater is assessed, and groundwater users whose water source is determined to be affected by the mining activities are provided mitigation for their loss. The RCT also issues a permit before the use of freshwater for injection to enhance oil and gas production. Another example is the TCEQ's consideration of the contribution to groundwater as part of the surface water rights permitting programs.

Nonregulatory Programs for Groundwater Conservation

There are many nonregulatory groundwater conservation programs that are conducted by the state (Table 6). Some of these programs offer technical assistance or financial assistance incentives. Others focus on planning to address potential groundwater shortage and management scenarios. Educational and outreach programs are also used to raise the awareness of the general or regulated public to specific issues. Still other agencies conduct groundwater monitoring or other basic research on topics related to groundwater conservation issues. Many programs incorporate some or all of these elements to promote groundwater conservation and management.

Table 6. Groundwater CONSERVATION — NONREGULATORY Programs

Agency	Program Type (if applicable) and Program Name
Tx Agricultural Experiment Station	■Public Education/Conservation Programs ■Applied Research Regarding Groundwater Resource Monitoring/Modeling
Texas State Soil and Water Conservation Board	■Technical Assistance Through Farm Plans ■State Cost Share Program ■Technical and Financial Assistance for Brush Control
Bureau of Economic Geology	■Applied Research Regarding Groundwater Modeling
Texas Water Development Board	■Groundwater Availability Modeling for Major and Minor Aquifers ■State Revolving Fund ■Groundwater Conservation District Technical Assistance/Grants ■State Water Plan ■Regional Water Planning Process ■Groundwater Data Collection/Database ■Public Education on Conservation
Texas Department of Agriculture	■Weather Modification/Rainfall Enhancement Grant Program ■Facilitation of Invasive Species Control Activities
Railroad Commission of Texas	■Technical Assistance to Groundwater Conservation Districts
Members of the Texas Alliance of Groundwater Districts	(Not all member districts have the same programs) ■Groundwater Management Plan Development ■Groundwater Resource Surveys ■Joint Planning in Groundwater Management Areas ■Water Use, Availability and Projected Use Data Collection and Management ■Information Sharing Between Existing and New Districts ■Public Educational Programs ■Conservation Assistance Grants ■Irrigation Planning ■Point and Non-Point Source Pollution Management ■Weather Modification/Rainfall Enhancement ■Water Well Records ■Applied Research Projects Regarding Groundwater/Conservation/Recharge Enhancement
Texas Alliance of Groundwater Districts	■Technical Assistance to Water Code Chapter 36 Groundwater Districts ■Information Sharing Between Existing and New Districts ■Public Educational Programs

Technical Assistance Programs

Technical assistance programs conducted by state agencies and others take many forms. Some provide assistance to new and existing GCDs to facilitate district formation, compliance with required regulatory programs, and development of district rules and regulation. For example, the TAGD provides assistance to newly created GCDs as they go through the election confirmation process.

Other technical assistance programs promote the more efficient use of groundwater and recharge of the aquifers. These programs include technical assistance to farmers through brush control programs, irrigation planning, and weather modification.

The TSSWCB's Brush Control Program protects groundwater resources by controlling invasive brush species, which utilize a large amount of water. By controlling the brush in an area and restoring the native grasses, more water is available to recharge the underlying aquifer.

Another example is weather modification/rainfall enhancement, under the jurisdiction of the TDA and TDLR and implemented by several groundwater districts in West Texas. Cloud seeding to enhance precipitation can result in direct recharge to some aquifers in the state and may result in groundwater conservation due to the lessened need to pump irrigation water from aquifers.

TWDB, TSSWCB, and GCDs have programs that recognize the importance of improving irrigation equipment efficiencies. The incorporation of more efficient irrigation equipment/technology in a farming/ranching operation provides another method of conserving groundwater. Significant savings in water use can be accomplished with improvements in conveyance systems, the use of more efficient irrigation application systems, soil moisture monitoring, the development and use of drought tolerant plant strains and varieties of crops, and the use of growth regulators and evaporation suppressants.

Financial Assistance

Some nonregulatory programs provide financial assistance to the public to address water conservation needs and also provide technical assistance and grants to the groundwater conservation districts and to water utilities. For example, the State Cost Share Program in the Panhandle (specifically for groundwater) helps landowners implement Water Quality Management Plans by funding 75 percent of the costs. These plans are developed by the TSSWCB to address the land uses of farms and ranches and conserve their natural resources. The conservation of groundwater is a major focus in the Panhandle region and practices such as LEPA (Low-Energy Precision Application) irrigation are being used by more landowners because of the financial assistance provided under this program.

Planning and Coordination

Many agencies have developed plans, either on the local or statewide level, that include or promote groundwater conservation or identify water needs for future planning purposes. These plans take several forms such as individual farm plans and joint planning by groundwater conservation districts within identified Groundwater Management Areas. Groundwater conservation districts are required to develop and adopt a comprehensive management plan for the most efficient use of groundwater, for controlling and preventing waste of groundwater, and for controlling and preventing land subsidence.

On a statewide basis, the TWDB is responsible for developing and adopting the State Water Plan. *Water for Texas - 2002* is the first State Water Plan to be adopted by the TWDB since the passage of Senate Bill 1 (SB1) during the 1997 Texas Legislature. This session changed the planning process to one based on public participation at each step of the process and local and regional decisions to produce regional water plans - plans that form the basis of the State Water Plan. Sixteen Regional Planning Groups, which included approximately 450 representatives of a broad array of interests, worked for more than three years to develop their plans.

The State Water Plan incorporates the 16 TWDB-approved regional water plans and describes how local governmental entities throughout the state will address their water supply needs for the next 50 years. The regional plans are based on historical drought-of-record and water use patterns. Regional water planners have the authority to modify their plans as use patterns change, as additional conservation methods are incorporated, and as different approaches to drought-of-record conditions are developed.

Water for Texas - 2002 discusses water-related data, water management strategies, and key policy recommendations. The plan includes concepts and suggestions made by the TWDB, including recommendations on how the state government can support the regional authorities and local governments which will remain the primary financiers of water projects in Texas.

Regional water planners were required to include consideration of impacts on the environment. Every strategy requiring a new water right, including reservoirs and other surface water strategies requiring new permits, were evaluated on their impact to bay and estuary and other environmental flows.

Innovative water management strategies also received much attention in the plans. Wastewater reuse, desalination, brush control, and other strategies were also featured in the plans. In addition to considering conservation in calculating water demand in accordance with recent laws requiring more water efficient plumbing fixtures, over 12 percent of new water needs were met through conservation.

The TAES, TWDB, TAGD, TCEQ, and individual groundwater conservation districts also conduct various educational and outreach programs by providing information to the public on groundwater conservation techniques and planning activities.

Monitoring and Research Programs

Some nonregulatory groundwater conservation programs monitor groundwater use, groundwater level changes, and surface subsidence, either as part of data gathering to characterize existing water resources in the state or to provide for projected trends in the future. For example, the Irrigation Metering Project is being developed by the TWDB and some member districts of the TAGD to collect information to facilitate the effective use of groundwater in agriculture.

Irrigated agriculture is the largest groundwater use sector in Texas. In the past, estimates of groundwater use for irrigated agriculture have been derived from controversial methods. Water use figures for irrigated agriculture are derived from state and federal agencies utilizing locally reported numbers and agency field estimates. A method of gathering accurate agriculture irrigation data at a series of sites, called monitor plots, is being developed to provide data to both local and state planners.

Currently, TWDB has contracted with five groundwater conservation districts to locate suitable sites and install metering equipment. For planning purposes it will be important to know all of the major factors that directly affect the groundwater level and how they vary from year to year. The monitor plots will go beyond simply gathering crop water use data. Site-specific data will be collected on snowfall, rainfall, soil type(s), crop acres, irrigation systems, amount of water pumped, and how all of those input figures relate to the aquifer level, which will also be measured.

Basic research is another type of nonregulatory groundwater conservation activity conducted by the TWDB, BEG, TAES, and local groundwater conservation districts. Some research supports the development of various best management practices to aid in the conservation of groundwater and to determine the practicability of recharging a groundwater reservoir. The TWDB has started the “High Plains Playa-Classification Initiative” to catalog playas in the High Plains area. Part of the project will identify playas that could be modified to increase recharge to the Ogallala Aquifer. Modifying the playa floor by removing silt and clay could increase leakage of ponded water into the aquifer.

Other research projects involve the study of hydrogeologic characteristics to provide information to better evaluate the impact of certain uses of groundwater. For example, the Groundwater Availability Modeling (GAM) initiative by the TWDB is developing state-of-the-art, publicly available, numerical groundwater flow models to provide reliable

information on groundwater availability in Texas aquifers. It will result in computer models of groundwater flow in the major and minor aquifers in the state that currently supply 95 percent of produced groundwater.

GAM will assist groundwater conservation districts in the management of groundwater resources and Regional Water Planning Groups in planning for future water supplies and will result in a greatly improved understanding of groundwater resources in the state. Groundwater conservation districts and Regional Water Planning Groups can also use the models to evaluate various water management strategies and to simulate future water conditions.

Analysis

Virtually all water used in rural homes is from groundwater. The U.S. Census from 1990 reported private supplies in Texas were used by 691,863 households, or 9.7 percent based on a total of 7,108,999 households statewide.[3] According to the census, approximately 92.5 percent of private water supplies are used by nonfarm households. Users of private water supplies decreased as a percentage of population from 11.9 percent in 1970 to 8.1 percent in 1990, even though the absolute number of people using private water supplies increased. In recent years, there has been a proliferation of domestic wells in suburban and rural areas due to rapid population growth in developments outside the service area of local drinking water providers.

There are no specific programs that routinely examine the quality of water being consumed by Texans utilizing these private/domestic wells. Surveys of the groundwater quality of private wells in Texas are rare; however, studies that have been conducted by the various agencies have indicated that both man-made and naturally occurring contaminants — such as fecal coliform, nitrate, radioactive nuclides, pesticides and pesticide degradation by-products, arsenic, and other heavy metals — have been found in some domestic wells at levels that exceed health-based maximum contaminant levels (based upon a lifetime exposure to the constituent).

A comparison between the level of effort expended by state programs to evaluate and address potential contamination of private and public drinking water sources indicates that there is a gap in the protection efforts provided to domestic/private well users.

[3]The U. S. Census did not survey for similar information during the 2000 Census.

Providers of public water supplies are required to have wells that have been constructed to meet specific standards to prevent contamination. The treated water must be analyzed for a wide variety of chemical and microbiological contaminants before distribution to consumers. This routine water quality testing of treated groundwater helps the system and the state to identify problems.

If a contaminant level is too high for treatment the water supplier has several options available to meet the mandated drinking water standards, such as blending water from several wells to lower the contaminant level, closing off contaminated groundwater zones within the well, or electing not to use the contaminated well and using alternative water sources instead. The state-enforced compliance with regulations ensures the delivery of adequate quality water to the consumer. In addition, public water suppliers are required to inform their customers as to the quality of the finished water they are consuming.

In contrast, regulations applying to private wells only relate to the construction of the well by the water well driller. In addition, the remediation programs discussed earlier in this chapter address domestic well contamination when discovered.

Current well construction standards for domestic wells will protect the water source from surface or very shallow groundwater contamination, but will not address naturally occurring contaminants or contamination in the targeted aquifer that migrates from another area due to nonpoint source contamination. Chemical testing at the time the well is drilled is usually restricted to simple inorganic constituents, such as total dissolved solids and for coliforms and sometimes nitrate. It is rare for a water well driller or a private homeowner to test for radioactive constituents, arsenic, or organic constituents because of the expense.

If a private well owner is aware of the presence and characteristics of contamination in his well or naturally occurring problems in the area, then existing treatment technologies, such as softeners, reverse osmosis, and carbon filters are often effective. Awareness of the type and concentration of the contamination, would allow the homeowner to try treatment or to utilize alternate drinking water sources, such as drilling deeper or using bottled water. In some areas where radionuclides are prevalent, release of radon gas into the home from washing, bathing, and other water use activities could also be important.

A better understanding of the contamination issues facing private well owners is needed to assess how to better address this programmatic gap. Water quality sampling strategies that target the voluntary sampling of private wells need to be developed and implemented. This is especially important in areas already known or suspected to be contaminated, or in aquifers that are known to contain high levels of naturally occurring constituents that are of concern. Information could be disseminated to the public to allow private well owners to make informed choices about sampling, treatment strategies, or alternative drinking water sources.

CHAPTER V: GROUNDWATER INFORMATION AND DATA MANAGEMENT

The successful implementation of groundwater protection and conservation programs is dependent on different kinds of informational and measurement data. Data used by these programs includes measurements of water chemistry (indicating groundwater quality); the quantity of groundwater pumped from wells or discharged from springs; the amounts of chemicals in spills, releases, or other types of waste; and the water level in wells. Other kinds of information data are used to evaluate groundwater conditions. These include identifying potential sources of contamination, locating actual contamination sites, delineating the boundaries of contaminant plumes, and predicting groundwater movement from computerized models.

Some groundwater protection programs may require "raw" data to be collected from a site for use in determining regulatory compliance or evaluating if conditions change over time. This data includes the measured water quality or water level information taken directly from monitoring wells. The data are reported to the regulatory entity, which then develops an assessment of groundwater conditions based on the data.

Other regulatory and nonregulatory programs may require an interpretation of the raw data to generate a "product" like an assessment, model or groundwater study. The product then becomes a source of additional information for regulatory programs.

To be useful, the collection of data should follow recognized quality assurance procedures and criteria. The data must be representative of the groundwater targeted for sampling, for example a well used for data collection in the Edwards Aquifer should actually be completed in the Edwards Aquifer, not be completed in both the Edwards and the underlying Trinity Aquifers.

Analysis of the groundwater quality should be accurate, using a standard method in the laboratory for the analysis. The acceptable range of values for the method is specified. Test results should be reproducible and independently verified if regulatory action is needed. Similarly, measurements and calculations for groundwater pumping tests or related analyses should follow an accepted method.

Groundwater data should be managed to ensure that data can be used by all entities protecting groundwater resources. The data set must contain additional information such as time and location of the sample, quality control, and aquifer sampled so that the data can be used and compared to

other sampling results. This minimum set of data elements allows different groups to share the data for a variety of purposes such as research, computer modeling, regulatory enforcement, or aquifer remediation.

Data storage formats must be compatible and should be made readily accessible for users. To achieve efficient database management, data sharing efforts should be coordinated among potential users to ensure that these requirements are met.

Types of Groundwater Information and Data

Groundwater information can be considered as one of four basic types: environmental, infrastructure, assessment, and programmatic. Environmental and infrastructure data are site-specific with the collection point location an essential part of the information. The date of the data collection is also an important element of the information. Assessment and programmatic information are often groups of data and information that are compiled, compared, and interpreted to form conclusions about impacts to the environment or the effectiveness of actions taken to protect groundwater or clean up contamination.

Environmental Data

Environmental data are measurements and descriptions of physical features of the environment and include the geology or rock type of a given area, the occurrence or presence of water at the surface or underground and the quality or chemical composition of the surface and groundwater. Rock type is observed and described from rock material removed in the well-drilling process. Each type of rock has different hydrological characteristics. “Tight” rock formations, consisting of fine grained or well cemented rocks such as clays are very restrictive to water flow, whereas highly porous formations with large grains such as sand or cave features in limestone can store a great deal of water and allow for rapid movement. These hydrological characteristics can be determined from data on water levels, pump tests, spring-flow and other measures of water quantity. Most important for regulatory programs, however, is water quality data, which is typically more easily measured than the quantity data. Location of the data sampling point is a critical component of all environmental data collection and analysis.

Data on Infrastructure

Infrastructure data such as water well construction and groundwater pumping volumes for a municipal water supply well are examples of manmade features or activities, which can have a direct effect on groundwater hydrology. Similarly, other activities involving waste or toxic products, such as septic tanks or petroleum storage tank installations may have an impact on the groundwater quality in an area. Information on these types of operations would fall under the infrastructure data category as

well. Information about water, oil, and gas wells can assist in predicting how these wells might affect groundwater. The location of these features is a critical element of the information for this category.

Assessment Data

Unlike the previous two data categories, assessment information is not measured directly. This category of data are generated from the analysis and synthesis of environmental data. Evaluation of measured water quality data in an area combined with information on groundwater hydrology can provide an assessment of the potential for drilling additional wells. This same approach over a larger area can be included in a computer model to generate data or information such as groundwater availability estimates, pumpage demand projections, or contaminant movement projections. This kind of information can be refined using directly measured field data, and is important to planning entities and water utilities.

Programmatic Data

Programmatic data measures or describes administrative activities such as corrective action enforcement tracking information for contamination sites, the number of permits issued for regulated activities that address groundwater protection measures, groundwater management plan status/content, and information on licensed groundwater related professionals. While this information is not necessarily used to assess groundwater quality or quantity, it is useful in establishing the frequency and number of groundwater related activities for planning purposes, for determining the effectiveness of regulatory programs and for reporting activities to policymakers.

State Responsibility for Maintenance of Groundwater Data

Members of the TGPC have legislatively mandated responsibilities that rely on the collection and maintenance of groundwater data. The data may be collected from several sources by an organization. The compiled data may then be used internally by the organization or by others in regulatory, research or assessment activities. While some data are readily accessible through electronic databases and in a format that can easily be shared, much of the existing data may only be available in paper files. The following discussion provides some examples and information on groundwater-related data maintained by specific state agencies.

TCEQ Groundwater Data

The TCEQ issues permits or authorizations for many of the activities under its jurisdiction, and in turn requires data collection and reporting in compliance with those permits or authorizations. The data are used as the basis for enforcement, remediation, and planning programs, relative to the permitted activity.

Groundwater data are analyzed to determine if spills or releases from regulated facilities have occurred. Groundwater data are also used to determine if contaminated groundwater cleanup activities are successful.

Water quality data from public water supply systems, which is used to determine the safety of water supplies, is collected through the agency's Public Drinking Water program. TCEQ is also responsible for analyzing this and groundwater data from other sources for reports to the EPA on the status of groundwater quality in the state. The reported data may also be supplemented by information from USGS, TWDB, BEG, GCDs, and TDA.

RCT Data

The RCT collects data regarding groundwater contamination that may be related to oil and gas well drilling and production activities, transmission (pipeline) spills, and surface mining operations. For oil and gas wells, an applicant must obtain a letter stating the level of the base of usable quality groundwater prior to the RCT authorizing drilling operations. This letter is obtained from the TCEQ, and is based on data maintained in TCEQ files. The RCT also maintains data on oil and gas well construction and the locations of the well.

TWDB Data

The TWDB has the responsibility for collecting and maintaining ambient groundwater conditions throughout the state. Ambient data are used by regulatory entities to protect groundwater resources during various permitting processes.

TWDB also compiles environmental data from other sources, and develops assessment models for use in groundwater management and planning activities. The data collected is typically water quality and water level measurements obtained through the TWDB's ambient groundwater monitoring network. This data are supplemented by data from the USGS, GCDs, the BEG, and the TCEQ. A substantial body of other infrastructure information may be used by the TWDB such as "monitoring well" information and well logs, which details the rock formations.

Groundwater Conservation Districts' Data

Many of the GCDs have well-developed monitoring programs that are primarily intended to monitor the volume of water in an aquifer, but also carry a substantial body of groundwater quality information. Data are maintained by the GCD, and is generally reported to the TWDB for inclusion in their ambient groundwater database. Some GCDs also maintain data on the volume of water withdrawn from aquifers under their jurisdiction.

BEG Data

The BEG collects local and regional groundwater environmental data during the BEG studies, and, similar to the TWDB, develops assessment data in the form of models and reports. This data collection and analysis typically is developed for a study and is funded on a case-by-case basis. While the data needs of studies vary, BEG procedures remain the same, so data are comparable, and can be included in larger compilations of data.

TAES/Texas Cooperative Extension Data

The TAES collects environmental data, as well as uses data from other agencies to conduct research on groundwater use and behavior. The Texas Cooperative Extension (TCE) uses data in the development of educational and assistance programs, including programs that focus on groundwater protection through the proper installation and maintenance of on-site wastewater systems and through the proper closure of abandoned water wells. Other TCE programs focus on pesticide applicator training and agricultural practices that are protective of groundwater and surface water resources in the state.

TDLR Data

The TDLR compiles programmatic data in the form of water well driller licensing information. Required driller reports provide TCEQ and TWDB with environmental data.

Other TGPC Members Data

TDA, TDH, and TSSWCB do not compile groundwater data specifically, but they may compile programmatic data relative to their areas of concern. Any of the these agencies may use groundwater data developed by others.

Data Exchange Among TGPC Members

Data compiled by a TGPC member may used by any to develop regulatory, research and planning programs. For example, GCDs may use models developed by the TWDB, based in part on data that the district provided, to establish well spacing criteria. The reciprocal exchange of data is vital to groundwater management and protection activities. Exchange of “quality assured” data is essential to the characterization of groundwater quality and the evaluation of the effectiveness of groundwater protection programs.

Standards for Groundwater-Related Data

Quality Assurance

For environmental data to meet the need of various users, it must have utilized the quality assurance requirements. These requirements include the use of standard methods of laboratory analysis that specify: minimum detection levels for constituents; preservation methods for field sample collection; the length of time that a sample may be held before analysis; and procedures for reducing the chances of error in sample collection, transportation and analysis. Quality assurance requirements are typically detailed in a "Quality Assurance Project Plan" developed by the program collecting the data and is often specific to the current project.

Environmental Testing Laboratories

The TCEQ requires that environmental testing laboratories providing data and analysis to the agency be accredited. Additionally, environmental testing laboratories providing data and analysis relating to compliance with the Safe Drinking Water Act (SDWA) must be certified against the EPA "drinking water manual." Since the TCEQ uses the results of these analyses to make permitting, compliance, enforcement, cleanup, and other decisions, all laboratories providing data to the agency are required to follow National Environmental Laboratory Accreditation Conference (NELAC) standards.

Common Data Elements and Mapping

Data sets must contain a sufficient number of common data elements to provide comparability and consistency on a statewide basis. Recognizing this need, the TGPC facilitates data exchange between member agencies, and other water programs, through the use of the *Texas Ground-Water Data Dictionary* (AS-109, August 1996). This generic groundwater data dictionary provides groundwater professionals in Texas with specific guidelines, including *EPA/USGS Minimum Set of Data Elements (MSDE) for Groundwater Protection* (EPA, 1992a), and the *Texas Standards and Guidelines for Geographic Information Systems* (Texas Geographic Information Systems Standards Committee, 1992).

The Texas Natural Resource Information System (TNRIS), a part of the TWDB, serves as a clearinghouse for different types of environmental data. TNRIS' recent efforts have focused on creating a collection of statewide base map files for use by state agencies and the public in the compilation and presentation of environmental data. These base maps can be used to accurately illustrate many groundwater related features on a two dimensional map. The maps are designed to be usable with established TNRIS data sets, which served as a standard for groundwater programs in Texas.

The Texas Water Monitoring Council provides a forum for exchange of water data, including groundwater data. While this group does not set standards for data exchange, it does provide a valuable resource for those who do set standards to determine which participating organizations have data and how to access it.

Coordination of Data Management Activities

The TGPC is charged with publishing the *Joint Groundwater Monitoring and Contamination Report*, a compilation of all of the known groundwater contamination cases in the state and their enforcement status. The report also serves as a compendium of groundwater monitoring activities being conducted by members of the TGPC. The TGPC has also developed and published the *Texas Ground-Water Data Dictionary* (discussed earlier in this chapter) to facilitate information exchange.

TGPC members often exchange groundwater-related data for use in assessment activities. For example, TCEQ obtains ambient groundwater quality data from the TWDB. The data are then added to the data obtained from the *Joint Groundwater Monitoring and Contamination Report*, and the Public Drinking Water program, and used to make a general assessment regarding the groundwater quality for specific aquifers. The state report is then forwarded to the EPA as part of Texas' Water Quality Inventory, for their use in preparing the National Water Quality Inventory. The state report also includes data on the surface water – groundwater interaction obtained from the USGS through the National Water Quality Assessment (NAWQA).

Ongoing Review and Revision of Data Collection Efforts

TGPC members, through its Data Management Subcommittee, continually review internal data management activities. Changes, improvements, or problems are reported to the TGPC. These reviews are intended to provide better data products and promote efficiency within the TGPC members' programs.

The *Joint Groundwater Monitoring and Contamination Report* and TGPC's biennial report to the Legislature serve as opportunities for the TGPC to review the data collection and management processes for groundwater contamination and monitoring. In a similar manner, preparation of the groundwater portion of Texas' contribution to the National Water Quality Inventory report is a biennial opportunity to review data management aspects of ambient water condition monitoring programs. If problems are discovered during the development of any of these documents, the TGPC serves as a body entrusted with coordinating the resolution of the issue among its members.

Analysis

Ambient Groundwater Monitoring

Ambient groundwater quality monitoring program needs more resources to sample more sites and provide a better picture of ambient groundwater conditions. The suite of chemicals that is analyzed needs to be expanded to include organic and synthetic chemicals. There is no organized statewide voluntary program to collect water samples from private drinking water wells for ambient/contaminant analysis. Such a program would add significant information for state groundwater planning efforts, and a new body of data for inclusion in reports to EPA, specifically the Texas Water Quality Inventory.

Data Dictionary

Changing technology, especially in the area of spatial data, requires that the Texas *Ground-Water Data Dictionary* be reviewed and possibly amended to ensure compliance with new guidelines issued by the Texas Geographic Information Council (TGIC) in 2001. These guidelines are intended to ensure accuracy and consistency of location data obtained through Global Positioning Systems (GPS). They also include accuracy standards for location data obtained by other means to ensure compatibility and comparability with the GPS data. The Texas Geographic Information Council also established standards for a Geographic Information System (GIS) file structure, which is crucial for the interchange of different databases.

Improving Coordination of Data Management

Data management is a dynamic process and requires continual improvements. Unfortunately some improvements are made without coordination among all of the concerned parties, and some deviation from an accepted standard may result. Because data management is dynamic, accepted standards may become outdated or simply no longer needed. As a result, standards should be aggressively reviewed and amended to avoid a serious breakdown in information exchange. The TGPC should actively promote the acceptance and use of their standards and guidelines, and should actively participate in the various data management advisory groups.

Need for Spatial Databases for Contamination and "Bad Water"

Geographic Information Systems/relational database for waste site and groundwater contamination site characterizations and the location of "bad water" are critically important to any planning process. The ability to display data graphically, and to correlate data from a variety of sources into the graphic display is currently not available throughout the TGPC member agencies.

Both TCEQ and RCT track certain waste and/or contaminant plumes. The location and geometry of these plumes should be placed in a GIS format for access by other planning and regulatory entities, and other affected groups (i.e. groundwater conservation districts, water well drillers, regional water planning authorities, and domestic well owners) to facilitate the development of high quality groundwater resources.

Not all data are available in an electronic format because the data have been maintained in paper files and never transcribed. The data are scattered throughout thousands of separate case files. For example, the TDLR has developed a relational database that includes water well driller information such as the location of "bad" water when it is encountered. The water well driller's report also includes a spatial coordinate (latitude and longitude) and has been in operation for approximately one year. However, there is a large number of existing historical hard-copy water well drillers reports that need to be placed in the digital format used by this system.

All available data sources should be checked for validity via accepted quality assurance measures, and once accepted, placed into an electronic format with a spatial data element for indexing in a relational database. The TGPC should promote the development of a central database to house this information or establish a platform that will allow for easy data sharing by all interested parties.

More Data on Naturally Occurring Elements That May Have Health Effects

Assessment of hazardous wastes in groundwater is covered by a number of state and federal programs. However, substances in groundwater that may be deemed "naturally occurring" and may have health effect, such as nitrates, arsenic, and radionuclides, need better assessment.

CHAPTER VI: RESEARCH TO IMPROVE GROUNDWATER MANAGEMENT

Natural systems in the environment are characterized by complex processes and many and varied components. Man's interaction with these systems introduces further complexity and can result in contaminants being introduced into the natural system.

Groundwater, hidden beneath the surface, is often removed from our direct observation and experience. The results of man's interaction with a groundwater system, such as a spill or leak of gasoline, can be seen at some future point in time when a water well is contaminated, but the process and movement of the contaminant is not easily seen nor understood.

Contaminant behavior in groundwater also varies geographically across Texas because different aquifer and rock formations have unique physical characteristics. Effective implementation of groundwater conservation, protection and remediation programs requires an understanding of these varying characteristics of natural systems.

The focus of research conducted on groundwater has changed in recent years. Research in the past was focused on the development and production of natural resources such as oil, lignite, and uranium. With significant development of groundwater resources in Texas research has shifted towards conservation, protection, and remediation.

A sound scientific basis, established through research, is fundamental to the development and implementation of reasonable and effective conservation, protection, and remediation programs. Because the state's aquifers vary in their potential for use and in their susceptibility to contamination, the use of "best professional judgement" has been recognized by the Legislature (as discussed earlier in Chapter I) and is an important component in achieving the state's goals and policy.

Regulatory program development has evolved from basic command and control solutions to more complex and flexible approaches such as risk-based program implementation. Best professional judgement based on sound scientific research allows the government agencies to develop fair, equitable and reasonable regulatory, conservation, and remediation requirements.

Subject Areas for Groundwater Research

Groundwater research efforts in the state not only support current programs, but help to identify future areas of concern. Traditionally, groundwater research has focused on both basic, large scale, hydrogeologic research that characterizes water resources or water quality; and targeted research regarding specific contamination sources, localities, or technologies. These diverse efforts reflect the unique research needs of the TGPC membership.

The role of research in protecting groundwater resources is varied. Research studies provide reliable and timely information on groundwater availability, quantifying the resource to plan for future water use needs. Studies address physical hydrogeologic issues, including hydrogeologic properties and processes controlling occurrence and movement of groundwater, and the interaction of surface water and groundwater.

Water quality research also contributes to the assessment of groundwater usability to meet future needs by quantifying natural or ambient water quality, changes in water quality caused by aquifer development, and the extent of contamination brought about by man's activities such as over pumpage, spills, or releases from other regulated activities.

Research also supports regulatory programs. Many research projects test new or alternative technologies to prevent or remediate groundwater contamination. Identification and verification of new site characterization methodologies improves the ability to quantify local groundwater conditions. These new technologies can provide support in all phases of remediation including assessment, prioritization, methodology selection, and monitoring. Basic research on the movement and toxicity of contaminants and their decay products is the foundation for both regulatory and nonregulatory programs as they quantify how these contaminants move in the soil and within the aquifers.

Research on various water conservation technologies addresses the need for more efficient use of water resources. These projects can include the examination and verification of innovative irrigation strategies, equipment, and best management practices.

Analysis

State agencies and other groundwater program areas are facing more sophisticated and difficult regulatory decisions and have an increasing need for research tailored to specific environmental and regulatory problems. The traditional research organizations, generally associated with universities, in both the agricultural and natural resource sectors, have developed the experience, infrastructure, and technical expertise needed to address complex research needs. However, there is no formal mechanism

to get the agencies that need the research together with the organizations that perform the research. The member agencies of the TGPC represent both types organizations.

The TGPC should form a research subcommittee to identify interagency research needs and to provide a coordinated approach for discussion with federal agencies for funding. A multi-disciplinary approach should be facilitated to build upon expertise from many different areas. Committee members could share resources to solve problems that are common to all, including cooperatively applying to federal agencies for pass-through monies. The subcommittee should facilitate cooperation by identifying ways to join research forces with state or federal agencies and local governmental entities.

Additionally, the subcommittee should work with the universities to develop stronger research proposals to address specific problems. The subcommittee should identify research and program needs and help focus the efforts of the researchers on meeting these needs. In areas were overlapping research initiatives are discovered, the subcommittee should facilitate communication between various research organizations**.** In addition, the subcommittee should share the results of their work with TCEQ for consideration under the TCEQ's research model requirements found in TWC Sections 5.1191-5.1193.

CHAPTER VII: PUBLIC EDUCATION

Groundwater is a valuable component of our water supply, providing roughly one-half of the state's water supply. Approximately 85 percent of the state's public drinking water systems obtain some or all of their drinking water from wells and springs. Since 1965, an estimated 618,390 water wells have been drilled in the state. Because of the importance of groundwater to both humans and the environment, government agencies have designed and implemented efforts to educate the public about groundwater quality and the need to protect and conserve the state's valuable groundwater supply.

Most of the groundwater programs conducted by the members of the TGPC have some educational or outreach component that targets a specific regulated group. This component may be as simple as a brochure or a web site that explains the program, or as complex as detailed technical guidelines for a regulated industry. Because the universe of groundwater educational programs is so broad, this chapter is limited to the programs that are specifically designed to educate the general public.

Importance of Public Education

Groundwater is easily impacted by the actions or inactions of individuals. This is especially true in suburban or rural areas where a high percentage of homesteads rely on on-site (septic) wastewater disposal systems and shallow domestic water wells. Environmental impacts occur not just from industrial or waste management facilities but also in homeowners backyards. Domestic water well owners manage chemicals for home and business use that can pose a threat to groundwater and water well contamination. The increase in population in rural areas associated with large population centers has resulted in an increased demand for water resources and has exacerbated the effects of recurring Texas droughts. There is a great need to improve the understanding of the general public on factors affecting their water supply and their own water well.

Agricultural producers can affect groundwater quality and quantity by activities such as pesticide applications and the use of water-saving irrigation techniques. While there may be government programs that regulate the activities noted above, it is often more effective, both in terms of environmental protection and costs, to seek individual cooperation in groundwater protection efforts. This cooperation is encouraged through the educational efforts of the programs highlighted in this chapter. The program discussion that follows is by no means exhaustive. The chapter is intended to provide a sampling of the many groundwater education programs available to the general public and to identify gaps in the current delivery of educational programs.

Public Education Initiatives

Abandoned Water Well Closure

Abandoned water wells are a serious threat to the quality of our groundwater resources and to public safety. If not properly plugged, unused wells can provide a direct conduit for surface water carrying pollutants to groundwater, or these abandoned wells can allow contaminants to move from one aquifer to another. Furthermore, just as these wells pose a threat to groundwater, large open wells are safety hazards for small children and animals.

State law requires that abandoned wells be maintained and capped or properly plugged. The landowner where an abandoned well is located is responsible for well closure and compliance with state law. Many abandoned water wells are not properly closed because landowners may not have sufficient resources or may be unaware of the requirements for closure.

The TGPC has initiated and coordinated an interagency effort to promote the closure of abandoned water wells. An internet site, http://abandonedwell.tamu.edu, is devoted to informing the public of the risk brought about by abandoned wells, and to promote the proper plugging of abandoned wells. The site includes a facilitators guide, fact sheets, a hands-on video and step-by-step photos or slides of the process. The Texas Cooperative Extension (TCE) leads the educational outreach activities with programs available through County Extension Offices. Texas Department of Licensing and Regulation serves as the technical resource for well closure standards and regulations.

Farm Pollutant Inventory and Management

Another education program established by TCE is TEX*A*Syst, a rural well water protection program that addresses a wide range of potential contaminants and provides remedies in a comprehensive, yet simple way. Potential problems covered with TEX*A*Syst include contaminated wellheads and how to protect them, fertilizer storage, household wastewater treatment and disposal, hazardous waste management, establishment of livestock holding facilities with proper manure treatment and disposal, and properly closing abandoned wells. Developed from the national Farm*A*Syst groundwater protection program, the TEX*A*Syst system is designed to help the user learn more about the environment, existing environmental policies, and recommended management practices for household and agricultural activities.

The TEX*A*Syst publication series incorporates current regulations and the latest technologies into an applied decision-making format. By answering several questions, rural residents have the means to assess how their home site activities are affecting their environmental risks. Once

environmental risks are assessed, the user can voluntarily reduce the pollution risks by incorporating individual practices that help protect groundwater. More importantly, however, TEX*A*Syst helps rural residents take decisive actions to preserve the quality of their own drinking water, prevent further water pollution, and protect their health.

One component of TEX*A*Syst is county water testing campaigns. Citizens have the opportunity to send in water samples to be tested at the Texas Cooperative Extension Laboratory. Educational meetings are then conducted in the county to discuss the water sample test results.

Soil testing campaigns are also conducted to increase nutrient management education. Educational programs following soil test results teach citizens on the proper use of nutrients to prevent surface and groundwater contamination. The programs are directed to agricultural and urban audiences and target proper timing, rate and methods of application for inorganic fertilizers and organic nutrients sources containing nitrogen. In addition, TEX*A*Syst materials help the landowner identify and implement practices that can prevent pesticides from causing water quality problems.

Groundwater Conservation Districts' Educational Efforts

Groundwater conservation districts play a critical role in protecting the state's groundwater resources. These local governments are the "on-the-ground" implementors of state and local efforts to conserve groundwater. They are uniquely suited to provide groundwater conservation education and technical assistance. Interest in groundwater management and districts has increased greatly in recently years. Thirty-five new groundwater districts were created by the 77th Legislature. If all are confirmed by voter election, the number of established groundwater conservation districts would increase from 52 to 87.

Groundwater districts vary in size and scope. Many have extensive educational efforts designed to meet local needs. For example, the Edwards Aquifer Authority has educational programs specifically designed for school children. The High Plains Underground Water District, headquartered in Lubbock, focuses its educational effort on assisting the region's farmers conserve water resources. Some groundwater districts education programs include the distribution of information through radio, television, and newspaper coverage and through speaking engagements at various civic groups and other organizations. A district may also distribute water conservation literature and often a newsletter.

With the significant increase in new groundwater districts and increased interest in groundwater management generally, new educational outreach efforts have been initiated by individual groundwater districts, the Texas Alliance of Groundwater Districts (TAGD) and TCE. TCE has lead an interagency effort including TAGD, TCEQ and TWDB in providing educational materials, outreach and area-specific programs on groundwater management programs and district activities.

On-Site Wastewater Disposal Education

An effective on-site system removes wastewater from the home, treats and distributes the wastewater, and protects our water resources. The Texas Legislature passed a law in 1987 regulating on-site sewage facility (OSSF) systems statewide. The law called for regional and local governments such as counties, cities, river authorities and special districts to implement and enforce on-site sewage regulations with approval and oversight by the Texas Commission on Environmental Quality (TCEQ).

Selecting the appropriate system for the site conditions is critical to the system's success. The internet site http://ossf.tamu.edu provides publications and videos of the variety of OSSF systems available for both private and public use. Furthermore, the site publishes a schedule of public short courses located throughout the state, which provide an overview of wastewater treatment systems. Each publication is devoted to a different type of system outlining the advantages and disadvantages of each, the approximate cost of installing and maintaining the system and the proper steps required in maintaining the system.

Drinking Water "Right-to-Know"

Starting in October 1999, the federal government required all community water systems in Texas and nationwide to deliver to consumers a water quality report showing exactly what constituents are present in their drinking water and the likely sources of those constituents. The "right-to-know" report is likely the most widely distributed environmentally-related public education document.

The "right-to-know" requirement applies to more than 80 regulated contaminants and naturally occurring materials that can affect the quality of drinking water. The water quality reports list minerals such as nitrates and fluorides, organic compounds such as toluene or pesticides, bacteria such as coliform organisms, and metals such as lead, copper, and arsenic. For the first time, this new "right-to-know" requirement gives consumers much more information about the water they drink and empowers them to make more informed choices — for example, the choice between a utility's drinking water, in-home treatment systems, and bottled water.

Roughly 85 percent of the state's public drinking water systems obtain some or all of their drinking water from groundwater sources. The bulk of these systems are subject to the "right-to-know" requirement and provide water quality reports to their consumers.

Analysis

Access to Agency and Program General Information

Programmatic information on groundwater quantity and quality is typically available in either electronic or printed versions from the state and federal agencies responsible for administering that program. While finding information on some groundwater programs may be fairly easy, oftentimes agency web pages are not organized around groundwater as a theme. For example, impacts to groundwater are considered in TCEQ's wastewater permitting, but it would be hard for a member of the general public to determine that by searching the agency's website. Much of the information may exist but is hard to access. To remedy this, the TGPC should establish on its web page links to key groundwater information residing at state agencies and educational institutions. The TGPC would focus on linking documents and educational material designed for use by the general public.

*TEX*A*Syst*

While a great deal of information and effort has been incorporated into the development of the TEX*A*Syst program, only limited resources have been available for actual implementation and outreach. Along with the development of the program, rural farmstead outreach using the TEX*A*Syst materials was conducted with landowner participants in the Seymour Aquifer area. There was also some limited outreach work in the Lubbock area. Land owners over the greater part of the state have not had the opportunity to participate in the program. There are many areas of the state where groundwater protection education through this program would benefit rural landowners.

On-Site Wastewater Treatment Systems

An on-site wastewater system requires maintenance in order to ensure proper operation and environmental protection. Unlike a centralized sewer system maintained by a city or water district, maintenance of an on-site system is the responsibility of the homeowner. According to the Texas On-Site Wastewater Treatment Council, a state agency, 13 percent of the state's on-site wastewater disposal systems are chronically malfunctioning. In a survey of local entities implementing the state's on-site wastewater program, 73 percent reported that they did not believe that OSSF owners received adequate education regarding their systems.

The failure rate cited above combined with the increasing number of new on-site systems presents special challenges to state's counties experiencing rapid population growth. Much of the growth in these counties is relying on OSSF systems for wastewater disposal. In fact, the majority of the recent on-site wastewater disposal system installations have occurred in the counties adjacent to the state's largest cities. For example, over 13,000 on-site wastewater disposal systems have been installed in Montgomery County, north of Houston, since 1994.

Inadequate OSSF owner education has been cited as one of the principal causes of on-site wastewater system failures. With a statewide OSSF failure rate of 13 percent and increase in new systems, the TGPC recommends that the state continue to support the efforts of the On-Site Wastewater Treatment Research Council, the Texas Cooperative Extension, the TCEQ's on-site wastewater program, and local governments in their efforts to develop and deliver effective educational material that addresses OSSF maintenance in order to prevent failures. The TGPC is uniquely suited to assist this effort by providing technical assistance related to groundwater quality. In addition, the government agencies involved in OSSF regulation and outreach may want to consider developing programs specially designed to reach and serve the state's high growth counties.

Education for Private Domestic Water Well Owners

For the domestic water wells owners, there are no federal or state requirements for monitoring drinking water quality, no "right-to-know" report informing well owners of the quality of their drinking water, and no requirements for treatment. The TGPC has identified two significant programatic gaps related to private domestic water wells. More water quality information is needed to develop an assessment of water quality and health risk for the domestic well owner segment of the population. Public educational materials and outreach programs are needed to educate well owners on drinking water quality and potential health risks.

CHAPTER VIII: PUBLIC PARTICIPATION

As noted in Chapter VII, individual action can have a significant impact on the groundwater resource. Similarly, individual and group participation can play significant roles in the formation of state groundwater policy. This chapter will discuss ways that the public can get involved and/or monitor in the development of groundwater policy.

Oftentimes, public involvement is initiated by an individual's interest in a specific rule or permit action proposed to be undertaken by a state agency or water district. In these cases, the public input and notification processes used by the state assures that notice is provided to the public. This is accomplished through mail notification or a newspaper advertisement in the case of some proposed permit actions or publication in the *Texas Register* during the rule development and adoption process.

Individuals or groups interested in getting involved in groundwater protection on a more comprehensive scope can do so through monitoring and commenting on the activities of the regional water planning groups coordinated by the Texas Water Development Board (TWDB) or through the activities of the Texas Groundwater Protection Committee (TGPC).

State law required the TWDB to establish regional water planning groups (RWPGs) to develop long-term water supply strategies for their regions. The TWDB was required to select the initial members of the regional planning groups from 11 interests identified in state law and other relevant interests in the regional water planning areas. Interests identified in state law include the public, counties, municipalities, industry, agriculture, environment, small businesses, electric-generating utilities, river authorities, water districts, and water utilities. The planning groups were able to add other individuals as appropriate.

With support from the RWPGs and others, the TWDB was able to develop the state water plan, *Water for Texas — 2002*. Plan development was a culmination of 3 years' effort by regional representatives, nearly 900 public meetings and hearings, and the combined efforts of the state's natural resource management agencies. The plan provides detailed water management for the next 50 years, identifies all water user groups in the state (including cities having populations of 500 or more and aggregations of demand according to county for other sectors, such as manufacturing and irrigation), records the projected water demand for each water user group over the 50-year planning period, indicates whether the water user group has a need for additional water in the future, and provides water management strategies to meet the projected need.

Although *Water for Texas* - 2002 is complete, the RWPGs will continue to work. The TWDB has asked the RWPGs to focus future efforts on the review, revision and refinement of the currently approved regional water plans, and to respond to changed conditions that may impact water supplies or recommended water management strategies in the regions. The TWDB and the RWPGs are also making additional efforts to get public participation by ensuring that RWPGs minutes and agendas will be posted in the future on either the TWDB web page or on the web pages of the RWPGs.

The TGPC seeks to bridge the gaps between existing state groundwater programs in order to improve groundwater quality and quantity protection. As an entity comprised of representatives from the state agencies with significant groundwater-related activity, the TGPC offers the opportunity for the public to access many state agencies at once. TGPC also conducts a number of activities throughout the year and the state's biennium that provide an overview of groundwater activities taking place in the state. TGPC activities include the publication of a biennial report to the Legislature containing a summary of committee activities and proposing legislative recommendations; the distribution of a groundwater monitoring and contaminations report; and the undertaking of special projects like the development of an abandoned well plugging initiative. The TGPC meets quarterly, its meetings are open to the public, and the public is given the opportunity to address the committee. Additionally, the public and groundwater stakeholders are encouraged to participate in the TGPC working subcommittees. More information about TGPC meeting times can be found in the *Texas Register*, at the committee's internet site http://www.tgpc.state.tx.us, or by contacting TGPC at (512) 239-4514.

CHAPTER IX: STRATEGY DEVELOPMENT AND PLANNING

State law requires the TGPC to: *" . . . develop and update a comprehensive groundwater protection strategy for the state that provides guidelines for the prevention of contamination and for the conservation of groundwater and that provides for the coordination of the groundwater protection activities of the agencies represented on the committee . . ."* (Water Code Section 26.405(2)). This document is based on the legislative requirement described above and two additional duties required of the TGPC by state law.

TGPC's additional duties considered in the development of the *Strategy* are: *the coordination of groundwater protection activities of the agencies represented on the committee (TWC* Section *26.405(1))*; and *study and recommend to the Legislature groundwater protection programs for each area in which groundwater is not protected by current regulation* (TWC Section 26.405(3)).

The *Strategy*, presented in this publication, is the state' second groundwater protection strategy. The first state *Groundwater Protection Strategy* was published in January 1988. The strategy has not been updated since that time. In the fourteen or so years since that publication, water policy in the state has continued to evolve. Because of the changes in water policy, the TGPC recognizes the need to update the strategy on a regularly scheduled basis.

At its January 15, 2002 meeting and work session, the TGPC developed a time frame for future updates to the state *Groundwater Protection Strategy*. The committee decided to update the strategy every six years, in the year when the Legislature was not is session. The schedule allows the document to be published and distributed prior to the Legislature convening in the following year. Based on this schedule, work on the next strategy will begin in 2006, with publication of an updated documented prior to the Legislature convening in January 2007. The committee also agreed that the *Groundwater Protection Strategy* and its recommendations would incorporate a short term (5 years), medium term (6 to 15 years), and a long term planning horizon (16 to 25 years).

The TGPC believes that the state has numerous successful groundwater programs spread across local and state governmental agencies, and research institutions; however, these programs had not been catalogued in a single document. Therefore, a key part of this *Strategy* is documenting how the current regulatory, outreach, and research programs work to protect groundwater resources. The second fundamental component of this *Strategy* is the identification by TGPC members of protection gaps in

program implementation or coordination. TGPC believes that this approach to developing the strategy, grounded firmly within the existing policy and programmatic directions given by the Legislature, will result in a document that sets realistic objectives for success and provides a road map for action over the next five years (the TGPC's short-term planning horizon).

The TGPC recognizes that the current *Strategy* is missing an identification and ranking of significant threats to groundwater quality and a prioritization of actions needed to address those threats. As part of the development of the next *Strategy*, the TGPC intends to conduct an analysis to identify and rank threats to groundwater quality (taking into consideration the vulnerability of groundwater resources to such threats and using available data) and to prioritize possible actions that address those threats. Such an analysis would provide a valuable tool to both TGPC member agencies and the Legislature as they go about setting groundwater protection policy. To ensure objectivity of such an analysis, the committee could seek the assistance of a private consulting organization or academic institution to perform parts or all of the analysis. In addition, the TGPC will seek and promote public review and comment on the analysis.

In developing the current strategy, TGPC requested public comment on a draft *State Groundwater Protection Strategy* in the December 13, 2002 *Texas Register*. The deadline for submission of comments was January 17, 2003. Three sets of comments were received. A summary of those comments and the TGPC's responses can be found in Appendix 3.

CHAPTER X: RECOMMENDATIONS FOR ACTION

In providing recommendations, the TGPC considered the policy and programmatic gaps identified in Chapters I through IX. These recommendations represent a summary of those gaps, and a more detailed description of the issues can be found within the indicated Chapter. The recommendations also incorporate a suggested goal for completion of the identified actions - short term (5 years), medium term (6 to 15 years), and a long term (16 to 25 years).

The following recommendations reflect a consensus of the committee members and do not necessarily reflect all of the views and policies of each participating organization. The recommendations are not listed in any order of priority.

Strengthen Communication with the State's Water Planning Efforts

The Committee needs to strengthen the lines of communication and information sharing with the Regional Water Planning Groups. The lack of communication between these two groups is a gap in the TGPC's ability to coordinate the state's groundwater protection strategy with the state's water supply planning efforts led by the Texas Water Development Board. *(Short Term Goal - See Chapter III.)*

Improve Groundwater Data

Gaps exist in the data collection and data assessment processes. The existing ambient groundwater quality monitoring program needs more resources to sample additional sites that will provide a better picture of ambient groundwater conditions statewide. The parameters that are analyzed need to be expanded to include organic and synthetic chemicals. While site specific assessment of hazardous wastes in groundwater is covered by a number of state and federal programs, other substances in groundwater, such as nitrate and arsenic, that may be deemed naturally occurring need better assessment. The TGPC should develop recommendations on the design of an ambient groundwater monitoring system that will meet the needs of all member agencies. Any new monitoring of domestic water wells would be on a voluntary basis. *(Short Term Goal - See Chapter V.)*

Data management is a dynamic process and, as such, accepted data management standards may become outdated, superceded by a better, newer standard, or simply no longer needed within a short period of time. It is imperative that these data management standards be periodically reviewed and amended to facilitate information exchange. The Committee

must review and revise its groundwater data management standards and guidelines, and must actively participate in the various data management advisory groups. *(Short Term Goal - See Chapter V.)*

The need for a geographic information systems/relational database for waste site and groundwater contamination site characterizations is critical to any planning process. All available data sources should be checked for validity via accepted quality assurance and quality control measures, and once accepted, placed into an electronic format with a spatial data element for indexing in a relational database. The location and geometry of contamination plumes should be placed in a GIS format. *(Medium Term Goal - See Chapter V.)*

The TDLR has developed a relational database that includes water well driller information, the water well driller's reports, and reports of encountering undesirable water zones when wells are drilled, in a spatial coordinate (latitude and longitude) database. There is a large number of existing hard-copy water well drillers reports that need to be placed in a digital format and made accessible through the existing system. *(Medium Term Goal - See Chapter V.)*

Coordinate Research

Traditional groundwater research organizations, generally associated with universities, in both the agricultural and natural resource sectors, have developed the experience, infrastructure, and technical expertise needed to address complex research needs. However, there is no formal mechanism to link the agencies on the Committee that need research performed together with the organizations that are capable of performing the research. The TGPC should form a research subcommittee to identify interagency research needs and to provide a coordinated approach for discussion with federal agencies for funding. The results of this work should be shared with the TCEQ for its consideration under the research model authorized under TWC Sections 5.1191 - 5.1193. *(Short Term Goal - See Chapter VI.)*

Increase Public Outreach

Virtually all water used in rural homes, not connected to a public drinking water system, comes from domestic/private water wells. There are no specific programs that routinely examine the quality of groundwater being consumed by Texans utilizing these wells. More water quality information is needed to develop assessments of water quality and health risk for the domestic/private well owner segment of the population. The state should undertake a voluntary program targeted at private well owners, designed to identify problem areas and assist private well owners in understanding these groundwater quality issues. *(Both Short Term and Medium Term Goal, see Chapters IV and VII.)*

Public educational materials and outreach programs are needed to educate domestic/private well owners on drinking water quality and potential health risks. More support needs to be given to educational efforts for targeted geographic areas of concern for high concentrations of naturally occurring groundwater contaminants and on various treatment options available to the domestic/private well owner. Support is also needed for educational efforts to develop and deliver effective educational materials that target potential sources of contamination such as abandoned wells. Special effort should be made to develop programs designed to reach and serve the state's high growth areas. *(Both Short Term and Medium Term Goals, see Chapter VII.)*

An effective on-site system removes wastewater from the home, treats and distributes the wastewater, and protects our water resources. An on-site wastewater system requires maintenance in order to maintain proper operation and environmental protection. Unlike a centralized sewer system maintained by a city or water district, maintenance of an on-site system is the responsibility of the homeowner. A statewide OSSF failure rate of 13 percent and the growing dependence on these systems in the suburban fringe around urban areas continues to create human health and environmental concerns.

Therefore, the TGPC recommends that the state continue to support the efforts of the On-Site Wastewater Treatment Research Council, the Texas Cooperative Extension Service, the TCEQ's on-site wastewater program, and local governments in their efforts to develop and deliver effective educational material that addresses OSSF maintenance in order to prevent failures. In addition, the government agencies involved in OSSF regulation and outreach may want to consider developing programs specially designed to reach and serve the state's high growth counties. (*Short Term and Medium Term Goals, See Chapter VII*)

Oftentimes, state agency's web pages are not organized around groundwater as a theme, making it difficult for the general public to find information on the state's groundwater protection efforts. To remedy this, the TGPC should establish, on its web page, links to key groundwater information residing at state agencies and educational institutions. *(Short Term Goal - See Chapter VI.)*

Commit to Development of Periodic Updates and Improvements to the *State Groundwater Protection Strategy*

The first groundwater strategy was developed in 1988 and has not been updated prior to this document. The TGPC should update the *Strategy* every 6 years. *(Short and Medium Term Goals - See Chapter IX)*

As part of the ongoing process for developing the next *Strategy*, the TGPC intends to conduct an analysis that will identify and rank threats to groundwater quality (taking into consideration the vulnerability of groundwater resources and using available data), and prioritize possible actions that address those threats. Such an analysis would provide a valuable tool to both TGPC member agencies and state legislators as they go about setting groundwater protection policy. *(Short and Medium Term Goal - See Chapter IX.)*

APPENDIX 1. GROUNDWATER CLASSIFICATION SYSTEM

Purpose

The Texas Groundwater Protection Committee and its member agencies recognize that groundwater classification is an important tool to be used in the implementation of the groundwater policy contained in Section 26.401 of the Texas Water Code. Through classification, the groundwaters 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.

Basis

Four classes are defined based on quality as determined by total dissolved solids content (Figure 15). The names and concentration ranges are based on traditional nomenclature associated with each class. Quality also determines usability, however, it is implicit in this classification that a water-bearing zone must be able to produce sufficient quantities of water to meet its intended use. The examples of use are intended to describe some of the common uses of these classes and are not meant to be exclusive of other uses that might arise due to unusual circumstances or application of new technology such as desalinization.

Application

This groundwater classification system applies to all groundwaters in the state. In assigning a classification, the member agencies shall endeavor to use the natural quality of the groundwater that is unaffected by discharges of pollutants from human activities.

All usable and potentially usable groundwaters are subject to the same protection afforded the nondegradation policy goal of the Texas Water Code in Section 26.401. This section further states that nondegradation does not mean zero-contaminant discharge. Starting with this nondegradation policy goal, protection or restoration measures can be varied according to the response level set by the classification and guidance of this narrative so long as the following conditions are met:

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

In determining protection or restoration measures, the member agencies should consider all beneficial uses to that groundwater of a given quality can currently or potentially be put. Generally, the use of groundwater requiring the highest degree of protection or restoration is human consumption as drinking water. Protection for this use will also be protective of all other current or potential uses in almost all circumstances. The suitability of a zone for use as a human drinking water supply can be based on the quality and quantity of the water it contains as well as its ability to produce enough water to meet its intended use. These considerations facilitate 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.

Evaluations

In specifying a protection or restoration measure, member agencies must apply best professional judgement on a case-by-case basis. Evaluations to be made include but are not limited to such factors as yield, the availability of alternate sources of water, any 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. In instances where there is a likelihood of hydrologic interconnection with resultant potential for contaminant movement from a given groundwater zone to a surface water body or other groundwater zones, protection and restoration measures for that zone should be determined by the quality and current and potential use of the receiving waters.

Additional Functions

This classification system is intended to be implemented by member agencies as an integral part of their groundwater quality programs. In addition to its response setting function, the classification system can also serve as a common basis among the various programs to foster consistency. It can also be used as a mapping tool to delineate specific areas in need of more detailed groundwater quality management. Towards this end, the Committee recognizes the important contributions of all agencies that compile such data and supports the continuing efforts to enhance the statewide database.

Texas Groundwater Protection Committee - Groundwater Classification System

CLASS	QUALITY*	EXAMPLES OF USE	AGENCY RESPONSE
Fresh	Zero to 1,000	Drinking and all other uses	**Level I Response:** Protection or restoration measures based on current use as a human drinking water supply
Slightly Saline	More than 1,000 to 3,000	Drinking (if fresh water is unavailable), livestock watering, irrigation, industrial, mineral extraction, oil and gas production	
Moderately Saline	More than 3,000 to 10,000	Potential/future drinking and limited livestock watering and irrigation (if fresh or slightly saline water is unavailable); industrial, mineral extraction, oil and gas production	
Very Saline to Brine	More than 10,000	Mineral extraction, oil and gas production	**Level II Response:** Protection or restoration measures based on indirect exposure or no human consumption

* Concentration range of total dissolved solids in milligrams per liter.

APPENDIX 2. TGPC RULES

Texas Administrative Code
Title 31: Natural Resources and Conservation
Part 18: Texas Groundwater Protection Committee
Chapter 601: Groundwater Contamination Report
Subchapter A: General Provisions Relating to Public Files and Joint Report

Section601.1 Purposes of Rules

The purpose of these sections is to implement duties and responsibilities assigned to the committee under the Texas Water Code, §26.406, concerning the maintenance by certain state agencies of public files containing documented cases of groundwater contamination and the publication by the committee, in conjunction with the commission, of annual groundwater monitoring and contamination reports and to establish general policies of the committee to guide such implementation.

§601.2 Applicability

These rules specifically apply to each state agency or organization having membership on the committee. The committee is composed of the Texas Natural Resource Conservation Commission (or effective September 1, 2002, the Texas Commission on Environmental Quality), the Texas Department of Health, the Texas Department of Agriculture, the Railroad Commission of Texas, the Texas Water Development Board, the Texas Alliance of Groundwater Districts, the Texas Agricultural Experiment Station, the Bureau of Economic Geology of the University of Texas at Austin, the State Soil and Water Conservation Board, and the Water Well Drillers and Water Well Pump Installers Program of the Texas Department of Licensing and Regulation.

§601.3 Definitions

The following words and terms, when used in this chapter, shall have the following meanings unless the context clearly indicates otherwise.

(1) Act--House Bill 1458 (71st Session) codified as Texas Water Code §§26.401 - 26.407.

(2) Commission--Texas Natural Resource Conservation Commission (or effective September 1, 2002, the Texas Commission on Environmental Quality).

(3) Committee--Texas Groundwater Protection Committee.

(4) Documented groundwater contamination--A case of groundwater contamination where an agency has an established procedure for making a determination based on the quality of groundwater and the information pertinent to making the determination is maintained by the agency under §601.4(b) of this title (relating to Public Files).

(5) Enforcement action--Any action of the agencies, identified in §601.2 of this title (relating to Applicability), which accomplishes or requires the identification, documentation, monitoring, assessing, or remediation of groundwater contamination.

(6) Groundwater--Water below the land surface in a zone of saturation.

(7) Groundwater contamination--The detrimental alteration of the naturally occurring physical, thermal, chemical, or biological quality of groundwater. Furthermore, groundwater contamination, for purposes of inclusion of cases in the public files and the joint groundwater monitoring and contamination report, shall be limited to contamination reasonably suspected of having been caused by activities or by entities under the jurisdiction of the agencies identified in §601.4(b) of this title (relating to Public Files), except in the case of an underground source of drinking water granted an aquifer exemption by the commission with concurrence from the United States Environmental Protection Agency in accordance with 40 Code of Federal Regulations, Parts 144, 145, and 146, and 30 TAC Chapter 331 (Underground Injection Control); and affecting groundwater which contains a concentration of:

(A) less than or equal to 10,000 milligrams per liter (mg/liter) of dissolved solids; or

(B) greater than 10,000 mg/liter if it is:

(i) currently extracted for beneficial use such as domestic, industrial, or agricultural purposes; or

(ii) hydrologically connected with, and with the potential for contaminant movement to, a surface water body or another zone of groundwater which has a concentration of less than or equal to 10,000 mg/liter of dissolved solids.

§601.4 Public Files

(a) Subject to the limitations provided by the Texas Water Code, §§26.401-26.407 (the Act), and the Open Records Act, Texas Civil Statutes, Article 6252-17a, information collected, assembled, or maintained by the committee and the agencies having responsibilities related to protection of groundwater under the Act is public record open to inspection and copying during regular business hours.

(b) Each agency having the responsibilities related to the protection of groundwater under the Act shall maintain a public file of all documented cases of groundwater contamination that are reasonably suspected of having been caused by activities regulated by the agency.

§601.5 Joint Groundwater Monitoring and Contamination Report

In conjunction with the commission, the committee shall publish not later than April 1 of each year a joint groundwater monitoring and contamination report covering the activities and findings of the committee made during the previous calendar year. The report must:

(1) describe the current status of groundwater monitoring programs conducted by or required by each committee agency or organization at regulated facilities or in connection with regulated facilities;

(2) contain a description of each case of groundwater contamination documented during the previous calendar year and of each case of groundwater contamination documented during previous years for which enforcement action was incomplete at the time of issuance of the preceding report; and

(3) indicate the status of enforcement action for each case of groundwater contamination that is included in the report.

APPENDIX 3. PUBLIC COMMENTS AND TGPC RESPONSES

The Texas Groundwater Protection Committee (TGPC) requested public comment on the draft *State Groundwater Protection Strategy* in the December 13, 2002 *Texas Register*. The deadline for submission of comments was January 17, 2003. Three sets of comments were received. A summary of those comments and the TGPC's responses follow.

Comments dated January 10, 2003 from R. Kinnan Golemon on behalf of the Hickory Underground Water Conservation District No. 1

Comment #1

Comment Summary:

Implementation of the U.S. EPA's rule for the reduction of the radionuclides in public water supplies will drastically impact the Hickory Underground Water Conservation District (HUWCD) No. 1 because the Hickory Aquifer contains radionuclides above the Maximum Contamination Level (MCL). TCEQ's implementation of the federal rule threatens the ability of the public drinking water supply systems to use Hickory Aquifer water. The commentor states that there is no authority dictating Texas must accept federal demands and regulations on state groundwater resources.

TGPC Response:

The issues raised by the commentor are under TCEQ's jurisdiction. TGPC will refer these issues to TCEQ for their consideration.

COMMENT #2

Comment Summary:

There is no formal mechanism to link the state's leading research organizations to the TGPC. The Hickory (UWCD) No.1 urges the TGPC to mandate (1) coordination between state research organizations, including the Texas Radiation Advisory Board (TRAB), and the relevant TGPC state agencies; and (2) a fundamental reliance on the part of TGPC agencies on the findings and recommendations of its state research organizations over reliance on unscientific federal findings.

TGPC Response:

Two research organizations, the Texas Agricultural Experiment Station and the Bureau of Economic Geology, are members of the TGPC. The *Strategy* recommends the formation of a research subcommittee to focus groundwater research needs at a state level. In response to the *Strategy*, the TGPC has created a Research Subcommittee and charged it with prioritizing groundwater research needs and fostering cooperation among state research organizations. Involvement of the TRAB on the Research Subcommittee is welcome.

TGPC has no authority to mandate coordination or agency reliance on any particular scientific findings.

COMMENT #3

Comment Summary:

The Hickory UWCD No.1 comments that, unlike private domestic well users, public drinking water suppliers do not have the opportunity to use point-of-use treatment systems as an option for handling contamination. They further comment that the TCEQ refuses to approve point-of-use systems in its Public Drinking Water Supply Program and the Water Development Board will not fund point-of-use systems because they are considered a private, rather than public, remedy. The Hickory UWCD No. 1 believes the *Strategy* is misleading in its discussion of point-of-use systems as possible treatment options.

TGPC Response:

Treatment options for drinking water in the Chapter IV Analysis focus solely on private domestic wells, not public drinking water systems. Water quality from domestic water wells is not regulated. This contrasts with water delivered to consumers through public water supply systems which is regulated by the TCEQ. Point-of-use treatment is an optional step that private domestic well owners may voluntarily take to improve their drinking water quality.

The TGPC has referred the comment on point-of-use systems for public drinking water systems to both the TCEQ and the TWDB for consideration.

COMMENT #4

Comment Summary:

The district urges the TGPC to include in the final *Strategy* sound and viable water treatment solutions that are approved for both use and funding.

TGPC Response:

The TGPC is encouraging the development of treatment options for the domestic well owner. This is a programmatic gap not covered by existing state programs. Treatment options approved for use by the public drinking water suppliers are under the sole jurisdiction of the TCEQ.

Comments dated January 16, 2003 from Sylvia Ritzky, US EPA Region 6

COMMENT #1

Comment Summary:

The EPA commended the committee's efforts and stated that they were pleased to see a commitment to update the *Strategy* every six years because this will allow the committee adequate time to evaluate the short term goals and adjust the medium and long term goals to suit the state's changing needs.

TGPC Response:

The committee acknowledges and thanks the EPA for its comment.

COMMENT #2

Comment Summary:

The EPA commented that the committee should pursue two of the recommendations 1) designing an ambient groundwater monitoring strategy that meets the needs of all member agencies and facilitates the sharing of information, and 2) forming a research subcommittee to identify interagency research needs and to provide a coordinate approach for discussion with federal agencies for funding.

TGPC Response:

The committee intends to begin addressing the ambient groundwater monitoring strategy through its Data Management Subcommittee.

The Groundwater Research Subcommittee has been formed and charged by the full committee to act as a formal mechanism for identifying interagency research needs and providing a coordinated approach for discussion with potential funding sources. They will use a multi-disciplinary approach to build upon expertise from many different areas and will identify projects where shared resources could support research to solve problems that are common to many committee members, including identifying opportunities for cooperatively applying to federal agencies for passthrough monies. Additionally, the subcommittee has been charged to work with the universities to develop stronger research proposals to address specific identified problems. Currently the subcommittee is evaluating previous efforts to identify research needs and determine the effectiveness of these efforts, including whether the identified projects are still needed and identify successful funding methods. The Subcommittee's second task will be to present, to the TGPC, an operational plan to identify interagency research needs and methods to provide a coordinated approach for prioritizing projects and finding potential funding sources.

Comments dated January 22, 2003 from Veronica J. Godley, Director, Resource Quality Management Department, San Antonio Water System (SAWS)

Note: Despite being received after the close of the official comment period, the TGPC has opted to include a response to these comments in the *Strategy* document.

COMMENT #1

Comment Summary:

The Strategy document underestimates the importance of urban water purveyors in conservation, education, and water protection.

TGPC Response:

The TGPC agrees that urban (and suburban) water purveyors are important to water conservation, education, and protection efforts. Additionally, the TGPC agrees that the current *Strategy* document fails to fully address the importance of urban water purveyors. The TGPC will work to ensure that

(1) future updates of the *Strategy* (every 6 years) will address the importance of urban water purveyors; and (2) the role of urban water purveyors is considered in TGPC's on-going work.

COMMENT #2

Comment Summary:

SAWS urges the TCEQ to review how graywater can be a useful resource for conservation efforts. SAWS also recommends that graywater should not be authorized for use on the Edwards Aquifer Recharge Zone.

TGPC Response:

The TGPC agrees that graywater may be a useful resource for conservation efforts and that the review of graywater use is of merit. The TGPC's Research Subcommittee welcomes input from SAWS and others in its efforts to determine groundwater research priorities and gaps; and will consider graywater use in its future coordination efforts.

The TGPC has referred the issue of prohibiting graywater use over the Edwards Aquifer Recharge Zone to the TCEQ.

COMMENT #3

Comment Summary:

SAWS states that abandoned water wells are a statewide problem because they serve as potential pathways for pollutants to contaminate groundwater resources. SAWS requests that the TGPC actively support state legislation to provide a funding mechanism to plug abandoned wells.

TGPC Response:

The TGPC agrees with SAWS that abandoned water wells pose a threat to groundwater quality. While the TGPC, as a state agency, cannot actively support legislation, the TGPC in its *Report to the 78th Legislature* recommends the creation of an abandoned well plugging fund.

Acronyms

AFY	Acre-Feet per Year
ASDWA	Association of State Drinking Water Administrators
ASIWPCA	Association of State and Interstate Water Pollution Control Administrators
AWWA	American Water Works Association
BEG	Bureau of Economic Geology at the University of Texas at Austin
BRC	Bureau of Radiation Control at the Texas Department of Health
COC	Chemical of Concern
DOD	United States Department of Defense
DOE	United States Department of Energy
DRASTIC	Depth to water; annual Recharge; Aquifer media; Soil media; Topography; vadose zone Impact; hydraulic Conductivity
ECOS	Environmental Council of the States
EPA	United States Environmental Protection Agency
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
GAM	Groundwater Availability Model
GCD	Groundwater Conservation District
GMA	Groundwater Management Area
GPS	Global Positioning System
GWPC	Ground Water Protection Council
IBWC	International Boundary and Water Commission
LEPA	Low Energy Precision Application
MSDE	Minimum Set of Data Elements
NAS	National Academy of Sciences
NAWQA	National Water Quality Assessment
NELAC	National Environmental Laboratory Accreditation
OSSF	On-Site Sewage Facility
PBB	Prescribed Burning Board
PCB	Polychlorinated Biphenyl
PGMA	Priority Groundwater Management Area
PMP	Pesticide Management Plan
PST	Petroleum Storage Tank
PWS	Public Water Supply
RCRA	Resource Conservation and Recovery Act
RCT	Railroad Commission of Texas
RWPG	Regional Water Planning Group
SDWA	Safe Drinking Water Act
SFIREG	State FIFRA Issues Research Evaluation Group
SWAP	Source Water Assessment Program
TAC	Texas Administrative Code
TAES	Texas Agricultural Experiment Station
TAGD	Texas Alliance of Groundwater Districts
TCE	Texas Cooperative Extension
TCEQ	Texas Commission on Environmental Quality
TDA	Texas Department of Agriculture
TDH	Texas Department of Health
TDLR	Texas Department of Licensing and Regulation
TDS	Total Dissolved Solids
TGIC	Texas Geographic Information Council
TGPC	Texas Groundwater Protection Committee
TNRIS	Texas Natural Resource Information System
TRRP	Texas Risk Reduction Program
TSCA	Toxic Substance Control Act
TSSWCB	Texas State Soil and Water Conservation Board
TWC	Texas Water Code
TWDB	Texas Water Development Board
USDA	United States Department of Agriculture
USGS	United States Geological Service
VCP	Voluntary Cleanup Program