Texas Commission on Environmental Quality

Texas State Soil & Water Conservation Board

Managing NONPOINT SOURCE POLLUTION IN TEXAS

2009 ANNUAL REPORT

Funding provided by the Environmental Protection Agency through Clean Water Act Section 319(h) grant funds

SFR-066/09

January 2010

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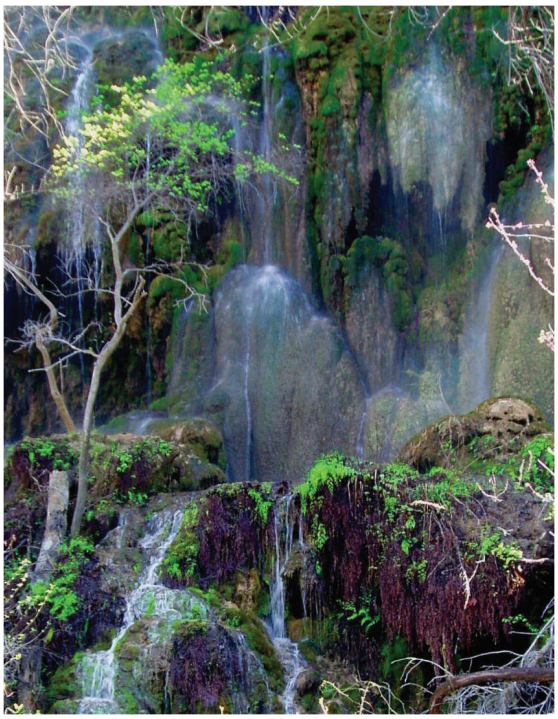

Plum Creek Watershed (photo by Matt Berg of Texas AgriLife Extension Service)

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Published and distributed
by the
Texas Commission on Environmental Quality
P.O. Box 13087
Austin, TX 78711-3087

and by the

Texas State Soil and Water Conservation Board
P.O. Box 658
Temple, TX 76503

From The Executive Directors

The *State of Texas Nonpoint Source (NPS) Management Program* is the state's official blueprint to protect and restore water resources impacted by nonpoint sources of pollution and is jointly developed and administered by the TCEQ and the TSSWCB. The NPS Management Program uses baseline water quality management and regulatory, voluntary, financial, and technical assistance approaches to achieve balanced results. The TCEQ and TSSWCB have established goals and objectives for guiding and tracking the progress of NPS management in Texas. The U.S. Environmental Protection Agency (EPA) provides grant funding to Texas to implement the NPS Management Program. Success in achieving the goals and objectives are reported annually in this report, which is submitted to the EPA in accordance with Section 319(h) of the Clean Water Act (CWA).

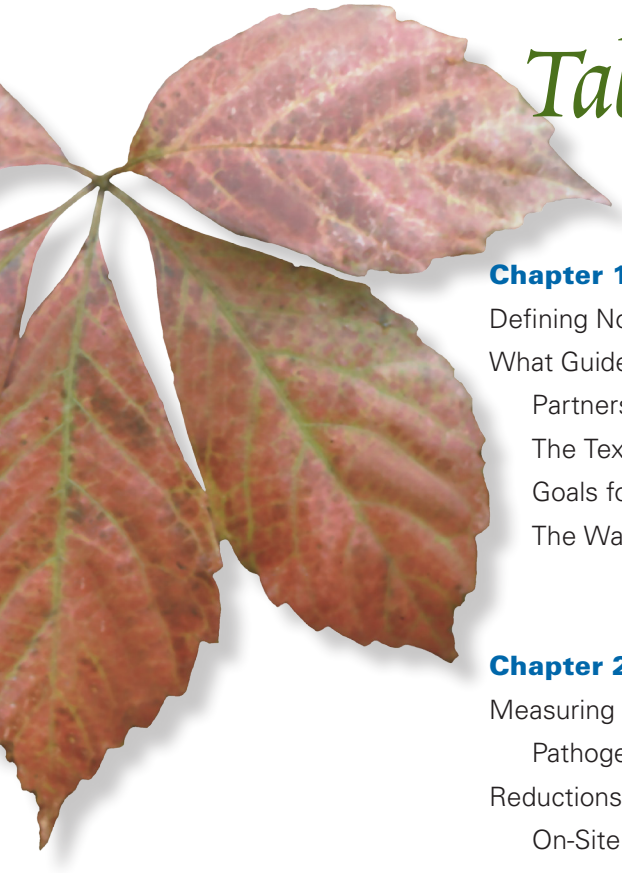
NPS pollution continues to be a major source of water quality impairment in the state. With the extent and variety of NPS issues throughout Texas, cooperation across political boundaries is essential. Many local, regional, state, and federal agencies play an integral part in managing NPS pollution, especially at the watershed level. They supply information about local concerns and infrastructure and build support for the kind of pollution controls that are necessary to prevent and reduce NPS pollution. By establishing coordinated frameworks to share information and resources, the state can more effectively focus its water quality protection and restoration efforts.

We are pleased to present this annual report of the state's NPS Management Program. The report documents our progress during 2009 in meeting the goals of the program. In partnership with the EPA and other federal, state, regional, and local watershed stakeholders, the TCEQ and the TSSWCB welcomes input to the planning and implementation of the program and looks forward to the continued growth in the program's successes.

Sincerely,

Rex Isom
Executive Director
Texas State Soil and
Water Conservation Board

Mark R. Vickery, P.G.
Executive Director
Texas Commission on
Environmental Quality



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Introduction

Defining Nonpoint Source Pollution

NPS pollution is all water pollution that does not come from point sources. Point sources are regulated end-of-pipe outlets for wastewater or storm water from industrial or municipal treatment systems.

NPS pollution occurs when rainfall or snowmelt flows off the land, roads, buildings, and other features of the landscape. This runoff carries pollutants into drainage ditches, lakes, rivers, wetlands, coastal waters, and even underground sources of drinking water. NPS pollution also includes flows of polluted water from sources not subject to permits, such as car washes and leaking septic tanks. Common NPS pollutants include:

- fertilizers, herbicides, and insecticides from agricultural lands and residential areas
- oil, grease, and toxic chemicals from spills, roads, urban areas, and energy production
- sediment from construction sites, crop and forest lands, and eroding stream banks
- bacteria and nutrients from livestock, pet waste, and leaking septic systems

Some NPS pollution starts as air pollution deposited onto the ground and into waterways (*atmospheric deposition*). Changes in the flow of waterways due to dams and other structures (*hydromodification*) can also cause NPS pollution.

Middle Bosque River in Mclennan County (photo courtesy of TSSWCB)

What Guides Nonpoint Source Pollution Management in Texas?

Under the federal CWA, Texas and other states must establish water quality standards for waters in the state, regularly assess the status of water quality, and implement actions necessary to achieve and maintain those standards. The mission of the NPS Management Program is to protect the quality of the state's water resources from the adverse effects of NPS pollution. This protection is achieved through cooperative implementation using the organizational tools and strategies defined below.

Partnerships

The TCEQ is designated by law as the lead state agency for water quality in Texas. The TSSWCB is the lead agency in the state for planning, implementing, and managing programs and practices for preventing and abating agricultural and silvicultural NPS pollution. The TCEQ administers the NPS Management Program for all other sources of NPS pollution.

Management of NPS pollution in Texas involves partnerships with many organizations to coordinate, develop, and implement the NPS Management Program. With the extent and variety of NPS issues across Texas, cooperation across political boundaries is essential. Many local, regional, state, and federal agencies play an integral part in managing NPS pollution, especially at the watershed level. They provide information about local concerns and infrastructure and build support for the kind of pollution controls that are necessary to prevent and reduce NPS pollution. By coordinating with these partners to share information and resources and to develop and implement strategies, the state can more effectively focus its water quality protection efforts.

The Texas Nonpoint Source Management Program

The *Texas NPS Management Program*, approved by both the TCEQ and the TSSWCB in 2005 <www.tceq.state.tx.us/goto/nps-report> is the state's official plan for addressing NPS pollution and presenting the goals, priorities, programs, and milestones for the program. The publication is updated every five years and is currently under

revision for 2010. The NPS Management Program is required by Section 319(h) of the federal CWA and prepared jointly by TCEQ and TSSWCB.

Pages 12–16 of the current Texas NPS Management Program present goals and objectives for addressing NPS pollution in the state. The Texas NPS Management Program uses a balanced approach incorporating baseline water quality management programs and regulatory, non-regulatory, financial, and technical assistance. The goals describe high-level guiding principles for all activities under the Program. The objectives specify the key methods that will be used to accomplish the goals. This NPS Annual Report, which is also required by CWA Section 319(h), provides an annual update of progress toward meeting the goals and milestones set forth in the Texas NPS Management Program. Additionally, the Annual Report briefly summarizes the state's NPS Program and how it is integrated with the state's other water quality programs.

Goals for Nonpoint Source Management

Long-Term Goal

The long-term goal of the NPS Management Program is to protect and restore water quality from NPS pollution through assessment, implementation, and education.

Short-Term Goals

Goal One—Data Collection and Assessment

Coordinate with appropriate federal, state, regional, and local entities, private sector groups, and citizen groups and target CWA Section 319(h) grant funds towards water quality assessment activities in high priority, NPS-impacted watersheds, vulnerable and impacted aquifers, or areas where additional information is needed.

Goal Two—Implementation

Coordinate and administer the NPS Management Program to support the implementation of Total Maximum Daily Load (TMDL) implementation plans (I-Plans) and watershed protection plans (WPPs) and other state, regional and local plans and programs to reduce NPS pollution. Manage all CWA Section 319(h) grant funds efficiently and effectively to target implementation activities to the areas identified as impacted, or potentially degraded with respect to use by NPS pollution.

Goal Three—Education

Conduct education and technology transfer activities to help increase awareness of NPS pollution and prevent activities contributing to the degradation of water bodies, including aquifers, by NPS pollution.

The Watershed Approach

Protecting the state's streams, lakes, bays, and aquifers from the impacts of NPS pollution is a complex process. Texas uses a watershed approach to focus efforts on the highest priority water quality issues of both surface water and groundwater. The watershed approach is based on the following principles:

- geographic focus—based on hydrology rather than political boundaries
- water quality objectives based on scientific data
- coordinated priorities and integrated solutions
- diverse, well-integrated partnerships

For groundwater management, the geographic focus is on aquifers rather than watersheds. Otherwise, the approach is the same as for surface water. Wherever interactions between surface water and groundwater are identified, management activities will support the quality of both resources.

Progress in Improving Water Quality

Section 319(h) of the CWA requires that state NPS annual reports include, "to the extent that appropriate information is available, reductions in nonpoint source pollutant loading and improvements in water quality …" This specifically applies to the water bodies of the state that have previously been identified as requiring NPS pollution control actions in order to "attain or maintain applicable water quality standards or the goals and requirements of the Clean Water Act."

The two primary ways of measuring improvement in water quality are:

- reductions in pollutant loadings resulting from management measures implemented, estimated with the help of models or other calculations
- water quality improvements measured by changes in pollutant concentrations before and after implementation of management measures

Other indicators of progress toward water quality improvements include physical or behavioral changes that are associated with reductions in loadings or pollutant concentrations in water bodies. Examples include restored riparian or aquatic vegetation and reduced use of fertilizers and pesticides.

Measuring the Effectiveness of Best Management Practices

Pathogen Reduction in Urban Watersheds

Since 2006, the TCEQ has funded a project evaluating the efficiency and effectiveness of several types of best management practices (BMPs) for reducing pathogens in urban runoff. Dry and wet ponds, water quality basins and swales in the Houston metropolitan area were studied. Their efficiencies, defined as the reduction of pathogens in the effluent relative to the influent, were determined by sampling for *Escherichia coli* (*E. coli*) during a number of rainfalls along with measurement of standard water quality parameters such as total suspended solids, pH, and temperature. Of the four BMPs studied, wet ponds exhibited the highest overall efficiencies for removing *E. coli* from runoff, ranging from 95 to 99 percent. Efficiencies for dry ponds, water quality basins, and swales varied, with those that were improperly maintained prior to a storm event resulting in lower water quality effluent and in some cases negative reductions (Table 2.1).

Table 2.1
Reductions in *E. coli* in Effluent from BMPs

BMP Type	Minimum	Maximum
Wet Pond	95%	99%
Dry Pond	-185%	72%
Water Quality Basin	-20%	97%
Swale	3,729%	99%

The effectiveness of wet and dry ponds, defined here as the performance of the BMP in terms of reducing instream *E. coli* concentrations, was also studied using a hydrologic simulation program in Fortran for the Buffalo Bayou watershed in Houston. Multiple scenarios were analyzed that involved different management strategies (e.g., wet ponds implemented in sub-basins with the highest *E. coli* loads). It was determined that both of these BMPs were effective in reducing instream concentrations of indicator pathogens in Buffalo Bayou. This was true even when the efficiency of the BMP was negative, mainly because there were instream benefits from retaining runoff flows and releasing the water at a later point in time. The strategy of implementing BMPs in every sub-basin yielded slightly higher *E. coli* reductions in wet basins (32 percent) and dry basins (24 percent) than implementation of BMPs only in sub-basins, which contribute 75 percent of the load (24 percent and 22 percent). The developed model can thus be used to design implementation strategies that meet established reduction goals within the watershed.

Reductions in Pollutant Loadings

On-Site Sewage Facility Upgrades in Oso Creek

Installation of properly functioning septic systems, replacement of malfunctioning septic systems, or properly

decommissioning nonessential septic systems in the Oso Creek watershed can improve water quality in the bacteria-impaired segments of Oso Creek and Oso Bay. The TCEQ is developing a TMDL aimed at restoring the contact recreation use. The Coastal Bend Bays and Estuaries Program (CBBEP) received a CWA Section 319(h) NPS grant thru the TCEQ to improve water quality in the Oso watershed by installing, replacing, or properly decommissioning on-site sewage facilities (OSSFs) in the Tierra Grande Colonia outside the Corpus Christi city limits. This multi-year project installed or repaired an estimated 22 septic systems in fiscal year 2009.

The project began by compiling information from the Nueces County Health Department, the Center for Water Supply Studies, the City of Corpus Christi, and other appropriate authorities with the locations and status of households on OSSFs within the watershed. The information compiled from the assessment was discussed and coordinated with project partners and area residents to determine areas with the maximum potential for water quality improvement. A prioritized work plan was developed. The work plan included the households to be targeted; the locations; whether the OSSF would be upgraded, replaced or properly decommissioned; and the estimated cost. The CBBEP project expects to include two years of required maintenance on the systems to ensure that they continue to function properly. It is estimated the project will reduce the daily load of bacteria by 145.548 billion colony-forming units (cfu).

Implementing Agricultural Best Management Practices in the Arroyo Colorado Watershed

The Arroyo Colorado flows through Hidalgo, Cameron, and Willacy counties in the Lower Rio Grande Valley into the Laguna Madre. Flow in the Arroyo Colorado is sustained by wastewater discharges, agricultural irrigation return flows, urban runoff, and base flows from shallow groundwater. To address the Arroyo Colorado's bacteria and dissolved oxygen (DO) impairment as well as nutrient concerns, the Arroyo Colorado Watershed Partnership developed *A Watershed Protection Plan for the Arroyo Colorado—Phase I.* For information regarding the Arroyo Colorado WPP, please see Chapter 4 of this report.

The Arroyo Colorado WPP calls for the voluntary adoption of agricultural BMPs on 33 percent of the watershed's irrigated cropland by 2010 and 50 percent by 2015. In response, the Southmost and Hidalgo Soil and Water Conservation Districts (SWCDs) received a CWA Section 319(h) NPS grant through the TSSWCB to provide technical and financial assistance to implement BMPs on agricultural land in the Arroyo Colorado.

Over the past year, 13 water quality management plans (WQMPs) were written, covering 223 acres. The BMPs being implemented include irrigation land leveling, residue management, conservation crop rotation, nutrient management, pasture planting, and prescribed grazing. According to modeling using the Spreadsheet Tool for Estimating Pollutant Load (STEPL), these BMPs achieved the following load reductions:

sediment—13 tons
phosphorus—100 lbs
nitrogen—720 lbs

Implementing Agricultural Best Management Practices in the Granger Lake Watershed

Granger Lake is located in the northeastern corner of Williamson County. Originally constructed for flood control and recreation, Granger Lake is the sole drinking water supply for Williamson County, which has one of the highest rates of population growth in the state. While the demand for water from Granger Lake is increasing, its storage capacity is decreasing due to sedimentation. Volumetric surveys suggest that Granger Lake has lost more than 12,000 acre-feet of storage since its initial construction in 1980 and continues to lose between 200 and 300 acre-feet of storage per year, on average. It is estimated that by 2067 there will be no storage capacity left with the current lake level. Water quality monitoring has also detected elevated levels of nutrients in the lake and elevated bacteria levels in several of its tributaries.

In an effort to reduce sedimentation to Granger Lake, the Little River SWCD is providing technical and financial assistance to agriculture producers for the development and implementation of BMPs.

Through this effort, 78 WQMPs have been developed for producers in the watershed. BMPs installed through 28 WQMPs covering 3,592 acres included 90,221 ft of terraces, 15 acres of waterways, 86 acres of cropland conversion to grassland, 3 acres of critical area shaping and planting, and 3 livestock-watering ponds. According to STEPL modeling, these BMPs achieved the following load reductions:

sediment— 4,766 tons
phosphorus— 8,989 lbs
nitrogen— 88,827 lbs

C H A P T E R 3

Progress toward Meeting the Goals and Objectives of the Texas Nonpoint Source Management Program

The NPS Management Program uses baseline water quality management and regulatory, non-regulatory, financial, and technical assistance to achieve balanced results. NPS pollution is managed through assessment, planning, implementation, and education. The TCEQ and TSSWCB have established goals and objectives for guiding and tracking the progress of NPS management in Texas. The goals describe high-level guiding principles for all activities under the Texas NPS Management Program. The objectives specify the key methods that will be used to accomplish the goals. Success in achieving the goals and objectives is reported annually in this document, which is submitted to the EPA in accordance with CWA requirements. Although not comprehensive, this chapter reports on a variety of programs that directly support the goals and objectives of the Texas NPS Management Program.

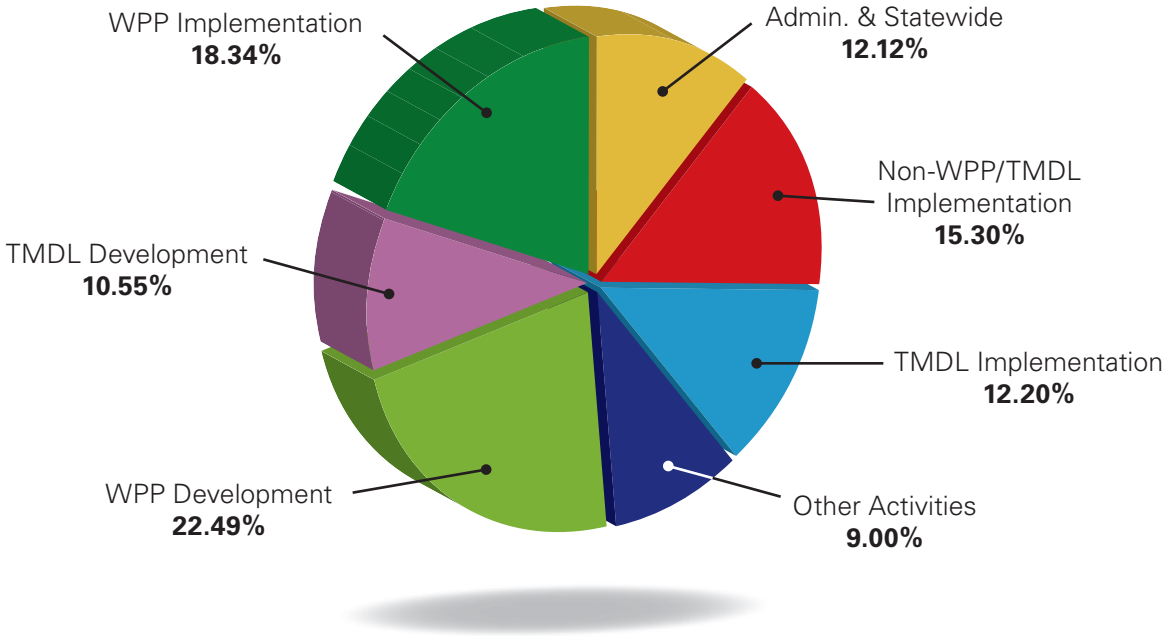
Clean Water Act Section 319(h) Grant Program

Section 319(h) of the CWA established a grant that is awarded annually by Congress to the EPA. The EPA allocates these funds to the states to implement activities supporting the goals of the CWA. The TCEQ and the TSSWCB target these grant funds toward all NPS activities consistent with the long- and short-term goals defined in the *Texas NPS Management Program*.

Status of Clean Water Act Section 319(h) Grant–Funded Projects

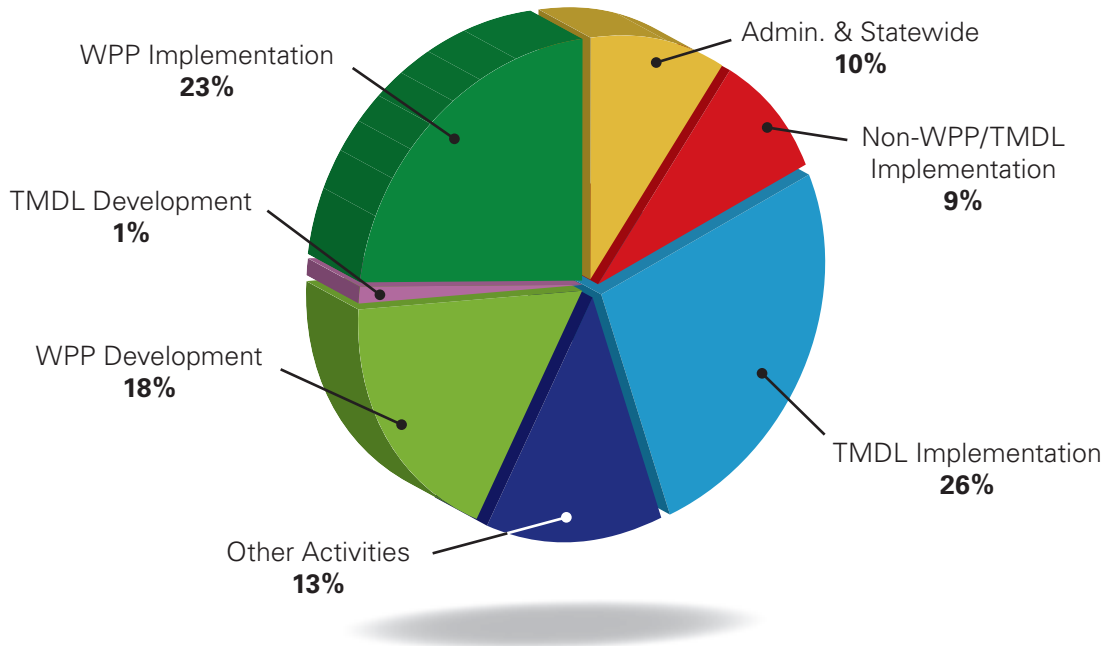
In fiscal year 2009, the TCEQ had 42 active multi-year CWA Section 319(h) grant–funded projects with a total budget of approximately $13.6 million in federal funds, addressing a wide range of NPS issues (Figure 3.1). These projects focus on the development and implementation of WPPs and TMDLs where the primary sources of NPS pollution are neither agricultural nor silvicultural. General projects include retrofits to enhance urban storm water quality, OSSF upgrades, public education and outreach projects, demonstration projects, and a variety of BMPs chosen on the basis of local water quality needs.

Figure 3.1
TCEQ Current Nonpoint Source Grant-Funded Projects



In fiscal year 2009, the TSSWCB had 54 active multi-year CWA Section 319(h) grant–funded projects which had a total budget of approximately $13 million in federal funds addressing a wide array of agricultural and silvicultural NPS issues (Figure 3.2). Specific project actions include development and implementation of WPPs and TMDLs, supporting targeted educational programs, and implementing BMPs to abate NPS pollution from dairy and poultry operations, silvicultural activities, grazing operations, and row-crop operations.

Figure 3.2
TSSWCB Current Nonpoint Source Grant-Funded Projects



Short-Term Goals and Milestones of the Texas Nonpoint Source Management Program

Goal One—Data Collection and Assessment

One of the goals of the NPS Management Program is to collect and assess water quality data. Data collection requires the coordination of appropriate federal, state, regional, and local authorities as well as private and citizen groups. The TCEQ's Surface Water Quality Monitoring (SWQM) program, operating from the central office and 16 regional offices, conducts both routine monitoring and special studies. In addition, the Clean Rivers Program (CRP), a collaboration between the TCEQ and 15 regional water agencies, collects surface water quality data throughout the state in response to both state needs and local stakeholder interests. Furthermore, the TCEQ acquires water quality data from other state and federal agencies, river authorities, and municipalities after assuring the quality of the data are comparable to that of data collected by the TCEQ's programs.

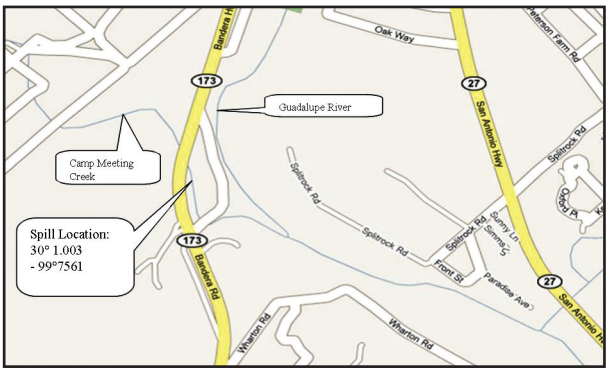
Data are assessed by the TCEQ to determine if a water body meets all its designated uses or if activities to improve water quality are achieving their intended goals. For impaired waters, water quality data can be used in the development of WPPs and TMDLs. Data are also used to determine sources of pollution, the adequacy of regulatory measures, watershed improvements, and restoration plans. Data collection primarily guides the distribution of CWA Section 319(h) grant funds toward water quality assessment activities in high priority, NPS-affected watersheds, vulnerable and impacted aquifers, or areas where additional information is needed.

Nonpoint Source Funded Watershed Assessment Work Pinpoints Leaking Sewer Main

Water quality monitoring being conducted by the Upper Guadalupe River Authority (UGRA) will provide further delineation of the sources of bacteria as well as support the evaluation of measures taken to reduce bacteria concentrations. During CWA Section 319(h) water quality monitoring activities in Camp Meeting Creek, a tributary to the Guadalupe River in Kerrville, UGRA personnel discovered a leaking sanitary-sewer force main. The water quality monitoring was being conducted by UGRA in support of the development of an I-Plan to address elevated levels of bacteria in the Guadalupe River. Water quality sampling conducted by the state's SWQM program has previously documented bacteria concentration in the Guadalupe River in excess of the level set to protect human health. The TCEQ developed a TMDL for the river with assistance from UGRA and other area stakeholders in 2007.

UGRA staff immediately reported the leak to City of Kerrville staff. The force-main leak occurred due to a faulty fitting on a 4-inch PVC line. The leak was at a joint in the pipe at the top of the bank, approximately 20 ft above the creek. The sewage escaped the pipe and ran down the bank to the creek. The pipe leaked for approximately 5 minutes at a time—only when the line was pressurized by an upstream sewage lift station. City of Kerrville staff repaired the leak and reported the spill to TCEQ. The City of Kerrville staff gave UGRA additional contact information so that any future spills can continue to be addressed promptly.

Water samples for *E. coli* enumeration analysis were taken of the sewage that escaped the pipe and yielded a value of 218,700 cfu/100 mL. Water samples for *E. coli* enumeration analysis were taken in the creek immediately downstream of the leak and yielded a value of 1,203 cfu/100 mL. The spill was estimated by the City of Kerrville Public Works Department to measure 1,225 gallons. The estimated *E. coli* load to Camp Meeting Creek from the force main leak was 1 × 1010 cfu.



Street map location of leaking sanitary sewer force main in Kerrville (photo courtesy of UGRA)

North Bosque River Watershed Assessment

Excessive nutrients, elevated chlorophyll *a* concentrations and indicator bacteria levels exceeding the established criterion have been a concern in the North Bosque River watershed for over a decade. The TCEQ approved two TMDLs for phosphorus in the North Bosque River for Segments 1226 and 1255 on February 9, 2001. The TMDLs were subsequently submitted to and approved by the EPA. The I-Plan for the two North Bosque River segments was approved by the TCEQ in late 2002, and the TSSWCB in early 2003. Bacteria concerns continue in Segment 1255, which has resulted in that segment being listed on both the 2002 and 2004 Texas 303(d) lists. The two TMDLs and subsequent I-Plan focus on contaminants originating from municipal wastewater treatment plants, animal feeding operations, and animal-waste application fields.

The North Bosque River Effectiveness Monitoring project is designed to obtain necessary water quality and

stream flow data to allow assessment of the effectiveness of various BMPs and nutrient control activities that are either ongoing or scheduled for implementation in the North Bosque River watershed. Monitoring efforts and direct data collection are conducted by the Texas Institute for Applied Environmental Research (TIAER) and TCEQ staff.

North Bosque River (photos courtesy of TIAER)

In the approved I-Plan, a number of efforts are presented to reduce phosphorus levels in the North Bosque River watershed. The four basic elements of phosphorus control identified in the plan are:

(1) phosphorus application rates on dairy-waste application fields

(2) reduced phosphorus diets for dairy cows to decrease phosphorus content of dairy waste

(3) removal of approximately half of the dairy-generated manure from the North Bosque River watershed for use or disposal outside the watershed

(4) effluent limits on phosphorus for municipal wastewater treatment plants

The monitoring activities of this project consist of automated storm water sampling at seven stream stations, biweekly ambient grab sampling at nine locations, and continuous stream flow measurement at most stream stations. Both storm water and routine sampling are needed to evaluate NPS loadings as well as ambient stream concentrations.

A statistical analysis including indirect and direct data from 1993 through 2009 will be used to determine if a significant downward trend ($a = 0.10$) can be determined and related to watershed BMPs focusing on orthophosphate-P and chlorophyll *a* as the primary parameters associated with the North Bosque River TMDLs. Trend analysis will also be conducted on other consequential parameters, such as nitrogen forms, bacteria, and suspended solids, to ensure that BMPs are not causing an unexpected increase in other pollutants.

Interim annual assessment reports are produced as part of the project. Data assessment involves trend analyses of the historical water quality data at each station and interpretation of those analyses in terms of BMPs and changing conditions at the dairies (e.g., changes in total milking-cow herd sizes, changes in number and size of dairies, etc.) within the watershed. The assessment reports also evaluate the data against the phosphorus-reduction goals specified in the approved TMDLs.

Texas Water Quality Inventory

Section 305(b) of the CWA requires all states to assess the quality of surface waters every two years. The Texas Water Quality Inventory (TWQI) describes the status of all surface water bodies of the state evaluated for the given assessment period. To accomplish this, the TCEQ uses data collected during the most recent seven-year period. The descriptions of water quality present a snapshot of conditions during the limited time period considered in the assessment. Water bodies identified as impaired by NPS pollution are given priority for CWA Section 319(h) grants and other available funding. Guidance for developing the assessment is based on a set of methods that apply the surface water quality standards, or goals for water quality. These methods are developed by the TCEQ with the advice of a diverse group of stakeholders, and are detailed in the *2008 Guidance for Assessing and Reporting Surface Water Quality in Texas* (available online at <www.tceq.state.tx.us/assets/public/compliance/monops/water/08twqi/2008_guidance.pdf>).

The CWA Section 303(d) List is an important management tool produced as part of the assessment. It identifies waters for which the existing preventative measures, such as permits that limit discharge of wastewater and the technology used by the dischargers, are not sufficient to achieve water quality standards. The TWQI, including the 303(d) List, is subject to review and approval by the EPA.

Categories Indicate Water Quality Status

The TWQI assigns each assessed water body to one of five categories in order to report water quality status and management information to the public, the EPA, state agencies, federal agencies, municipalities, and environmental groups. These categories indicate the status of a water body and describe how the state will approach identified water quality problems. Table 3.1 defines the five categories and shows the number of water bodies assigned to each assessment category in 2008.

Table 3.1

Number of Water Bodies Assigned to Each Assessment Category in the 2008 Texas Water Quality Inventory

Category	Definition	Water Body Classification		Number of Water Bodies
		Classified	Unclassified	
1	Attaining the water quality standard and no use is threatened.	8	0	8
2	Attaining some of the designated uses, no use is threatened, and insufficient information, or none, is available to determine if the remaining uses are attained or threatened.	187	212	399
3	Insufficient or information, or none, to determine if any designated use is attained. Many of these water bodies are intermittent streams and small reservoirs.	4	99	103
4	The standard is not supported or is threatened for one or more designated uses but does not require the development of a TMDL.	15	14	29
5	The water body does not meet applicable water quality standards or is threatened for one or more designated uses by one or more pollutants.	160	226	386
Totals		**374**	**551**	**925**

Water bodies in Category 5 of the 303(d) List are those water bodies that require remedial action by the state to restore water quality. For water bodies in Category 5a, the state must develop a scientific model called a TMDL and a plan to implement it. Water bodies in Category 5b require a review against water quality standards and those in Category 5c require additional monitoring to further define the impairment. Table 3.2 shows the total number of impairments in the water bodies requiring remedial action.

The categories must be applied to each combination of designated use and criteria, or parameter, for determining support. The combination of the use with the pollutant or condition of concern is called an impairment. For example, the concentration of DO is one of the criteria used to determine the support of the aquatic life use. If DO concentrations are too low, the water body being evaluated will have an aquatic life use impairment. Since a water body has multiple uses, it may fall into different categories for different uses. In that case, the overall category for the water body is the one with the highest category number.

Table 3.2

Number of Water Bodies Evaluated in the 2008 Texas Water Quality Inventory Requiring Remedial Action

Category	Definition	Water Body Classification		Total Number of Impairments
		Classified	Unclassified	
5	5a—TMDL scheduled or underway	99	84	183
	5b—Water quality standards review scheduled or under way or undergoing use-attainability analysis	39	15	54
	5c—Need additional monitoring	111	168	279
Total Number of Impairments in Category 5		**249**	**267**	**516**

Summary of the 2008 Texas Water Quality Inventory and 303(d) List

In 2007, the TCEQ assessed several specific groups of water bodies for the 2008 TWQI. These water bodies include classified segments and other segments with a pending regulatory reason for evaluation or the need to initiate or revise planning activities such as a TMDL or standards revision. The TCEQ relied on cooperation with entities such as local and state water management agencies, to identify additional water bodies for the assessment. The 2008 TWQI included the assessment of 427 (375 classified, 52 unclassified) water bodies. The status of 925 water bodies was reported. Of the 925 water bodies, 386 were included as Category 5 water bodies. This was a slight decrease from the 2006 303(d) List which included 399 water bodies. The total number of impairments also decreased from 543 to 516 (Table 3.3). Public comment was solicited in January 2008 and the draft TWQI was submitted to the EPA for approval on April 1, 2008. The TCEQ received final approval for the 2008 TWQI on July 9, 2008.

Summary of 2008 Impairments

Impairments identified in the 2008 TWQI have been grouped by the cause and the beneficial use of the water body affected (Table 3.3). Elevated levels of bacteria cause 53 percent of the listed impairments. Many of these bacteria

Table 3.3

Summary of Impairments Identified on the 303(d) List for the 2008 Texas Water Quality Inventory

Impairment Group	Media	2006 Number of Impairments	2008 Number of Impairments	Use
Bacteria	in water	291	274	Recreation
	in shellfish	21	21	Oyster Waters
Dissolved Oxygen	in water	96	84	Aquatic Life
Toxicity	in ambient water	5	5	Aquatic Life
	in ambient sediment	6	6	
Organics	in water	0	0	Fish Consumption, Aquatic Life
	in fish or shellfish	31	34	
Metals (except Mercury)	in water	4	4	Fish Consumption, Oyster Waters, Aquatic Life
	in fish or shellfish	0	0	
Mercury	in water	1	1	Fish Consumption, Oyster Waters, Aquatic Life
	in fish or shellfish	15	17	
Dissolved Solids	chloride	13	16	General
	sulfate	6	6	
	total dissolved solids	11	8	
Temperature	in water	0	0	General
pH	in water	13	16	General
Nutrients	nitrogen	0	0	General, Public Water Supply
Biological	habitat, macrobenthos community, or fish community	30	24	Aquatic Life
Totals		**543**	**516**	

impairments are the result of urban and agricultural NPS pollution. Low DO, impairing many of the same water bodies, results in an unhealthy environment for aquatic life. DO levels are depressed by both point and nonpoint sources of oxygen-demanding substances and nutrients which overfertilize aquatic plants and algae. Contaminants in fish tissue originate primarily from the landscape. For example, heavy metals and organic contaminants such as pesticides are often components of runoff from urban and agricultural land.

Continuous Water Quality Monitoring Network

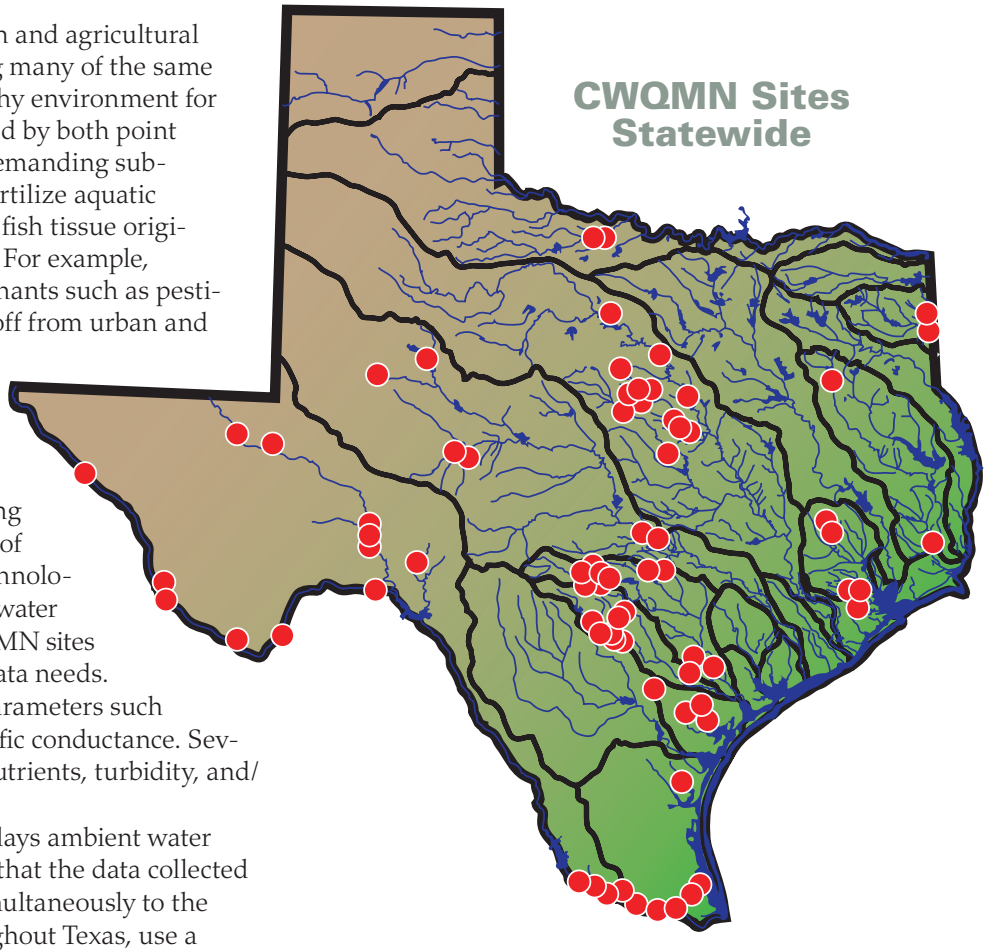
In 2001, the TCEQ established a continuous water quality monitoring network (CWQMN). The purpose of the network is to use advanced technologies to enhance the state's surface water quality monitoring program. CWQMN sites are designed to meet site-specific data needs. Most sites monitor conventional parameters such as temperature, pH, DO, and specific conductance. Several of the sites can also monitor nutrients, turbidity, and/or chlorophyll.

The CWQMN collects and displays ambient water quality data in real time, meaning that the data collected in the field are reported almost simultaneously to the TCEQ. The stations, located throughout Texas, use a combination of in situ probes and automated analysis instruments. Data are transmitted from the stations to the TCEQ using phone modems, wireless modems, and satellite telemetry. Once data are transferred, they are stored in the Leading Environmental Analysis and Display System (LEADS) database. The data can be accessed by the public via the Web at <www.texaswaterdata.org >.

The CWQMN Sites Statewide map identifies the locations of 74 existing CWQMN sites. The TCEQ cooperators and contractors deployed 11 sites during fiscal year 2009. In addition to establishing new sites, the TCEQ worked to improve data return, data management, operator training, and instrument selection. These efforts will be continued in fiscal year 2010 and additional CWQMN sites may also be deployed.

The TCEQ maintains a prioritized list of continuous monitoring proposals for deployment in fiscal year 2010 and beyond. Personnel from water programs throughout the TCEQ, with input from cooperators outside the agency, base the list on the following criteria:

- demonstrated data needs
- availability of monitoring technology to address the specific data needs
- intended use of data
- availability of personnel—internal or external—for operation and maintenance (including data validation)



Numerous organizations cooperate with the TCEQ in the CWQMN, including the following:

- Caddo Lake Institute
- Nueces River Authority
- San Antonio River Authority
- San Antonio Water Supply
- Colorado River Municipal Water District
- Bexar Metropolitan Water Supply
- San Antonio Metropolitan Health District
- City Public Service Energy
- H-E-B
- TXI
- Water Monitoring Solutions
- Guadalupe Blanco River Authority
- United States Geological Survey
- Witte Museum
- Cow Creek Groundwater Conservation District
- South Texas Groundwater Alliance
- Barton Springs / Edwards Aquifer Conservation District
- Edwards Aquifer Authority
- Public Center for Environmental Health
- United States International Boundary and Water Commission

Several of the CWQMN sites have been established based on a need to monitor NPS pollution. These include seven sites in the Bosque and Leon River watersheds, two Edwards Aquifer recharge monitoring sites, 16 sites in the Rio Grande Basin, and two sites in the Upper Colorado River watershed.

Continuous Water Quality Monitoring Network on the Pecos River

The Pecos River is the largest tributary in Texas to the Rio Grande. From Amistad Reservoir to the Lower Rio Grande Valley, the river is critical to the TCEQ's border initiatives, including those on water quality and quantity. The TCEQ has an existing network of five CWQMN sites in the Pecos River watershed. This watershed includes four sites on the Pecos River and one on Independence Creek. This network of sites provides continuous water quality monitoring data in support of multiple objectives for the TCEQ and the TSSWCB, including the CWA Section 305(b) Water Quality Inventory and tracking the implementation of the Pecos River WPP. For information regarding the Pecos River WPP, please see Chapter 4 of this report.

Above: *Pecos River*

Right: *CWQM site on the Pecos River (photos by Christine Kolbe of TCEQ)*

Rio Grande Watermaster Continuous Water Quality Monitoring Network

Data from the CWQMN sites on the Rio Grande are used to assist with water use and agricultural production in the Rio Grande region. Mexico diverts irrigation water from the Rio Grande and San Juan River downstream of Falcon Reservoir. Agricultural return flows from these diversions reenter the river upstream of Anzalduas Reservoir.

The Anzalduas Reservoir is an important diversion point for irrigation water for both Texas and Mexico. When the agricultural return-flows from Mexico contain high concentrations of total dissolved solids (TDS) (>1000 mg/L), Mexico can divert those flows around the Anzalduas Reservoir via a constructed bypass called the El Morillo Drain to a coastal lagoon and then the Gulf of Mexico.

The TCEQ installed a CWQM site on Anzalduas Reservoir at Hardwicke Farms in December 2006. The site monitors field parameters including temperature, pH, DO, and specific conductance. Water quality data are collected every 15 minutes and telemetered to the TCEQ database. Electronic notifications are automatically distributed when TDS concentrations are greater than 1000 mg/L.

Based on these notifications, the Rio Grande Watermaster can request release of freshwater by the International Boundary and Water Commission (IBWC). The freshwater is released from upstream storage to dilute TDS to acceptable concentrations for irrigation purposes. The Watermaster also requests that the IBWC verify proper operation of the El Morillo Drain by Mexico. If Mexico fails to properly operate the El Morillo Drain, the waters released by IBWC are taken from Mexico's water allocation.

This project has proven successful and the Rio Grande Watermaster has requested three additional CWQM sites between Anzalduas and Falcon Dam to improve their ability to detect and respond to high TDS waters. These sites were successfully deployed in July 2009 and are currently reporting data. The addition of a site at the City of Roma water intake extends the benefit of the project to the municipal potable water supply.

CWQM site on the Lower Rio Grande River (photo by Christine Kolbe of TCEQ)

Watershed Protection Plans

The TCEQ and the TSSWCB apply the Watershed Approach to managing NPS pollution by supporting the development and implementation of WPPs. These plans are developed through local stakeholder groups, and a significant portion of the funding for preventing NPS pollution under the federal CWA is dedicated to the development and implementation of WPPs where NPS pollution has contributed to the impairment of water quality. In Texas, WPPs are locally developed water quality plans that coordinate activities and resources to manage water quality. They facilitate the restoration of impaired water bodies and the protection of threatened waters before they become impaired. These stakeholder-driven plans give the decision making power to the local groups most vested in the goals specified in the plans. Bringing groups of people together through watershed planning efforts combines scientific and regulatory water quality factors with social and economic considerations. While WPPs can take many forms, the development of plans funded by CWA Section 319(h) grants must follow guidelines issued by the EPA. See *Nonpoint Source Program and Grants Guidelines for States and Territories,* available online at <www.epa.gov/fedrgstr/EPA-WATER/2003/October/Day-23/w26755.htm>.

In 2009, the TCEQ and the TSSWCB have facilitated the development and implementation of WPPs (Table 3.4) throughout Texas via technical assistance and funding through grants to local stakeholder groups. WPPs are also being developed or have been developed in Texas independently of those listed in the table. Therefore, the following list is not intended to be comprehensive of all the watershed protection planning efforts currently underway in Texas.

Available online are overviews and summaries of WPPs in progress or completed in Texas by the TSSWCB, <www.tsswcb.state.tx.us/en/wpp>, and the TCEQ, <www.tceq.state.tx.us/compliance/monitoring/nps/mgmt-plan/watershed-pp.html>. Specific WPP activities are described in Chapter 4 of this report.

Table 3.4
Texas Watershed Protection Plans

TCEQ WPP	Links
Armand Bayou Watershed	www.armandbayou.org/
Arroyo Colorado Watershed	www.arroyocolorado.org/
Brady Creek Watershed	www.ucratx.org/NPSBrady.html
Caddo Lake Watershed	www.netmwd.com/Caddo%20Lake%20Protection%20Plan/Caddo_index.html
Dickinson Bayou Watershed	www.dickinsonbayou.org/
Hickory Creek Watershed	cityofdenton.com/pages/mygovenvironmentalwater319grant.cfm
Lake Granbury Watershed	www.brazos.org/gbWPP.asp
Upper San Antonio River Watershed	sara-tx.org/site/water_quality/water_qual_mon/wpp/wppintro.html
Halls Bayou-Westfield Estates	www.h-gac.com/community/water/watershed_protection/westfield_estates.aspx
Cypress Creek	www.cypresscreekproject.org/
Bastrop Bayou	www.h-gac.com/community/water/watershed_protection/bastrop_bayou.aspx
TSSWCB WPP	**Links**
Buck Creek Watershed	twri.tamu.edu/buckcreek/
Concho River Watershed	www.ucratx.org/CRiverRest_UCRA.html
Geronimo Creek Watershed	geronimocreek.org/
Granger Lake Watershed	www.tsswcb.state.tx.us/en/managementprogram/granger
Lampasas River Watershed	www.lampasasriver.org/
Leon River Watershed	www.brazos.org/leonriverwpp.asp
Pecos River Watershed	pecosbasin.tamu.edu/
Plum Creek Watershed	pcwp.tamu.edu/

Goal Two—Implementation

Texas Nonpoint Source Management Program Implementation

The second goal of the Texas NPS Management Program involves the management of CWA Section 319(h) grant funds and the leveraging of additional funds to efficiently and effectively target implementation activities to areas identified as suffering the impact, or at risk for such an impact, of NPS pollution. Implementation activities are conducted with the goal of preventing and reducing NPS pollution in surface water, groundwater, wetlands, and coastal areas, through the execution of TMDL I-Plans, WPPs, recommendations from the *Joint Groundwater Monitoring and Contamination Report*, the Texas Groundwater Protection Strategy, and the TSSWCB-certified WQMPs on agricultural and silvicultural lands. The following sections give updates on various programs and projects that involve NPS implementation activities and are examples of the results of additional funding that targets NPS pollution.

Total Maximum Daily Loads and Implementation Plans

The state's TMDL program works to improve water quality in impaired or threatened water bodies in Texas. This program is a major component of the state's strategy for managing the quality of water in Texas streams, lakes, bays, and other surface waters. The federal mandate for state TMDL programs is contained in the Federal Water Pollution Control Act and its amendments, also known as Section 303(d)(1)(C) of the CWA and the EPA's implementing regulations in Title 40, Code of Federal Regulations, Part 130, require states to identify waters where effluent limitations alone are not sufficient to meet water quality standards. Every two years, the identified water bodies are compiled in the CWA Section 303(d) List. The CWA requires that, where point source controls are not sufficient to attain water quality standards, a TMDL must be established to account for and allocate loadings from point, nonpoint, and natural sources of pollution.

The state's TMDL program is a major component of the state's strategy for managing the quality of water in Texas streams, lakes, bays, and other surface waters.

The TCEQ and TSSWCB are both responsible for developing TMDLs for Texas' water bodies. The TCEQ develops most TMDLs in Texas. However, the TSSWCB is involved in and may take the lead in developing TMDLs in watersheds where agriculture or silviculture have significant land uses. The TCEQ and the TSSWCB coordinate closely on all TMDLs in which agricultural or silvicultural nonpoint sources are involved, no matter which agency leads TMDL development. It is also possible for an organization to initiate and develop a TMDL for a water body in the state without invitation or funding support from the state. TMDLs developed by such organizations are commonly referred to as "third-party" TMDLs. The state strongly suggests that entities developing third-party TMDLs coordinate closely with the TCEQ and the TSSWCB as appropriate to their jurisdictions and interests. Regardless of who develops a TMDL, the TCEQ has jurisdiction for managing the overall quality of surface waters in Texas. The TCEQ must adopt all TMDL reports developed for Texas water bodies and is responsible for submitting adopted TMDLs to the EPA for concurrence.

Texas TMDLs are developed via a rigorous process of data collection and analysis. Impairment refers to the combination of the use that is not supported with the parameter of concern for an individual segment. Federal regulations require that the state develop a TMDL for each impairment within a particular body of water. The state is committed to developing TMDLs in a timely manner and implementing all approved TMDLs. Implementation of TMDLs may require the TCEQ to impose new or revised limitations on discharge of some pollutants in the permits it issues under the Texas Pollutant Discharge Elimination System (TPDES). Where nonpoint sources of pollution are identified, the state will work through the NPS programs at the TSSWCB and TCEQ to encourage local implementation of voluntary actions that reduce the amount of pollutants entering waters. The state leverages existing resources whenever possible to achieve the load reductions identified in TMDLs.

The TCEQ and TSSWCB believe it is essential to engage stakeholders in the watershed when developing plans to reduce pollution. Stakeholders provide the local expertise needed to identify site-specific problems, target those areas for cleanup, and help determine what measures will be most effective. Anyone whose interests may be affected by a TMDL project has a stake in the process. Stakeholders include, among others, permitted wastewater dischargers, municipal and county governments, regional or state governmental agencies, agricultural producers, recreational clubs, homeowners associations, environmental groups, and interested individuals. Experts from local, regional, state, and federal agencies and universities also participate, giving technical and scientific support.

As of August 2009, the TCEQ had approved TMDL I-Plans for streams, reservoirs, and estuaries that are impaired in part due to nonpoint sources of pollution, as listed in Table 3.5. Each project is identified by water body, basin, and segment number of the impaired water body, the designated use that has been affected, and the geographic extent of the impairment.

Table 3.5

Total Maximum Daily Load Implementation Plan Status

I-Plan: Impairment	Basin & Segment(s)	Use Affected	Year Begun	Status	Area of Impairment
Aquilla Reservoir: atrazine	Brazos River; 1253	Source for drinking water	2002	Goals met	3,943 lake acres
Arroyo Colorado: legacy pollutants and organics	Nueces–Rio Grande Coastal; 2202, 2202A	Safety of fish consumption	2001	Under way	504 stream miles; 333 lake acres
Clear Creek: dissolved solids	San Jacinto-Brazos Coastal; 1102	General (not tied to a specific use)	2006	Under way removed from 303(d) list	60 stream miles
Colorado River below E.V. Spence Reservoir: dissolved solids	Colorado River; 1426	General (not tied to a specific use)	2007	Under way	56 stream miles
Dallas and Tarrant counties waterways: legacy pollutants*	Trinity River; 0805, 0841, 0841A	Safety of fish consumption	2001	Under way	18,970 lake acres; 127 stream miles
E.V. Spence Reservoir: dissolved solids	Colorado River; 1411	General (not tied to a specific use)	2001	Under way	29,000 lake acres
Fort Worth waterways: legacy pollutants*	Trinity River; 0806, 0806A, 0806B, 0829, 0829A	Safety of fish consumption	2001	Under way; some goals met	101 lake acres; 47 stream miles
Lake O' the Pines: low dissolved oxygen	Cypress Creek; 0409	Support of aquatic life	2006	Under way	18,700 lake acres
North Bosque River: soluble reactive phosphorus	Brazos River; 1226, 1255	General (not tied to a specific use)	2002	Under way	121 stream miles
Petronila Creek above tidal: dissolved solids	Nueces–Rio Grande Coastal; 2204	General (not tied to a specific use)	2007	Under way	44 stream miles

**Note:* Legacy pollutants are chemicals that persist in the environment long after their use has been banned or severely restricted.

Texas Coastal Nonpoint Source Control Program

Section 6217 of the Coastal Zone Act Reauthorization Amendments of the Coastal Management Act created a requirement for states to develop and implement a coastal NPS control program. The program is unique in that it establishes a set of management measures for states to use in controlling polluted runoff; it is jointly administered by the National Oceanic and Atmospheric Administration (NOAA) and the EPA. Thirty-three coastal states (including Texas) are required to develop coastal NPS pollution control programs. Section 6217 envisions a two-tiered management approach for NPS:

(1) Implementation of management measures to protect coastal waters generally (i.e., technology-based approach), and;

(2) Implementation of additional management measures needed to attain and maintain applicable water quality standards (i.e., water quality-based approach, TMDLs).

State coastal NPS programs must provide for implementation of management measures in conformity with guidance published by EPA and NOAA. Management measures are defined as economically achievable measures for the control of NPS which reflect the greatest degree of pollutant reduction achievable through the application of the best available nonpoint pollution control practices. Management-measure guidance has been developed for six main categories of NPS pollution: forestry, agriculture, urban areas, marinas, hydromodification, and wetlands.

The Texas Coastal NPS program has been approved for all management measures except the measures for operating on-site disposal systems and four urban measures: new development, existing development, watershed protection, and site development. The state continues to implement programs and projects in an effort to gain full approval of its coastal NPS program. Various projects have been funded and implemented in recent years which specifically address the remaining conditions of the state's coastal NPS program. In addition, the fiscal year 2009 CWA Section 319(h) grant provides $1 million for a project to inspect high priority operating on-site disposal systems in the coastal zone. Similarly, funding will be provided in future CWA Section 319(h) grant cycles for the implementation of low-impact development (LID) management practices for urban runoff. LID management practices have the potential to satisfy the requirements of Section 6217. These projects will be designed to document the costs and benefits of LID practices. It is anticipated that the favorable demonstration of the costs and benefits of LID practices will increase the likelihood that these practices will be implemented more generally in the state and the coastal zone in particular. Funding will also be provided for educational activities, technical assistance, and legal analyses needed to support the goal of widespread use of LID practices in urban areas of Texas.

The Galveston Bay Estuary Program

The Galveston Bay Estuary Program (GBEP) is part of a network of 28 National Estuary Programs in the United States working with local stakeholders to restore and protect estuaries that are threatened by pollution, development, and overuse. The GBEP is a partnership of stakeholders, which includes a 41-member advisory committee, the Galveston Bay Council, and its six standing subcommittees. The GBEP and its stakeholders implement a Comprehensive Conservation Management Plan, the Galveston Bay Plan. One of the highest priorities of the plan is controlling or eliminating NPS pollution. The *Nonpoint Source Pollution Action Plan* is the portion of the plan that was developed in order to reduce and eliminate NPS pollution entering Galveston Bay, including toxins, nutrients, pathogens, sediment, and oxygen-depleting substances. The specific goals of this action plan are to reduce NPS pollutant loads from industry, agriculture, construction, sewage, and marinas.

The GBEP gives technical and financial assistance, through workshops, conferences, and grants, to Galveston Bay area municipalities. GBEP encourages the use of storm water management initiatives that provide public education and outreach, public involvement and participation, illicit-discharge detection and elimination, construction site storm water runoff control, post-construction storm water management in new developments, and

pollution prevention for municipal operations. As an example, the GBEP gives financial and technical support to locally driven, watershed-wide management planning efforts to improve water quality, including streams listed as impaired for aquatic life use, contact recreation, and public health. Each plan focuses on solutions to NPS pollution problems, including the development of BMPs that will be implemented by local governments and citizens. Since 2005, five watershed plans have been initiated in the Galveston Bay area: for Dickinson Bayou, West Bay, Bastrop Bayou, Double Bayou, and Highland Bayou. For more information, see Chapter 4 of this report.

West Bay, which includes the watersheds of Highland, Marchand, Halls, and Chocolate Bayous, is currently being characterized by land uses, and initial efforts are focusing on agricultural land practices and conservation. Initiation of a WPP for the Highland Bayou watershed will begin in fall 2009. The Bastrop Bayou watershed is adjacent to West Bay. The GBEP is a supporting partner, through matching funds and technical assistance, to the Houston-Galveston Area Council (H-GAC) and the

TCEQ in the development and implementation of the Bastrop Bayou WPP. The Bastrop Bayou WPP is anticipated to be completed in the spring of 2010.

In addition to developing WPPs, the GBEP continues to support the region's annual Rivers, Lakes, Bays 'N Bayous Trash Bash, <www.trashbash.org>, through funding and coordinating assistance. Trash Bash is an annual litter cleanup on local waterways that encourages voluntary public cleanup and educates the public about NPS pollution. In 2009, the GBEP continued to coordinate the cleanup site at Brays Bayou at Mason Park adjacent to the Brays Bayou Storm Water Treatment Wetland. The Mason Park site received 195 volunteers who collected 3,380 pounds of trash and two tires. Overall, the event was hosted at 16 sites and cleaned up 79 miles of waterways in Houston. Volunteers totaled 4,678 and collected 112,450 pounds of trash and 636 tires in 22,582 volunteer hours.

The GBEP held its biennial State of the Bay Symposium from January 12 through 14, 2009. One symposium workshop, "Best Management Strategies that Sustain Our Estuary," focused on tools to help local organizations address the regulatory requirements for water quality set forth by the EPA and TCEQ. Participants learned the latest strategies for funding BMPs—including outreach and education—and received instruction on identifying and prioritizing impaired areas, determining the best placement of BMPs, and selecting the right BMP to address water quality improvement needs. A total of 47 people attended the workshop from state, regional, and local government agencies. Participants included university researchers, consultants, and nonprofit organizations.

The Texas Groundwater Protection Committee and Pesticide Management

The Texas Groundwater Protection Committee (TGPC) was created by the Texas Legislature in 1989. It was formed as an interagency committee with representatives from nine state agencies and the Texas Alliance of Groundwater Districts. The TGPC strives to identify areas where new groundwater programs can be implemented or where existing programs can be enhanced. It works to protect groundwater as a vital resource by bridging the gaps between existing state groundwater programs and by improving coordination between member agencies. The TGPC works on special issues through subcommittees composed of agency personnel and the general public. The Agricultural Chemicals Subcommittee (ACS) is the primary vehicle for interagency coordination and communication regarding pesticide groundwater issues.

Specific management measures on which the TGPC focuses are described in the *Texas Groundwater Pesticide Management Plan* (PMP), the *Texas NPS Management Program*, and *Best Management Practices to Prevent Pesticide Contamination of Water Resources*. The PMP focuses on the implementation of management practices that prevent groundwater degradation by pesticides or help to restore groundwater degraded by their use. The ACS guides the implementation of the PMP by suggesting avenues of investigation, by reviewing monitoring plans and reports, and by recommending responses. During the 2009 monitoring period, the TCEQ sampled 22 wells in the Panhandle and 19 wells and 17 springs in the greater Austin metropolitan area. Additionally, 132 wells were sampled by the Texas Water Development Board and analyzed by the TCEQ using immunoassays. Five pesticides were subjected to immunoassay analyses, while laboratory analyses included four methods for over 50 pesticides. For these 2009 groundwater samples, 878 immunoassay analyses and 59 laboratory analyses were completed for pesticides. Water quality monitoring results will be available in the *Joint Groundwater Monitoring and Contamination Report—2009*, made available by the TGPC at <www.tgpc.state.tx.us/>.

The Texas Groundwater Protection Committee works to protect groundwater as a vital resource by bridging the gaps between existing state groundwater programs and by improving coordination between member agencies.

Another useful tool for pesticide management is the TCEQ's Interagency Pesticide Database which is an endeavor to compile all groundwater pesticide monitoring data for the whole state. The database, at its last update, included data for more than 173,308 pesticides or other chemical analytes, from analyses on 8,294 groundwater samples, collected from 5,204 wells. Data came from 12 agencies and other organizations.

Pesticide information is now also being included in the EPA's Pesticides-of-Interest Tracking System (POINTS), an online system for entering information on pesticides assessed by each state and tribe. The ACS and the TCEQ, supported by this EPA initiative, continue to focus on the management of pesticides by first assessing them, and classifying them as pesticides of interest or pesticides of concern. The PMP still acts as the foundational guide, and groundwater pesticide monitoring still serves as a primary component in making assessments. Sixteen pesticides were assessed on the EPA's POINTS Web page at <www.points.wsu.edu/reports/fullReport.aspx> in December 2008, with another 19 assessed by the end of December 2009.

Nonpoint Source Project Helps Eliminate Pollution Source in San Antonio River Watershed

The San Antonio Water System (SAWS) is a public utility owned by the City of San Antonio. It was created in May

1992 through the consolidation of three predecessor agencies. SAWS is committed to working with program partners and stakeholders to identify and abate illicit sources of bacteria within the San Antonio River I-Plan project area, primarily north of Loop 410. SAWS maintains > 5000 miles of sanitary sewers in the San Antonio area and operates three large water-recycling centers. SAWS has an Illicit Discharge Program aimed at identifying and eliminating illicit discharges.

Programs at SAWS have been expanded to include followup visits and investigations of possible sanitary sewer leaks based on synoptic and intensive bacteria data generated from the I-Plan project. Following each synoptic and intensive sampling event, the San Antonio River Authority (SARA) makes the bacteria results available to the SAWS by generating maps that identify the sampling locations and concentration of bacteria at each site. If a source is identified as a leak or seepage from the sanitary sewer, then SAWS prioritizes the discharge based on the magnitude and nature of the suspected discharge as well as the sensitivity of the receiving stream. Field testing by SAWS for ammonia, chlorine, surfactants, or other parameters helps identify and confirm the nature of the discharge.

Monthly synoptic sampling was initiated by SARA in September of 2009, and two intensive sampling events have been conducted in the I-Plan project area. SAWS has actively used data on bacteria generated from the I-Plan project to investigate possible illicit discharges since November 2008, and the efforts have identified and corrected numerous problems within the project area. The I-Plan project is scheduled to continue synoptic sampling through 2009. The SARA will continue to supply bacterial data to SAWS in an effort to reduce the levels of bacteria in streams within the project area.

Weep hole in sanitary sewer main (photo courtesy of SAWS)

Goal Three—Education

The third goal of the Texas NPS Management Program is education and technology transfer to help raise awareness of NPS pollution and prevent activities contributing to the degradation of water bodies, including aquifers, by NPS pollution.

Education is a critical aspect of managing NPS pollution. Public outreach and technology transfer are integral components of every NPS grant project, WPP, TMDL, and I-Plan. This section highlights some of the NPS education and public outreach activities conducted in Texas in fiscal year 2009.

Texas Stream Team Volunteer Monitoring and Environmental Education Program

The Texas Stream Team (formerly Texas Watch) is a statewide organization committed to improving water quality through volunteer monitoring and NPS pollution education. The program is based at the River Systems Institute (RSI) at Texas State University in San Marcos. The Texas Stream Team is administered primarily through a partnership, funded under CWA Section 319(h), between the RSI, the TCEQ, and the EPA.

Fiscal year 2009 marks the Texas Stream Team's 10-year anniversary at Texas State University and 18 years since its establishment at the TCEQ in 1991. From 1991 through the end of 2008, trained monitors spent more than 46,666 hours sampling and testing Texas water resources—the equivalent of one person working for seven hours per day, 365 days every year since 1991. This effort has resulted in 26,850 samplings from more than 800 locations.

The Texas Stream Team trained more than 310 new water quality monitors in fiscal year 2009. Monitors tested surface waters in 1,978 monitoring events and submitted data for 246 sites statewide. Certified Water Quality Monitors sample streams, reservoirs, and tidal areas for *E. coli*, DO, specific conductivity, pH, Secchi depth, temperature, and various field observations including flow severity. The Texas Stream Team staff also gave watershed-education workshops, training teachers in education methods relating to water quality monitoring and NPS pollution.

Highlights from this year include the intensive bacteria survey on Gilleland Creek, the statewide Meeting of the Monitors conference, teacher workshops, and positive reports from monitors who are making a difference. In December, the Texas Stream Team partnered with the Gilleland Creek TMDL project and local partners to collect and analyze *E. coli* at 110 sites along the main stem and its tributaries. This hybrid outreach and

Texas Stream Team, Volunteer Water Quality Monitoring Training (photos courtesy of Texas Stream Team)

sampling event generated media attention, educated several classes from a local school, brought project partners together and got stakeholders to the creek to observe and measure the water quality themselves. Problems identified, which corresponded with historical hot spots, are being investigated by volunteer monitors from the Colorado River Watch Network and local authorities.

Monitors are focusing efforts in impaired watersheds to monitor overall water quality and BMPs over time. For example, in the Houston area, upstream and downstream sampling shows signs of significant *E. coli* decreases downstream of a constructed mitigating wetland pond. In the Arroyo Colorado watershed, trained monitors are sampling at least 10 sites on tributaries and the main stem.

In addition to statewide programmatic activities, the Texas Stream Team also focused efforts in several targeted watersheds. These included the Plum Creek WPP, the Gilleland Creek TMDL, the Arroyo Colorado WPP, the Oso Bay–Oso Creek TMDL, and the Orange County TMDL. A suite of watershed services, such as NPS pollution outreach, monitor trainings, outreach internships, community cleanup coordination assistance, data summary reports, and other initiatives were assisted in the development and implementation of TMDL and WPP projects. The Texas Stream Team intends to continue supporting these areas and to expand efforts into additional watersheds in fiscal year 2010.

Lower Colorado River Authority: Illegal-Dumping Campaign

The Lower Colorado River Authority (LCRA) is working with counties, councils of governments, citizens, and private companies to educate the public on how to minimize the risk of water contamination due to improperly disposed solid waste. The LCRA partnered with Bastrop County to install over 80 "no dumping" signs along county roadways. Bastrop County made and installed the signs, and county road crews will maintain them as needed. In addition, "report illegal dumping" billboards (in English and Spanish) were installed in Bastrop, Lee, Fayette, and Travis counties. The number for the Capital Area Council of Governments (CAPCOG) hot line is listed on the billboards and "no dumping" signs, and CAPCOG has reported a 25 percent increase in calls to the hotline since installation.

LCRA Illegal Dumping Billboard: "What mark are you leaving? Report illegal dumping." (photo courtesy of LCRA)

LCRA No Dumping sign (photo courtesy of LCRA)

Part of this campaign includes the creation of a Keep Bastrop County Beautiful affiliate to continue the campaign to eliminate illegal dumping and to work with local decision makers. An organizational meeting, with over 40 Bastrop County residents in attendance, was held in the spring of 2009. Those attending the meeting agreed to form a Keep Bastrop County Beautiful affiliate with a focus on recycling and illegal dumping.

City of Austin: Lawn and Garden Chemical Education

The City of Austin developed a multimedia campaign to educate homeowners on the proper use of lawn and garden chemicals. The campaign was designed to reduce the amount of NPS that washes into lakes and rivers. The campaign focuses on three simple messages: *Don't Over-Fertilize, Just Kill the Bad Guys, and Accept a Few Weeds*. Specific cartoon characters were developed to present each message. The cartoon characters have become iconic symbols that are recognized by the public as being synonymous with proper lawn and garden care.

The City of Austin developed public service announcements (PSA) for television, radio, and informational flyers. The television and radio PSAs were aired during the spring growing season when most people begin their lawn and garden maintenance. The flyers were mailed to homes located in environmentally sensitive neighborhoods and are used during education and outreach events. Follow-up surveys revealed that the animated PSAs were very successful in getting people's attention and encouraging them to take action to protect water quality. The television PSAs featuring Dan-D-Lion won the EPA's national People's Choice award for the best landscape PSA during the 2009 EPA conference for education and outreach.

Texas Watershed Coordinator Roundtable

The Texas Water Resources Institute (TWRI), the TCEQ, the TSSWCB, and the EPA recently collaborated to organize the Texas Watershed Coordinator Roundtable. The establishment of this group stems from the Texas Watershed Planning Short Course and an initial roundtable meeting was held on August 20, 2007, with 30 persons involved in watershed planning in attendance. The purpose of the roundtable group, slated to meet semiannually, is to offer a forum for establishing and maintaining dialogue between watershed coordinators, facilitate interactive solutions to common watershed issues faced throughout the state, and add to the fundamental knowledge conveyed at the short courses.

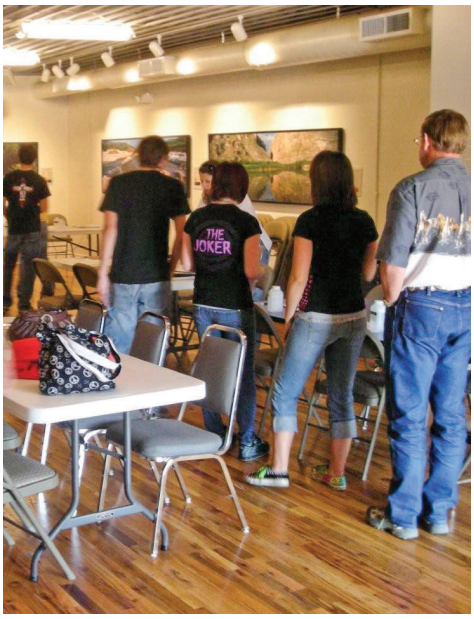
The most recent meeting on July 8, 2009 focused on sustaining watershed plan implementation, and over 80 watershed professionals were in attendance. The meeting included presentations on organizing watershed groups, creating and working with nonprofit partners, and forming the legal framework for a nonprofit organization. Among the presenters were the Northwest Environmental Finance Center, the Guadalupe-Blanco River Authority (GBRA), and the Texas Association of Nonprofit Organizations. The TSSWCB, as well as the San Marcos River Foundation, the Lower Rio Grande Valley Storm water Task Force, and CBBEP, led discussions about watershed organizational structures. Additionally, representatives of the Texas Watershed Steward Program (TWSP), the Initiative for Watershed Excellence, the Texas Stream Team, and the TWRI updated the group on their efforts and progress. The roundtable is tentatively scheduled to meet in January and July 2010.

Concho River Basin Aquatic Research and Education Center

The mission of the Concho River Basin Aquatic Research and Education Center, commonly called the Water Education Center, is to educate the community of the Concho River Basin about the importance of watershed protection, water quality preservation, and water conservation. The Upper Colorado River Authority (UCRA), with CWA Section 319(h) funding from the EPA through the TCEQ, accomplishes this mission through ongoing exhibit development and targeted program offerings for student groups, teachers, and adults. The Water Education Center is a management measure listed in the Concho River Basin WPP. The WPP was produced by the UCRA and the Concho River Basin WPP Stakeholder Group with CWA Section 319(h) funding from the TSSWCB and the EPA. For information regarding the Concho River WPP, please see Chapter 4 of this report.

Beginning in the summer of 2008, the UCRA partnered with the San Angelo Independent School District (SAISD) and the San Angelo Museum of Fine Arts in working with a group of talented secondary level students to plan exhibits and programs. The students, calling themselves the Aqua Squad, learned about Concho Basin water issues from UCRA personnel and exhibit design from the director of the San Angelo Museum of Fine Arts. The Aqua Squad, funded by the SAISD through its Texas Research Institute for Young Scholars, traveled to Washington to visit museums and take part in a day-long workshop on design at the Smithsonian's National Museum of Natural History. These 10 students have since helped to conceptually develop the main ideas and suggestions for exhibits. They have presented these ideas to the UCRA, the SAISD, and the Concho River Basin WPP Stakeholder Group. Aqua Squad members also continue to serve as educational ambassadors for the Water Education Center, performing outreach to schools and community groups.

The Center bases its exhibit development around the conceptual plans from the Aqua Squad. Displays developed or purchased and installed at the Center include large aquariums (containing native Concho River fish) placed in the front windows of the Center; a portable, hands-on Enviroscape model to demonstrate how pollutants such as fertilizers, pesticides, oil, and sludge enter surface water and groundwater—and how to prevent that entry from occurring; and an interactive computer room where computer monitors allow visitors to view actual water quality data within the Colorado River Basin, learn about the workings of the storm water filtration system installed along the Concho River, and watch short videos on Texas water issues. Exhibits under development include seven foot tall, three-sided educational panels for the main Center room, where education sessions and public meetings are held; a large, 3-D watershed model of the Concho River; and a 3 ft by 2 ft enamel sign to be installed near the storm water polishing pond system, known as the "living laboratory."



The Concho River Basic Aquatic Research and Education Center (photo courtesy of UCRA)

In fiscal year 2009, the Center directly served over 2,500 visitors. Programs included school tours of the storm water polishing ponds, hands-on programs, school and community outreach programs, teacher workshops, and community meetings. In addition, the Aqua Squad was featured several times on the "Green Scene," a local news spot, where members discussed the importance of water conservation and maintaining water quality. Another main Center activity was its annual Eco Fair Family Day, which over 3,000 people attended. The Water Education Center was a big part of this event, with many hands-on activities and demonstrations held in the Center, on the sidewalk, and along filtration ponds near the river.

Storm Water Management for Cedar Creek

The Tarrant Regional Water District (TRWD) has been concerned about the recent water quality issues caused by NPS pollution in the Cedar Creek Reservoir Watershed. Excess nutrient loading to the reservoir has led to eutrophication, depletion of DO, and excess algal growth. In an effort to educate and demonstrate ways in which individuals, cities, and developers can improve the quality of storm water, the Texas AgriLife Research and Extension Urban Solutions Center, with CWA Section 319(h) funding from TCEQ, and working through the Kaufman County Master Gardener's Association, have implemented a training program.

This training program addresses three different methods to increase rainwater retention in the landscape: landscape collection with soil storage, subsurface storage, and tank-based storage methods. These training programs are designed as hands-on experiences, to allow stakeholders to become part of a state core of rainwater harvesting experts and educators to effectively support and multiply AgriLife Extension efforts in educational programs.

AgriLife Extension has trained 32 master gardener specialists in the region and conducted 11 classes on making rain barrels. These efforts have reached almost 300 persons and resulted in the making of 745 rain barrels, for a combined storage of almost 42,000 gallons of water per rainfall. The program has grown tremendously in popularity. In addition to the training programs, storm water BMP demonstrations have been installed within the watershed. The project has also worked with five local schools to set up large-scale rainwater harvesting projects, demonstrating the ability to store 5,600 gallons of rainwater in polyethylene tanks.

Texas Watershed Stewards

TWS is a highly successful one-day training program designed to increase citizen understanding of watershed processes and to foster increased local participation in watershed management and watershed protection planning activities across the state.

The program curriculum comprises five different units, including a program introduction, an overview of watershed systems, an overview of watershed impairments, watershed management and regulation, and community driven watershed protection strategies. The curriculum is compiled into a full-color handbook that also includes a comprehensive glossary of terms and three appendixes with detailed information on federal, state, and local water quality agencies and organizations; important Web sites pertaining to water quality projects, management and regulation; and a list of important activities for communities to engage in to help protect their local water resources. In addition, interactive topic modules were developed for each of the five curriculum units to serve as the foundation for the training program.

To date, 14 workshops have been conducted across the state in project watersheds undergoing TMDL or WPP development or implementation. In all, more than 800 citizens have become trained Texas watershed stewards representing small-business owners, landowners, cities, agricultural producers, schools, state environmental agencies, universities, and other watershed residents.

Results from pre- and post-test evaluations indicate that knowledge regarding watershed function, pollutant sources and BMPs, water quality, and regulatory-agency responsibility has increased by 31 percent. Program success is also indicated by the fact that more than 99 percent of program participants report the program has enabled them to be better stewards of their water resources. Furthermore, results from 6-month-delayed post-test evaluations indicate that 80 percent of workshop attendees have more closely monitored individual actions that could impair water quality, 80 percent have adopted or maintained water quality BMPs on their property, and 65 percent have encouraged others in their community to attend a TWS workshop.

At present, 15 additional TWS training events are being planned across the state. Future training locations are currently being prioritized in collaboration with the TSSWCB and other project partners.

In addition, work continues on the development of the online TWS training course. Once completed, the online course materials will be accessible from the program Web site at <tws.tamu.edu/> and will allow those unable to attend a watershed-based workshop to complete the course curriculum.

Plum Creek Watershed Partnership water bottles given to community cleanup volunteers (photo by Matt Berg of Texas AgriLife Extension Service)

Outreach and Education Efforts in the Plum Creek Watershed

The GBRA and Texas AgriLife Extension are wrapping up the two-year "Taking Charge of Water Quality in the Plum Creek Watershed" project focused on public outreach and education in the watershed. Supported by TCEQ CWA Section 106 funds, the project has supported the Plum Creek Watershed Partnership in implementing key components of the WPP. The project funded assessment and prioritization of illegal dumping sites in the watershed, and nine road crossings in Caldwell County were cleaned and restored this year. More than 8,500 lbs of illegally dumped trash and debris were removed, including 82 tires, 6 vehicle batteries, 5 gallons of paint, and assorted appliances. This funding also sponsored a community cleanup in Kyle, involving 1,455 volunteer hours, which removed 2,300 lbs of trash and collected 1,560 lbs of recyclable material from 4.5 miles of Plum Creek.

Due to the success of the first Annual Lockhart Stream Cleanup, which included over 350 volunteers removing 1,260 lbs of trash from two miles of a Plum Creek tributary, planning meetings are ongoing for the coordination of additional events to be held every third weekend in September. In conjunction with a series of five workshops this year on conventional and aerobic septic systems attended by homeowners and professionals, an online educational septic system module was developed as a tool to educate the public on their proper operation and maintenance of septic systems to protect the environment. In addition, online modules geared toward management of fats, oils, and grease and urban storm water have been developed and will be advertised to the public.

The Texas AgriLife Extension Service developed an informational brochure for distribution at public meetings and events throughout the watershed, emphasizing project goals and opportunities to support efforts of the Plum Creek Watershed Partnership. This document has been distributed alongside the brochure Don't Be Clueless about the Plum Creek Watershed" brochure developed by the GBRA. The Texas AgriLife Extension Service also hosted a Sport and Athletic Field Education (SAFE) workshop to encourage irrigation and nutrient management of intensively managed turf areas. For the third consecutive year, the GBRA education coordinator worked side by side with teachers and students in Plum Creek watershed schools, continuing in-school water quality monitoring during school year 2008-09. The coordinator presented information to students using a tabletop watershed model to discuss watersheds, NPS pollution, and the Plum Creek project. A total of 600 students and 16 teachers, at seven campuses in three school districts, conducted three rounds of water quality monitoring in the last year. Using Texas Stream Team methods as a model for their monitoring, students tested water from Plum Creek for temperature, DO, pH, turbidity, nitrates, and phosphates. The results indicated a slight decrease in DO and increases in phosphates and nitrates as the creek moves from the urban northern area into the more rural southern area. For more information about the Plum Creek WPP see chapter 4 of this report.

Alternative Water Supplies for Improving Water Quality

Several recent TMDLs in Texas have identified grazing cattle as a contributor to bacterial water quality impairments through direct deposition and runoff of fecal matter to streams. To address this issue, the TSSWCB, the Texas AgriLife Extension Service, the TWRI, and the Natural

Resources Conservation Service (NRCS) are developing technical information for ranchers regarding protecting Texas waterways through well-managed grasslands.

Several BMPs have been identified to reduce direct deposition of bacteria and runoff from grazing lands into streams by helping maintain adequate ground cover and protecting environmentally sensitive riparian areas. Maintaining adequate ground cover enhances the filtering of runoff while simultaneously reducing runoff by increasing water infiltration into the soil. Protecting riparian areas reduces direct deposition of fecal matter into streams and provides a filter for runoff.

This project's goals are to (1) compile existing information on environmentally sound grazing BMPs, (2) evaluate the effects of various riparian protection practices on cattle behavior and water quality, (3) evaluate and demonstrate the effectiveness of grazing management in reducing bacterial runoff, and (4) promote adoption of grazing land BMPs.

The evaluation of alternative water supplies' effects on cattle behavior is complete. Alternative water supplies can be used alone or in conjunction with riparian fencing to minimize the time livestock spend in riparian areas (Figure 3.3). Quarterly evaluations using global positioning system (GPS) collars indicated cattle spent 50 percent less time near the stream when alternative water was provided.

These data are consistent with the findings of others. This decrease in the amount of time cattle spend in the riparian corridor can bring about substantial water quality improvements. Previous studies have found that stream bank erosion decreased 77 percent, total suspended solids decreased 90 percent, total nitrogen decreased 54 percent, and total phosphorus decreased 81 percent when alternative water was provided. However, an alternative water supply alone will not achieve targeted improvements unless used in conjunction with good grazing management. The benefits of these practices to water quality will continue to be evaluated and will be published next year.

Texas Silviculture Nonpoint Source Pollution Prevention

The Texas Silvicultural NPS Pollution Prevention Project continues to have a tremendous effect on Texas' water resources. A December 2008 monitoring report by the Texas Forest Service (TFS) documented that 92 percent of all forestry operations implemented BMPs, one of the highest rates in the South. Based on this rate of implementation, computer models predict annual soil savings of 100,000 tons across East Texas, including 12,000 tons which would otherwise enter our streams, lakes, and rivers.

Cypress swamp in Gray, Texas (photo by Mike Olivas of TFS)

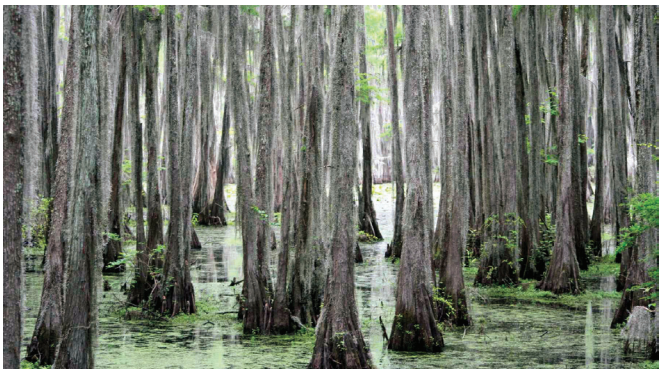
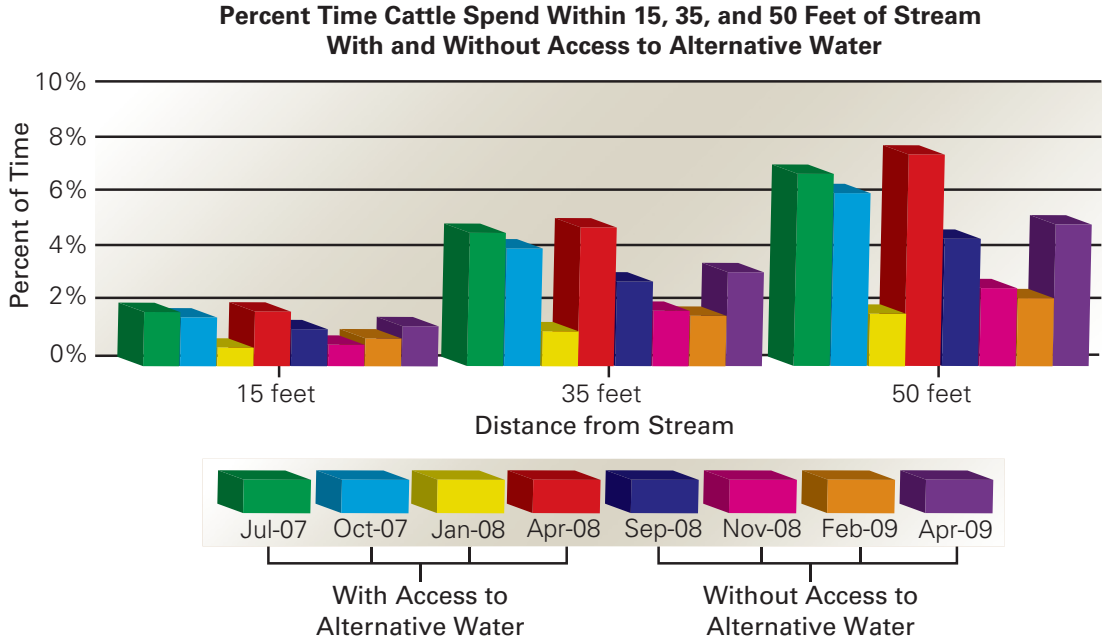


Figure 3.3
Percentage of Time Cattle Spend Near Stream



Jones Park in W.G. Jones State Forest (photo by Ron Billings of TFS)

The sustained success of this project is directly attributed to its extensive educational outreach and technical assistance. Project personnel have worked to promote BMPs, logging over 1,500 contact training hours to landowners, loggers, and foresters this past year. Project staffers also gave over 600 hours of technical assistance to landowners through phone calls and site visits. Additionally, over 100 college students at Stephen F. Austin State University were educated on the importance of implementing BMPs. This training is critical to the future success of the program, since those students will become the land managers of tomorrow.

Continual improvement has always been the goal of the program and, as such, new training workshops have been developed based on needs identified through implementation monitoring. This year, a workshop focusing specifically on forest roads was offered, as a result of the success of the stream-crossing workshop after it was developed two years ago. A similar response was received for this course, with 96 percent of attendees saying they would recommend it to others. Post workshop evaluations also showed that 92 percent of attendees would be interested in attending future BMP workshops, clearly demonstrating the ability of the TFS to effectively convey to attendees the importance of implementing BMPs in their operations.

As the state continues to work towards restoring impaired water bodies, models that accurately predict runoff from various land uses are critical. Forests present unique challenges to modelers. Data collected by this project is currently being used to test some of those models, which will be extremely helpful in watershed planning efforts.

Maintaining a proactive approach to addressing water quality issues is one of the foundations of this project. As new research, technology, and operational methods arise, so does the need to update the forestry BMP handbook. This stakeholder-driven process is currently under way and will result in a new BMP manual being published in early 2010, ensuring that these recommended practices continue to be the most effective way to mitigate forestry NPS pollution.

C H A P T E R 4

Progress in Developing and Implementing Watershed Protection Plans

In Texas, WPPs are locally developed water quality plans that coordinate activities and resources to manage water quality. They facilitate the restoration of impaired water bodies and the protection of threatened waters before they become impaired. These stakeholder-driven plans give the decision making power to the local groups most vested in the goals specified in the plans. Bringing groups of people together through watershed planning combines scientific and regulatory water quality factors with social and economic considerations.

While WPPs can take many forms, the development of plans funded by CWA Section 319(h) grants must follow guidelines issued by the EPA. These guidelines can be found online at <www.epa.gov/fedrgstr/EPA-WATER/2003/October/Day-23/w26755.htm>.

In fiscal year 2009, the TCEQ and the TSSWCB facilitated the development of WPPs throughout Texas by providing technical assistance and funding through grants to local partners. WPPs are also being developed or have been developed in Texas independently of this grant funding.

TSSWCB Watershed Protection Plans

Buck Creek

Buck Creek is a small intermittent water body in the southeastern corner of the Texas Panhandle. The creek flows east-southeast for 68 miles before entering Oklahoma and joining the Lower Prairie Dog Town Fork of the Red River to form the Red River. The creek is encompassed by a predominantly rural watershed that includes agricultural, feral-hog, human, livestock, and wildlife influences. Small springs greatly influence the flow in the creek, as when crop irrigation begins in the spring and the creek subsequently begins to go dry.

In 2000, Buck Creek water quality data resulted in its listing on the CWA Section 303(d) List for *E. coli* levels that exceeded Texas Surface Water Quality Standards (TSWQS). As a result of this listing, Texas AgriLife Research in Vernon and the TWRI received a CWA Section 319(h) grant from the TSSWCB to collect additional water quality data and further evaluate the impairment. Data indicated that at times, elevated *E. coli* levels do exist in portions of the creek. Based on this fact, further CWA Section 319(h) funding was provided by the TSSWCB to facilitate the development of a WPP for the Buck Creek watershed that collectively approaches the management of bacteria sources and other water quality concerns.

Buck Creek (photo by Lucas Gregory of TWRI)

Work in fiscal year 2009 has focused on continued water quality monitoring, watershed modeling, and the initial steps in developing the Buck Creek WPP. Three stakeholder meetings were held to discuss potential BMPs to be included in the WPP, initial results from bacterial-source tracking (BST) and the development of load

reduction curves. Initial sections of the WPP were also drafted and distributed for stakeholder review.

Preliminary BST work has indicated that major sources of bacteria in Buck Creek are feral hogs, livestock, and wildlife. Further work is planned for the coming year to verify the presence of these sources. Load duration curves (LDCs) developed for the waterbody indicate that water quality has been improving since the initiation of the projects and will allow comparisons to be made between past and present water quality. Increased awareness and educational programming delivered through this project have influenced *E. coli* loadings in the watershed.

Work on the WPP will continue into fiscal year 2010 and will culminate with the completion of the document currently scheduled for September 2010. This plan will include management strategies desired by landowners to mitigate E. coli and nitrate loading to the creek and result in decreased loads of each constituent in the creek to the point that the creek achieves TSWQS.

Concho River

The Concho River basin lies within 13 West Texas Counties and encompasses a watershed of approximately 4.5 million acres. Four major reservoirs—the O.H. Ivie, O.C. Fisher, and Twin Buttes Reservoirs, and Lake Nasworthy—are located within the watershed boundaries. These reservoirs provide potable water, either wholly or in part, to approximately 500,000 residents. In addition, the streams and reservoirs of the Concho Basin are used for agriculture. The Concho River itself lies below San Angelo and enters O.H. Ivie Reservoir near Paint Rock, Texas. In the San Angelo area, several major streams converge to form the Concho River. These include the North, South, and Middle Concho Rivers, Spring Creek, and Dove Creek. Many historical springs feed into the tributaries of the Concho. It is at these locations that the more environmentally sensitive aquatic habitats are commonly found. In 2002, the Concho River was placed on the 303(d) List for having impaired macrobenthos communities. The O.C. Fisher Reservoir was also listed for TDS and chlorides.

UCRA staff monitoring flow in the Concho River Basin (photo courtesy of UCRA)

The UCRA and City of San Angelo have begun implementing the Concho River Basin WPP. The UCRA has received 319(h) grant funding for the Concho River Basin Aquatic Research and Education Center. Construction of the Center was completed in fiscal year 2008 and the center was in operation throughout fiscal year 2009 (see Chapter 3). In addition, San Angelo citizens voted to raise sales taxes within the city for improvements in Concho River water quality. These funds are being utilized by the City of San Angelo, in partnership with UCRA, to dredge and perform bank stabilization in portions of the North Concho, as outlined in the WPP. Additionally, the Concho River WPP steering committee continues to meet and discuss ongoing activities and issues occurring in the Concho Basin as well as updates to the many proposed BMPs in the Concho River WPP.

Geronimo and Alligator Creeks

The GBRA and Texas AgriLife Extension Service received a CWA Section 319(h) grant from the TSSWCB to facilitate the development of a WPP for Geronimo Creek and its tributary, Alligator Creek. The watershed is located in Guadalupe and Comal counties and is primarily agricultural, but includes urbanized areas located in the cities of Seguin and New Braunfels.

Sampling in Geronimo Creek (photos courtesy of GBRA)

Early on in the project, the GBRA, Texas AgriLife Extension Service and TSSWCB met with key stakeholders and state agencies and then treated them to a tour of the watershed. Representatives from the cities of New Braunfels and Seguin, Comal and Guadalupe Counties, county extension agents, NRCS, New Braunfels Utilities, and the Comal-Guadalupe SWCD, saw first hand the

expansion of impervious cover in the watershed as well as the various springs that contribute the majority of the flow in Geronimo Creek.

Two public meetings for the Geronimo and Alligator Creek WPP have occurred in New Braunfels and Seguin. A TWS Workshop took place in Seguin to increase public participation in the process.

Granger Lake

Granger Lake is the sole drinking water supply for Williamson County, which has one of the highest rates of population growth in the state. (Refer to Chapter 2 for a discussion of the threat sedimentation and increased demand pose to this lake.)

The TSSWCB partnered with the Brazos River Authority (BRA), the Little River–San Gabriel SWCD, and Texas AgriLife Research to quantify sediment loadings and develop a WPP for Granger Lake and the San Gabriel River. The BRA and the Little River–San Gabriel SWCD have met with local agricultural producers and landowners to prioritize the most effective BMPs for reducing sediment and nutrient runoff. The BRA has also met with city and county officials regarding urban BMPs and other planned implementation measures.

In an effort to reduce sedimentation to Granger Lake, the Little River SWCD is providing technical and financial assistance to agriculture producers for the development and implementation of BMPs. This project is featured in Chapter 2.

Lampasas River

The Lampasas River rises in western Hamilton County 16 miles west of Hamilton and flows southeast for 76 miles through a rural agricultural landscape in Lampasas, Burnet, and Bell Counties. Rocky Creek was classified as an "ecologically unique stream" by the Texas Parks and Wildlife Department due to its geological and biological characteristics. Above Stillhouse Hollow Lake the river is listed as impaired due to elevated bacteria levels, and North Fork Rocky Creek is impaired for DO.

River flow and water quality data were gathered and organized into a relational database. Using the database, Texas AgriLife Research pieced together an 84-year continuous streamflow record. In addition, an automated procedure for creating LDCs was developed and linked to the database. A review of existing information about the Lampasas which will result in a topical bibliography has been undertaken and is nearing completion. In addition, an annotated bibliography of scientific research into identifying contributing sources of bacterial contamination has been completed. Various geodatabase architectures and methods of classifying watershed land use for developing improved geographic information system (GIS) layers were studied and the GIS work was initiated.

Texas AgriLife Research partnered with Texas AgriLife Extension Service to host a TWS workshop in Lampasas which had over 60 participants. An initial set of "listening sessions" were conducted with key stakeholders and briefed local community groups about the watershed protection plan. In addition, two watershed-wide stakeholder meetings were held in the spring and were attended by over 100 people. Through these efforts, likely members of the steering committee and work groups were identified.

Lampasas River (photo courtesy of City of Killeen)

Leon River

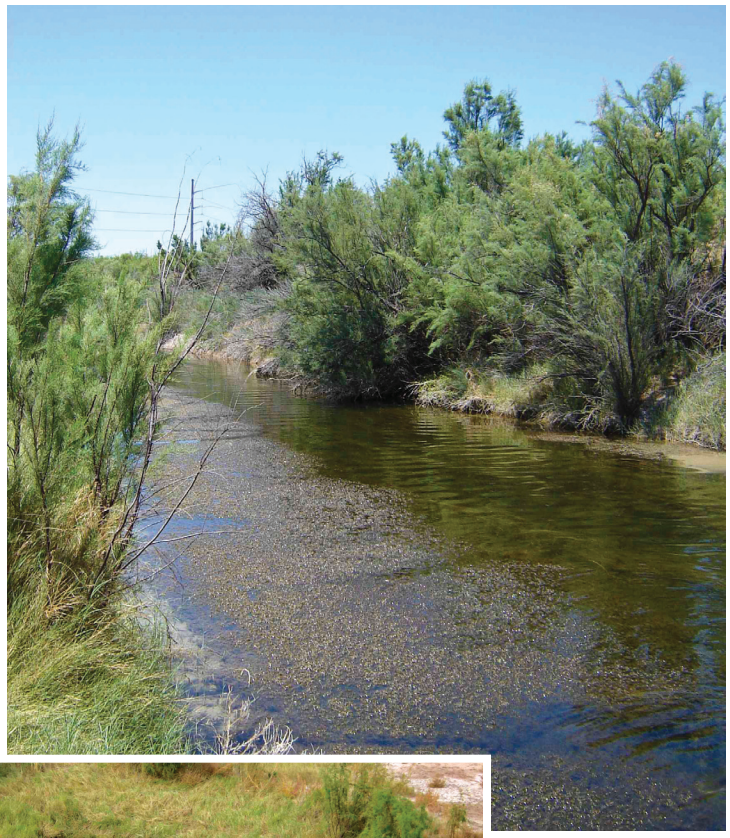
The Leon River Watershed encompasses approximately 1,340 square miles in Bell, Coryell, Hamilton, Comanche, and Erath counties. In 1998, the Leon River was placed on the state's CWA Section 303(d) List for having bacteria concentrations that exceeded TSWQS for contact recreation, prompting the TCEQ to commence a TMDL project for bacteria in 2002. To take a more proactive role in developing management strategies to reduce bacteria loadings to the Leon River, local TMDL stakeholders initiated a WPP in 2006. The BRA was asked to take the lead in facilitating that effort.

Over 130 local citizens, city and county officials, and state and federal agencies have been actively involved in Leon River watershed planning. The BRA conducted a series of focus group meetings, which represent farms and ranches, dairies, landowners, and city and county governments, to identify management measures—specific to each focus group—that would reduce bacteria and nutrients in the Leon River. A working committee, consisting of representatives from each focus group, met to develop consensus on the load reductions expected from the management measures. To assist in their decision making, the focus groups and working committee utilized an implementation support tool that illustrated the potential effects of varying degrees of BMP implementation. A technical advisory group also met to review and make suggestions on the management strategies

recommended by stakeholders and guide several agencies' roles in providing future technical and financial support of solutions in the Leon River WPP. The WPP will be finalized and submitted to the EPA in fiscal year 2010.

Pecos River

The Pecos River meanders 418 miles through the driest region of West Texas south-southeast before merging with the Rio Grande at the International Amistad Reservoir. Along the river's journey southward, the surrounding watershed changes from a relatively flat, short-brush dominated rangeland interspersed with short grasses above IH 10 to one filled with plateaus, valleys, and steep cliffs and is dominated by larger brush species and sparse, short grasses below IH 10.



Pecos River above Girvin (photo by Lucas Gregory of TWRI)

Pecos River at SH305 (photo by Lucas Gregory of TWRI)

The focus of this project has been the assessment of the watershed and its associated water quality and the development of a WPP that addresses water quality and watershed concerns. Work conducted in fiscal year 2009 has focused on the completion of this WPP and coordination with EPA Region 6 to complete a WPP consistency review before moving forward with implementing the WPP. Two project work plans have been developed for implementing the WPP and further refining the understanding of the DO impairment that currently exists in the river between Pecos and Girvin, Texas.

Planned activities incorporated into these work plans include additional spraying of live salt-cedar stands along the river; burning debris along the river that has been sprayed in previous years; implementing biological salt-cedar control measures in areas where spraying or burning has not been conducted, is not planned, or is not feasible; implementing WQMPs along the riparian corridor; continuing to compile water quality data germane to the watershed; installing a new, real-time water quality monitoring station near Girvin; continuing outreach and education to keep landowners informed about project activities and WPP implementation; and developing a watershed model to evaluate the DO impairment and aid in developing management practices to address this impairment.

Plum Creek

The Plum Creek Watershed was selected as the first WPP pilot project by the TSSWCB's Regional Watershed Coordination Steering Committee in December 2005. Plum Creek is a 400 sq mi watershed with headwaters north of Kyle in Hays County, which drains much of Caldwell County and a small portion of Travis County. The creek is listed as an impaired water body on the CWA Section 303(d) List due to high levels of bacteria and concerns for nutrient enrichment. A key objective of the project was to demonstrate the most efficient and effective strategies for evaluating, planning, and developing a WPP. However, the ultimate goal of the project is to restore and protect the quality of the water in Plum Creek. The Plum Creek WPP was completed and adopted in February 2008 by the Steering Committee composed of local stakeholders, with acceptance by the EPA in July 2009.

Implementing Components of the Plum Creek Watershed Protection Plan

In the first full year of implementing the Plum Creek WPP, significant progress toward achieving a number of WPP components has been made. Public involvement and education continues to be a key focus of implementation, in an attempt to engage stakeholders and appropriately inform them to encourage watershed stewardship. Over 58 meetings, workshops, and trainings have

been conducted in fiscal year 2009 totaling about 2,444 participants, 179 hours of training, and over 7,699 contact hours. These meetings, workshops, and trainings included: 3 steering-committee meetings, 13 work group meetings, 16 public and local-government meetings, 3 meetings of the TSSWCB watershed coordination steering committee, and 23 educational events. Through these efforts, Texas AgriLife Extension Service, in collaboration with the GBRA, has engaged personnel and officials with each of the municipalities and counties within the watershed to build strong cooperative partnerships.

Critical education programs addressing targeted issues already have been conducted including: five OSSF management trainings, one workshop on feral-hog management, one training on athletic-field management, one Texas Stream Team monitoring workshop, and two community stream cleanups and environmental fairs. The Texas AgriLife Extension Service continually works to secure additional funding for implementation in both rural and urban areas.

Through the project "Implementing Agricultural Nonpoint Source Components of the Plum Creek WPP," the Plum Creek Watershed Partnership launched its feral hog management education strategy. Following a management workshop attended by more than 350 landowners from the Plum Creek Watershed and surrounding counties, a feral hog reporting system was introduced to allow landowners to report sightings of feral hogs or damage from their activity. In addition, an AgriLife Extension Assistant was hired to spearhead the local effort by coordinating with local landowners, tracking feral hog activity, providing technical assistance, and developing additional educational materials. Through the same project, the Caldwell-Travis SWCD hired a technician to engage with landowners via outreach on conservation issues and technical and financial assistance to develop holistic WQMPs for agricultural operations in the watershed. In support of the WPP, the GBRA continues to conduct Surface Water Quality Monitoring to Support Plum Creek Watershed Protection Plan Development, an intensive project in Plum Creek and its tributaries. The GBRA is collecting targeted routine ambient, stormflow, 24-hour DO, wastewater effluent, and springflow samples at 43 sites throughout the watershed. The monitoring program in the watershed has been somewhat hampered by the lack of flow in the creeks due to the severe drought that has plagued the region for the last 22 months. As a result, this program has been extended to allow monitoring through February 2010 to provide a more complete picture of pollutant-loading dynamics in the Plum Creek watershed.

TCEQ Watershed Protection Plans

Arroyo Colorado

The Arroyo Colorado, an ancient distributary channel of the Rio Grande, extends about 90 miles from Mission, Texas, to the Laguna Madre in the Lower Rio Grande Valley. Flow in the Arroyo Colorado is sustained by wastewater discharges, agricultural irrigation return flows, urban runoff, and base flows from shallow groundwater. To address the Arroyo Colorado's bacteria and DO impairment as well as nutrient concerns, the Arroyo Colorado Watershed Partnership developed *A Watershed Protection Plan for the Arroyo Colorado—Phase I.*

Following the release of the WPP in 2006, the "Arroyo Colorado Watershed Protection Plan Implementation" project began putting the strategies and objectives listed within the plan into action. The Arroyo Colorado Watershed Partnership has grown to over 700 members. Over 21,000 individuals have experienced the physical watershed model, an excellent hands-on educational tool that teaches youth and adults about their local watershed, their impact on water quality, and how they can be better watershed stewards. Through this project, the Partnership levered local dollars and time from the Lower Rio Grande Valley TPDES Storm water Task Force and citizens to host a watershed-wide event in conjunction with Earth Day to install more than 1,000 storm-drain markers reading "No Dumping, Drains to Laguna Madre." The task force plans to fund an additional 20,000 markers in the future. The partnership also installed 10 road signs marking the watershed boundary on major entry points to the watershed, and the storm water task force has plans to fund and facilitate the installation of at least 35 more signs. Currently, the part-

Above: *Earth Day activities in the Arroyo Colorado Watershed (photo courtesy of Harlingin ISD)*

Left: *Earth Day activities in the Arroyo Colorado Watershed (photo courtesy of City of Pharr)*

nership tracks activities from at least 16 projects working to implement the WPP. Of those projects, four began this year and are summarized later in this section. Over $3.9 million federal and $2.2 million local funds support the implementation of the Arroyo Colorado WPP.

"Arroyo Colorado Watershed: Construction of Wetland Treatment Systems" financially assists the cities of San Juan, San Benito, and La Feria to improve water quality through the design, construction, maintenance, operation, and monitoring of wetlands that will receive treated effluent from municipal wastewater treatment facilities and storm water runoff. Recreational appurtenances such as boardwalks, all-weather paths, signage, and kiosks will be developed. San Juan completed the construction of the wetland in September 2009. The city of La Feria completed construction of the wetland in August 2009. The city of San Benito has completed the permitting process and the design of the project. Construction of the wetland in San Benito is scheduled to begin in winter of 2009.

Since the project's inception in 2005, "Education of Best Management Practices in the Arroyo Colorado Watershed" taught agricultural producers about how to improve their produce and manage their acreage.

Since the project's inception in 2005, "Education of Best Management Practices in the Arroyo Colorado Watershed" taught agricultural producers about how to improve their produce and manage their acreage. That initiative also informed producers about how to reduce the potential for NPS pollution. Upon project completion in February 2009, over 3,600 producers and citizens of the Valley and South Texas participated in trainings and received information of BMPs, crop production techniques, pesticide safety, soil testing, and WQMPs. The annual soil testing campaign resulted in the analysis of 337 soil samples. Although the project has ended, education and outreach for agricultural producers continues to be a need as additional water quality management plans are needed to reach the goals of the WPP. Because cost-share programs continue to not reach full participation increased targeted outreach is needed.

The primary focus of the *Arroyo Colorado Agricultural Nonpoint Source Assessment* is to better characterize agricultural runoff in the Arroyo Colorado, assess and demonstrate the effects of BMP implementation at the field and sub-watershed level, and measure progress towards meeting WPP goals. As the watershed has undergone considerable growth and rapid land use changes, its land use–land cover (LULC) map was updated, published, and used to accurately characterize and model the watershed. Scientists monitored water quality in agricultural drainage ditches to assess potential mitigation and attenuation within the drainage way and also collected irrigation return water to gain better data on the quality of tailwater leaving the fields currently using BMPs. Agricultural BMPs installed throughout the watershed were inventoried and mapped to better target future education efforts and cost-share programs. Effects of BMPs on water quality and potential mitigation effects of drainage ditches will continue to be monitored during the next year.

WQMP Implementation Assistance in the Arroyo Colorado Watershed gives technical and financial assistance to local watershed landowners to develop WQMPs. This project is featured in Chapter 2.

To increase the sophistication of the TMDL analysis to reduce uncertainty and to better characterize the watershed, the SWAT Model Simulation of the Arroyo Colorado Watershed used the Soil and Water Assessment Tool (SWAT) model and GIS to simulate the current sediment, biochemical oxygen demand, and nutrient loadings in the Arroyo Colorado watershed. Data were collected for input into the SWAT model, including the updated LULC map of the watershed; the model was then calibrated and validated. During the next year, scientists will simulate load reduction scenarios based on a suite of potential BMPs.

Bastrop Bayou

The Bastrop Bayou watershed is located entirely within Brazoria County. Ambient water quality monitoring began for the watershed in August 2004 under the CRP. A risk assessment completed for the watershed in June 2006 revealed that, although the watershed is not currently on the 303(d) List, rapid population growth in the area is a significant risk to water quality. By 2025, the watershed is expected to have a 50 percent growth in households. Based on the risk assessment, the TCEQ, the GBEP, and the H-GAC began the WPP in 2006.

In concert with the WPP, Dow Chemical will donate 330 acres in the watershed as a permanent conservation easement. The U.S. Fish and Wildlife Service will maintain the property. Also, the science curriculum coordinator for the local school district has approved the inclusion of watershed conservation as a part of the curriculum for all students. In addition, the first community cleanup event, Trash Bash, was held on March 28, 2009. The event was featured in *Texas Saltwater Fishing Magazine* and on the local NBC and CW affiliates, as well as in *The Facts* newspaper. Over 100 families were present to help clean the bayou.

The WPP is scheduled for completion by spring of 2010. The stakeholders have selected and prioritized the implementation projects, and several projects are scheduled for completion by August 2010.

Brady Creek

Brady Creek is an intermittent to perennial stream that originates in Concho and Menard Counties, flows through Concho and McCulloch Counties, and finally confluences with the San Saba River in San Saba County, east of Brady, Texas. Since construction of Brady Lake in the early 1960s, Brady Creek from below the dam through the city of Brady has primarily consisted of flows from urban runoff. Since this time, the creek through Brady has experienced significant algae blooms and fish kills. The creek was first identified on the 2004 CWA Section 303(d) List for not supporting the designated aquatic life use due to low DO. Concerns have also been identified for chlorophyll *a* and nutrients.

Brady Creek just upstream of the confluence with the San Saba River (photo courtesy of UCRA)

In fiscal year 2009, the UCRA completed the initial watershed-characterization portion of a WPP for Brady Creek, in which existing data and new monitoring data were assessed to determine overall water quality and potential sources and causes of pollution. In addition, the UCRA applied to the TCEQ for CWA Section 319(h) funding for the completion of the WPP. The application for the WPP has been approved by the TCEQ and the EPA and the three year project will begin in fiscal year 2010.

Overall, the WPP is an expansion of the Brady Creek Master Plan that addresses the entire Brady Creek watershed. The WPP includes a focus on nonpoint sources of pollution in the downtown Brady portion of the watershed, sources and potential sources of pollution in the greater watershed, and other water quality and quantity issues of interest identified by stakeholders. The new WPP project will include refining the Brady Creek watershed characterization by conducting additional monitoring and modeling; further identifying and quantifying pollutant loading sources; prioritizing BMPs identified in the master plan for the city of Brady; identifying additional BMPs for the greater watershed, along with associated costs and load reductions to be achieved; creating a schedule of implementation with measurable milestones; and involving stakeholders throughout watershed protection planning.

Caddo Lake

The Caddo Lake watershed is a rich and unique ecosystem that straddles the Texas-Louisiana border. Historical, current, and possible future stressors on this system may destroy aspects of the lake that make it valuable to humans and wildlife. The existing stressors have resulted in at least three major areas of concern, which overlap: water quality, water quantity, and aquatic and riparian habitat. In order to encourage the wise use of this ecosystem by those who live in the watershed and those who visit it, stakeholders in the Caddo Lake community have proposed undertaking a comprehensive, watershed-level planning effort. Six stakeholder meetings were held in fiscal year 2009.

The data inventory was completed in fall 2008. Based on stakeholder concerns, the CWA Section 303(d) List, and the TWQI, data were queried from the Surface Water Quality Monitoring Information System (SWQMIS) database. In the spring of 2008, several maps indicating land use, location, topography, soils, major cities and other communities, and highways and county roads were developed for the Caddo Lake watershed. Photographic surveys were used to document features like the courses of streams, the topography of the land, the extent of forest cover and other land uses, and other natural and human-made features of the watershed. Phase I of the modeling was completed in the fall of 2009. The parameters evaluated included DO, pH, ammonia, total nitrite-nitrate nitrogen, total phosphorus, orthophosphate, chlorophyll *a*, and bacteria (fecal coliform and *E. coli*). A technical memorandum was developed using the information gathered in the data inventory to classify the current land use for the watershed, rank the potential source locations of pollutants, identify data gaps and needs, recommend additional data collection or monitoring, and recommend a modeling approach for Phase II of watershed planning. Phase II began in the summer of 2009 and will include watershed modeling. The models being utilized for Phase II were determined from the Phase I technical memorandum and include SWAT, Water Quality Analysis Simulation Protocol (WASP), and Spatially Explicit Load Enrichment Calculation Tool (SELECT) models. The modeling is scheduled to be completed in summer 2010.

Dickinson Bayou

The Dickinson Bayou watershed is located within the San Jacinto–Brazos Coastal Basin, southeast of Houston and west of Galveston Bay. The bayou begins near the city of Alvin in Brazoria County. The Dickinson Bayou watershed covers approximately 63,830 acres or 99.7 square miles and is elongated, approximately 24 miles long from west to east. The maximum width of the watershed is approximately 7 miles. Water falling within this area eventually makes its way into Dickinson Bay, a secondary bay of Galveston Bay. Cat's Point, April Fool Point, and Shell Island bound the roughly circular bay just over a mile across.

Dickinson Bayou above Tidal is currently listed as impaired for high bacteria levels. Other concerns include low DO and pollutant loading. This section of the bayou runs 7 miles and is freshwater. Dickinson Bayou Tidal, which is the main stem of the bayou, is listed as impaired for low DO. A special study conducted through the CRP revealed that tidal fluctuations allow surface water to flush and replenish itself with DO, while deep water remains in the same location. This section of the bayou runs 15 miles and is brackish, a mix of salt and freshwater creating an estuarine habitat. The entire watershed is listed as impaired for high bacteria levels. Low levels of DO are found in Borden's Gully and Magnolia (Geisler) Bayou.

Above: *Marissa Sipocz lectures on the importance of wetlands and native habitat at a workshop on urban growth management in the Dickinson Bayou watershed. (photo by Chris LaChance of Texas AgriLife Extension Service)*

Above: *Stakeholders participate in a voting activity to prioritize watershed issues at a meeting of the Dickinson Bayou Watershed Partnership. (photo by Susan Benner of Texas AgriLife Extension Service)*

Left: *Dickinson bayou watershed stakeholders view a living shoreline demonstration project along Dickinson Bayou. (photo by Susan Benner of Texas AgriLife Extension Service)*

The Dickinson Bayou Watershed Partnership has completed a WPP for Dickinson Bayou, and the draft was submitted to the EPA for review in March 2009. The WPP outlines a series of actions aimed at improving the overall health of the watershed and reducing the amount of pollutants entering the bayou. These actions are based on the vision and goals proposed for the watershed by a broad group of stakeholders representing individual citizens, nonprofit and commercial interests, and local, state, and federal government authorities. The plan sets forth specific short-term (~ 5 year) and long-term (~ 20 year) goals and pollutant reduction targets. The initial implementation phase proposes modest short-term pollutant reduction targets of 23,394 lbs/yr of total nitrogen (6 percent reduction), 5,816 lbs/yr of total phosphorus (5 percent reduction), 1.9 x 106 billion colonies/yr of bacteria (15 percent reduction), and 1,000 acres of preserved land. Overall, the plan is intended to be a living document, frequently visited by the stakeholders.

With the GBEP's support, the Dickinson Bayou effort secured a CWA Section 319(h) Watershed Implementation Plan grant, which will assist in accomplishing most of the plan's short-term goals. Several on-the-ground demonstrations of site specific water-quality-improvement projects (WQIPs) are funded though this grant. These projects have a short-term goal of treating 250 acres with on-the-ground WQIPs. The CWA Section 319(h) funding will also help install a demonstration storm water wetland in the watershed and provide educational workshops for many different groups.

Halls Bayou–Westfield Estates

The Westfield Estates Watershed comprises a small part of the urban drainage to Halls Bayou located in unincorporated northeast Harris County. The sanitary-sewer needs of its community are served entirely by OSSFs, many of which have failed or are failing due to design, maintenance, or operational issues made worse by a general lack of available funding. As a result, this predominantly low-income, minority neighborhood of 700 households was identified by the county as the community most in need of adequate wastewater treatment. Combined with bacterial contamination from domestic animals (primarily dogs and chickens) and other wildlife, the failing OSSFs have led to elevated bacteria levels (> 100,000 cfu/100mL) in the watershed's drainage ditches. These conditions do not meet the state's criteria for contact recreation and pose direct risks to human health.

To alleviate these risks, the Westfield Estates WPP was developed through a stakeholder involvement, led by an interdisciplinary stakeholders advisory group composed of members from local political jurisdictions, water quality professionals, and interested community members. The advisory group met several times over the last year and provided resources, technical assistance, and expertise throughout planning. The goals of the plan are to reduce bacteria levels, institute management practices to maintain improved water quality, and raise awareness of water quality issues in the watershed. These aims will be achieved by reducing the human and non-human bacteria load through maintenance, repair, replacement, or installation of OSSFs, developing and implementing BMPs to maintain water quality, fostering a community watershed management group to insure continued stakeholder commitment to implementation activities, and ongoing community education. The draft plan is currently under final revision.

Hall's Bayou Adjacent to Westfield Estates (photo courtesy of H-GAC)

Hickory Creek

The Hickory Creek arm of Lake Lewisville was identified as a water body of concern for ammonia nitrogen in the 2004 TWQI and CWA Section 303(d) List. Lake Lewisville is not currently identified on the CWA Section 303(d) List; however, significant development is anticipated for the area within the next several years. This growth has the potential to threaten designated uses of the creek. In fiscal year 2009 Denton completed the Hickory Creek WPP. Its goals of the WPP are to identify sources and causes of pollution and to determine which management strategies are best suited to protect the city's drinking-water supply. The WPP is designed to prevent net increases in sediment and nutrient loading. The WPP includes an in-depth cost analysis of the BMPs versus their effectiveness at removing pollutant loads. The WPP also proposes a pilot program for trading nutrient and sediment loads.

Lake Granbury

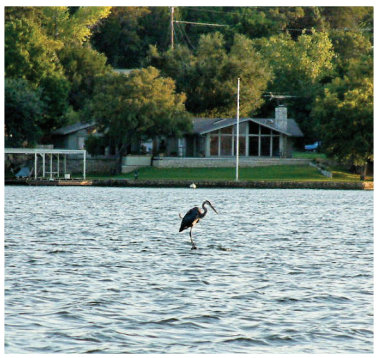
Lake Granbury in Hood County serves as a water supply for more than 250,000 people in North Central Texas. For the last several years, regular water quality testing has found elevated concentrations of *E. coli* in the coves of Lake Granbury, resulting in water quality exceeding the criteria limit for contact recreation use. A substantial portion of the developed area around Lake Granbury, which lies wholly within Hood County, consists of unincorporated subdivisions that do not have sewage collection systems and centralized sewage treatment facilities.

The Lake Granbury WPP Project will assess existing and potential water quality threats from ongoing NPS pollution within the Lake Granbury watershed. Analysis of historical data was completed and a water quality characterization report with trend analysis produced. The results of the BST data was presented in fiscal year 2009 and stakeholders chose to rely on modeling as the primary source of information to support decision making for the plan.

Monthly sampling of bacteria, conventional laboratory parameters, and field parameters continues under various climatic conditions to develop a database of water quality conditions over a long period of time. Stakeholders chose to collect additional data on wastewater to help define an assumption for the model for the concentration of bacteria that may exist in raw wastewater from treatment plant overflows and septic tank seepage. Modeling of eight canal systems have been completed and presented to the stakeholder group.

In fiscal year 2009, work progressed from reviewing modeling results to identifying and prioritizing management practices for each of the canal systems. A series of selection criteria assists stakeholders in selecting those practices with the greatest cost/benefit ratio. Finalization of the plan will occur in fiscal year 2010 with a highly defined plan of stakeholder-vetted management practices.

Jetskier on Lake Granbury (photo courtesy of BRA)



Above: *Lake Granbury sunset (photo courtesy of BRA)*

Right: *Blue Heron on Lake Granbury (photo courtesy of BRA)*

Upper San Antonio River

The Upper San Antonio River WPP, completed in 2006, addresses elevated concentrations of fecal bacteria in the upper reach of the San Antonio River, north of South Loop 410 in the city of San Antonio. The SARA, coordinating with local governments through the interagency Bexar Regional Watershed Management Group, developed this strategy to restore the river to contact recreation standards. Key elements of the strategy include reducing bacterial contributions from the San Antonio Zoo by 99.9 percent, from general urban runoff sources by 25 percent, and from wastewater collection system sources by 12 percent. Among the implementation projects under way for this WPP are a social marketing and collaborative education campaign to control food residues and bird feeding in the River Walk reach, an engineering design for the City of San Antonio's ultraviolet treatment system for the zoo drainage, and removal of bird and bat roosts from underneath bridges over the river.

In January 2008, SARA, the TCEQ, and the EPA initiated a three-year TMDL I-Plan for the Upper San Antonio River, Salado Creek, and Walzem Creek (the planning area).

Third-Party Watershed Protection Plans

North Central Texas Water Quality Project

Watershed planners with the North Central Texas Water Quality Project (NCTWQP) have worked diligently to continue the momentum established with watershed planning efforts for Cedar Creek, Eagle Mountain, and Richland-Chambers reservoirs. The three reservoirs are owned and operated by the TRWD and are in various stages of project development. The NCTWQP was created to develop WPPs for these reservoirs and is working to perfect a template for watershed planning emphasizing the use of computer modeling, prioritization of targeted sub-basins, and economic analysis of conservation practices to allow for strategic use of funds.

The NCTWQP is a partnership of the TRWD, the TWRI, and the Texas AgriLife Research and Extension Urban Solutions Center at Dallas. Funding for the project is provided by the NRCS, the EPA, the TSSWCB, the TCEQ, and the TRWD.

Cedar Creek Reservoir Watershed

Development of the Cedar Creek WPP is on track for submission to the EPA for review and subsequent implementation in December 2009. Cedar Creek Reservoir appears on the 2006 and 2008 CWA Section 303(d) List for high pH levels. Watershed protection efforts are focused on the reduction of the algae indicator chlorophyll *a* through the limitation of phosphorus and sediment entering the reservoir.

Featured in the WPP is extensive and collaborative modeling utilizing the SWAT for watershed-level modeling, Enhanced Stream Water Quality Model (QUAL2E) for in-channel processes, and a WASP model for the reservoir. Additionally, completion of a conservation-practice economic-performance-analysis model by Texas A&M University economists has offered project leadership and stakeholders several scenarios of conservation-practice implementation, integrating cost figures and pollutant-reduction performance. Use of this tool has shown that the strategic placement of filter strips, grassed waterways, grade-stabilization structures, terracing, and the enforcement of a 2,000 ft buffer strip surrounding the reservoir in which fertilizer use is eliminated will achieve the previously determined goal of 35 percent phosphorus reduction. This effort joined with ongoing efforts of the Kaufman–Van Zandt SWCD to develop WQMPs for individual landowners within priority sub-basins.

A stakeholder work group led by the Texas AgriLife Extension and the Kaufman County Environmental Co-op have determined a list of targeted audiences for informational and outreach programming as well as catered messages to foster watershed awareness and stewardship among sportsmen, homeowners, agricultural producers, and schoolchildren. To supplement these planned outreach efforts, demonstration sites for selected conservation practices such as rainwater harvesting and bioswales, funded by the TCEQ, have been installed or planned within watershed communities.

Reporting of pollutant contributions associated with discharges from wastewater treatment plants has been coupled with recommended upgrades for each facility currently discharging within the watershed.

Implementation protocol for management practices as well as interim milestones for progress will be based upon the number of practices installed and advancement of educational programming. Monitoring of pollutant reduction will be conducted with the same methodology of computer modeling and ambient water quality testing utilized to analyze current and past watershed and reservoir conditions.

Eagle Mountain Lake Watershed

Planning for the Eagle Mountain Lake Watershed is moving toward completion based upon computer modeling and sub-basin analysis of conservation practices for both pollutant reduction and economic performance.

Planning efforts are driven by a rising trend of chlorophyll *a* within the reservoir. Stakeholder interest in the plan has increased substantially as reflected by attendance at quarterly meetings, media attention, and the prospect of partnerships with organizations such as Save Eagle Mountain Lake and the Trust for Public Land, and the LBJ National Grasslands. SWAT and WASP modeling of the watershed and reservoir are complete, thus allowing for advancement of planning efforts into the targeting phase in which management practices are strategically proposed for areas of highest priority. Reporting of pollutant loadings and recommended upgrades to watershed wastewater treatment plants have been conducted to account for point sources within the watershed. Development of an economic performance analysis of conservation practices by Texas A&M University is currently in progress to guide project leadership and stakeholders toward the most efficient use of project funds.

The NCTWQP participants are cooperating with Texas AgriLife Research in Stephenville as they conduct a recreational-use attainability analysis for portions of the upper Trinity River basin, including portions of the Eagle Mountain Lake watershed, for bacterial impairments.

Richland-Chambers Reservoir Watershed

SWAT modeling of the Richland-Chambers watershed has been completed by the Texas AgriLife Blackland Research Center at Temple. Building upon that study, the benefits of strategically located conservation practices within the watershed have been evaluated. Further analysis of the modeling report will determine the scope and timeline of watershed planning for this reservoir.

Martin Canyon on the Rio Grande (photo courtesy of TCEQ)

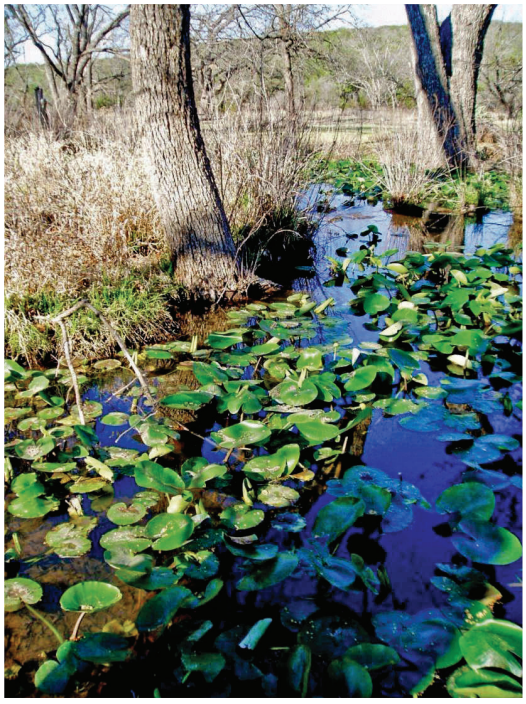
Abbreviations

ACS	Agricultural Chemicals Subcommittee
BMP	Best Management Practice
BRA	Brazos River Authority
BST	Bacterial Source Tracking
CAPCOG	Capital Area Council of Governments
CBBEP	Coastal Bend Bays and Estuary Program
CFU	Colony-Forming Unit
CRP	Clean Rivers Program
CWA	Clean Water Act
CWQMN	Continuous Water Quality Monitoring Network
DO	Dissolved Oxygen
E. coli	*Escherichia coli*
EPA	U.S. Environmental Protection Agency
GBEP	Galveston Bay Estuary Program
GBRA	Guadalupe-Blanco River Authority
GIS	Geographic Information System
GPS	Global Positioning System
H-GAC	Houston-Galveston Area Council
IBWC	International Boundary and Water Commission
I-Plan	Implementation Plan for a TMDL
LCRA	Lower Colorado River Authority
LDC	Load-Duration Curve
LEADS	Leading Environmental Analysis and Display System
LID	Low-Impact Development
LULC	Land Use-Land Cover
NCTWQP	North Central Texas Water Quality Plan
NOAA	National Oceanic and Atmospheric Administration
NPS	Nonpoint Source
NRCS	Natural Resource Conservation Service
OSSF	On-Site Sewage Facility
PMP	Texas Groundwater Pesticide Management Plan
POINTS	Pesticide of Interest Tracking System
PSA	Public Service Announcement
QUAL2E	Enhanced Stream Water Quality Model
RSI	River Systems Institute (Texas State University)
SAFE	Sport and Athletic Field Education
SAISD	San Angelo Independent School District
SARA	San Antonio River Authority

Abbreviations

SAWS	San Antonio Water System
SELECT	Spatially Explicit Load Enrichment Calculation Tool
STEPL	Spreadsheet Tool for Estimating Pollutant Load
SWAT	Surface Water Assessment Tool
SWCD	Soil and Water Conservation District
SWQM	Surface Water Quality Monitoring
SWQMIS	Surface Water Quality Monitoring Information System
TCEQ	Texas Commission on Environmental Quality
TDS	Total Dissolved Solids
TFS	Texas Forest Service
TGPC	Texas Groundwater Protection Committee
TIAER	Texas Institute of Applied Environmental Research
TMDL	Total Maximum Daily Load
TPDES	Texas Pollutant Discharge Elimination System
TRWD	Tarrant Regional Water District
TSSWCB	Texas State Soil and Water Conservation Board
TSWQS	Texas Surface Water Quality Standards
TWQI	Texas Water Quality Inventory
TWRI	Texas Water Resources Institute
TWS	Texas Watershed Stewards Program
UCRA	Upper Colorado River Authority
UGRA	Upper Guadalupe River Authority
WASP	Water Quality Analysis Simulation Program
WPP	Watershed Protection Plan
WQIP	Water Quality Improvement Project
WQMP	Water Quality Management Plan

Rio Grande (photo courtesy of TCEQ)

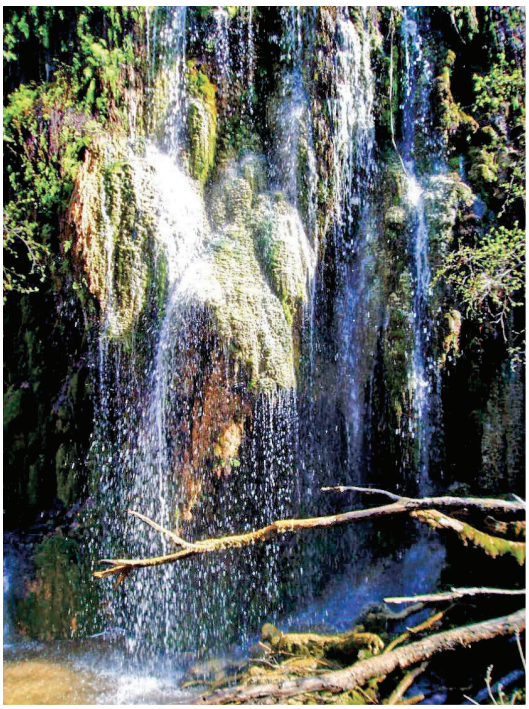


Gorman Creek at Colorado Bend State Park (photo by Matt Berg of Texas AgriLife Extension Service)

Bill Harris collecting a benthic sample (photo by Christine Kolbe of TCEQ)

Electrofishing (photo courtesy of TCEQ)

Hunter Park in Lake Granbury (photo courtesy of TCEQ)



Gorman Falls at Colorado Bend State Park (photo by Matt Berg of Texas AgriLife Extension Service)

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