Surface Water Quality Monitoring Program

TCEQ Region 5 Personnel Collecting Fish by Seine

Surface Water Quality Monitoring Program

Program Mission and Emphasis

The TCEQ Surface Water Quality Monitoring (SWQM) program provides for an integrated evaluation of physical, chemical, and biological characteristics of aquatic systems in relation to human health concerns, ecological condition, and designated uses. SWQM data provide a basis for the establishment of effective TCEQ management policies that promote the protection, restoration, and wise use of Texas surface water resources.

The TCEQ SWQM program, which was initiated in 1967, includes the monitoring of streams, reservoirs, estuaries, and the Gulf of Mexico. The SWQM program encompasses the full range of activities required to obtain, manage, store, assess, share, and report water quality information to other TCEQ teams, agency management, other agencies and institutions, local governments, and the public. Primary statutory authority for the SWQM program is provided under Section 26.127 of the Texas Water Code, which states, “The executive director has the responsibility for establishing a water quality sampling and monitoring program for the state. All other state agencies engaged in water quality or water pollution control activities shall coordinate those activities with the Commission.” The SWQM program is strongly influenced by Sections 104(b), 106, 205(j), 303(d), 305(b), 314, 319, and 604(b) of the CWA of 1987. The TCEQ SWQM program is partially funded through the CWA Section 106 Water Quality Management portion of the Performance Partnership Grant (PPG) from EPA Region 6.

The mission of the SWQM program is to characterize the water quality of the ambient surface waters of the state. Basic components of the program include a fixed station monitoring network, intensive surveys, special studies, aquatic life assessments (ALAs), receiving water assessments (RWAs), and use attainability analyses (UAAs). Water quality data obtained through these components are stored in the SWQM Database. The monitoring results obtained through the SWQM program may be used by the TCEQ to:

- characterize existing conditions,
- evaluate spatial and temporal trends,
- determine water quality standards compliance,
- identify emerging problems, and
- evaluate the effectiveness of water quality control programs.

The TCEQ's SWQM program is coordinated by the SWQM Team within the Monitoring Operations Division and by the Water Program within the Field Operations Division. Fixed station monitoring is conducted by SWQM program personnel in the TCEQ's 16 regional offices, CRP contractors, and the USGS. The cities in which TCEQ regional offices are located and the areas monitored by each region are shown in Figure 4-1.

TCEQ's CRP contributes significantly to the SWQM program (see Clean Rivers Program Section on page 4-60 for program highlights). The CRP is coordinated by the Watershed Management Team in the Technical Analysis Division. Fixed station and special study monitoring are important facets of the CRP and are conducted by contractors (primarily river authorities) in each of the 23 major river and coastal basins. The CRP coordinates with the TCEQ's SWQM Team to ensure consistency in water quality sampling, assessment, and data reporting protocols. The CRP is designed to provide a holistic watershed assessment. The term "watershed" in this context is broadly defined as the geographic delineation of an entire river or coastal basin and the surrounding land that drains to it.

The USGS also conducts a large amount of monitoring statewide and reports most of the data to the TCEQ. The USGS surface water collection network in Texas is primarily established to monitor stream flow continuously at many permanent sites. Field measurements, routine water chemistry, and metals in water are also collected at many of the fixed sites. Sites are chosen to represent a mix of major natural and human factors that influence water quality. Chemical variables are then related by the USGS to hydrological conditions to interpret water-resource conditions and meet water quality management needs. Estimation of point and nonpoint source loadings, stormwater management, and chemical-contaminant controls are some of these needs. Samples are collected using standard USGS methods, which are similar to those used by the TCEQ and CRP.

TMDL contractors are emerging as important sources of SWQM data. Much of their work consists of special studies to evaluate the cause(s) and source(s) contributing to impairments of designated uses in water bodies.

Coordinated Statewide Monitoring Meetings

The implementation of coordinated statewide monitoring is a priority of the TCEQ and CRP to ensure reduced duplication of effort, improve spatial coverage of monitoring sites, and improve consistency of parametric coverages. An annual meeting is held in each major river basin, hosted by the CRP Planning agency, during the spring of each year. The purpose of the meeting is to develop a coordinated basin-wide monitoring schedule (plan). All water quality monitoring groups that collect SWQM data and commit to comply with TCEQ requirements for collecting quality-

Region 1 - Amarillo
806/353-9251

Armstrong, Briscoe, Carson, Castro, Childress, Collingsworth, Dallam, Deaf Smith, Donley, Gray, Hall, Hansford, Hartley, Hemphill, Hutchinson, Lipscomb, Moore, Ochiltree, Oldham, Parmer, Potter, Randall, Roberts, Sherman, Swisher, Wheeler

Region 2 - Lubbock
806/796-7092

Bailey, Cochran, Crosby, Dickens, Floyd, Garza, Hale, Hockley, King, Lamb, Lubbock, Lynn, Motley, Terry, Yoakum

Region 3 - Abilene
915/698-9674

Archer, Baylor, Brown, Callahan, Clay, Coleman, Comanche, Cottle, Eastland, Fisher, Foard, Hardeman, Haskell, Jack, Jones, Kent, Knox, Mitchell, Montague, Nolan, Runnels, Scurry, Shackelford, Stephens, Stonewall, Taylor, Throckmorton, Wichita, Wilbarger, Young

Region 4 - Arlington
817/469-6750

Collin, Cooke, Dallas, Denton, Ellis, Erath, Fannin, Grayson, Hood, Hunt, Johnson, Kaufman, Navarro, Palo Pinto, Parker, Rockwall, Somervell, Tarrant, Wise

Region 5 - Tyler
903/535-5100

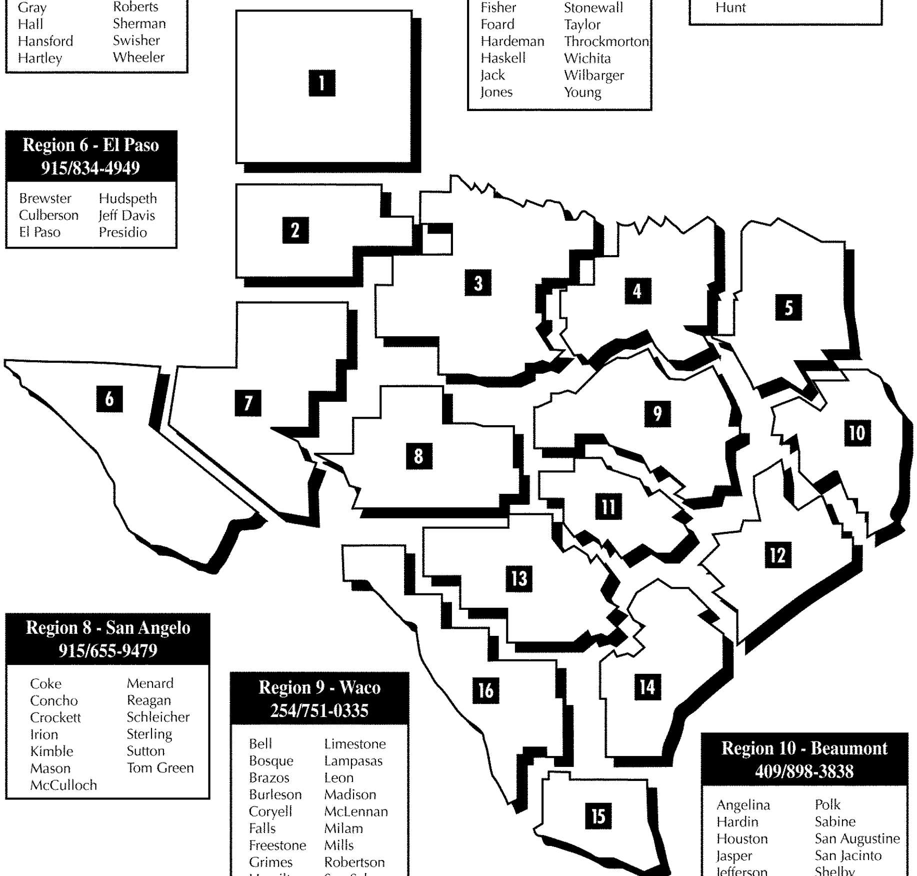
Anderson, Bowie, Camp, Cherokee, Cass, Delta, Franklin, Gregg, Harrison, Henderson, Hopkins, Lamar, Marion, Morris, Panola, Rains, Red River, Rusk, Smith, Titus, Upshur, Van Zandt, Wood

Region 6 - El Paso
915/834-4949

Brewster, Culberson, El Paso, Hudspeth, Jeff Davis, Presidio

Region 7 - Midland
915/570-1359

Andrews, Borden, Crane, Dawson, Ector, Gaines, Glasscock, Howard, Loving, Martin, Midland, Pecos, Reeves, Terrell, Upton, Ward, Winkler



Region 8 - San Angelo
915/655-9479

Coke, Concho, Crockett, Irion, Kimble, Mason, McCulloch, Menard, Reagan, Schleicher, Sterling, Sutton, Tom Green

Region 9 - Waco
254/751-0335

Bell, Bosque, Brazos, Burleson, Coryell, Falls, Freestone, Grimes, Hamilton, Hill, Limestone, Lampasas, Leon, Madison, McLennan, Milam, Mills, Robertson, San Saba, Washington

Region 10 - Beaumont
409/898-3838

Angelina, Hardin, Houston, Jasper, Jefferson, Nacogdoches, Newton, Orange, Polk, Sabine, San Augustine, San Jacinto, Shelby, Trinity, Tyler

Region 11 - Austin
512/339-2929

Bastrop, Blanco, Burnet, Caldwell, Fayette, Hays, Lee, Llano, Travis, Williamson

Region 12 - Houston
713/767-3500

Austin, Brazoria, Chambers, Colorado, Fort Bend, Galveston, Harris, Liberty, Matagorda, Montgomery, Walker, Waller, Wharton

Region 13 - San Antonio
210/490-3096

Atascosa, Bandera, Bexar, Comal, Edwards, Frio, Gillespie, Guadalupe, Karnes, Kendall, Kerr, Medina, Real, Uvalde, Wilson

Region 14 - Corpus Christi
361/825-3100

Aransas, Bee, Calhoun, De Witt, Goliad, Gonzales, Jackson, Jim Wells, Kleberg, Lavaca, Live Oak, Nueces, Refugio, San Patricio, Victoria

Region 15 - Harlingen
956/425-6010

Brooks, Cameron, Hidalgo, Jim Hogg, Kenedy, Starr, Willacy

Region 16 - Laredo
956/791-6611

Dimmit, Duval, Kinney, La Salle, Maverick, McMullen, Val Verde, Webb, Zapata, Zavala

Figure 4-1. Map of TCEQ Regional Office Boundaries
(including counties in each regions)

assured data are invited to participate in the meetings. At each of the meetings, a basin map showing all active monitoring sites is displayed. Monitoring station locations are discussed segment by segment and station by station by those in attendance. The merits of maintaining or relocating existing sites and changing parametric coverages are discussed in relation to historical baseline sampling, identification of use impairments and water quality concerns from the 305b assessment, local knowledge of water quality problems, permit activities, special studies, and TMDL monitoring projects. Special attention is focused on minimum sample numbers to ensure that sufficient data will be available to conduct full assessments of designated uses and identification of water quality concerns during the next 305b reporting cycle. Spatial gaps in station locations and gaps in different types of data are also discussed. New sites are added, existing sites may be relocated, and parametric coverages may be changed based on the discussions at the meetings.

Coordinated Statewide Monitoring Schedule

The preliminary basin-wide monitoring schedules developed at the coordinated monitoring meetings are reviewed by the CRP partners, their stakeholder groups, and TCEQ regional offices to ensure that proposed revisions to station locations and parametric coverages and workload measures are appropriate. The CRP partners that host the annual basin-wide meetings have responsibility for preparing the basin-wide monitoring schedule. Monitoring schedules from appropriate TCEQ regional offices and other monitoring groups within each basin are submitted to the host CRP partners. The finalized basin-wide schedules are then submitted to the CRP partners where they are aggregated to produce a coordinated statewide SWQM schedule. The statewide schedule are made available at the TCEQ Web site (http://www.TCEQ.state.tx.us/water/quality/data/wqm/). This link highlights the SWQM home page; the coordinated schedule is posted under the water data header.

Parametric coverages typically include field measurements, flow measurements, routine water chemistry, and fecal coliform analysis. Additional coverages may include toxic substances in water, sediment, or fish tissue, toxicity testing of water and sediment, and analysis of fish and/or macrobenthos community structure. The sampling methodologies employed by the TCEQ and CRP for the collection of each set of parameters are described in the *Surface Water Quality Monitoring Procedures Manual* (TNRCC, GI-252, 1999a). Additional information pertaining to the CRP is available in the *Clean Rivers Program Guidance and Reference Guide, FY 2000-2001* (CRP, 2002).

Table 4-1. Distribution of Statewide SWQM Fixed Network Sites by Water Body Type

Water Body Type	Number of Monitoring Sites
Classified Freshwater Streams and Rivers	544
Unclassified Freshwater Streams and Rivers	481
Classified Tidal Streams	96
Unclassified Tidal Streams	63
Classified Reservoirs and Lakes	339
Unclassified Reservoirs and Lakes	44
Classified Estuaries	148
Unclassified Estuaries	13
Gulf of Mexico	11
Grand Total	**1,739**

Fixed Station Monitoring Network

The TCEQ has subdivided river and coastal basins into segments for water quality management activities. Most of the major streams, reservoirs, and estuaries have been classified as segments by the TCEQ. In many cases, lengthy streams and rivers have been further subdivided into multiple segments. There are currently 225 stream segments, 100 reservoir segments, and 48 estuary segments (TCEQ, 2000). The Gulf of Mexico is treated as one segment. Minor streams, reservoirs, and estuaries are treated as unclassified waters by the TCEQ. One of the primary goals of the SWQM program has been to establish at least one fixed monitoring station within each of the 378 classified segments, while at the same time increasing monitoring on unclassified water bodies.

The number of fixed stations monitored each year, and the frequency at which they are sampled by the TCEQ, CRP, and USGS, varies from year to year depending on the amount of funding received and the manner in which the funds are allocated. During the current year (2003) 1,739 stations contribute to the assessment and are monitored statewide by the TCEQ (509 sites), the CRP (1,313 sites) and the USGS (29 sites) (Figure 8). More than one agency monitors water quality at 112 of the stations. In most cases, having more than one agency sampling a site results in increased cooperation rather than duplication of effort. For example, the TCEQ monitors a site on the Rio Grande near Fort Quitman quarterly. The International Boundary and Water Commission (IBWC) samples the same site, but coordinates its sampling with the TCEQ, so that sampling is done for the other eight months of the year.

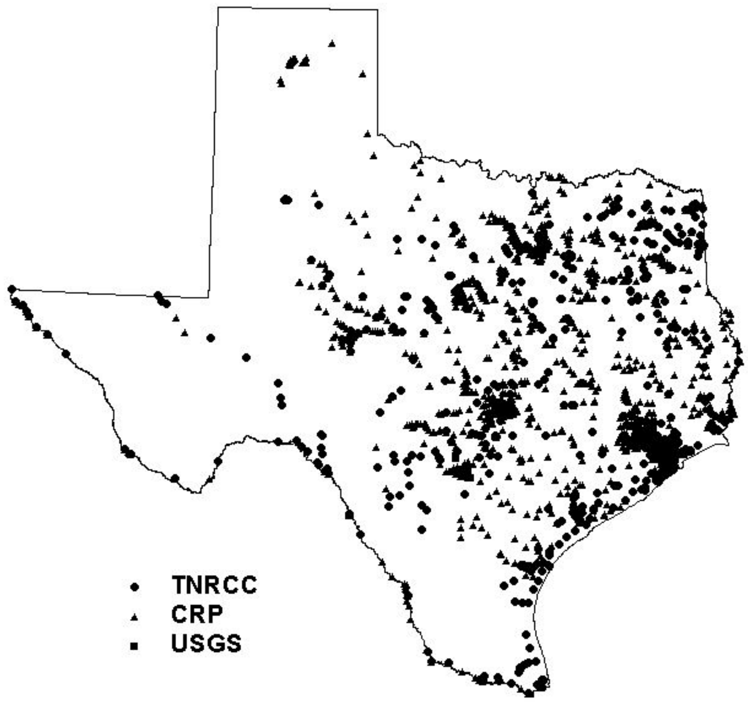


Figure 4-2.
Locations of TCEQ, CRP, and USGS Active Surface Water Quality Monitoring Sites for Fiscal Year 2003

The total number of sites monitored represents an increase of 1,293 sites over the number (446) that was monitored alone by the TCEQ in 1996, and demonstrates the power of coordinating statewide monitoring resources. Most of the current year fixed monitoring sites (1,138; 65%) are located within classified segments, but 601 (35%) are located on important unclassified water bodies (Table 4-1). The number of monitoring sites on unclassified water bodies has increased substantially from the 76 that were monitored in 1996, reflecting an increased emphasis on assessment of small headwater streams.

The fixed sites are monitored at varying frequencies, with 95 percent sampled quarterly or more frequently (Figure 4-3). Monitoring agencies have steadily increased monitoring frequency at many sites to improve confidence in water quality assessments. In 1996, no sites that contributed to the assessment were monitored more frequently than quarterly, while in

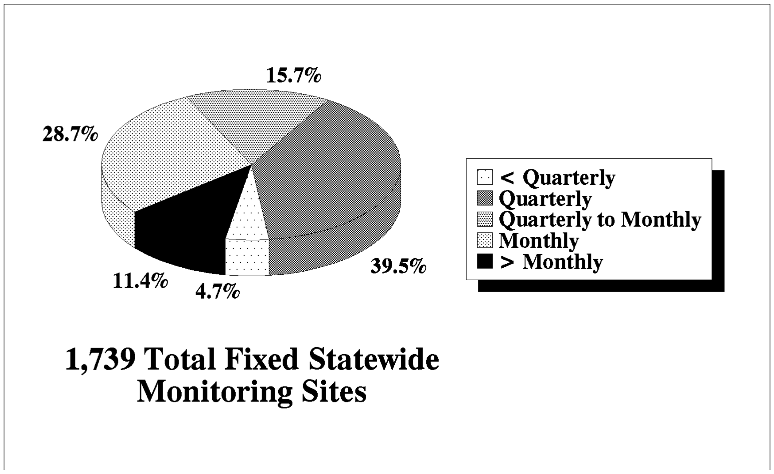


Figure 4-3. Sampling Frequencies at Fixed Sampling Sites in 2003

2003, 971 sites (55.8%) are monitored more frequently than four times per year, and about 40 percent are monitored at monthly or more frequent intervals..

Field Measurements, Routine Water Chemistry, and Bacteriological Analyses

Sampling that is common to most sites includes field measurements, routine water chemistry, and bacterial (fecal coliform, *E. coli*, or enterococci) densities (Table 4-3). Flow measurements are usually made at stream sites. The objectives of monitoring these parameters are to detect and describe spatial and temporal changes, determine impacts of point and nonpoint sources, and assess compliance with water quality standards.

Making a Flow Measurement with an Electronic Meter

Water samples are collected, preserved, and sent to the TCEQ, CRP, USGS, or a contract laboratory, where many routine water chemistry analyses are performed. The routine field and water chemistry parameters measured *in situ* or in the laboratory are listed in Table 4-2.

Dissolved oxygen, water temperature, and pH are field measurements for which water quality criteria are established for each classified water body. Analysis of chloride, sulfate, and TDS is included in routine water chemistry samples; criteria for these parameters are also established for most classified water bodies.

Dissolved oxygen is a basic requirement for a healthy aquatic ecosystem. Most fish and beneficial insects "breathe" oxygen dissolved in the water.

Table 4-2. Field Measurements and Routine Water Chemistry Analyses

Field Measurements	**Routine Water Chemistry***	
Water Temperature (EC)	Ammonia Nitrogen	Chloride
pH (standard units)	Chlorophyll a (Fg/L)	Sulfate
Dissolved Oxygen (mg/L)	Pheophytin a (Fg/L)	Total Alkalinity
Specific Conductance (Fmhos/cm)	Kjeldahl Nitrogen	Total Dissolved Solids
Salinity (ppt)	Nitrate + Nitrite Nitrogen	Total Organic Carbon
Secchi Disk (m)	Orthophosphorus	Total Suspended Solids
Fecal Coliform (#/100 mL)	Total Phosphorus	Volatile Suspended Solids
Stream Flow (cfs)		
Flow Severity		
Days Since Last Significant Precipitation		

* All routine water chemistry parameters reported in mg/L except where noted

Some fish and aquatic organisms (such as gar and sludge worms) are adapted to low dissolved oxygen concentrations, but most desirable fish species (such as largemouth bass and darters) suffer if dissolved oxygen concentrations are depressed below 3 to 4 mg/L (3 to 4 milligrams of oxygen dissolved in 1 liter of water, or 3 to 4 parts of oxygen per million parts of water). Insect larvae and juvenile fish are more sensitive and require even higher concentrations of dissolved oxygen to function in a healthy way.

Many fish and other aquatic organisms can recover from short, episodic periods of low dissolved oxygen availability. However, prolonged exposure to oxygen concentrations of 2 mg/L or less can suffocate adult fish or reduce their reproductive survival by suffocating sensitive eggs and larvae. Depressed dissolved oxygen concentration is the leading cause of fish kills in the state over the past five years (see Public Health and Aquatic Life Concerns Section). Low dissolved oxygen concentrations also affect aquatic insect larvae and other prey on which fish depend for food. Low dissolved oxygen concentrations also favor anaerobic (without oxygen) bacterial activity that produces gases (methane and hydrogen sulfide) and foul odors often associated with polluted water.

Deploying Multiprobe for Unattended 24-hour Measurements

Oxygen concentrations in the water column fluctuate under natural conditions, but severe depletion may result from human and natural activities that introduce biodegradable organic materials into surface waters. Biodegradable organic materials, including lawn clippings, raw and treated sewage, manure, food processing wastes, rice field drainage, pulp paper wastes, leaf litter, recycled plants, and animals are some examples of oxygen-depleting organic materials that enter surface waters.

In both pristine and polluted waters, beneficial bacteria use oxygen to decay or break apart organic materials. Organic wastes originating from natural, point, and nonpoint sources provide a continuous source of food for the bacteria, which accelerates bacterial activity and growth. In polluted waters, bacterial consumption of oxygen can rapidly outpace replenishment from the atmosphere (introduced by reaeration) and daytime photosynthesis performed by algae. In streams, most of the algae (periphyton) is attached to the stream bottom or objects in the water. In slow moving streams and in reservoirs and estuaries, the algae (phytoplankton) are usually floating free in the water.

The result of overuse of oxygen by bacteria and algae is a net decline in oxygen concentrations in the water. Abundant algae can also consume large amounts of oxygen at night through respiration. Organic materials

Taking Field Measurements with a Multiprobe

that are decayed by bacterial action may settle to the bottom of water bodies where they exert an oxygen demand in sediment, further reducing oxygen concentrations in the overlying water column.

Toxic pollutants can indirectly lower dissolved oxygen concentrations by killing algae, aquatic weeds, or fish and other aquatic organisms, thereby producing an abundance of food for oxygen-consuming bacteria. Oxygen depletion can also result from chemical reactions of some pollutants that do not involve bacteria. These pollutants place a chemical oxygen demand, caused by chemical reactions, on receiving waters and reduce the ambient concentration of dissolved oxygen.

Low temperature shock also kills fish, sometimes in large numbers. The typical situation is when a long, hot, low-flow period is interrupted by a large thunderstorm or sudden passage of a cold front. Fish stressed by the high water temperature and low dissolved oxygen concentration are suddenly exposed to a slug of cold water that results from sudden passage of an extreme cold front, or falls during a thunderstorm and flashes downstream. The shock of the rapidly lowered temperature can kill stressed fish.

Other factors such as temperature and salinity also influence the amount of oxygen dissolved in the water. Prolonged hot weather will depress dissolved oxygen concentrations and may cause fish kills, even in clean waters, because warm water can not hold as much oxygen as cooler water. Extremes in water temperatures (both hot and cold) are the third leading cause of fish kills in the state over the past five years. In bays, prolonged hot weather may reduce freshwater inflow and accelerate evaporation, thus concentrating dissolved minerals and increasing salinity. Saline water can not hold as much dissolved oxygen as brackish or freshwater. Warm conditions further aggravate oxygen depletion impacts because they promote respiration (oxygen consumption) of bacterial, plant, and animal populations. Removal of streamside vegetation eliminates shade, thereby raising water temperatures, and accelerates runoff of organic debris. Under hot conditions, even minor additions of pollution-containing organic material from point and nonpoint sources can severely deplete oxygen.

Water temperature is also an important indicator of general water quality, since it directly affects the rates of most chemical and biological processes. Temperature affects the dissolved oxygen content of water and influences the rate of photosynthesis by aquatic plants, the metabolic rates of aquatic organisms, and the sensitivity of aquatic organisms to toxic substances, parasites, and many diseases.

Collecting a Routine Water Sample From a Small Stream by Immersing the Container

Acidity affects many chemical and biological processes in water. The acidity of water is measured by determining the pH level on a scale of 0.0 to 14.0 standard units. A pH measurement of 7.0 indicates neutral conditions; greater than 7.0 indicates alkaline conditions; and less than 7.0 indicates acidic conditions. Most aquatic organisms flourish in water with a pH range of 6.0 to 9.0. The pH of water strongly influences toxicity and the bioavailability of metals. At low pH, metals become more mobile and available for uptake by aquatic life. Metals available at low pH can be toxic to sensitive aquatic species. Photosynthesis by aquatic plants (primarily periphyton and phytoplankton) removes carbon dioxide from water, which often substantially increases pH during daylight hours. Nutrientenriched waters with active, excessive blooms of algae often exhibit maximum pH values greater than 8.5 standard units, and exhibit wide daily temporal variations in both pH and dissolved oxygen.

Conductivity is a measure of the ability of water to pass an electrical current. Conductivity in water is influenced by the presence of inorganic dissolved ions, such as chloride and sulfate which carry a negative charge, or calcium and magnesium ions which carry a positive charge. Conductivity is affected by water temperature; the warmer the water, the higher the conductivity. For this reason, specific conductance is reported as conductivity at 25 ºC. Specific conductance in streams, rivers, and reservoirs is primarily determined by the geology of the watersheds through which waters flow. Specific conductance and salinity are monitored to estimate the total concentration of dissolved solids, evaluate mixing of fresh and salt water in estuaries, determine density stratification, and document impact and dispersion of pollutants.

Transparency is a measure of water clarity, or the degree to which suspended matter in the water decreases the passage of light. All solar radiation not reflected from a water body is absorbed. The Secchi disk provides a convenient method for measuring light penetration, and thus transparency. Turbidity most importantly affects the depth to which light can penetrate, thus affecting the depth at which heating occurs. As turbidity increases (Secchi disk depth increases), heating becomes more concentrated in the surface layer. This phenomenon may have profound effects on the annual decay of stratification and depth of the thermocline. Increased temperatures, in turn, lower dissolved oxygen concentrations, because oxygen is less soluble in warm water. Turbidity may also result in a more direct decrease in dissolved oxygen by reducing the amount of available light necessary for photosynthetic activity (which produces dissolved oxygen). Under normal summer conditions of low inflow, much of the turbidity in Texas reservoirs and lakes is due to suspended algae (phyto-plankton) in the water.

Many chemical and biological processes in the aquatic environment can be monitored through field measurements of parameters discussed in the preceding paragraphs (temperature, dissolved oxygen, pH, specific conductance, and transparency. Field measurements also provide complementary information necessary in evaluating chemical and biological data. For instance, to relate chemical concentrations and flow, instantaneous flow measurements are made at about half the stream sites (627 of 1,025 in 2003) concurrently with the collection of water samples. In some cases, stream flow is obtained at the time of sampling from a USGS gage if one is located nearby.

Numeric water quality criteria for nutrients and chlorophyll *a* in water have not been developed by the TCEQ, but their involvement in aquatic plant growth and proliferation warrants their consideration when assessing water quality. Chlorophyll *a* is the primary photosynthetic pigment and is present in all algae. The chlorophyll *a* concentration is used as an estimate of algal biomass (amount of algae). Nutrients are essential building blocks for healthy aquatic communities, but excess nutrients (especially nitrogen and phosphorus compounds) may overstimulate the growth of aquatic weeds and algae. Excessive growth of these plants can clog waterways and interfere with swimming and boating, out-compete native submerged aquatic vegetation, and, with excessive decomposition, lead to oxygen depletion. Oxygen concentrations often fluctuate widely, increasing during the day as algae conduct photosynthesis (produces oxygen), and falling at night as algae continue to respire, which consumes oxygen. In addition, elevated ammonia concentrations are toxic to aquatic life, deplete dissolved oxygen resources through bacterial nitrification, and are frequently indicators of recent sewage pollution. Beneficial bacteria also consume oxygen as they decompose the abundant food source liberated from dying algae cells.

Fertilizers used on crops and lawns, detergents, organic materials in treated sewage, and manure in agricultural runoff are some sources of nutrients and are often responsible for water quality degradation. Rural areas are susceptible to groundwater contamination from nitrates found in fertilizer and manure. Nutrients are difficult to control because they typically recycle among the water column, algae, and bottom sediments. For example, algae may greatly reduce phosphorus from the water column temporarily, but the nutrient will return to the water column when the algae die and are decomposed by bacteria. Because of this assimilative process, nutrients that are gradually added to a water body tend to accumulate over time, rather than leaving the system.

Collecting a Bacteriological Sample in a Sterile Plastic Bag

Some waterborne bacteria, viruses, and protozoa cause human illnesses that range from typhoid and dysentery to minor respiratory and skin diseases. These organisms enter water bodies from many routes, including inadequately treated sewage, stormwater drains, septic systems, and runoff from livestock holding areas. Due to the difficulty in culturing specific pathogens, the TCEQ, CRP, and TDH monitor fecal coliform and *Escherichia coli* (*E. coli)* in freshwaters and fecal coliform and enterococci in tidally influenced water bodies as indicators of human pathogen densities in order to assess the recreational potential of water bodies and to evaluate compliance of the oyster waters use in estuarine segments. All the monitoring agencies are moving towards using *E. coli* and enterococci exclusively, since they have been shown to be better indicators fecal coliform. The TDH will continue to use fecal coliform in their monitoring program due to legislative mandates. The three bacterial indicators are found in great numbers in the stomachs and intestines of warm-blooded animals and humans. The presence of the indicator bacteria suggests that the water body may be contaminated with inadequately treated sewage or nonpoint source wastes and that other, more pathogenic, organisms may be present. Water samples for fecal coliform analysis may be filtered and incubated in the field with the aid of portable equipment, or returned to laboratories for setup.

Toxic Substances in Water, Sediment, and Fish Tissue

A large number of organic substances in water, sediment, and fish tissue are monitored at selected fixed stations. Included are 45 pesticides, and 32 volatile (water only) and 63 semivolatile organic substances (Tables 4-3 and 4-4). Also monitored at selected sites are 13 metals in water, 13 in sediment, and seven in fish tissue (Table 4-5). Additional conventional parameters are monitored in sediment each time a sample is collected to allow assessment of potential toxicity due to metals and organic substances concentrations (Table 4-5). The focus of toxic substances monitoring is on those sites likely to be contaminated. Sample stations are carefully selected based on criteria that include:

- sites near dischargers that have shown receiving water or effluent toxicity;
- sites that have shown recurrent ambient water and/or sediment toxicity;
- sites near large industrial or domestic discharges;
- areas that receive high nonpoint source loads;
- areas with exceptional recreational uses;
- sites near hazardous waste facilities;
- sites downstream of major metropolitan areas;
- areas adjacent to Superfund sites; and
- sites that exhibit biological impairment.

Toxic organic substances are synthetic compounds that contain carbon, such as polychlorinated byphenyls (PCBs), dioxins, and DDT. Pesticides are organic chemicals that are applied to control or eliminate insect, fungal, or other organisms that may seriously reduce the yields of crops or impact the health of livestock. Herbicides are organic chemicals that are applied to control unwanted weeds from crops and lawns or aquatic plants and algae in water bodies. Some synthesized compounds often persist and accumulate in the environment because they do not readily break down. When pesticides and herbicides run off the land and enter water bodies, they may become toxic to aquatic life, build up concentrations in sediments, or bioaccumulate in food chains. Some of these compounds may cause cancer and birth defects in people and other predators near the top of the food chain, such as birds and fish.

Collecting a Dissolved Metals Sample with a Cartridge Filter and Peristaltic Pump

Metals occur naturally in the environment, but human activities (such as industrial processes and mining) may cause them to enter water bodies through direct discharges, spills, or storm water runoff. Metals contamination is often detected in bottom sediment or in fish tissues, even when not detected in the water column. Metals are attracted to soil particles rather than to water, and they accumulate in greater concentrations in predators near the top of the food chain.

Table 4-3. Routine Pesticides and Semivolatile Organic Substances in Water, Sediment, and Tissue

Pesticides and Semivolatile Organic Substances in Water (Fg/L); Sediment (Fg/kg dry weight) and Tissue (mg/kg wet weight)

	Semivolatiles	
Phenol	Isophorone	Fluoranthene
2-Chlorophenol	Bis(2-chloroethoxy)methane	Pyrene
2-Nitrophenol	1,2,4-Trichorobenzene	Benzidine
2,4-Dichlorophenol	Naphthalene	Butyl benzyl phthalate
3-Methyl-4-chlorophenol	Hexachlorobutadiene	Chrysene
2,4,5-Trichlorophenol	Hexachlorocyclopentadiene	Benzo(a)anthracene
2,4,6-Trichlorophenol	2-Chloronaphthalene	3,3'-Dichlorobenzidine
2,4-Dimethylphenol	Acenaphthylene	Bis(2-ethylhexyl) phthalate
2,4-Dinitrophenol	Dimethyl phthalate	Di-n-octyl phthalate
4-Nitrophenol	2,6-Dinitrotoluene	Benzo(b)fluoranthene
4,6-Dinitro-o-cresol (DNOC)	Acenaphthene	Benzo(k)fluoranthene
Pentachlorophenol (PCP)	2,4-Dinitrotoluene	Benzo(a)pyrene
N-Nitrosodimethylamine	Fluorene	Indeno(1,2,3-cd)pyrene
Bis(2-chloroethyl) ether	4-Chlorophenyl phenyl ether	Dibenz(a,h)anthracene
1,3-Dichlorobenzene	Diethyl phthalate	Benzo(ghi)perylene
1,4-Dichlorobenzene	N-Nitrosodiphenylamine	Cresols, total
1,2-Dichlorobenzene	1,2-Diphenylhydrazine	Hexachlorophene
Bis(2-Chloroisopropyl) ether	4-Bromophenyl phenyl ether	N-nitrosodiethylamine
Hexachloroethane	Phenanthrene	N-nitrosodi-n-butylamine
N-Nitrosodi-n-propylamine	Anthracene	Pyridine
Nitrobenzene	Di-n-butyl phthalate	1,2,4,5-Tetrachlorobenzene
	Pesticides	
DDT, total	Atrazine	Chloropyrifos (dursban)
DDD, total	Cyanazine	Endosulfan I and II
DDE, total	Alpha BHC	Endosulfan sulfate
Aldrin	Beta BHC	Demeton
Dieldrin	Delta BHC	Guthion
Endrin	Dicofol (kelthane)	Carbaryl (sevin)
Chlordane, total	Mirex	% Lipids (tissue only)
Alachlor	Pentachlorobenzene	PCB-1242
Heptachlor	Malathion	PCB-1254
Heptachlor epoxide	Parathion	PCB-1221
Methoxychlor	Diazinon	PCB-1232
Metolachlor	2,4-D	PCB-1248
Lindane (gamma BHC)	2,4,5-T	PCB-1260
Toxaphene	2,4,5-TP (silvex)	PCB-1016
Hexachlorobenzene	Diuron (karmex)	PCBs, total
Simazine		

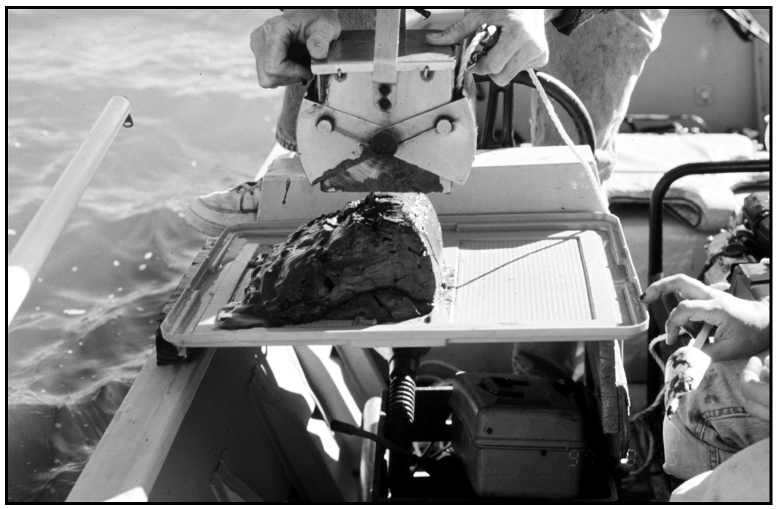
Table 4-4. Routine Volatile Organic Substances in Water

Volatile Organic Substances in Water (Fg/L)		
Volatile Organics		
Chloromethane	Carbon tetrachloride	Bromoform
Bromomethane	Bromodichloromethane	Toluene
Vinyl chloride	Benzene	Ethylbenzene
Chloroethane	Chlorodibromomethane	1,1,2,2-Tetrachloroethane
Acrylonitrile	1,1,1-Trichloroethane	Tetrachloroethylene
Chloroform	1,2-Dichloropropane	Chlorobenzene
Methylene chloride	trans-1,3-Dichloropropene	Total xylenes
1,1-Dichloroethylene	cis-1,3-Dichloropropene	Bis(chloromethyl) ether
1,1-Dichloroethane	1,1,2-Trichloroethane	1,2-Dibromoethane
1,2-trans-Dichloroethene	2-Chloroethyl vinyl Ether	Methyl tert-butyl ether (MTBE)

Table 4-5. Routine Metals in Water, Sediment, and Tissue

Water (Fg/L)	Sediment (mg/kg)	Tissue (mg/kg)
Aluminum	Aluminum	Arsenic
Arsenic	Arsenic	Cadmium
Cadmium	Barium	Chromium
Chromium	Cadmium	Copper
Copper	Chromium	Lead
Lead	Copper	Mercury
Mercury	Lead	Selenium
Mercury (total)	Manganese	
Nickel	Mercury	
Selenium	Nickel	
Selenium (total)	Selenium	
Silver	Silver	
Zinc	Zinc	
Additional Parameters Analyzed with Each Water, Sediment or Tissue Sample		
Hardness (mg/L) Total Suspended Solids (mg/L)	Oil and Grease or Total Petroleum Hydrocarbons Percent Solids (by weight) Total Organic Carbon Sediment Particle Size Clay < 0.0039 mm Silt 0.0039-0.0625 mm Sand > 0.0625-2mm Gravel > 2 mm	% Lipids

Bottom sediments consist of mineral particles, organic material, and water. Sediment deposits form primarily from the settling of material from the overlying water. Mineral particles include rock fragments and mineral grains that result from natural erosion of terrestrial materials. Mineral components in water body sediments are composed primarily of clay, silt, sand, and gravel. Organic matter from decaying or dead aquatic plants and animals usually comprises a small volume of the sediment. Sorption and bioavailability of many organic contaminants is largely controlled by the organic nature of the sediment. The spaces between sediment particles are occupied by interstitial water.



Collecting a Sediment Sample with an Ekman Dredge

Movement of materials into and out of sediments is controlled by physical, chemical, and biological processes. The porosity (volume of spaces between particles) and permeability (ability of water to move between, into, and out of spaces) of sediment are physical factors that largely control movement of materials. Gravels and sands are the most permeable; clays are the least permeable. The coarse fractions ($ sand) are generally noncohesive and not associated with metals or organic substances contamination. The fine fractions (silts and clays) are composed of particles with a relatively large surface-to-volume ratio and surface electric charges that cause them to be more chemically and biologically reactive than coarser materials. These physical properties increase the likelihood of sorption and desorption of contaminants. Consequently, chemical accumulations are most often associated with fine sediment. In general, sediment-sorbed contaminants are more persistent, less mobile, and occur at higher concentrations than those in the overlying water.

Many chemicals of anthropogenic origin [pesticides, polycyclic aromatic hydrocarbons (PAHs), PCBs and other chlorinated hydrocarbons] tend to sorb to sediments and organic materials. The result is that these chemicals concentrate in the sediment which serves as "sink" or reservoir. Many times concentrations in sediment may be several orders of magnitude higher than the overlying water, but bulk sediment concentrations have not been strongly correlated to bioavailability (Burton, 1991). However, fish have been shown to become highly contaminated from consuming bottom-feeding fish and benthic macroinvertebrates that are laden with organic substances. Texas has several fish consumption advisories and aquatic life closures in place due to mercury, PCBs, chlordane, dioxin, and other chlorinated hydrocarbons which are commonly found in sediments.

Toxic substances in water, sediment, and fish tissue are monitored to determine their prevalence and magnitude, to detect and describe spatial and temporal changes, and to evaluate compliance with applicable water quality standards. Water quality criteria to protect aquatic life and human health have been established by the TCEQ for some metals and organic substances. During 2003, fixed station monitoring is conducted at 454 stations for metals in water and at 123 stations for organic substances in water (Figure 4-4).

Although sediment criteria do not presently exist, sediments accumulate many toxic chemicals. The results of monitoring sediment chemistry may be used to evaluate the condition of the benthic habitat, determine point and nonpoint source contaminants, and to monitor rates of recovery following establishment of pollution controls or improved wastewater treatment. Conventional parameters in sediment are also measured: percent solids, for determination of water content; oil and grease or total petroleum hydrocarbons, for petrochemical influences; sediment grain size, for availability of contaminants; and total organic carbon, for bioavailability of contaminants that adsorb to organic particulates. During 2003, metals in sediment and organic substances in sediment were monitored at 185 and 46 SWQM program fixed stations, respectively (Figure 4-4).

Ambient Toxicity Monitoring

The ambient water and sediment toxicity testing program (TOXNET) was established in 1990 by EPA Region 6 in cooperation with the TCEQ. The TOXNET program encourages the use of ambient toxicity testing for water quality assessment, to assess potential toxicity in water bodies, and to evaluate the effectiveness of implemented toxicity control measures.

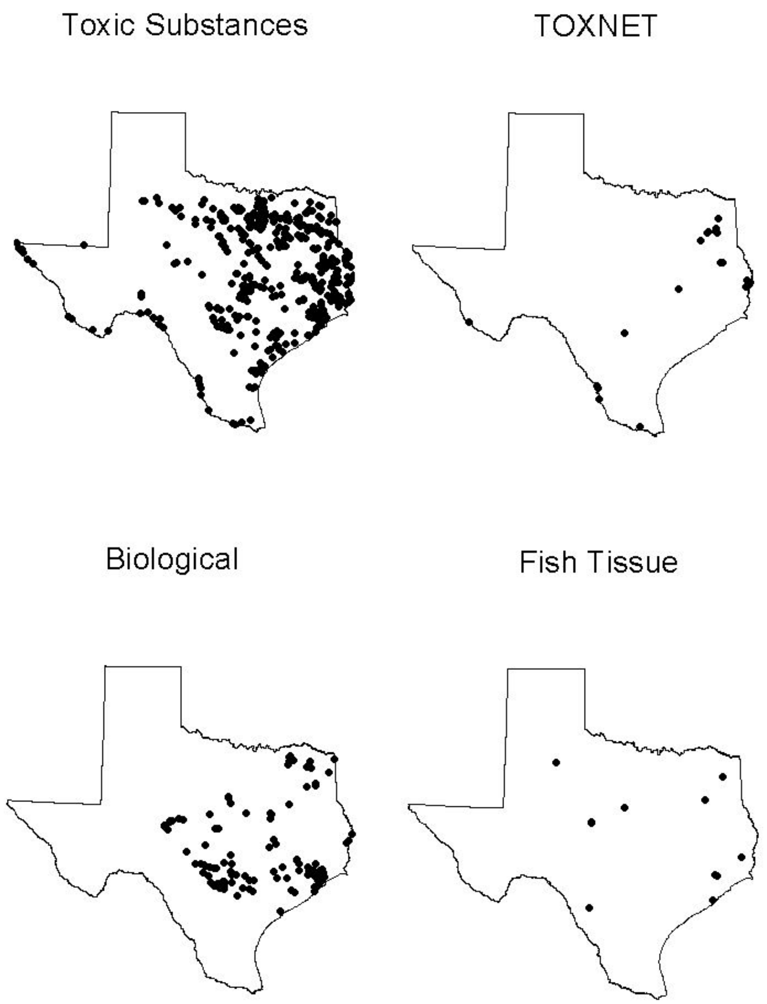


Figure 4-4. Locations of Different Kinds of Monitoring Sites

Water bodies that have shown recurrent toxicity are candidates for more intensive special study assessments to confirm the occurrence of toxic conditions or aquatic life use impairment, and determine causes and sources of the toxicity.

During the current year (2003), 25 sites are being monitored for water and/or sediment toxicity (Figure 4-4). Ambient water and sediment samples are collected by TCEQ Regional Office SWQM program personnel and are shipped to the EPA Region 6 Laboratory in Houston. Analyses of the samples include routine water quality parameters and standardized, short-term chronic bioassays. Sediment toxicity tests are performed on elutriates. Organisms used in the tests include *Ceriodaphnia dubia* (water flea) and *Pimephales promelas* (fathead minnow) in freshwater and *Cyprinodon variegatus* (sheepshead minnow) in estuarine or saline waters. Results of the water and sediment toxicity tests are sent to TCEQ's SWQM Team, the appropriate TCEQ regional offices, and EPA Region 6. The ambient water and sediment toxicity test results are currently stored on a database maintained by EPA Region 6. The data are available through the Internet (http://www.epa.gov/earth1r6/6wq/ecopro/watershd/monitrng/toxnet/index.htm).

Biological Monitoring

The SWQM program uses aquatic life monitoring (ALM) to provide baseline data on environmental conditions and determine if aquatic life uses and dissolved oxygen criteria are being attained. Fish and benthic macroinvertebrate and habitat assessments, flow measurements, and routine field measurements are common to ALMs. Biological communities are useful in assessing water quality for a variety of reasons, including their sensitivities to low-level disturbances and their function as continuous monitors. Monitoring of resident biota increases the possibility of detecting episodic spills and dumping of pollutants, wastewater treatment plant malfunctions, toxic nonpoint source pollution, or other impacts that periodic chemical sampling is unlikely to detect. Perturbations of the physical habitat, such as sedimentation from stormwater runoff, dredging, channelization, and erosion, may be detected through biological monitoring.

The objectives of monitoring fish and macrobenthic communities and habitat evaluations are to detect and describe spatial and temporal changes in their structure and function. These results can be used to assess impacts of point and nonpoint sources, assess community condition or "health," determine appropriate aquatic life uses, monitor rates of recovery following implementation of improved wastewater treatment, and provide early warning of potential impacts. Detailed procedures followed by the TCEQ and CRP for biological sampling and habitat evaluations are described in *Receiving Water Assessment Procedures Manual* (TCEQ, 1999b).

Macroinvertebrate communities are particularly good indicators of water quality impacts or physical habitat alterations because they are relatively sedentary, which enables the detection of localized disturbances. Their relatively long life histories and their continuous recruitment allow for integration of pollution effects.

Collecting Benthic Macroinvertebrates with a Surber Sampler (left) and a Kick Net (right)

The SWQM program uses standard procedures modeled after the rapid bioassessment (RBA) protocols developed by EPA for freshwater macroinvertebrate monitoring. Most samples are collected from riffle and other available habitats with a standard kick-net procedure. A subsample is obtained during field sorting of the samples. Organisms are typically identified to the family level in the field. Samples may be preserved and returned to the laboratory for more intensive enumeration and identification. In some cases, a quantitative technique employing a Surber net is used. In this case, several samples from a riffle area are composited and the entire sample is preserved and returned to the laboratory for identification and enumeration. At deep freshwater and estuarine sites, quantitative samples are collected with dredges. The integrity of macrobenthic communities is evaluated using metrics developed for either qualitative (5-minute kicknet and RBA snags) and quantitative (Surber and quantitative snags) sampling. During the current year (2003), macrobenthic community monitoring is conducted at 137 SWQM program fixed stations (Figure 4-4).

Fish communities are also useful as water quality indicators because many are high on the food chain and therefore reflect the responses of the entire trophic structure to environmental stress. Because fish are mobile, they have the potential to integrate impacts from a variety of habitats. Due to their longevity, fish also add a temporal perspective to monitoring.

Fish are typically collected by the SWQM program using a combination of seines and electrofishers (backpack or boat-mounted). In areas where electrofishing is not practical due to site constraints, elevated specific conductance, or equipment availability, gill nets and trawls may be used in combination with seines. Collections are made over a set time period, and the catch is typically identified and enumerated in the field. A portion of the catch is examined for abnormalities. These data are used to evaluate the integrity of the fish community based on the Index of Biotic Integrity (IBI). During the current year (2003), fish community monitoring is included at 95 SWQM program fixed stations (Figure 4-4).

Collecting Fish with a Backpack Electrofisher

Habitat includes all factors that define the stream environment and its relation to aquatic organisms. Evaluations are made to assess the condition of habitat where biological samples are collected. Changes in habitat complexity affect the structure and function of the communities. Habitat evaluations are also used to make accurate comparisons between ambient and reference conditions and to determine whether habitat might be a cause of impaired biological communities. An evaluation of habitat quality is critical to any assessment of ecological integrity. During the current year (2003) habitat assessments are included at 132 sites.

Physical habitat (for example, instream cover, depth, width, pool depth) is characterized to describe environmental settings at sites selected for biological sampling. Physical characterization parameters include estimates of general land use and physical stream and bank characteristics. The evaluation typically begins in the stream channel and proceeds to evaluation of the stream banks, and finally the riparian zone. The habitat

Measuring a Bank Angle with a Clinometer and Range Pole

parameters are evaluated at transects along the stream. The transect scores are summarized and evaluated through use of a habitat quality index. The total habitat score is then used to project an evaluation of aquatic life use based on habitat alone.

Fish Tissue Monitoring

Toxic chemical contaminants may be assimilated through aquatic food chains and subsequently bioaccumulated in fish tissues. The SWQM program uses fish tissue monitoring to provide indications of areas experiencing water quality and sediment contamination, and to detect and evaluate levels of contaminants in fish that may be harmful to humans. Information concerning elevated toxic chemical contaminants in fish tissue is communicated by the TCEQ to the TDH. If the TDH concludes, based on additional sampling of edible tissues, that consumption of chemically-contaminated fish poses an unacceptable human health risk, they may issue fish consumption advisories or aquatic life closures for specific water bodies. The advisories may apply to the general population and/or a subpopulation that could be at potentially greater risk pregnant women or children, for example). Aquatic life closures apply to everyone. They may prohibit the taking of all species of aquatic life, or may specify certain species.

Fish are collected using the gear described in the biological monitoring section, above. Whole fish are typically submitted for tissue analysis. Three to five fish of the same approximate size from a target freshwater or estuarine species are collected at each site and composited to constitute a sample. In special cases where human health is an important factor, fillets from individual targeted fish species or composited fillets may be submitted for laboratory analysis of contaminants. During the current year (2003), fish tissue monitoring is being conducted at 13 SWQM program fixed stations (Figure 4-4).

Electrofishing in the Rio Grande

Real Time Monitoring

A pilot study conducted by the TCEQ established two real time water quality monitoring stations in the North Bosque River watershed, and two stations in the Leon River watershed. A Monitoring Operations team comprised of technical staff from the air and water programs adapted existing continuous air monitoring technology and water quality field instruments to monitor conventional water quality parameters and nutrients in the North Bosque and Leon River Watersheds. This study is being conducted at the request of the Texas State Legislature and Executive Director of the TCEQ.

Stations consist of: a multiprobe outfitted with pH, DO, temperature, conductivity, chlorophyll a, and turbidity sensors; and communications equipment which relay instantaneous measurements to a data server at TCEQ headquarters. The first station was deployed on June 13, 2000. The remainder of the sites were deployed by August 1, 2002. All data collected at the sites are available for viewing on the internal TCEQ website. A continuous data record has been available since September 15, 2001. Data which meet quality assurance standards will continue to be posted for public viewing outside of the TCEQ firewall.

A test station has been deployed on a tributary of Walnut Creek, that crosses the TCEQ campus in Austin, to evaluate analytical and communications equipment before they are committed to field deployment. Currently an ion selective electrode autoanalyzer adapted to measure nitrate and ammonium in surface water; and a colorimetric autoanalyzer measuring reactive phosphate are being evaluated.

Realtime Monitoring Site Equipment on the Bosque River

National Fish Tissue Study

The TCEQ SWQMT is participating in the EPA National Study of Chemical Residues in Lake Fish Tissue study. This four-year study was designed to expand the scope of a 1987 screening-level investigation of bioaccumulative pollutants in fish tissue. The specific objective is to estimate the national distribution of 274 persistent, bioaccumulative, and toxic (PBT) chemical residues (including breakdown products) in game fish and bottom-dwelling fish in lakes and reservoirs across the country. The lakes and reservoirs, which range from small privately-owned ponds to large publicly managed reservoirs, were selected through use of a probability design. SWQMT personnel collect the fish using a boat-mounted electrofisher. The fish are sent whole, preserved on dry ice, to an EPA contract in Sidney, British Columbia.

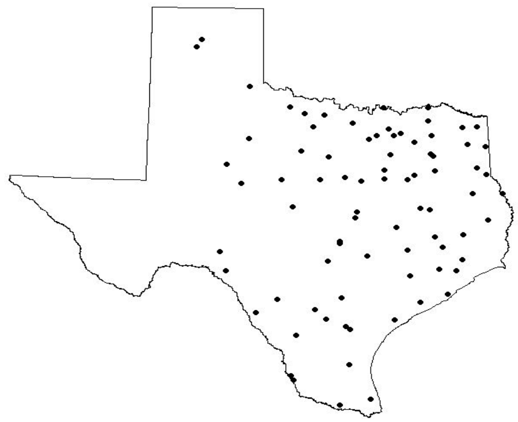


Figure 4-5. Distribution of National Fish Tissue Study Sites in Texas

The study results will be used by EPA to describe the extent to which fish are contaminated on a national scale. The results are not intended to provide a basis for setting fish consumption advisories. Results are currently available for only the first year of sampling. In Texas, samples of bottom-dwelling common carp, from Lake Palestine, contained the highest national concentration of arsenic. Bottom-dwelling blue catfish from B.A. Steinhagen Lake had the highest national concentrations of dioxin/furans plus PCBs and dioxin/furan only. Predator fish sampled in Texas included largemouth bass, white bass, striped bass, and white crappie. Bottom-dwelling species included smallmouth buffalo, common carp, freshwater drum, and channel and blue catfish.

Special Studies

Special studies provide the SWQM program with an opportunity to evaluate sources, distribution, and fate of particular constituents in selected water bodies. In some instances, special studies are conducted over the entire length of one or more segments. Special studies are conducted by the TCEQ's SWQM Team in the central office, by SWQM program personnel in the 16 regional offices, and by CRP contractors. Special studies are flexible, and use combinations of water, sediment, tissue, and biological data to assess water bodies with known or suspected problems. The TCEQ uses special study monitoring for a variety of purposes to:

- assess ambient water and sediment toxicity;
- evaluate dissolved concentrations over 24-hour or longer periods;

- assess impacts of point and nonpoint source discharges;
- develop water quality controls and water quality criteria;
- assess improvement in water quality after enforcement action or implementation of water quality controls, including best management practices (BMPs);
- develop new, or revise existing, sampling and assessment procedures;
- describe impacts of habitat modifications on water quality;
- describe water quality in intermittent streams, in isolated pools of intermittent streams, and in unclassified, effluent-dominated streams;
- augment significant complaint or fish kill investigations and enforcement cases;
- define water quality and biological characteristics of streams, reservoirs, estuaries and bays, and wetlands; and
- evaluate areas identified as "hot spots" by historical SWQM data.

Special study monitoring changes substantially from year to year. During the last five years, much of the emphasis of the special studies program has been placed on biological, toxic substances, and point and nonpoint source assessments. SWQM program personnel in the TCEQ regional offices and CRP contractors select the special study monitoring projects they will conduct. All water quality data collected during special studies are stored in the SWQM Database. Sixty-nine special studies have been conducted in the last five years (Table 4-6). Many of the special studies are published by the TCEQ or CRP.

Intensive Surveys

Intensive surveys are synoptic studies where specific hydraulic and water quality measurements (primarily dissolved oxygen) are made under low-flow conditions over several days. Intensive surveys are used by the SWQM program to evaluate wasteloads, verify stream standards, address existing or potential special water quality problems, and document water quality after controls are implemented. They are usually conducted over several days' duration on a stream, reservoir, or estuary segment.

Intensive surveys are generally conducted during steady state, low-flow conditions when the influence of point source discharges on water quality are most apparent. Segments that are selected for intensive survey monitoring generally include those with recurrent water quality standards violations, those:

- where new or amended major wastewater permits are scheduled, where substantial improvements in wastewater treatment have been implemented,
- that are affected by toxic substances,

Table 4-6. Special Studies Conducted by TCEQ and CRP during Fiscal Years 1998-2002

Fiscal Year	Segment Number	TCEQ Region/CRP Contractor	Study Description
1998	0200	CRP	Chloride Monitoring of the Wichita River Basin
	0402	5	Black Cypress Creek Biological, Physical, and Chemical Study
	0404	SWQMT	Cypress Creek Basin Poultry Study
	0409	CRP	Poultry Operations Impact Study
	0600	CRP	Poultry Operations Impact Study
	0803	CRP	Lake Livingston Water Quality Assessment
	1000	CRP	Biological and Habitat Study in Above Tidal Streams in the HGAC Service Area
	1005-07	CRP	Houston Ship Channel Copper Water Effects Ratio and Trace Metals Study
	1103/04	CRP	Nutrient Loading and Selected Water Quality and Biological Characteristics of Dickinson Bayou
	1414	SWQMT	Pedernales River Dissolved Oxygen Study
	1423	CRP	Dirunal Water Quality Fluctuations in Salado Creek
	1804	CRP	Analysis of Aquatic Plant and Nutrient Conditions in Lake Dunlap
	1803	CRP	Guadalupe River Basin Poultry Operations Study
	2435	CRP	Christmas Bay Hydrologic, Water Quality, and Sediment Study
1999	Statewide	SWQMT	Statewide Metals in Water Study
	0400/1800	CRP	Poultry Operations Water Quality Impact Study
	0401	CRP	Caddo Lake Contaminants Study Associated with Longhorn Army Ammunition Plant
	0507	CRP	Cowleech Fork of the Sabine River Special Study
	0508	CRP	Adams Bayou Special Study
	0511	CRP	Cow Bayou Special Study
	0823	CRP	Pecan Creek Water Quality Study
	0826	CRP	Lake Grapevine Nutrient Study
	1002/10	SWQMT	Metals in Water Study of Lakes Conroe and Houston
	1501/02	CRP-LCRA	Tres Palacios Bacteria Study
	1006	12	Effects of a High Conductivity Discharge on Water Quality of Sims Bayou
1999 Cont	1008	CRP	Characterization of Water Quality and Aquatic-Biological Conditions in the Panther Branch Watershed

Table 4-6. Special Studies Conducted by TCEQ and CRP (continued)

Fiscal Year	Segment Number	TCEQ Region/CRP Contractor	Study Description
	1400	CRP	Aquatic Resources Characterization Study, Austin to Columbus Subwatershed
	1400	CRP	Aquatic Resources Characterization Study, Columbus to Matagorda Bay Subwatershed
.	1400	CRP	Aquatic Resources Characterization Study, Lake Travis to Marble Falls Subwatershed
	1421	CRP	Concho River Nitrate Study
	1501/02	CRP	Bacteria Study of Tres Palacios River
	1800	CRP	Water Quality Effects of Urban Runoff in Kerr County
	2300	CRP	A Study of Chemical and Microbial Contamination in the Upper Rio Grande Basin
	2302-14	SWQMT	Rio Grande Toxic Substances Study
	2400	12	Characterization of Water Quality, Macrobenthos, and Nekton at Gulf of Mexico Beaches
2000	0403	CRP	Lake O the Pines Nutrient Study
	0800	CRP	Upper Trinity Bacteriological Regrowth Study
	1017	CRP	White Oak Bayou Bacteria Source Identification Study
	1005-07	CRP	Copper Water Effects Ratio and Trace Metals Study for the Houston Ship Channel
	1800	CRP	Guadalupe River Basin Urbanization Study
	2485	CRP	Bacteriological Indicator Study of Oso Bay
2001	Statewide	SWQMT	MTBE Monitoring Study
	0302	CRP	Lake Wright Patman Special Study
	0303	5	White Oak Creek Dissolved Oxygen and Biological Study
	0501	CRP	Little Cypress Bayou Special Study
	0600	SWQMT	TCEQ Color Initiative
	0803	CRP	Lower Trinity River Bacteriological and Lake Livingston Recreation Study
	0800	CRP	Algal Growth Study of Metroplex area Reservoirs
	0821	CRP	Atrazine Monitoring and Modeling in the Lake Lavon Watershed
	0823	CRP	Atrazine Monitoring and Modeling in the Lake Lewisville Watershed

Fiscal Year	Segment Number	TCEQ Region/CRP Contractor	Study Description
	0823	CRP	Water Quality Modeling and Characterization Study of Pecan Spring
	1005-07	12	An Evaluation of Nekton at Two Cooling Water Intake Structures in the Houston Ship Channel from 1972-2001
	1244	CRP	Brushy Creek TDS Study
	1800	CRP	Dissolved Oxygen and Bacteria Alternative Criteria Study
	1804	CRP	Effect of Sediments on Aquatic Plant Growth
	2311	CRP	Pecos River Aquatic Life Use Special Study
	2427	CRP	Texas City Ship Channel Dissolved Oxygen Study
2002	0302	CRP	Wright Patman Lake Special Study
	0404, 07, 09	CRP	Cypress Creek Basin Poultry Study
.	0505	CRP	Grace Creek Special Study
	1000	12	A Comparison Between Fecal Coliform, *E. coli*, and Enterococci as Bacterial Indicators in Recreational Surface Waters in Southeast Texas
	1008	CRP	Spring Creek Biological Study
	1013, 14, 17	CRP	Urban Bacteria Source Identification Study
	1113	CRP	Armand Bayou Special Study
	1006	12	Water Quality Evaluation of Simms Bayou
	1302	CRP	Water Quality and Biological Study of the San Bernard River
	1800	CRP	Guadalupe River Basin Nutrient Study
	2300	CRP	Salinity Study of the Upper Rio Grande
	2400	CRP	Dioxin Sediment and Tissue Study in the Houston Ship Channel and Upper Galveston Bay

SWQMT - SWQM Team; CRP - Clean Rivers Program Partner

- that are affected by nonpoint sources, and
- where a waste load evaluation or a total maximum daily load has not been developed or an existing one needs revision.

Field physicochemical, water chemistry, hydraulic, toxic substances, and biological data may be collected, depending on the scope of the project. Field measurements are collected at selected instream stations, on

Table 4-7. Intensive Surveys Conducted by the TCEQ and CRP during Fiscal Years 1998-2002

Fiscal Year	Segment Number	Agency	Water Body	Survey Date
1998	0303	TCEQ	Rock Creek	October 1998
	1016	CRP	Greens Bayou	January 1998
1999			No Intensive Surveys Conducted	
2000	1005-07	TCEQ	Houston Ship Channel	July 2000
	1110	TCEQ	Oyster Creek	August 2000
2001	1005-07	TCEQ	Houston Ship Channel	July 2001
2002	1005-07	TCEA	Houston Ship Channel	August 2002

significant tributaries, and at major wastewater treatment plants over one 24-hour period to measure temporal fluctuations in water quality. Water samples are collected, and typically composited, to characterize average water quality conditions. Hydraulic measurements are made to determine the amount of water flowing in the water body and the amounts contributed from tributaries and wastewater discharges. Stream velocity is determined by dye studies, and representative stream widths are measured and averaged. Biological data (benthic macroinvertebrates and/or fish) are occasionally collected to complement the physicochemical data and aid in determining water quality impacts on aquatic life in the water body. Although not done routinely, samples may also be collected for ambient water and sediment toxicity evaluations and toxic substances analyses in water, sediment, and fish tissue. Water quality data collected during most intensive surveys are stored in the SWQM database. Six intensive surveys have been conducted during the past five fiscal years (Table 4-7). The number of intensive surveys has declined in recent years because water quality problems related to point sources have diminished. Results of the surveys are published by the TCEQ in the Agency Study series.

SWQM Database

TCEQ SWQM data are stored in an Ingres database as one component of the agency's integrated database system (TRACS). The SWQM database contains SWQM data collected by the TCEQ, CRP, and other agencies such as the USGS, the IBWC, the TDH, Texas Watch, and city governments.

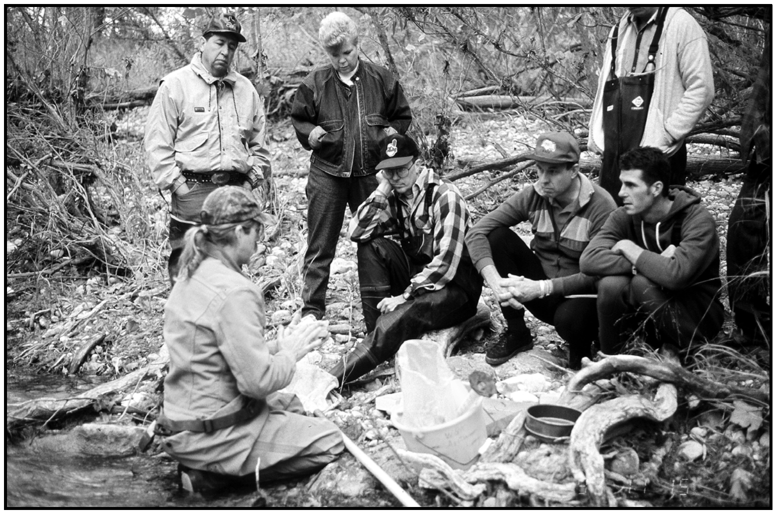
TCEQ regional office SWQM program personnel enter field data on an interactive screen that checks for errors and updates data into TRACS. TCEQ laboratory data and data from other agencies are screened by a program that flags records with invalid station numbers, dates, depths, and and warns of test results that are outside of ranges set by SWQM Team staff. The data are reported on preprinted forms or on computer diskettes that contain specially formatted ASCII files. Details of the SWQM program data management procedures are described in detail in the *SWQM Data Management Reference Guide* (TCEQ, 1999e) If questions arise, TCEQ staff contact the data collector or the laboratory to resolve them.

Data from CRP partner agencies are entered into TRACS in accordance with applicable sections of each partner's quality assurance project plan (QAPP). In general, the CRP partner agencies enter data into their own databases and conduct verification and validation routines prior to submittal to the TCEQ in electronic format. These steps are specified in a Data Review Checklist which must accompany each data submittal. Once received by the TCEQ, the data undergo additional screening by TCEQ CRP staff for proper formatting, invalid values, compliance with the QAPP, etc. Any problems with the data must be resolved by the CRP partner agencies. When the data are determined to be acceptable by CRP staff, they are uploaded to TRACS. Data from TMDL contractors is processed in a similar manner to that of CRP data.

As of September 2002, the SWQM portion of the TRACS database contained 5.7 million analytical and observational results for 570,000 samples collected between 1967 and 2002, representing 5,909 stations sampled by 32 entities. With the addition of CRP, USGS, and TMDL data, and TDH fecal coliform data, the database will continue robust growth in the future. The SWQM data are available on request to other agencies, institutions, consultants, local governments, and the public in paper report formats as well as ASCII files formatted for loading into spreadsheets or databases. SWQM data may be obtained by phoning the TCEQ's data line (512/239-DATA). A station inventory (describes all current and historical monitoring sites) and parameter code inventory (codes used to describe parameters entered into the database) are available at the TCEQ Web site (http://www.TCEQ.state.tx.us/water/quality/data/wqm). A project is underway by the TCEQ to make water quality data available at the same site in the near future.

SWQM Program Training

Each year, personnel from the TCEQ regional offices, CRP, and others that are involved in SWQM activities participate in a three-to-four day workshop to review administrative requirements and learn new procedures relevant to the monitoring program. Additional training workshops are conducted several times a year for TCEQ and CRP personnel to improve



Training Monitoring Staff on Macrobenthos Sampling Techniques

their skills in biological assessment and in data reporting and analysis. A SWQM program quality-assurance site visit is conducted each fiscal year in regional offices that have SWQM responsibilities. The purpose of the site visit is to ensure that TCEQ regional office SWQM program personnel are using acceptable procedures and that these are consistent with those used by other regions.

The quality-assurance site visits to TCEQ regional offices are conducted each year by personnel from the SWQM Team, and include any special training in field procedures and data management that the region personnel may need. Similar quality-assurance evaluations of CRP contractors are conducted by TCEQ quality assurance personnel within the Compliance Support Division. Records of site visits and memos describing performance by TCEQ region personnel and training activities are reported to TCEQ and EPA Region 6 management.

SWQM Water Quality Monitoring Procedures Manual

The *Water Quality Monitoring Procedures Manual* (TCEQ, GI-252, 1999) provides a single source of information describing procedures used by SWQM program personnel in the collection and reporting of surface water quality data. This manual has the purpose of promoting consistent methods statewide and is available to other government agencies, universities, and citizens engaged in water quality monitoring. Procedures include: instrument calibration and maintenance; in-situ field parameter and flow measurement; water, sediment, and fish tissue sample collection and preservation; bacteriological methods; biological sample collection; and data management. The manual also documents the quality assurance procedures used to demonstrate that surface water quality data collected by TCEQ personnel are of known and adequate quality. The manual is available on the Internet (http://www.TCEQ.state.tx.us/water/quality/wqm/).

Aquatic Life Use Assessments

An aquatic life use assessment (ULA) is a study conducted on unclassified streams, that are not included in Appendix D of the TSWQS, but have previously been assessed using presumptions for aquatic life use and dissolved oxygen criteria. ULAs are conducted on water bodies with some type of identified water quality impairment. The purposes of ULAs are to confirm indications of support or nonsupport, and identify appropriate aquatic life uses and dissolved oxygen criteria.

Two years of sampling during warm-weather index and critical periods are required for ULAs. Common parametric coverage includes routine field and water chemistry, 24-hour dissolved oxygen monitoring, flow measurements, and biological sampling (fish, benthic macroinvertebrate, and habitat analyses).

ULAs are conducted by the TECQ's SWQMT, field office SWQM personnel, CRP contractors, and TMDL contractors. ULAs that are currently

Table 4-8. Aquatic Life Use Assessments

Segment Number	Water Body Name	Type of Impairment	Performing Party
0101	Dixon Creek	Depressed Dissolved Oxygen	SWQMT/R1
0303	White Oak Creek	Depressed Dissolved Oxygen	R5
0506	Harris Creek	Depressed Dissolved Oxygen	R5
1217	Rocky Creek	Depressed Dissolved Oxygen	TMDL
1803	Elm Creek	Depressed Dissolved Oxygen	TMDL
1803	Sandies Creek	Depressed Dissolved Oxygen	TMDL
1806	Camp Meeting Creek	Depressed Dissolved Oxygen	TMDL

underway all involve impairment of dissolved oxygen criteria and are shown in Table 4-8. Results of ALAs can result in site specific criteria, assignment of different aquatic life uses, or requirements for TMDLs.

Receiving Water Assessments

A receiving water assessment (RWA) is a study conducted on a stream to assess its physical, chemical, and biological characteristics. The studies are done on unclassified streams, primarily to obtain data so that appropriate aquatic life uses can be assigned. When a new or an amended permit application is received, the WQS Team determines if an RWA is necessary before the application is declared administratively complete and before the technical review is done. The WQS Team reviews the quality and quantity of the discharge, information submitted with the application that characterizes the receiving stream, and available information on other dischargers and streams in the area. The WQS Team also consults with the regional staff about stream characteristics. If there are conflicts in this information or the area appears to have a use different from that presumed in the TSWQS, an RWA will be requested.

RWAs can also be requested by the WQS Team for renewal applications if subsequent information implies that the presumed and attainable uses of an unclassified stream are different. The request for a RWA is forwarded to the Field Operations Division, which sends the request to the appropriate TCEQ regional office. The regional staff visits the facility and characterizes the receiving stream upstream or downstream of existing or proposed outfalls. Figure 4-6 depicts the RWA sampling reach selection for a typical existing discharge where the immediate receiving stream is intermittent, but the potential impacts from the discharge may extend to the next downstream perennial stream. The length of the sampling reach is determined by the width of the stream. Figure 4-6 shows that the selected reach is upstream of the intermittent tributary which receives the discharge.

The regional staff verify stream data contained in the permit application or determine the physical characteristics of the stream. Data on stream physical characteristics include: (1) stream morphology, such as numbers of bends and substrate types; (2) information on the riparian zone, such as types of vegetation, bank slope, and percentage of erosion on banks; (3) flow characteristics, such as velocity and evidence of flow fluctuations; and (4) instream cover, such as logs and undercut banks. These physical characteristics are used to develop a habitat quality index for the stream. Habitat characteristics have been shown to be important factors affecting the structure and functionality of the aquatic communities.

Water quality parameters such as dissolved oxygen, pH, and temperature are measured in the field. A water sample may also be collected and sent to a laboratory to determine the concentrations of common constituents such as nutrients and dissolved salts. Biological characteristics are determined by sampling the fish and/or macroinvertebrate communities. Fish are collected by seining and/or electrofishing. Aquatic macroinvertebrates

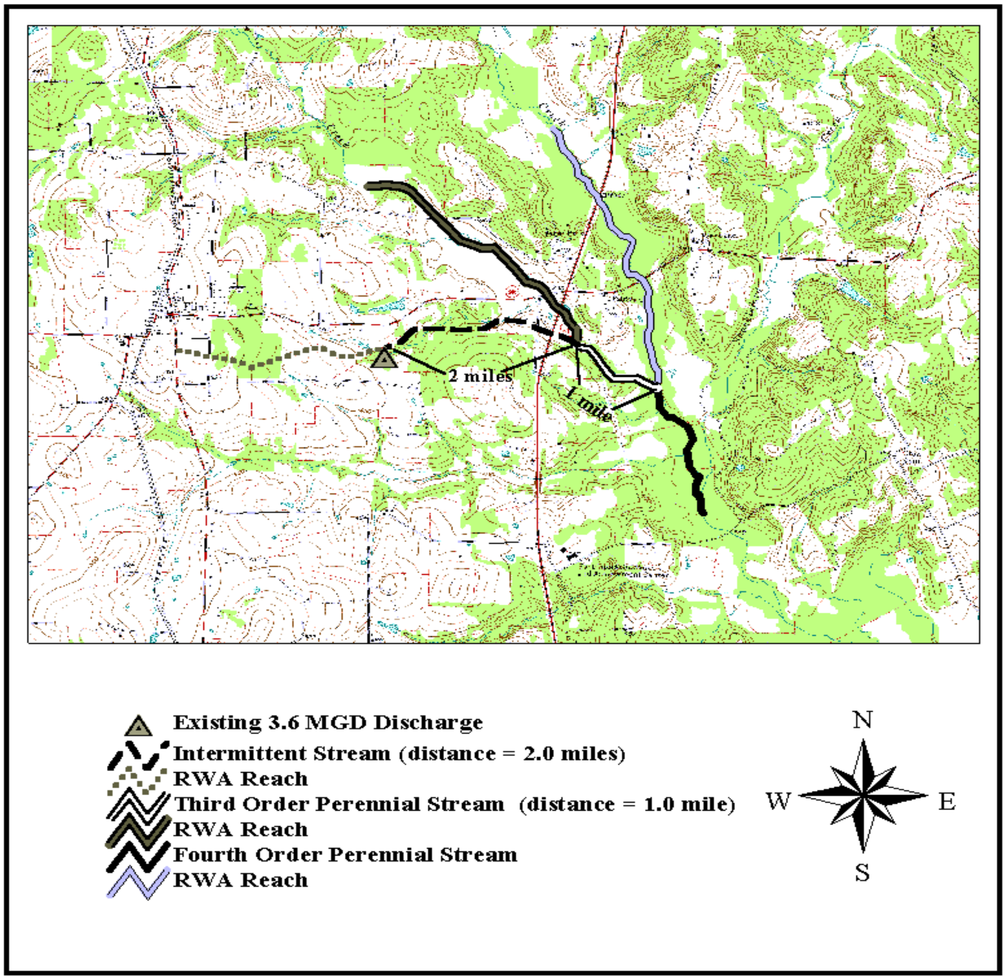


Figure 4-6. Example of an Existing Discharge to Intermittent and Perennial Streams

are collected by a variety of methods, including Surber samplers, kick nets, and/or artificial substrates. The numbers and kinds of fish and macroinvertebrates are determined. An index of biotic integrity is calculated to characterize the fish community. The numbers and types of macroinvertebrates collected are either compared to an appropriate reference site in the area or used in the calculation of indices to characterize the community. Other indices such as species diversity and species richness may also be used to characterize the biological community. Information on the physical, chemical, and biological characteristics of the stream are reported to the WQS Team. The WQS Team reviews the RWA, checks or calculates all indices, and, using all the information in the RWA, determines the aquatic life use for the receiving stream. The information collected in a RWA can later be used in a UAA to support the raising or lowering of a presumed use for an unclassified water body. If the UAA is approved by EPA, the change in aquatic life use for the water body becomes part of the TSWQS in the next triennial review.

Table 4-9 lists the RWAs that were completed from October 1988 to April 2002, the water bodies that were studied, the segments into which they eventually flow, and the date an aquatic life use was assigned to the receiving water after review of the RWA information. An asterisk (*) next the water body name indicates that the revised ALU has been incorporated into the TSWQS (Appendix D).

Table 4-9. Receiving Water Assessments, October 1988 - April 2002

Segment	First Level Segment Tributary	Use**	Second Level Tributary	Use	Third Level Tributary	Use	Date
0101	Red Deer Creek	N	Coon Hollow Creek	N			02/10/1989
0101	Rock Creek*	L	Unnamed tributary	N			03/08/1989
0201	Diversion Canal (McKinney Bayou)		Barkman Creek		Jones Creek*	I	06/28/1989
0201	Diversion Canal (McKinney Bayou)		Barkman Creek		Jones Creek*	I	01/13/1995
0202	Bois d'Arc Creek*	I					12/04/1990
0202	Choctaw Creek		Mill Creek		Corneliason Creek*	L	10/27/1988
0202	Pine Creek*	H	Hicks Creek	N			09/11/1992
0203	Big Mineral Creek*	I					11/17/1997
0203	Little Mineral Creek*	I					08/20/1997
0204	Salt Creek		Ritchie Creek*	L	Unnamed tributary	N	12/29/1989
0205	Wildhorse Creek	L					12/16/1992
0219	Holliday Creek		Unnamed Creek	N			02/10/1995
0301	Natural drainage channel	N					08/28/1990
0302	Big Creek*	I	Unnamed tributary	N	Unnamed tributary	N	01/31/1989
0302	Unnamed tributary	N					11/30/1989
0303	Little Mustang Creek		Morrison Branch*	I			05/10/1999
0303	White Oak Creek		Rock Creek	I			12/08/1992
0304	Wagner Creek*	I	Unnamed tributary	N			08/20/1996
0304	Wagner Creek*	I	Unnamed tributary	L	Unnamed ditch	N	12/19/1990
0305	Auds Creek		Cottonwood Branch		Unnamed reservoir	L	03/20/1989
0306	Spring Creek		Loring Creek	N	Unnamed tributary	N	11/19/1991
0400	Cross Bayou*	H					03/09/1994
0400	Cross Bayou (Louisiana)		Unnamed tributary	I			06/26/1992
0401	Central Bayou	H					10/29/1992

Table 4-9. Receiving Water Assessments (continued)

Segment	First Level Segment Tributary	Use**	Second Level Tributary	Use	Third Level Tributary	Use	Date
0401	Goose Prairie Bayou	H	North Bayou	I			10/29/1992
0402	Black Cypress Creek		Hughes Creek*	H			06/15/1998
0404	Boggy Creek		Okry Creek		Unnamed tributary*	I	12/01/1998
0404	Dry Creek*	I					09/05/1996
0404	Dry Creek*	I	Sparks Branch*	I			08/18/1997
0404	Ellison Creek Reservoir		Brutons Creek*	I	Unnamed tributary	N	02/16/1990
0404	Hart Creek*	H	Unnamed tributary	N			06/07/1989
0404	Tankersley Creek	L					02/16/1990
0404	Tankersley Creek*	H					01/29/1998
0407	Beech Creek*	I					06/19/1991
0409	Clear Creek		Bog Creek	N			06/06/1989
0409	Sugar Creek	H					11/02/1992
0409	Walnut Creek	H					01/24/1992
0501	County Relief Ditch*	L					08/26/1996
0501	Little Cypress Bayou		East Fork Cypress Bayou		ditch 5D, 5E	N	11/06/1992
0502	Caney Creek*	H					12/30/1996
0502	Dempsey Creek		Unnamed tributary*	I	Unnamed ditch	N	02/26/1990
0504	Flat Fork Creek		Unnamed trib (perennial)	H	Unnamed trib.(int. w/ pools)*	L	05/17/1993
0504	Tenaha Creek		Flat Fork Creek		Hilliard Creek	I	12/27/2001
0504	Tenaha Creek		Praire Creek		Cedar Creek	I	04/02/1991
0505	Eightmile Creek*	I	Parker Creek	L			04/29/1993
0505	Grace Creek*	I	Unnamed tributary	L			07/02/1991
0505	Hatley Creek		Wards Creek*	I			10/02/1995

Table 4-9. Receiving Water Assessments (continued)

Segment	First Level Segment Tributary	Use**	Second Level Tributary	Use	Third Level Tributary	Use	Date
0505	Hawkins Creek*	L					02/18/1989
0505	Irons Bayou		Wall Branch*	I			04/20/1999
0505	Mason Creek*	L	Unnamed tributary	N	Open Channel	N	07/20/1990
0505	Potters Creek		East Potters Creek	L	Unnamed ditch	N	09/19/1991
0505	Prairie Creek		Rocky Creek*	H			12/01/1997
0505	Rabbit Creek*	I	Bighead Creek	I			06/09/1993
0505	Rabbit Creek		Little Rabbit Creek*	L	Unnamed tributary	N	10/22/1991
0505	Unnamed tributary*	I					04/07/1989
0506	Glade Creek		Sandy Creek*	L			12/05/1988
0506	Grand Saline Creek		Unnamed tributary*	I			08/21/1997
0506	Harris Creek		Wiggins Creek*	H	Unnamed tributary	N	07/23/1999
0506	Mill Creek	H					08/27/2000
0506	Mill Creek		Giladon Creek*	I			01/11/2000
0506	Rogers Creek	L					08/24/1990
0506	Unnamed slough	L	Unnamed trib. (Redd Creek)	N			11/16/1990
0506	Unnamed slough	I	Unnamed trib. (Redd Creek)	N			07/31/1996
0506	Unnamed tributary (Nine Mile Creek)*	H	Unnamed tributary	N			01/16/1998
0507	Caddo Creek		West Caddo Creek*	L			08/10/1989
0507	South Fork Sabine River		Sabine Creek	I			04/27/1989
0510	Mill Creek*	I	Adaway Creek*	I			05/14/1999
0511	Coon Bayou (Tidal)*	H	Unnamed tributary	L	Drainage ditch	N	05/02/1989
0511	Unnamed trib(West Bunch Gully)*	H					01/24/1991
0513	Big Cow Creek		Trout Creek*	H			09/08/1997

Table 4-9. Receiving Water Assessments (continued)

Segment	First Level Segment Tributary	Use**	Second Level Tributary	Use	Third Level Tributary	Use	Date
0601	Meyer Bayou	I	Schoolhouse Ditch	I			04/23/1990
0601	Meyer Bayou		Tiger Creek*	L			04/20/1989
0601	Meyer Bayou		Tiger Creek	I	Caney Creek	I	06/10/1991
0602	Massey Lake Slough		Unnamed trib.(Booger Br.)*	L			10/26/1988
0604	Bean Creek		One-eye Creek*	I			06/12/1995
0604	Caddo Creek*	H	Unnamed tributary*	H			03/09/2001
0604	Caney Creek		Dabbs Creek*	H	Unnamed tributary	H	06/25/1992
0604	Jack Creek		Cedar Creek*	I	Hurricane Creek*	I	05/14/1999
0604	Larrison Creek*	H	Alto Branch*	H			08/11/1998
0604	Piney Creek		Bear Creek	H	Dry Creek	H	06/27/1991
0604	Wells Creek	H					10/16/1992
0605	Kickapoo Creek		Big Duncan Branch		Little Duncan Branch*	I	03/22/1999
0605	Saline Creek	I					08/16/1990
0606	Prairie Creek		Black Fork Creek*	L			06/15/1990
0606	Prairie Creek*	H	Black Fork Creek*	H			04/15/1997
0606	Prairie Creek*	H					08/17/2000
0607	Boggy Creek*	H	man made/natural ditch	N			01/30/1998
0607	Cotton Creek*	I					07/01/1998
0607	Willow Creek		Batiste Creek	I	School House Ditch	N	04/02/1991
0608	Cypress Creek*	H	Unnamed tributary	N			10/27/1995
0608	Mill Creek	L	Unnamed trib. (Icehouse Br.)	N			12/20/1990
0608	Turkey Creek*	H					11/22/1994
0608	Turkey Creek		Big Cypress Creek		Magnus Br.(and Barclay Lk.)	H	11/07/1990

Table 4-9. Receiving Water Assessments (continued)

Segment	First Level Segment Tributary	Use**	Second Level Tributary	Use	Third Level Tributary	Use	Date
0608	Turkey Creek	H	Doucette Branch	N			12/15/1989
0609	Beef Creek	H	Unnamed tributary	N			10/26/2001
0610	Anderson Creek		Unnamed tributary	I	Unnamed ditch	N	07/18/1990
0610	Ayish Bayou*	H					10/03/1996
0610	Papermill Creek		Mill Creek*	H	Unnamed tributary*	L	04/04/1989
0610	Pomponaugh Creek		Little Sandy Creek*	I			10/13/1989
0611	Bayou LaNana*	I					07/27/1990
0611	Mud Creek		Blackhawk Creek*	I			08/01/1996
0611	Mud Creek*	H	Keys Creek*	H	Ragsdale Creek*	I	08/01/1996
0611	Mud Creek		Kickapoo Creek	N	Unnamed tributary	N	08/23/1989
0611	Mud Creek		West Mud Creek*	L			08/01/1996
0611	Mud Creek		West Mud Creek		Unnamed tributary	I	05/01/2001
0611	Mud Creek		West Mud Creek		Henshaw Creek*	H	03/11/1999
0611	Shawnee Creek	I	Bromley Creek	H			11/18/1997
0611	Striker Creek and Lake Striker		Johnson Creek		Unnamed tributary*	L	07/10/1989
0611	Striker Ck,L.Striker,Bowles Ck		Mill Creek	H	Hampton Creek	L	08/11/1993
0701	Green Pond Gully*	I	Mayhan Gully*	I			07/23/1999
0701	Rhodair Gully*	I					05/08/1989
0701	Taylor Bayou		South Fork Taylor Bayou		Mayhaw Bayou	I	12/20/1990
0702	Main Canal D, Canal A, B, C*	I					05/08/1991
0704	Bayou Din	H	Kidd Gully	H			11/20/1992
0704	Willow Marsh Bayou*	I					04/23/1999
0802	Big Creek		Coley Creek		Unnamed tributary*	H	05/24/1996

Table 4-9. Receiving Water Assessments (continued)

Segment	First Level Segment Tributary	Use**	Second Level Tributary	Use	Third Level Tributary	Use	Date
0802	Long King Creek*	H	Choates Creek*	H			03/11/1999
0802	Harmon Creek*	H	Parker Creek*	I			07/21/1999
0803	Turkey Creek*	I	West Turkey Creek	N	Unnamed tributary	N	09/30/1996
0804	Big Brown Creek		Unnamed tributary	N			11/08/1988
0804	Box Creek*	I					04/25/2000
0804	Catfish Creek		Coon Creek	H	Unnamed ponds	I	11/02/1994
0804	Cedar Lake		Cedar Lake Slough	H	Clear Lake	N	02/14/1994
0804	Cedar Creek		Walnut Creek	I	man-made ditch	N	04/26/2002
0804	Hurricane Bayou	H	Unnamed tributary	L			09/30/1994
0804	Keechi Creek*	H	ditch	N			07/29/1994
0804	Rush Creek	H	Unnamed tributary	N			08/03/1992
0804	Toms Creek*	H	Unnamed trib(Northwest Br.)*	H			08/30/1996
0804	Town Creek	H	Basset Creek	H			10/20/1999
0804	Upper Keechi Creek		Mims Creek*	I			01/11/2000
0804	Wolf Creek	L	Unnamed tributary	-	drainage ditch	-	05/10/1995
0805	Parsons Slough	H	Hickory Creek	N			09/07/1994
0805	Tenmile Creek	H					02/25/1992
0810	Big Sandy Creek		Jones Creek	L	Unnamed tributary	N	08/24/1990
0814	Mill Creek		Elm Branch	N			10/05/1990
0815	Waxahachie Creek*	I					10/01/1991
0818	Caney Creek		Reservoir	H	One Mile Creek*	I	07/23/1997
0819	Buffalo Creek (3rd ord)(North)*	L	Unnamed tributary	N			02/09/1989
0819	Duck Creek*	I					04/23/1991

Table 4-9. Receiving Water Assessments (continued)

Segment	First Level Segment Tributary	Use**	Second Level Tributary	Use	Third Level Tributary	Use	Date
0819	South Mesquite Creek	I					10/18/1989
0820	Rowlett Creek*	I	Cottonwood Creek*	L			08/30/1996
0821	Pilot Grove Creek*	L					06/22/1990
0821	Slayter Creek	I	Unnamed tributary	N			08/03/1990
0823	Little Elm Creek*	I	Unnamed tributary	N			08/09/1989
0823	Pecan Creek	L					10/10/1990
0823	Stewart Creek	N					08/27/1993
0826	Denton Creek		Elizabeth Creek	H	Unnamed tributaries	N	10/26/1990
0826	Denton Creek		Hog Branch	N	Unnamed tributary	N	12/01/1999
0826	Denton Creek*	H	Trail Creek*	H			07/19/1989
0826	Elizabeth Creek	L	Drainage Ditch	N			04/30/2001
0827	White Rock Creek*	I	Cottonwood Creek*	I	Floyd Branch	N	04/29/1999
0828	Village Creek		Deer Creek		Unnamed trib. (2nd order)	L	04/13/1990
0831	South Fork Trinity River		Town Creek	I			05/25/1990
0831	South Fork Trinity River	I	Town Creek	I			03/01/2001
0836	Pin Oak Creek*	I					04/13/1998
0837	Battle Creek	I	Unnamed tributary	N			08/14/1990
0838	Mountain Creek		Grassy Creek	N	Unnamed tributary	N	02/10/1989
0840	Indian Creek		Lake Kiowa		Indian Creek	N	08/16/1990
0840	Jordan Creek		Unnamed tributary		Stock Ponds	L	12/30/1988
0840	Spring Creek	H					03/22/1993
1001	Jackson Bayou*	H	Gum Gully*	H			08/17/1998
1001	Rickett Creek*	L					08/14/1997

Table 4-9. Receiving Water Assessments (continued)

Segment	First Level Segment Tributary	Use**	Second Level Tributary	Use	Third Level Tributary	Use	Date
1002	Tarkington Bayou*	I	Unnamed tributary	N			09/19/1999
1004	Crystal Creek	H	West Fork Crystal Creek	I			03/09/1994
1004	Crystal Creek		West Fork Crystal Creek	L	Red Hollow Branch	N	06/29/1990
1004	Unnamed tributary*	I					01/11/2000
1004	White Oak Creek		East Fork White Oak Creek*	I			01/11/2000
1004	White Oak Creek		West.Fork White Oak Creek*	H			02/12/1999
1006	Halls Bayou (lower)*	I	Halls Bayou (upper)*	L			12/27/1990
1008	Mill Creek		Neidigk Lake		Mill Creek*	I	12/30/1999
1008	Panther Branch*	I	Lake Woodlands	H	Panther Branch*	L	05/18/1998
1008	Willow Creek		Cannon Gully		Metzler Creek*	L	07/10/1989
1008	Willow Creek		HFCD Ditch M121-00-00	N			04/13/1998
1008	Willow Creek	H	Unnamed tributary	N			07/02/1992
1009	Dry Creek (lower)*	I	Dry Creek (upper)*	L			02/24/1999
1009	Dry Gully (lower)*	I	Dry Gully (upper)*	L			07/26/2000
1009	Little Cypress Creek	I					11/09/1990
1009	Little Cypress Creek	I	Unnamed tributary	N			08/08/2001
1009	Turkey Creek	L	Harris Co. FCD	N	Lateral H Turkey Creek	N	10/01/1996
1010	Dry Creek	I	Unnamed drainage	N			04/26/2002
1012	Atkins Creek		Town Creek*	I			10/01/1996
1012	West Fork San Jacinto River		Robinson Creek*	I			02/08/1999
1014	Buffalo Bayou*	I	Mason Creek*	I			11/02/1998
1014	Buffalo Bayou		Willow Fork Buffalo Bayou*	I			01/03/1990
1014	South Mayde Creek (lower)*	I	Bear Creek* Turkey Creek*	I	Langham Creek (lower)* 4^{th} level-Horsepen Ck. (lower)*	I	02/12/1999 07/23/1999

Table 4-9. Receiving Water Assessments (continued)

Segment	First Level Segment Tributary	Use**	Second Level Tributary	Use	Third Level Tributary	Use	Date
1014	South Mayde Creek (upper)*	L	Bear Creek		Langham Creek (upper)* Dinner Creek* 4th level-Horsepen Ck. (upper)*	L	02/15/1995
1016	Garners Bayou*	L	Williams Gully	N			02/25/1991
1016	North Fork Greens Bayou		HCFCD P145-03-00	L	Storm sewer	N	10/01/1996
1017	Vogel Creek*	L					01/24/1994
1101	Magnolia Creek*	I					09/01/1999
1102	Cowart Creek*	L	Roadside ditch	N			02/16/1990
1102	Marys Creek*	I	North Fork Marys Creek*	I			11/12/1999
1104	Bushway Draw	I					09/04/1991
1105	Austin Bayou		Flores Bayou*	I			12/01/1998
1107	Corner Bayou		Unnamed tributary	I			08/21/1989
1202	Beason Creek*	I					04/23/1999
1202	Bessies Creek		Brookshire Creek*	L			04/15/1996
1202	Ditch H		Unnamed oxbow slough*	L			06/10/1998
1202	Dry Creek		House Bayou	I	Gapps Slough	I	12/18/1997
1202	New Year Creek*	I	Little Sandy Creek*	I	Hog Branch*	I	05/09/1996
1202	Rabbs Bayou*	L					07/17/1992
1203	Steele Creek*	H					06/14/1994
1203	Whitney Creek	N	Unnamed tributary	N			06/22/1990
1205	McCarty Branch*	L					06/12/1989
1206	Kickapoo Creek*	I					07/09/1999
1206	Rock Creek*	I	Unnamed tributary*	I			09/05/1997
1209	Carters Creek*	I	Burton Creek	L			07/29/1991

Table 4-9. Receiving Water Assessments (continued)

Segment	First Level Segment Tributary	Use**	Second Level Tributary	Use	Third Level Tributary	Use	Date
1209	Carters Creek		Wolfpen Creek*	L			04/03/1989
1209	Cedar Creek	I					10/07/1993
1209	Peach Creek		Unnamed tributary	L			12/19/1990
1209	Wickson Creek*	L					04/28/1999
1211	Davidson Creek*	I					01/02/1990
1213	Darrs Creek	L					07/15/1991
1213	Donahoe Creek		Indian Creek		Town Branch	N	07/26/1989
1213	Unnamed tributary	N					01/08/1990
1221	Indian Creek*	I					09/21/1999
1221	Pecan Creek*	I					03/19/1999
1222	Station Creek	I					10/25/1999
1224	Leon River (including Lake Olden)*	H	South Fork Leon River*	H			10/01/1991
1227	Buffalo Creek*	L					04/28/1989
1227	Mustang Creek*	I					03/27/1990
1228	Nolan River		West Nolan Creek	N			02/07/1991
1229	Squaw Creek		Squaw Creek Reservoir	H	Squaw Creek	L	03/14/1990
1230	Palo Pinto Creek*	H	Unnamed tributary	N			10/12/1995
1232	Deadman Creek	I	Freewater Creek	N	Unnamed ditch	N	08/10/1992
1232	Hubbard Creek	H	Gonzales Creek	H			03/01/1995
1235	Mule Creek	H	Rice Springs Branch	H			05/03/1993
1238	Duck Creek	L	Spade Draw	N			03/19/1992
1241	NFDMF Brazos River*	L					04/13/1990
1242	Deer Creek	I					03/23/1993

Table 4-9. Receiving Water Assessments (continued)

Segment	First Level Segment Tributary	Use**	Second Level Tributary	Use	Third Level Tributary	Use	Date
1242	Pond Creek*	L	Salt Creek	N			04/08/1994
1242	Thompson Creek*	I	Still Creek*	H	Cottonwood Branch*	I	04/30/1999
1244	Brushy Creek*	H					12/22/1999
1244	Mustang Creek*	I					07/28/1996
1245	Red Gully*	I					05/28/1996
1246	Harris Creek*	H	Comanche Springs spring brook*	H			08/17/1998
1246	Unnamed tributary of South Bosque*	I					11/21/1989
1248	Mankins Branch	H	Unnamed tributary	I			09/14/1990
1254	Hackberry Creek	L					02/21/1991
1304	Linnville Bayou*	L					11/13/1989
1305	Hardeman Slough*	I					04/15/1999
1402	Allen Creek*	I					08/16/1999
1402	Buckners Creek*	H					04/01/1999
1402	Cedar Creek*	H	Cedar Creek Reservoir*	H			11/09/1989
1402	Cummins Creek*	E					04/01/1999
1402	Rabbs Creek		Sandy Creek		Unnamed tributary	N	06/29/1989
1404	Hamilton Creek*	I					05/11/1999
1412	Beals Creek*	L	Unnamed tributary	N	Red Draw Reservoir	L	12/13/1988
1412	Big Sulphur Creek		Deep Creek*	I			12/06/1996
1412	Champion Creek		Champion Creek Reservoir		North Fork Champion Creek*	L	08/16/1999
1414	Barons Creek*	H					04/24/1989
1414	Town Creek	L					01/10/1989

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Table 4-9. Receiving Water Assessments (continued)

Segment	First Level Segment Tributary	Use**	Second Level Tributary	Use	Third Level Tributary	Use	Date
1415	Comanche Creek*	L					12/22/1988
1415	Dry Draw		Unnamed tributary	N			06/16/1989
1416	Brady Creek*	I					03/24/1995
1416	Unnamed slough	L					06/22/1990
1418	Jim Ned Creek		Hord Creek*	I			01/12/2000
1420	North Prong Pecan Bayou		Kaiser Creek*	L			06/28/1989
1420	Turkey Creek*	H					11/08/1990
1426	Elm Creek*	H					10/05/1995
1434	Cedar Creek*	H					04/01/1999
1434	Gazley Creek*	I					04/15/1999
1502	Tadpole Creek	N	Roadside ditch	N			10/15/1990
1602	Clarks Creek		Big Brushy Creek*	H			11/19/1999
1604	East Mustang Creek*	H	Drainage ditch	N			02/04/1998
1604	Sandy Creek		Middle Sandy Creek		Unnamed tributary	N	04/26/1989
1605	West Navidad River*	H	Unnamed tributary	N			02/03/1999
1804	Walnut Branch	H					07/14/1995
1810	Town Branch*	H					11/13/1997
1901	Escondido Creek	L	Abandoned Escondido Creek	N			09/30/1993
1902	Clifton Branch	L	Stockdale Creek	N			06/21/2000
1902	Martinez Creek*	I	Escondido Creek	N			11/07/1994
1903	Polecat Creek*	H					08/09/1991
2004	Poesta Creek	L					12/06/1993
2107	Goose Creek	N	Unnamed tributary	N			07/23/1996

Table 4-9. Receiving Water Assessments (continued)

Segment	First Level Segment Tributary	Use**	Second Level Tributary	Use	Third Level Tributary	Use	Date
2108	Chacon Creek*	I	Fort Ewell Creek*	I			06/30/1992
2117	Cibolo Creek		Unnamed tributary	N			06/08/1990
2202	Drainage ditch*	L					12/11/1996
2304	Chacon Creek(Lower)	L	Chacon Creek(Upper)	N	Unnamed tributary	N	01/24/1989
2304	Cienegas Creek*	H					07/10/1989
2304	Espada Creek		Pinto Creek	N			07/23/1990
2304	Las Moras Creek	H					10/22/1993
2422	Double Bayou (tidal)		West Fork Double Bayou (tidal)		Anahuac Ditch*	I	07/23/1999
2426	Goose Creek(tidal)		Goose Creek*	L	West Fork Goose Creek	N	04/11/1989
2432	New Bayou		Persimmon Bayou		Mustang Bayou*	0	05/07/1999
2437	Hurricane Levee Canal	I					09/24/1990
2441	Live Oak Bayou		Lake Austin and Peyton Creek		Cottonwood Creek	L	01/24/1992
2454	Huisache/Cox Creek Impoundment	H	Unnamed tributary	N			03/12/1992
2456	Carancahua Creek		West Carancahua Creek		Unnamed tributary	N	05/01/1989
2481	Kinney Bayou -tidal	I	Kinney Bayou - above tidal	N	West Fork Kinney Bayou	N	01/26/1989
2491	North Floodway		County Flood Control Syst		Unnamed Drainage Ditch	N	02/16/1989
2492	San Fernando Creek (tidal)	H					03/10/1999
2492	San Fernando Creek (tidal)		San Fernando Creek		Santa Gertrudis Creek	L	07/20/1992
2492	Laguna De Los Olmos	I	Los Olmos Creek	I			08/11/1989

* Water bodies that have had the aquatic life use incorporated into the TSWQS, Chapter 307, Appendix D; ** letters represent the aquatic life use assigned to the water body

N - No Significant; L - Limited; I - Intermediate; H - High

Use Attainability Analysis

TCEQ to determine existing and attainable uses of a water body. UAAs are conducted on either a single water body, a segment of a water body, or a group of segments with similar characteristics. They are conducted:

- when the designated uses for a water body do not include those uses specified in Section 101(a) of the federal Clean Water Act, that is, fishable/swimmable goals,
- when subcategories of uses specified in Section 101(a)(2) require less stringent criteria, or
- to affirm that a designated use is appropriate.

The UAA identifies and defines the existing and potential (attainable) uses of a water body and determines if designated uses established in the TSWQS are too stringent or impaired. If there is impairment, the cause and source of that impairment is identified, and it is determined whether the water body can support the designated use in the absence of the pollutant(s) or with improved water treatment. If the use cannot be supported, then the TCEQ can use the UAA to lower the designated use or make the numerical water quality criteria less stringent. Conversely, if designated uses and numerical water quality criteria are found not to be protective of the existing and potential uses, the TCEQ can use the UAA to upgrade the uses and criteria for the selected water body.

UAAs vary in scope depending on the nature of the water body, the available data, and the specific problem(s) defined. They may include a water body survey and assessment, a waste load allocation, and/or an institutional evaluation. The TCEQ initially conducts a thorough review of historical physical, chemical, hydrological, and biological data from each water body selected for a UAA. Some UAAs are based on existing data, while others may require the collection of additional supporting data.

After a UAA is completed, it is submitted to the EPA for approval, if changes in designated uses or water quality criteria are recommended. If the EPA approves the UAA, it is incorporated into the next triennial review of the TSWQS. Thirty-three UAA reports have been prepared by the TCEQ and approved by the EPA (Table 4-10).

Table 4-10. Use Attainability Analysis Reports

Segment No.	UAA No.	Segment Location	Date of UAA
0105	32	Rita Blanca Lake	March 1995
0225	5	Mc Kinney Bayou	June 1984
0230	33	Pease River	January 2000
0303/06/ 07	19	Sulphur River	Feb. 1987
0304	3	Days Creek	Apr. 1984
0404	14	Big Cypress Creek	Jan. 1985
0406	12	Black Bayou	Aug. 1984
0407	6	James' Bayou	June 1984
0508	7	Adams Bayou	June 1984
0511	25	Cow Bayou	Dec. 1988
0601	20	Neches River	Feb. 1987
0606	16	Neches River	Jan. 1986
0701	15	Taylor Bayou	June 1985
0704	22	Hillebrandt Bayou	June 1988
0805/41	28	Trinity River	May 1989
1006/07	2	Houston Ship Channel	March 1984
1013/14	23	Buffalo Bayou	Sept. 1988
1104	21	Dickinson Bayou	May 1988
1206	27	Brazos River	Feb. 1989
1218	17	Nolan Creek	Aug. 1986
1226/46/55	29	Bosque River	Aug. 1991
1227	26	Nolan River	Dec. 1988
1244	11	Brushy Creek	July 1984
1245	30	Oyster Creek	Oct. 1991
1417/31/32	1	Pecan Bayou	June 1982
1424	31	South Concho River	Feb. 1994
1427	18	Onion Creek	Oct. 1986

Table 4-10. Use Attainability Analysis Reports (Continued)

Segment No.	UAA No.	Segment Location	Date of UAA
1901/11	8	San Antonio River	June 1984
1902/13	9	Cibolo Creek	June 1984
2201/02	4	Arroyo Colorado	May 1984
2203/04	24	Petronila Creek	Sept. 1988
2308/14	10	Rio Grande River	June 1984
2426	13	Tabbs Bay	Aug. 1984

Border Monitoring

Rio Grande Toxic Substances Study

In February 1992, the United States and Mexico issued the first stage of the Integrated Environmental Plan (IBEP, now called Border 21) for the US-Mexico Border area. This plan set up the frame work for the two countries to work jointly on solutions to environmental problems along the border. On November 13, 1992, the U.S. and Mexican sections of the IBWC approved Minute No. 289, titled “Observation of the Quality of the Waters Along the United States-Mexico Border”. A result of this agreement was the Rio Grande Toxic Substances Study, a binational, multi-agency, multi-phase effort to characterize toxic contamination of the Rio Grande and its tributaries.

Through funding from the EPA, the TCEQ was given the responsibility to coordinate, and carry out the multi-phase investigation jointly with various state, federal and Mexican agencies. TCEQs primary partner in the joint effort is the Comision Nacional del Agua (CNA). The U.S. and Mexican sections of the IBWC act as diplomatic liaisons, provide logistics support and coordinate the participation of the Mexican agencies. The IBWC is also responsible for reviewing and approving a final binational report based on draft reports from the TCEQ and CNA.

Field work for Phase I of the Rio Grande Toxic Substances Study was done from November 1992 through March 1993. During this intensive monitoring program 45 sites were sampled under low flow conditions, including 19 on the mainstem, and 26 on tributaries (13 in Texas and 13 in Mexico). Monitoring consisted of: (1) toxic chemical and toxicity testing in water and sediment samples at 45 sites; (2) toxic chemicals in fish tissue samples from 24 sites; (3) biosurveys of benthic macroinvertebrate communities at 18 sites; and (4) biosurveys of fish communities at 24 sites. The findings of Phase I were published in the September 1994 report titled *Binational Study Regarding the Presence of Toxic Substances in the Rio Grande/Rio Bravo and its Tributaries Along the Boundary Portion Between the United States and Mexico*.

Field work for Phase II of the Rio Grande Toxic Substances Study was conducted from May 1995 through December 1995. Due to the need to collect samples under low flow conditions, monitoring from El Paso to Big Bend National Park was delayed three months due to high flows in the Rio Grande. Large releases from Elephant Butte Reservoir in New Mexico made the river inaccessible until December. During this second phase of intensive monitoring samples were collected at 46 stations, including 27 mainstem sites and 19 tributary sites. Sites from Phase I which showed a low potential for impact were excluded from Phase II. Sixteen added to Phase II in areas not covered in Phase I. Four of these new sites were located on Falcon and Amistad International Reservoirs.

Monitoring consisted of: (1) toxic chemical and toxicity testing in water at 37 sites and sediment at 33 sites samples; (2) toxic chemicals in fish tissue samples from 24 sites; (3) biosurveys of benthic macroinvertebrate communities at 16 sites; and (4) biosurveys of fish communities at 24 sites. The findings of Phase II were published in the September 1998 report titled *Binational Study Regarding the Presence of Toxic Substances in the Rio Grande/Rio Bravo and its Tributaries Along the Boundary Portion Between the United States and Mexico*.

Field work for Phase III of the Rio Grande Toxic Substances Study was conducted in November 1998. El Paso/Ciudad Juárez-Big Bend National Park was chosen for Phase III because it was one of the main areas of concern and this reach of the Rio Grande/Rio Bravo offers a unique opportunity to assess a variety of factors over these three areas including: habitat alteration, land use, water/sediment quality, flow variations and biological communities. Since toxic impacts alone can not be cited as the cause for aquatic life deterioration, both point and nonpoint sources of pollution as well as habitat modification must be investigated to be able to accurately describe the water quality and aquatic life conditions in the river. These components can be brought together to identify key stressors on each of these areas.

Collecting Fish by Electroshocking in the Rio Grande

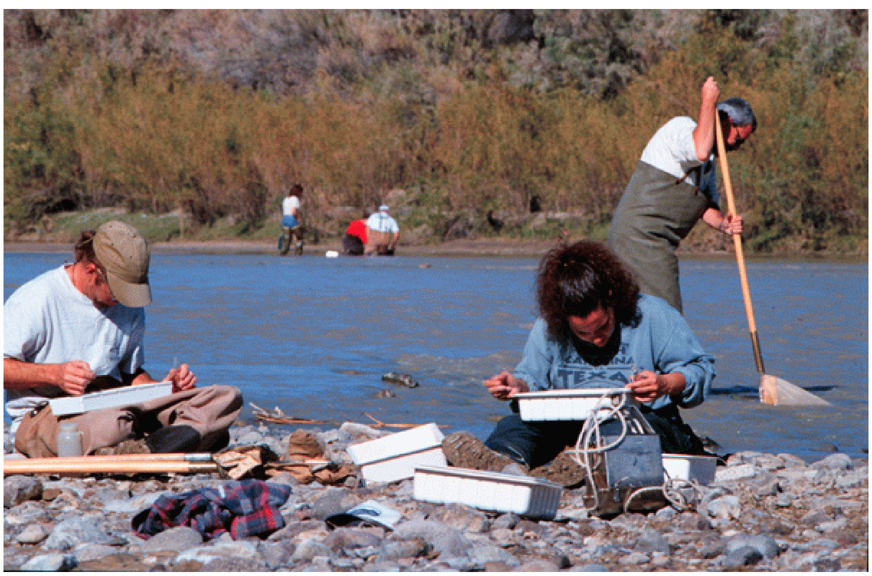
El Paso/Ciudad Juárez and Presidio/Ojinaga both represent sources of stress on the Big Bend National Park area and the protected areas in the states of Chihuahua and Coahuila Mexico, important and valued natural resources. A final report is expected in October 2002.

Rio Grande Basin Biocriteria Development

The TSWQS provide for the maintenance propagation and protection of aquatic life. The Standards specify four aquatic life use categories for freshwater systems in the state. These include limited, intermediate, high and exceptional aquatic life use. Classification of water bodies within this framework is based on evaluation of physico-chemical as well as biological characteristics. To this end, Texas has used biological monitoring, primarily fish and benthic macroinvertebrates, in conjunction with physico-chemical monitoring for a number of years in the water quality monitoring program. In the initial phases of implementation of biological monitoring in Texas, interpretation of fish and benthic macroinvertebrate data has been facilitated by the use of multi-metric indices of biotic integrity derived based on statewide data sets. However, Texas is a large physiographically diverse state, encompassing twelve different ecoregions. Ecoregions delineate areas of relative homogeneity as expressed by landscape patterns and human cultural patterns and effects.

Since landscape patterns and human activities can have profound effects on the nature of instream aquatic communities, biotic communities from similar sized streams within the same ecoregion can be expected to be more similar than biotic communities from similar sized streams in different ecoregions. These same ecoregion specific qualities provide for region-specific disturbances and risks to ecosystems. These factors have, since initial development of the IBI approach, prompted work to derive regionalized biotic indices to provide more refined tools for the interpretation of biological data.

Through funding from the US Environmental Protection Agency, the TCEQ was given the responsibility to coordinate, and carry out the development of Indices of Biotic Integrity (IBI) for fish and benthic macroinvertebrates. The goal of this project was to develop biologcial indicators or "biocriteria" for two ecoregions along the international reach of the Rio Grande: Southern Desert and South Texas Plains. Upon completion of this project, the TCEQ (at its discretion) may adopt these criteria as part of the agency's Water Quality Criteria. Otherwise, these criteria will serve as another indicator, along with currently adopted numerical water quality criteria and toxicity testing, for detecting impairments to aquatic



Collecting Benthic Macroinvertebrates with a Kick Net (background), While Sorting, Enumerating, and Identifying them (foreground) communities and provide a widely accepted approach to addressing the biological integrity objective of the CWA. A final report is expected in late 2002/early 2003.

Clean Rivers Program

The CRP is a unique, water quality monitoring, assessment, and public outreach program that is funded by state fees. The CRP is a collaboration of 15 regional water agencies and the TCEQ, and is authorized by Senate Bill 818. The CRP provides the opportunity to approach water quality issues within a watershed or river basin at the local and regional level through coordinated efforts among diverse agencies and various programs.

A set of nine key goals were developed with input from all regional cooperators to outline the focus of the program. Associated with each goal are specific objectives that are implemented throughout Texas' 23 river and coastal basins. These goals and objectives are described in the CRP Long-Term Action Plan, updated for fiscal years 2000-2005 (CRP, 2000).

Implementation of the nine goals of the CRP is manifest in the biennial CRP Guidance document developed by TCEQ project management staff with input from the regional water agencies. The Guidance identifies seven key tasks, each with a number of deliverables designed to accomplish the goals and objectives set out in the Long-Term Action Plan.

Factors Influencing Implementation of the Clean Rivers Program

Each regional water agency implements the CRP Guidance based on the unique circumstances that are present in its basin. There is a minimum expectation set forth in the CRP Guidance, but based on a number of factors, there is a certain amount of individuality in the focus and implementation of the program in each basin.

Funding is based on the number and size of wastewater treatment plants and surface water right permittees that reside within each river basin. Some basins receive a much larger allocation than others, since at least 70 percent of the dollars collected from a river basin are returned to that basin for conducting CRP tasks.

CRP Staff Receives Input from Local Stockholders

Stakeholder input determines the unique focus of the CRP within a river basin. Each basin holds annual steering committee meetings to discuss current studies

The geographic size of a river basin can have an impact on how the program is implemented. River basin size varies widely in Texas. The cost to monitor and assess all the streams in a river basin that is almost as wide as Texas is much greater than the cost to monitor one that is the size of four typical Texas counties.

Density of population and industry can also have an impact on the costs associated with implementing the CRP. The greater the density of factors that tend to have an impact on water quality, the greater the density of water quality issues that require attention.

The CRP Monitoring Strategy Supports Four Objectives

Long-term trend analysis is accomplished through "routine" monitoring of the same sites for the same constituents over a five-to-ten-year period of time, or longer. Identification of water quality issues is accomplished through both routine and "systematic" water quality monitoring. Systematic monitoring consists of sampling at sites selected in areas where routine monitoring is not located (smaller tributaries) for a period of one to two years. Systematic monitoring is used when resources are too limited to enable routine monitoring on every stream in the basin. The available resources are applied to a few watersheds at a time and then moved to another set of watersheds each year (or every two years) so that most streams in the basin are monitored to determine their water quality.

Definition of water quality issues and sources is accomplished through special studies of sites or areas identified to have potential water quality problems based on either routine or systematic monitoring data, as well as stakeholder input.

Information for permit decisions is acquired through “targeted” monitoring of those streams directly related to wastewater permits. Targeted monitoring provides information that can be used in the permit development process to base decisions on site-specific conditions instead of default criteria.

Overview of CRP Functions

Monitoring

Routine water quality monitoring is performed at a number of stations on either a monthly or quarterly basis for constituents such as dissolved oxygen, temperature, conductivity, pH, flow, total dissolved solids, total suspended solids, chloride, sulfate, nutrients (nitrogen and phosphorus), and chlorophyll *a*. In addition, a number of regional water agencies

CRP Partners Collecting Fish by Seine

conduct semi-annual and annual monitoring of metals in water and biological communities (benthic macroinvertebrates, fish, and habitat).

Systematic water quality monitoring is performed at a number of stations on either a monthly or quarterly basis. Systematic monitoring may include all or a subset of the constituents sampled in routine monitoring, based on knowledge of the factors in the watershed. This monitoring is generally conducted for only one to two years to determine whether any water quality issues exist. If the data show a potential problem, a systematic sampling site or area may become the basis for a special study.

Quality Assurance

In order to ensure consistent, comparable, high-quality data across the state, all field methods, laboratory analysis methods, and data management functions follow a pre-defined QAPP, which is reviewed and approved every two years by the TCEQ.

Identify Factors Influencing Water Quality

Each regional water agency collects information on potential sources of pollution throughout its planning area or river basin. This information is used to correlate water quality to the environmental factors that influence it, such as soils, climate, hydrology, wastewater treatment plants, urban runoff, and agricultural runoff.

Water Quality Data Assessment and Reporting

The CRP strives to report water quality data in a user-friendly format to inform the public and to provide support for the state's review of water quality. An annual basin status report, the *Basin Highlights Report*, is published for each basin, and provides an overview of water quality issues and the status of ongoing projects/tasks. A detailed and in-depth data analysis is provided for each basin in the *Basin Summary Report* once every five years. Timing of the report is based on the state's Basin Management Cycle. This report provides trend analysis, spatial analysis (correlating environmental factors to water quality), an explanation for why certain water quality issues exist, and recommendations for addressing persistent water quality problems.

Public Involvement

The program strives to involve the public and other stakeholders on a regional and local basis in the assessment of water quality within each river basin. Each regional water agency maintains a list of steering committee members from the basin who receive water quality assessment reports, meet with the regional water agencies at least once per year, and are requested to provide direction for monitoring and assessment activities for the basin. This has resulted in a significant degree of participation and "buy-in" by the stakeholders. They are able to discern a benefit from the program, not only from the discussion of water quality issues, but also due to the presentation of supporting documentation in a user-friendly format. This dissemination of information enables their participation in decision-making and gives them a more complete understanding of the water quality issues in their basin and how those issues relate to each individual.

Texas Watch Environmental Monitoring Program

Texas Watch is a network of trained volunteers and supportive partners working in concert to gather and share environmental information to protect the natural resources of Texas.

A growing population and expanding resource development have increased the levels of nonpoint source pollution entering Texas waters. Professional monitoring resources are increasingly drawn to water bodies with the most severe problems, straining the field resources responsible for ambient monitoring. Texas Watch provides, at an affordable cost, an expanded capacity to collect ambient water quality data and consequently, the ability to identify potential environmental impacts associated with nonpoint source pollution. Volunteer monitoring, in effect, can help "free up" professional monitoring resources to address the most severe water quality problems without sacrificing ambient water quality monitoring of less impacted water bodies.

The Texas Watch program is a partnership between the EPA, the TCEQ, and Southwest Texas State University (SWT). Texas Watch offers guidance to citizens with water quality concerns and trains committed individuals to collect useful water quality data. It also supports other active volunteer monitoring programs in Texas. Texas Watch encourages effective networking between citizens, industries, government resource protectors, water districts, foundations, students, and teachers through our pursuit of three main goals:

- produce environmental information needed by agencies, waste generators, and the public to make environmentally sound decisions
- improve communication about the environment and environmental issues
- resolve conflicts over environmental impacts through positive cooperation

These goals are based on the premise that water quality and quantity issues are inextricably linked with air, biological, land, and human resource issues.

Texas Watch Goals and Philosophy

Texas Watch promotes active participation by coordinating volunteer environmental monitoring and nonpoint source (NPS) water pollution education activities among water resource stakeholders throughout the state. This active participation was recently demonstrated at a Texas Watch Regional Meeting that took place in Lampasas, Texas. Input provided by the city's mayor and manager, a hydrogeologist, a nutrients expert, Friends of Sulphur Creek volunteer monitors, the Saratoga Water District, a local judge, and an aquatic biologist helped provide a holistic interpretation of the information available for making the best decisions regarding their community and quality of life.

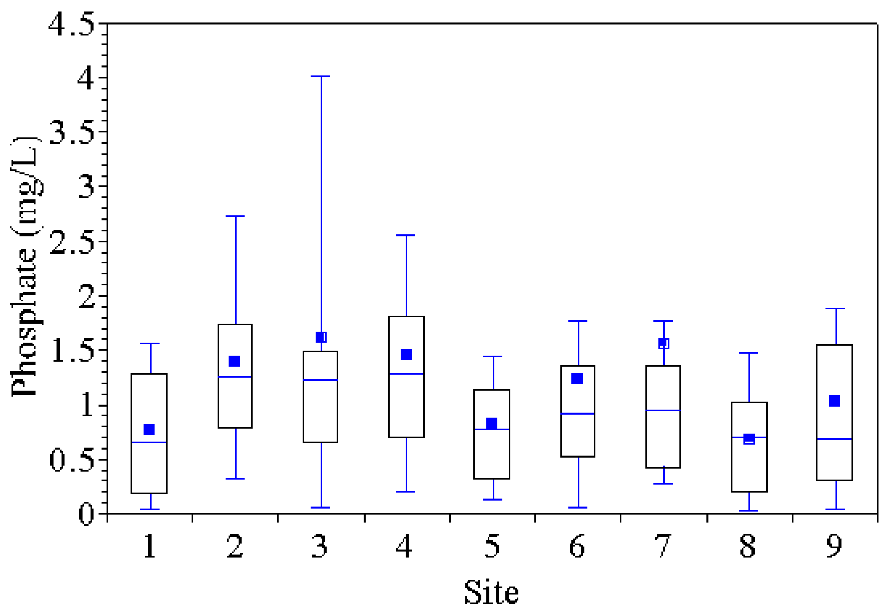


Figure 4-7. Phosphate Concentrations in the Lampasas River and Sulphur Creek. The Friends of Sulphur Creek volunteer monitors generated data for this graph. Nine sites are listed from upstream to downstream, and they are located on the Lampasas River and Sulphur Creek.

Other water quality monitoring projects, like Rockport, Texas or Hays County also involve collaborative efforts between volunteers and local agencies. In both cases, the groups are collecting information to assess areas of concern related to pathogens and contact recreation. A successful collaboration occurred recently, when the Texas Watch Rockport Sentinels monitoring group was officially recognized as a committee of the city and is now being funded to collect water chemistry and bacterial indicator data.

Partner Activities

The Texas Watch partners program solicits the assistance of public and private entities in training, equipping, managing, and general support for the growing number of volunteer monitors. Partner support is a key to the success of Texas Watch. The partners program facilitates communication and cooperation between partners and citizens.

Monitors Brave Cold Weather During a January Water Quality Monitor Certification Training.

Quality Assurance of Texas Watch Data

For volunteer data to be useful, they must be collected and recorded following established quality assurance methods. The EPA Region 6 provides the funding for Texas Watch a nonpoint source grant program under CWA Section 319. Federal policy requires that data collected through EPA grants be collected following precise standards. These standards must be specified in an approved QAPP. By adhering to these guidelines, Texas Watch is able to assure all users that volunteer data meet specified quality standards. Currently, Texas Watch operates within two QAPPs. The Integrative Quality Assurance Project Plan (IQAPP) covers ambient water quality monitoring across the state. Data collected within the guidelines of the IQAPP can be used for educational purposes, research, screening and problem identification, and other uses deemed appropriate by resource managers and the TCEQ. The Project-Specific Quality Assurance Project Plan (PSQAPP) involves twenty monitors who sample eighteen sites in the lower Colorado, San Jacinto, and Lavaca-Guadalupe Coastal basins. The data collected within PSQAPP guidelines can be used in TMDL development, stream standards modifications, permit decisions, water quality assessments, and other programs deemed appropriate by the TCEQ. Texas Watch has submitted 326 monitoring events and 1,549 monitoring results from 20 sites to TRACS.

Texas Watch Data Viewer

Texas Watch's new data viewer has been restructured and is working with new query capabilities and updated information. The purpose of this viewer is to make the data collected by Texas Watch water quality monitors available to researchers, teachers, water quality professionals, and concerned citizens. With this interface, now users can access assorted locational attributes for each site, including the site number, basin and county. To further help provide a geographic context for the data sites, as the map is zoomed in, supplementary layers are added to the view in a geographic information system (GIS) style interface. This technology uses the most current mapping information available. With these sources at hand, users can see nearby roads, city polygons, rivers and major lakes. In addition to spatial information, water quality parameters such as dissolved oxygen, pH, conductivity and temperature can also be accessed and examined. The data viewer also allows for spatial interpretation of where Texas Watch has monitoring coverage throughout the state.

Readers are encouraged to try out this new site and provide feedback. The Texas Watch data viewer can be accessed at: www.texaswatch.geo.swt.edu/

Volunteers monitor a wide variety of habitats ranging from rivers, creeks, ponds, and lakes to bays, bayous, and estuaries. Texas Watch supports a wide range of monitoring activities, including a rigorous certified water quality monitoring program and nonpoint source education programs.

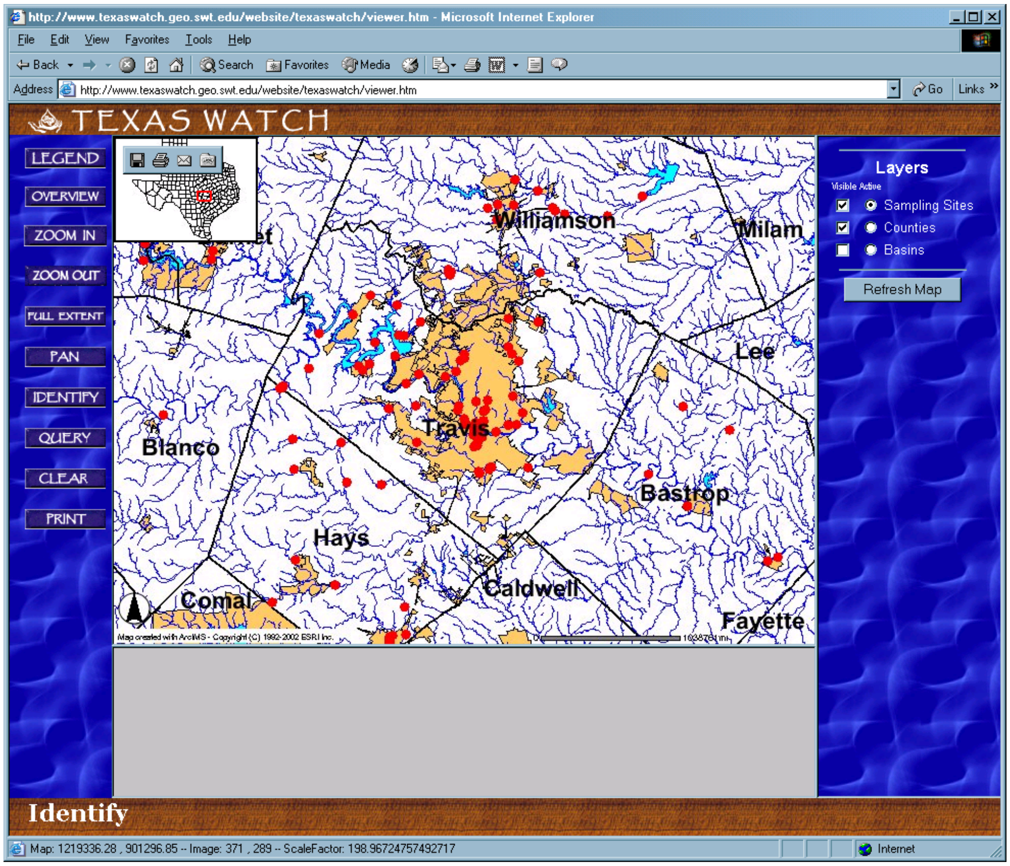


Figure 4-8. Texas Watch Data Viewer Screen

Current Program Status

Texas Watch monitors have 16,882 separate monitoring events from 644 different sites. During each monitoring event, volunteers routinely collect pH, conductivity or salinity, dissolved oxygen (duplicate sample), water temperature, secchi depth, flow severity, algae cover, water color, water clarity, water surface, water conditions, water odor, and precipitation information. Veteran monitors may also gather nutrients, bacteria, and biological information at select sites. 208,493 separate water quality parameters are stored in the Texas Watch Database.

Texas Watch is dedicated to establishing open lines of communication with the public and among institutions concerned about water quality. The Texas Watch central office is located in the Department of Geography at

SWT. Texas Watch produces a quarterly newsletter, which currently reaches 3,200 subscribers. Its web site provides NPS information, environmental education curriculum, Texas Watch water quality data, and contact information about partnering organizations that support Texas Watch.

Everyone Learns About NPS Pollution and Water Quality during Texas Watch events.