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Executive Summary

Local residents swimming in Elm Creek near Ballinger

Executive Summary

The Texas Natural Resource Conservation Commission (TNRCC) is a public agency that strives to protect the state's precious human and natural resources consistent with sustainable economic development. The TNRCC's goal is clean air, clean water, and safe management of waste. To accomplish this mission, the TNRCC will provide efficient, prompt, and courteous service to the people of Texas, ever mindful that its decisions are based on common sense, good science, and fiscal responsibility.

The Texas Water Quality Inventory is prepared by the TNRCC and submitted to the United States Environmental Protection Agency (EPA) biennially on even-numbered years in accordance with Section 305(b) of the Clean Water Act (CWA). Due to the enabling legislation, the Inventory is often called the 305(b) report. The 305(b) report enables the public, local governments, state agencies, the Texas Legislature, the EPA, and Congress to evaluate water quality in Texas. Water bodies identified with impaired designated beneficial uses as a result of the 305(b) assessment are placed on the 303(d) list of impaired water bodies [as required under CWA Section 303(d)].

General water quality described in the 2000 report represents a "snapshot," or water quality conditions at the time of assessment. This is because of the short duration (five years) over which the assessment is made and the fact that survey methods, criteria and screening levels, the number and types of water bodies included, and portions of water bodies assessed are often modified or changed from one reporting period to the next. Changes in survey methods and criteria are made to reflect revised water quality standards and EPA guidance for preparation of the report and are necessary to improve overall confidence in the assessment. For these reasons, the report should only be used to indicate water quality status in the year the assessment is made and is not recommended for comparison of change or "trends" between reporting periods.

The report includes descriptions of the Texas Surface Water Quality Standards (TSWQS) and the TNRCC and Clean Rivers Program (CRP) Surface Water Quality Monitoring (SWQM) program. The TNRCC's Public Drinking Water program and the agency's program to provide for protection of instream uses are detailed. In addition, the report includes an assessment of the extent to which the state's waters provide for healthy aquatic communities, recreation in and on the water, and safe public water supplies. Also identified are water bodies where concerns are caused by elevated nutrient concentrations, excessive algal growth, elevated dissolved minerals in public water supplies, and toxic contaminants in sediment and fish tissue. Information on the programs to protect and

restore the state's wetlands is provided. An overview of the state's groundwater protection programs, major sources of groundwater contamination and ambient groundwater quality monitoring are also included. Eighteen aquifers have been selected for assessment in this report, and other documented cases of groundwater contamination and ambient groundwater quality data are discussed. The surface water pollution control programs utilized by the TNRCC to ensure protection and restoration are described. Descriptions of surface water quality within each monitored water body where data are sufficient to provide assessment of at least one designated beneficial use are included in Volumes 2 and 3 of the report.

Texas has a large number of water bodies with 11,247 streams and rivers large enough to be named. The total length of all streams and rivers combined totals 191,228 miles. However, only 40,194 miles of streams and rivers (21%) are considered perennial, meaning that they have sustained flow throughout the year. Portions of the Red River, Sabine River, and Rio Grande, which form parts of borders with Oklahoma, Louisiana, and Mexico, respectively total 2,475 miles. Texas has 9,993 inland reservoirs and lakes 10 acres or larger in size that together cover approximately 1,994,600 acres and 203 major reservoirs (greater than 5,000 acre-feet each) that encompass approximately 1,690,140 surface acres. Texas bays and estuaries cover approximately 2,394 square miles along a coastal shoreline that stretches 624 miles in length. The Gulf of Mexico, within Texas' jurisdiction from Sabine Pass on the north to Brazos Santiago Pass on the south, covers approximately 3,879 square miles. With 4,959 total square miles covered by fresh water and saltwater, Texas ranks first among states in the conterminous United States. In addition, nine major and 20 minor aquifers, underlying approximately 76 percent of the state's surface area, provide an extensive groundwater resource. Approximately 61 percent of the 15.4 million acre-feet of water used by Texans in 1997 was derived from groundwater sources. About 75 percent of the groundwater produced is used for irrigation. Municipal water supply systems statewide rely on groundwater for about 39 percent of their annual usage.

In response to a favorable climate, adequate water, and a strong economy, Texas' population has shown robust growth since 1900. Texas' current population was estimated in 2000 at 20,231,000, ranking it second in the nation. The forecast is for continued moderate growth, with the population nearly doubling to 36,671,000 residents by 2050. Agricultural irrigation has historically been the largest use of water, but as the population continues to grow, combined water use by municipalities and industries is projected to surpass agricultural usage. As water use continues to increase in response to the growing population, the source of supply is expected to shift more to surface water due to decreasing availability of groundwater.

Despite the magnitude of water resources in Texas, they are not uniformly distributed. In several areas of the state during recent periods of drought, surface and groundwater supplies have nearly been depleted in some localized areas. Surface and groundwater supplies have already limited growth and agricultural production in some areas of the state. As the Texas population has continued to grow at a rapid pace, pushing it to the second most populous state in the nation, the need to conserve, protect, and restore surface water and groundwater supplies has never been more paramount.

Surface Water Quality Monitoring Program

The TNRCC maintains an ambitious SWQM program in order to characterize existing water quality and emerging problems, define long-term trends, determine water quality standards compliance, and describe seasonal variation and frequency of occurrence of selected water quality constituents. The program's monitoring strategy involves:

- sampling at a large fixed network of sites statewide,
- special studies and intensive surveys to identify causes and sources of pollutants and quantify point and nonpoint source loads,
- receiving water assessments (RWAs) to determine appropriate aquatic life uses (primarily in small streams at the time of permit discharge action), and
- use attainability analyses (UAAs) to ensure standards and criteria are appropriately set.

The SWQM Program is coordinated by the SWQM Team within the Monitoring Operations Division of the TNRCC. The SWQM Team interacts with several other key organizational units within the TNRCC that are also involved directly in SWQM activities. The Watershed Management Team coordinates the CRP and nonpoint source monitoring activities. The Water Quality Standards Team (WQST) coordinates receiving water assessments and use attainability analyses. Although these TNRCC teams are not part of the SWQM Program, they are included because they participate in collecting and managing SWQM data.

Surface water quality monitoring conducted by the TNRCC regional and central offices is closely coordinated with the CRP to enhance spatial coverage of monitoring sites, reduce duplication of monitoring effort, and ensure consistency in sampling methods. Annual meetings are hosted by the CRP planning agency within each of the major river basins and a coordinated basin-wide schedule (plan) is compiled. The basin monitoring plans are then aggregated to produce a statewide SWQM schedule. During the current year (2000), 1,429 fixed monitoring sites are being monitored by the TNRCC (431 sites), the CRP (920 sites), and the United States

Geological Survey (USGS) (78 sites). This total represents an increase of 943 sites over the number (446) that was monitored by the TNRCC alone in 1996. The substantial increase in the number of monitoring sites demonstrates the power of coordinating statewide monitoring resources.

Parametric coverage that is common to most sites includes field measurements (dissolved oxygen, pH, water temperature, and specific conductance), fecal coliform (bacteria), and a water chemistry sample (nutrients and dissolved minerals). Flow measurements are made at the time of sampling at most stream and river sites to relate chemical concentrations and flow. Monitoring of toxic substances in water, sediment, and fish tissue, toxicity testing of ambient water and sediment, and biological sampling (benthic macroinvertebrates and fish community structure analyses) are additional coverages that are included at about only 100 sites due to much higher costs associated with laboratory analytical determinations of toxic substances and time required for sampling and analysis.

Since 1995, 32 special studies and 11 intensive surveys have been conducted by TNRCC and CRP monitoring personnel. RWAs are another important component of the SWQM Program. RWAs are conducted primarily on unclassified streams in conjunction with a new or amended TNRCC discharge permit application. RWAs may be conducted by TNRCC Regional Office SWQM Program personnel, TNRCC Central Office SWQM and WQS teams, or by CRP personnel. These studies involve the use of physical, chemical, and biological characteristics in the assessment of appropriate aquatic life uses. Since 1988, 229 RWAs have been conducted statewide by monitoring personnel. Since 1982, the WQST has conducted 32 UAAs on classified water bodies to ensure that the assigned designated uses and supporting water quality criteria are appropriately set. In some cases, the use attainability analyses may be used to subdivide existing segments and establish site-specific water quality standards for newly created classified segments.

The Texas Watch volunteer environmental monitoring program also collects of water quality data. The number of participating Texas Watch groups across the state has steadily grown since 1995. Volunteers monitor a wide variety of river, creek, pond, reservoir, and estuary habitats. Texas Watch data are collected according to rigid quality assurance protocols to ensure consistency and reliability. The data from these groups are used in addition to the professionally collected data to provide a broader basis for analysis.

The CRP is a unique water quality monitoring, assessment, and public outreach program, and is funded by state fees. The CRP is a collaboration of 15 regional water agencies and the TNRCC that provides an opportunity to approach water quality issues within a watershed or river basin at the

local and regional level, coordinating efforts among diverse agencies and various programs. Each regional water agency implements the CRP guidance based on the unique circumstances that are present in its basin. Minimum expectations are set forth in the CRP guidance, and based on local factors, there is a certain amount of individuality in the focus and implementation of the program in each basin.

The CRP strategy supports four major objectives: long-term trend analysis, identification of water quality issues, definition of water quality issues and sources, and information for permit decisions. Through the public outreach efforts of each regional water agency, public input is sought and information is disseminated. This outreach enables the public to participate in decision-making, and provides them with a more complete understanding of the water quality issues and how they relate to each citizen.

Substantial improvements to the surface water quality monitoring program have been made since the last reporting cycle (1996) through improved coordination with CRP contractors and USGS. The number of monitoring sites was increased by more than 250 percent, with 920 new sites added to the statewide fixed network since 1996. The addition of these new sites enabled the assessment of 2,994 more miles of streams and rivers, 34,294 more acres or reservoirs and lakes, and 2.7 more square miles of estuaries in 2000 than in 1996.

The overall goal of the TNRCC and CRP monitoring programs is to provide complete spatial coverage of streams and rivers, reservoirs and lakes, estuaries, and ocean waters. Such comprehensive monitoring would provide information on assessment value (condition of the resource), spatial and temporal trends in resource condition, and identification of causes and sources of pollution that impairs designated uses.

Monitoring of reservoirs and lakes (78% assessed) and estuaries (83% assessed) is nearing comprehensive coverage, but significant gaps remain for streams and rivers (43% of perennial waters assessed), and the Gulf of Mexico (less than 1% assessed). These coverage estimates are based primarily on the least expensive and most indirect method of monitoring (instantaneous field measurements). Far less area is covered for all water body types when more rigorous, expensive, and direct indicators are used for determining support of designated uses (that is, 24-hour dissolved oxygen, toxic substances in water and fish tissue, ambient water and sediment toxicity testing, and biological monitoring). For these individual indicators, monitoring coverage is generally less than 10 percent in streams and rivers, reservoirs and lakes, estuaries, and the Gulf.

Public Water Supply

The TNRCC is charged with enforcing the Public Water Supply Supervision program of the Safe Drinking Water Act and the National Primary Drinking Water Regulations. The act and regulations establish standards for chemical and microbiological quality of public water systems.

The Drinking Water Standards are basically divided into two parts. The primary standards are set to protect the health of the consumers by setting maximum contaminant levels (MCLs) for inorganic and organic substances. In all instances, the Texas primary standards are set at the same level as the federal primary standards. The secondary standards are set at levels that, in most cases, prevent the water from being aesthetically objectionable; they generally are equivalent to the federal standards.

In order to ensure standards compliance, samples for chemical analysis are collected from a water treatment plant at the point where water enters the distribution system following mixing and treatment. Current chemical compliance in the state is good. Only 162 violations of the primary organic and inorganic MCLs have occurred statewide. Most of these episodic exceedances have been due to elevated levels of fluoride or nitrate nitrogen. These contaminants occur primarily in groundwater sources and result from natural background conditions. The most commonly detected surface water contaminant is atrazine, but only one MCL violation has occurred.

Water Rights and Instream Uses

The TNRCC has the authority to grant water rights permits for unappropriated waters of the state. Chapter 11 of the Texas Water Code specifies that before the TNRCC grants a right to use state water, it must first determine whether unappropriated water is available at the applicant's requested location. Current procedures define unappropriated water as the amount remaining in the stream after all existing authorized water rights holders withdraw their permitted amounts and after all environmental needs for instream uses have been met. Granting water rights without a review of water availability would compromise existing authorizations and threaten aquatic natural resources.

Although a current regulatory program exists to protect instream uses, including freshwater inflows to bays and estuaries, there are a number of potential problems that may place the ecological health of instream and estuarine communities at risk. These include:

- inadequate regional or basin-specific biological information on the instream flow needs of freshwater riverine species or communities;

- inadequate assessment of the role of groundwater connections to surface water; and
- lack of a current framework or regulatory authority to review existing permits that contain no provisions for instream flows or for bay and estuary freshwater inflows.

These potential problems may contribute to the following impacts.

- Increases in anthropogenic water use and consumption of water by streambank vegetation decrease the amount of stream flow and spring flow available to maintain an ecologically healthy instream community.
- Modification of stream channels, building of reservoirs, and irrigation of cropland change the seasonal distribution of flows and the location of terrestrial water storage.
- Diversion, impoundment and terrestrial use of water have the potential to decrease freshwater stream flow from reaching the bays and estuaries along the Texas coast. These freshwater inflows are critical for maintaining the historical productivity of these waters.

Based upon these areas of concern, the Colorado and Nueces Rivers appear to be at greatest potential risk from unrestricted diversion of stream flow for consumptive purposes. However, this risk is alleviated in the Lower Colorado Basin by the implementation of a management plan by the Lower Colorado River Authority (LCRA). The Nueces River continues to be at risk; however, much of the demand for water in the basin is concentrated near the coast, limiting the geographical distribution of the risk. Ongoing negotiations between state agencies and water users in the lower Nueces Basin may alleviate the risk to instream communities. Many of the existing rights authorizing diversion under Texas' appropriative water rights system have never been fully utilized. As a result, the high level of appropriation in many river basins is less of an immediate risk to instream uses, but this situation is expected to change in the near future. Projections for water use in the year 2050 suggest that current water rights will be heavily utilized. At that time, the potential risks to instream uses, including freshwater inflows to bays and estuaries, will become much more significant.

Surface Water Assessment

In order to assess surface water quality for the 2000 report, the SWQM Team evaluated compliance with the TSWQS (approved in 1997) and other screening levels. Support of aquatic life uses was primarily determined by evaluating historical instantaneous dissolved oxygen data. Support of aquatic life uses was also assessed by other indicators, such as

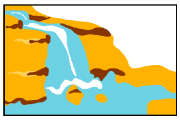
24-hour dissolved oxygen concentrations, toxic substances in water (acute and chronic exposure to aquatic life), ambient water and sediment toxicity testing, and biological community structure analyses. Fecal coliform data were used to determine support of the contact and noncontact recreation uses and the oyster waters use. Water temperature, pH, and dissolved mineral data were used to evaluate support of general uses. Primary organic constituents in finished drinking water were compared to MCLs to determine support of the public water supply use. Exceedance of human health criteria (toxic substances in water) and issuance of consumption advisories and aquatic life closures by the Texas Department of Health (TDH) were used to assess the fish consumption use.

Five years of recent SWQM data for parameters which are protective of assigned uses (for instance, aquatic life and contact recreation) were compared to established criteria. The number of criteria exceedances were divided by the total number of measurements for each parameter and expressed as a percentage. The percent exceedance values were compared to rating criteria (for example, 0-10%; greater than 10%-25%; and greater than 25%) to determine if a use is supported, partially supported, or not supported. In some cases (dissolved minerals, chronic exposure to toxic substances, human health criteria, and finished drinking water criteria), an average value was compared to criteria to determine support of the use.

The number of stream and river miles, reservoir and lake acres, or estuary and Gulf of Mexico square miles supporting each designated use were aggregated to provide statewide assessment status information.

The TNRCC developed screening levels for nutrients and chlorophyll *a* in water, toxic substances in sediment and fish tissue, and narrative criteria. These screening levels are used to identify concerns; however, they are not standards, nor are they threshold levels for health effects. Secondary standards for dissolved minerals in finished drinking water were used to identify public water supply concerns in both finished (after treatment) and surface water samples.

If nutrient concentrations in water, toxic substance concentrations in sediment or fish tissue, or average concentrations of dissolved minerals in finished drinking water or surface water samples exceed their screening levels, there is a cause for concern. Water bodies with identified concerns may be scheduled for more intensive monitoring or special studies to determine causes and sources of the concern. Water quality indicators screened for concerns do not cause direct impairment of uses. Therefore, water bodies with only identified concerns are not placed on the 303(d) list. Five years of recent SWQM data were compared to screening levels in order to identify areas of water quality concern.



Streams and Rivers

Streams and rivers are characterized by flow. Perennial streams flow continuously throughout the year. Intermittent streams and rivers become completely dry in portions of their channels for a period of a week or more during most years due to drought conditions or upstream withdrawals. Some intermittent streams become completely dry in shallow portions of their channels but maintain perennial pools in deeper areas of the channel.

Texas has a total of 191,228 miles of streams and rivers. Of this total, about 40,194 miles (21%) are considered perennial. For the 2000 report, sufficient water quality data were available to provide assessment of 348 streams (222 classified and 126 unclassified) that cover approximately 15,082 miles (8% of total miles and 38% of perennial miles). About 70 percent of assessed streams and rivers fully support all their designated uses. Some form of pollution impairs the remaining 30 percent. Contact recreation is the use most frequently impaired in assessed streams and rivers. Impairment of general uses and aquatic life uses also contributes significantly to impairment of overall uses.

Elevated fecal coliform densities (contact recreation use), depressed dissolved oxygen concentrations (aquatic life uses), and elevated average concentrations of dissolved minerals and low or high pH values (general uses) are the most common causes or stressors affecting assessed streams and rivers. Bacteria provide evidence of possible fecal contamination that may cause streams and rivers to be unsafe for swimming and other recreational activities. Most of the streams and rivers with impaired aquatic life uses have low dissolved oxygen concentrations and are located in East Texas. In this area of the State, streams and rivers typically have low stream velocity, dense tree canopy shading, low stream gradients and few riffles (limiting replenishment of oxygen by physical reaeration), and high sediment oxygen demand (caused by decaying leaves and other debris). These are naturally-occurring factors which contribute to low dissolved oxygen concentrations. In other areas of the state, low stream flow caused by drought, or sluggish tidal activity in coastal regions, contributes substantially to depression of dissolved oxygen in streams and rivers. Assimilation of even minor point and nonpoint source pollutant loads in streams and rivers, already stressed by near stagnant velocity, contributes further to depression of dissolved oxygen concentrations. Low pH values are common in East Texas streams and rivers due to the low presence of acid-neutralizing materials in the sandy soils of the region. High pH values may result from photosynthesis in the daytime by abundant algae. Elevated dissolved mineral concentrations typically occur in streams and rivers that cross salt-bearing strata.

Sources of point and nonpoint pollution in assessed streams and rivers are largely unknown. Of the known sources, discharges from municipal sewage treatment plants account for the largest category. Urban runoff, sources from outside the state (inflowing water with high dissolved minerals), agricultural sources (irrigated crop production and confined animal feeding operations), and natural sources are also known sources of pollution that impair designated uses. Discharges from municipal sewage treatment plants, if not properly treated, may introduce organic matter (which depletes dissolved oxygen), ammonia nitrogen (which depletes dissolved oxygen and is toxic to aquatic life), nutrients (which stimulate excessive growth of aquatic plants), and bacteria (which make waters unsafe for swimming).

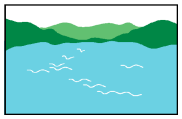
For the 2000 report, sufficient data were available to assess individual nutrient concerns in about 50 percent of assessed streams and rivers. Of the approximately 9,000 miles assessed, nutrient concerns were identified in only eight percent (22 streams and rivers) for ammonia nitrogen, 14 percent (34 streams and rivers) for nitrite plus nitrate nitrogen, six percent (22 streams and rivers) for orthophosphorus, and seven percent (22 streams and rivers) for total phosphorus. Most of the streams and rivers identified with nutrient concerns receive heavy municipal and urban nonpoint source loadings. About 18 percent of the 7,300 miles of streams and rivers assessed for chlorophyll *a* were identified with concerns. Of the 32 streams and rivers in which chlorophyll *a* causes concern, only eight also had concerns for at least one of the nutrient indicators. The lack of correlation in streams and rivers with elevated nutrient concentrations and chlorophyll *a* concentrations demonstrates some of the difficulties in development of water quality criteria for nutrients. In many cases, elevated nutrient concentrations fail to produce responding elevated chlorophyll *a* concentrations. Other factors such as turbidity, stream flow characteristics, and tree canopy shading influence availability of nutrients and their assimilation by algae and aquatic plants.

Due to limited sampling data, only 767 stream and river miles (4.4% of 17,341 surveyed miles) were assessed for sediment concerns. Of the assessed miles, 46 percent (21 streams and rivers) were identified with concerns for one or more sediment contaminants, and most of which were metals. Even fewer stream and river miles (127 miles, or less than 1% of surveyed miles) were assessed for contaminants in fish tissue. Fish from the Houston Ship Channel (Segment 1007) exceeded screening levels for dieldrin and chlordane. These two pesticides have historically been used to control residential insect pests and probably entered the Buffalo Bayou drainage through urban runoff.

All of the 8,881 stream and river miles designated for public water supply were assessed for concerns by use of secondary criteria for dissolved

minerals. About 12 percent of assessed miles (nine water bodies) were identified with concerns for chloride, sulfate, or total dissolved solids (TDS) in either finished drinking water samples or in surface water. Most of the streams and rivers with public water supply concerns are located in the headwater regions of the Colorado or Brazos River basins where elevated dissolved minerals concentrations are natural due to flow over salt-bearing strata. In the Rio Grande basin (four stream and river segments), surface water is used repeatedly for irrigation, thereby concentrating dissolved mineral concentrations.

The Bosque River (Segments 1226 and 1255) and Papermill Creek (Segment 0610B) are the only streams and rivers with narrative criteria concerns. Their combined mileage is less than one percent of the total miles assessed for narrative criteria concerns. In both segments of the Bosque River, nutrient concentrations overstimulate the growth and proliferation of algae. In Papermill Creek, color and odor of the stream is influenced by effluent from a paper mill.



Reservoirs and Lakes

Reservoirs and lakes are depressions that hold water for extended periods of time. Lakes are natural and reservoirs are man-made. Lakes and reservoirs may receive water carrying pollutants from inflowing streams and rivers, runoff from their watersheds, and direct discharges from domestic and industrial sources. Some pollutants become trapped in reservoirs and lakes because relatively low current velocities, long storage times, and lack of shading by riparian canopy encourages uptake of dissolved minerals by algae and bacteria, and their subsequent sedimentation, along with much of the particulate load delivered through tributary inflows. Even under natural conditions, sediment, nutrients, and organic materials accumulate in reservoirs and lakes as part of the natural aging process (eutrophication). Texas has a total of 9,993 reservoirs and lakes that are ten acres or larger in size that collectively cover an estimated 1,994,600 acres. For the 2000 report, sufficient water quality data were available to assess 119 reservoirs and lakes (99 classified and 20 unclassified) which cover 1,571,233 acres, or 79 percent of the total acres. About 62 percent of the assessed acres fully support all their designated uses. Some form of pollution impairs the remaining 38 percent. The fish consumption use is the most frequently impaired individual use in assessed reservoirs and lakes. Impairment of general uses and aquatic life uses also contributes significantly to impairment of overall uses in assessed reservoirs and lakes.

Elevated mercury concentrations in fish tissue (fish consumption use), low and high pH values, and elevated average concentrations of dissolved minerals (general uses), and depressed dissolved oxygen concentrations (aquatic life use) are the most common causes or stressors affecting

assessed reservoirs and lakes. The TDH has issued consumption advisories for six East Texas reservoirs due to elevated mercury concentrations in fish tissue (primarily largemouth bass). The advisories recommend restrictions in consumption of fish caught from these reservoirs. Mercury is a naturally-occurring element that can be toxic when consumed by animals and humans. Sources of mercury include weathering of the earth's crust, the burning of garbage and fossil fuels, and industries that use mercury. Low pH values are common in East Texas reservoirs and lakes due to the low presence of acid-neutralizing materials in the sandy soils of the region. Algae and other aquatic plants may cause high pH values in reservoirs and lakes due to photosynthesis during daylight hours. Low dissolved oxygen concentrations are generally restricted to localized headwater areas in reservoirs where tributary inflows transport substantial point and nonpoint source pollutant loads. The headwaters areas are typically marshy and shallow in depth. Reduced velocity and little physical turbulence (low aeration) in these headwaters are natural factors that contribute equally to lower dissolved oxygen concentrations. Elevated dissolved mineral concentrations may occur in reservoirs if inflowing tributaries pass over salt-bearing strata in their watersheds. High evaporation rates in the western part of the state also accelerate concentration of dissolved minerals in reservoirs and lakes.

Sources of pollution in assessed reservoirs and lakes are largely unknown. Of known sources, atomospheric deposition of mercury contributes most to use impairment in reservoirs and lakes. Bioaccumulation of mercury in East Texas fishes occurs primarily because of in-reservoir processes related to low pH, elevated organic carbon, and low dissolved oxygen concentrations which control its availability to aquatic organisms. Irrigated crop production, sources outside the state (inflowing water with elevated dissolved minerals), and urban runoff are also identified as significant known sources which impair designated uses in reservoirs and lakes.

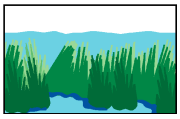
For the 2000 report, sufficient data were available to provide assessment of individual nutrient concerns in about 500,000 reservoir and lake acres (about 30% of surveyed acres). Of the acres assessed, only six percent (four reservoirs) were identified with concerns for ammonia nitrogen, 13 percent (11 reservoirs and lakes) for nitrite plus nitrate nitrogen, nine percent (five reservoirs and lakes) for orthophosphorus, and four percent (five reservoirs and lakes) for total phosphorus. Available chlorophyll *a* data provided assessment of slightly fewer acres (430,737 or 27% of surveyed acres), and 14 percent (eight reservoirs and lakes) were identified with concerns. About half of the reservoirs and lakes with chlorophyll *a* concerns also had concerns for one or more of the nutrient indicators, suggesting that nutrient loading may be responsible for stimulation of algal growth in the impoundments.

Due to high analytical laboratory costs associated with sediment samples, only 88,463 reservoir and lake acres (5.6% of surveyed acres) were assessed for sediment concerns. However, 94 percent (nine reservoirs) of assessed acres were identified with sediment concerns. In all but one reservoir, metals were the only toxic substance contaminants reported in the sediments.

Even fewer acres were assessed for fish tissue concerns (28,448 acres; 2% of surveyed acres) and only two percent were identified with concerns. Town Lake in Austin was the only reservoir identified with fish tissue concerns due to elevated concentrations of hexachlorobenzene. The TDH has concluded, however, that the hexachlorobenzene concentrations in fish from the reservoir do not pose a health risk to human consumers.

Public water supply concerns were identified in about 11 percent (nine reservoirs) of the 1,516,932 acres surveyed. All of the reservoirs and lakes that exceed chloride, sulfate, and TDS criteria are located in the Canadian, Upper Red River, Upper Colorado River, and Upper Brazos River basins where water is naturally salty due to runoff from salt-bearing strata.

The extreme headwaters region of Sam Rayburn Reservoir is the only reservoir area identified with narrative criteria concerns. The color and odor of water in the upper portion of the Angelina River Arm is influenced by effluent from a paper mill.



Estuaries

Estuaries are coastal waters where inflowing stream or river water mixes with, and measurably dilutes, sea water. In Texas, estuaries are the lower tidal portions of rivers and streams that directly enter the Gulf of Mexico or its bay systems. Estuaries serve as important nursery areas for many commercial fish and most shellfish populations, including shrimp, oysters, crabs, and scallops. For this report, tidal portions of streams and rivers, although estuaries, are considered part of the stream and rivers category.

Texas has a total of 2,394 square miles of estuaries. For the 2000 report, sufficient water quality data were available to provide assessment of 49 estuaries (46 classified and 3 unclassified) which cover 1,993 square miles, or about 83 percent of the total area in estuaries. About 62 percent of assessed estuary square miles fully support all their designated uses. Some form of pollution impairs the remaining 38 percent. The oyster waters use is the most frequently impaired individual use in assessed estuaries. Impaired aquatic life and fish consumption uses also contribute significantly to overall use impairment in assessed estuaries.
Elevated fecal coliform densities (oyster waters use), depressed dissolved oxygen concentrations (aquatic life use), and elevated dioxin in fish and

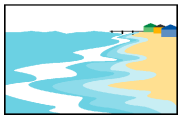
crab tissue (fish consumption use) are the most common causes or stressors affecting assessed estuaries. Elevated fecal coliform densities occur in localized estuary areas due primarily to inflowing streams and rivers. Oyster harvesting is closed or restricted by the TDH in areas where fecal coliform densities exceed criteria on a frequent basis. These areas are depicted on shellfish harvesting maps, which are updated and published each year by the TDH. The cause of low dissolved oxygen in estuaries is generally due to a combination of natural factors. As the estuarine waters warm in the hot summer months and become more saline due to reduced freshwater inflow, they lose their ability to retain dissolved oxygen. Assimilation of even minor point and nonpoint source loads, and natural loading resulting from cycling of internal sources of carbon and nutrients from the growth of sea grasses, may result in depression of dissolved oxygen below criteria. In many cases, depressed dissolved oxygen concentrations in estuaries result from natural factors (for example, elevated water temperature and salinity and nutrient cycling) that are not caused by human activities. Due to elevated concentrations of dioxin in fish and crab tissues, the TDH issued a no-consumption advisory governing children and women of child bearing age for the entire Upper Galveston Bay area, including tidal portions of streams and rivers that are contiguous with the bay.

Sources of pollution in assessed estuary square miles are largely unknown. Of known sources, natural sources (high water temperature and saline water) account for the largest number of impaired estuary square miles. Industrial sources (dioxin is a by-product of paper and pulp mill bleaching processes which use chlorine), urban runoff, and municipal point sources also contribute significantly to impairment of estuary square miles.

For the 2000 report, sufficient data were available to provide assessment of about 1,300 square miles (about 65% of surveyed square miles) for individual nutrient indicators. Of the square miles assessed, concerns were identified in only two percent or less for ammonia nitrogen, orthophosphorus, and total phosphorus. Nitrite plus nitrate nitrogen was the nutrient indicator with the highest number of assessed square miles with concerns (21%, or 12 estuaries). Approximately 1,306 square miles (65% of surveyed square miles) was assessed for chlorophyll *a* concerns. Of the assessed square miles 14 percent (five estuaries) were identified with concerns for chlorophyll *a*.

Sediment and fish tissue sampling data are very limited in estuaries due to high laboratory costs. Most of the limited sampling is targeted to areas where contamination is suspected due to nearby locations of industries. Of the 1,993 square miles surveyed, only 91 square miles (4.6% of surveyed square miles) and eight square miles (less than 1% of surveyed estuary square miles) were assessed for sediment and fish tissue concerns, respec-

tively. Elevated metals in sediment exceeded screening levels in six estuaries. No fish tissue or narrative criteria concerns were identified in any of the 1,993 square miles of estuaries assessed.



Ocean Water

The Gulf of Mexico is critical habitat for various stages of commercial fish and shellfish (such as shrimp). It provides habitat for endangered species (such as sea turtles), and is heavily used for recreational activities (such as fishing and swimming). The Gulf of Mexico, within Texas' jurisdiction, covers an area of approximately 3,879 square miles. For the 2000 report, sufficient data were available to provide assessment of the entire area.

Issuance of a no-consumption advisory by the TDH due to elevated mercury concentrations in king mackerel applies to the entire Gulf. For this reason, the fish consumption use and overall designated uses are not supported. Surface water quality monitoring of the Gulf for other indicators is actually very limited (8 square miles or less than 1% of the total area).

Elevated mercury in king mackerel is the most common cause affecting assessed Gulf square miles. The consumption advisory issued by the TDH is based on the size of fish. Since the advisory recommends no consumption of king mackerel larger than 43 inches, the entire Gulf is assessed as impaired. Separate stocks of king mackerel migrate to Texas waters in the early summer months (May and June) from waters off Florida and Mexico and typically stay through September. King mackerel from the Florida stocks contain elevated mercury concentrations and most states along the Gulf of Mexico have issued advisories similar to the one issued in Texas. Mercury contamination of the Mexico stocks has not been determined. The source of mercury in king mackerel is thought to be from atmospheric deposition. Other fish species, crabs, shrimp, oysters, and other marine organisms are not affected by the advisory

Of the 3,879 square miles of Gulf waters within the jurisdiction of Texas, only eight square miles were assessed for most concern indicators. In the assessed square miles, no concerns were identified for individual nutrient and chlorophyll *a* indicators. Fish tissue and sediment concerns were not assessed due to lack of data. Narrative criteria concerns were not identified in 3,879 square miles assessed.

Groundwater Assessment

Groundwater is a major source of the water used by Texans for domestic, municipal, industrial, and agricultural purposes. Texans use between nine and eleven million acre-feet of groundwater each year, the majority being

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

In 1989, the 71st Texas Legislature created the Texas Groundwater Protection Committee (Committee or TGPC) as a means to bridge the gap between existing state groundwater programs and to optimize water quality protection by improving coordination among agencies involved in groundwater activities. The Texas Water Code (TWC), §§26.401 through 26.407, establishes the Committee, whose membership includes the TNRCC, the Texas Water Development Board (TWDB), the Railroad Commission of Texas (RCT), the TDH, the Texas Department of Agriculture (TDA), the Texas State Soil and Water Conservation Board (TSSWCB), the Texas Alliance of Groundwater Districts, the Texas Agricultural Experiment Station (TAES), the Bureau of Economic Geology, and the Texas Department of Licensing and Regulation (TDLR). This section of the TWC also establishes the state's groundwater protection policy of non-degradation of the state's groundwater resources as the goal for all state programs.

This 305(b) report shows the groundwater inventory efforts performed in 1998 and 1999 that are part of the TGPC's consolidation of ambient, facility, and public water supply groundwater monitoring data. This inventory will be readily available to the public, local government, state agencies, the Texas Legislature, the EPA, and Congress so that they may evaluate Texas water quality. The TGPC's goal is to inventory the water quality of all major and minor aquifers at least every five years.

The 2000 groundwater inventory efforts show that ambient groundwater quality in Texas varies among the eighteen study aquifers, with MCL exceedances occurring for some parameters (nitrate, sulfate, total dissolved solids, or others) in groundwater taken from as many as half of the water wells sampled in the Ogalalla aquifer in the Texas Panhandle, and in some wells in the Edwards-Trinity, Cenozoic Pecos Alluvium, Capitan Reef Complex, and Rustler, Seymour, and Bone Spring–Victorio Peak aquifers. Ambient groundwater quality is generally good in the other aquifers inventoried in 1998.

Groundwater contamination at regulated facilities occurs principally in heavily populated areas of the state, such as Houston, Dallas, Fort Worth, San Antonio, and El Paso. Petroleum storage tank facilities are the largest category of contamination sources, but other regulated surface activities have resulted in contamination as well. Fortunately, regulated surface

activities tend to impact shallow, local water-bearing zones more than the deeper major and minor aquifers, but the potential for contamination remains.

Water Pollution Control Programs

The Water Pollution Control Program (WPCP) includes the primary regulatory programs being implemented by the TNRCC to maintain, restore, and enhance water quality in Texas. The watershed approach, being implemented in Texas as a process to address water pollution, is described. The WPCP describes the TSWQS which are the water quality goals of the TNRCC, which are consistent with the federal CWA goals; describes how point and nonpoint source discharges of pollutants are addressed; and describes how total maximum daily loads (TMDLs) are developed in Texas and how these regulatory activities will restore surface water quality in Texas. The WPCP also describes the Texas Coastal Management Program and the primary relationships between the TNRCC and other state and local agencies involved in water quality management.

Stream and river, reservoir and lake, estuary, and ocean waters identified with impaired or threatened designated uses and water quality concerns are targeted by the TNRCC and CRP for increased fixed station monitoring. Intensive surveys and special studies may be conducted on the water bodies to assist in identifying causes and sources of use impairments as well as for providing information on instream effects. Use attainability analyses may be required to ensure that water quality standards are appropriately set. TMDLs will be developed to evaluate point and nonpoint source impacts for water bodies with impaired or threatened uses.

Threatened Water Bodies

Less than one percent of assessed stream and rivers miles (Little River) and 6.3 percent of reservoir and lake acres (nine centrally located Texas reservoirs) are threatened, but fully support all designated uses. Public water supply use is threatened by elevated atrazine concentrations in finished drinking water samples. Atrazine is a herbicide that is used extensively in Texas for control of weeds in agricultural crops such as corn, sorghum, wheat, and soybeans. Atrazine enters the water bodies from nonpoint source runoff following rainfall. Surface waters surrounded by agricultural lands may receive several pulsed doses over the growing seasons, corresponding to rainfall events. Atrazine in finished water samples from the threatened water bodies exceed 50 percent of the MCL. Potential sources of atrazine in the watersheds of these water bodies are being managed by the TNRCC, the Texas State Soil and Water Conservation Board (TSSWCB), and local cooperators through implementation of best management practices.

Benefits and Costs of Surface Water Quality Programs

As part of the biennial report, states are required to provide an estimate of the cost and benefits of actions taken to meet the objectives of the CWA. Given the water quality conditions identified in the report, current expenditures must continue and new initiatives are needed to restore water quality so that impaired waters meet their beneficial uses.

The report provides a framework that identifies and systematically presents the benefits and costs for water quality programs. Cost data specific to Texas are presented. The framework is a summary matrix that presents different types of information - biological, economic, and social; for example, annual municipal capital costs and estimated annual sport fishing income are included. Generally, there is not very much data regarding the economic benefits of protecting aquatic life use and other water quality characteristics; however, it is possible to report some costs. Texas has spent approximately $5.2 billion in public monies since 1972 for water quality management programs. The benefit of these expenditures is that 70 percent of the assessed streams and rivers support their designated beneficial uses. As an annual investment, this is small; only one percent of the state's Gross Product. Industrial and private sector costs, that certainly have contributed significantly to meeting the goals of the CWA, are not available, and the need for more data on the private sector investment is an important planning issue. The framework developed for the 2000 report will be enhanced with additional data and studies so that a more comprehensive accounting can be presented in future 305(b) reports.