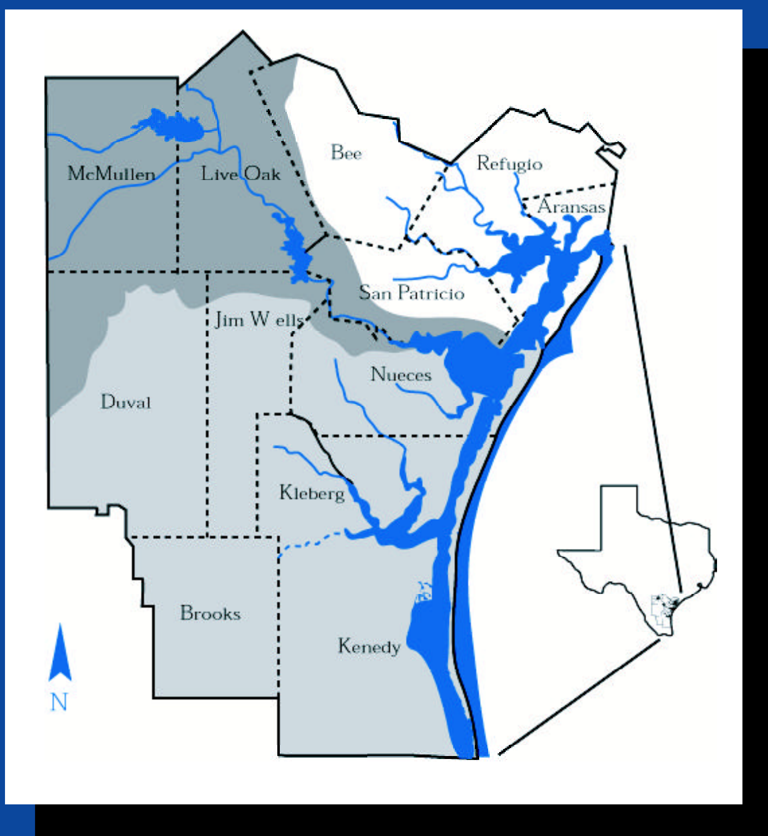
Characterization of Nonpoint Sources and Loadings to the Corpus Christi Bay National Estuary Program Study Area



Corpus Christi Bay National Estuary Program

CCBNEP-05 • January 1996

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Characterization of Nonpoint Sources and Loadings to Corpus Christi Bay National Estuary Program Study Area

Charles Baird, Natural Resources Conservation Service
Marshall Jennings, United States Geological Survey
Co-principal Investigators and Editors

and

Darwin Ockerman, United States Geological Survey
Tim Dybala, Natural Resources Conservation Service

January 1996

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TAMU-CC Campus Box 290 • 6300 Ocean Drive • Corpus Christi, TX 78412
512/985-6767 • FAX 512/985-6301 • CCBNEP home page: //www.sci.tamucc.edu/ccbnep

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CORPUS CHRISTI BAY NATIONAL ESTUARY PROGRAM

The Corpus Christi Bay National Estuary Program (CCBNEP) is a four-year, community based effort to identify the problems facing the bays and estuaries of the Coastal Bend, and to develop a long-range, Comprehensive Conservation and Management Plan. The Program's fundamental purpose is to protect, restore, or enhance the quality of water, sediments, and living resources found within the 600 square mile estuarine portion of the study area.

The Coastal Bend bay system is one of 28 estuaries that have been designated as an **Estuary of National Significance** under a program established by the United States Congress through the Water Quality Act of 1987. This bay system was so designated in 1992 because of its benefits to Texas and the nation. For example:

- Corpus Christi Bay is the gateway to the nation's sixth largest port, and home to the third largest refinery and petrochemical complex. The Port generates over $1 billion of revenue for related businesses, more than $60 million in state and local taxes, and more than 31,000 jobs for Coastal Bend residents.
- The bays and estuaries are famous for their recreational and commercial fisheries production. A study by Texas Agricultural Experiment Station in 1987 found that these industries, along with other recreational activities, contributed nearly $760 million to the local economy, with a statewide impact of $1.3 billion, that year.
- Of the approximately 100 estuaries around the nation, the Coastal Bend ranks fourth in agricultural acreage. Row crops -- cotton, sorghum, and corn -- and livestock generated $480 million in 1994 with a statewide economic impact of $1.6 billion.
- There are over 2600 documented species of plants and animals in the Coastal Bend, including several species that are classified as endangered or threatened. Over 400 bird species live in or pass through the region every year, making the Coastal Bend one of the premier bird watching spots in the world.

The CCBNEP is gathering new and historical data to understand environmental status and trends in the bay ecosystem, determine sources of pollution, causes of habitat declines and risks to human health, and to identify specific management actions to be implemented over the course of several years. The 'priority issues' under investigation include:

- altered freshwater inflow
- declines in living resources
- loss of wetlands and other habitats
- bay debris
- degradation of water quality
- altered estuarine circulation
- selected public health issues

The **COASTAL BEND BAYS PLAN** that will result from these efforts will be the beginning of a well-coordinated and goal-directed future for this regional resource.

STUDY AREA DESCRIPTION

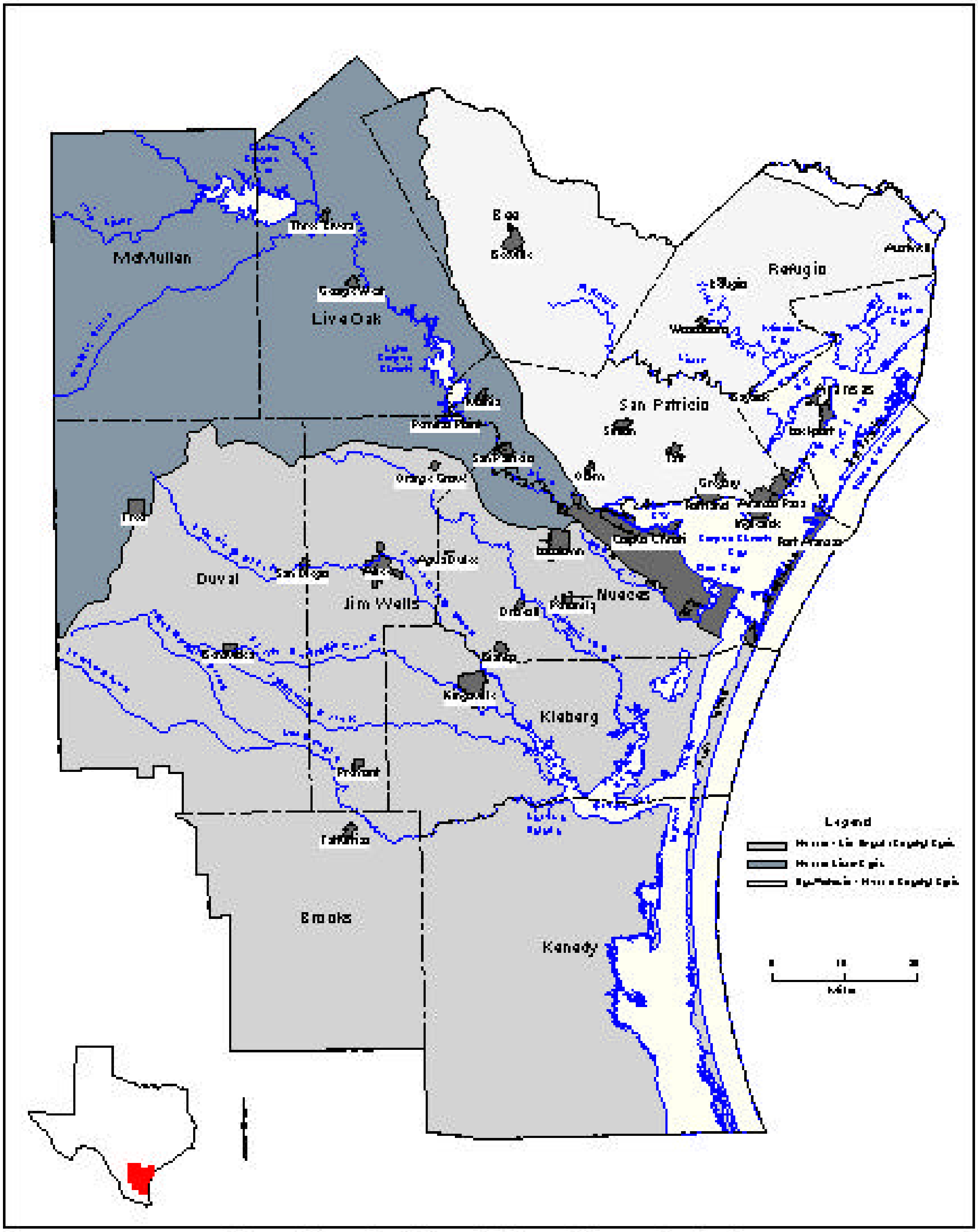
The CCBNEP study area includes three of the seven major estuary systems of the Texas Gulf Coast. These estuaries, the Aransas, Corpus Christi, and Upper Laguna Madre are shallow and biologically productive. Although connected, the estuaries are biogeographically distinct and increase in salinity from north to south. The Laguna Madre is unusual in being only one of three hypersaline lagoon systems in the world. The study area is bounded on its eastern edge by a series of barrier islands, including the world's longest -- Padre Island.

Recognizing that successful management of coastal waters requires an ecosystems approach and careful consideration of all sources of pollutants, the CCBNEP study area includes the 12 counties of the Coastal Bend: Refugio, Aransas, Nueces, San Patricio, Kleberg, Kenedy, Bee, Live Oak, McMullen, Duval, Jim Wells, and Brooks.

This region is part of the Gulf Coast and South Texas Plain, which are characterized by gently sloping plains. Soils are generally clay to sandy loams. There are three major rivers (Aransas, Mission, and Nueces), few natural lakes, and two reservoirs (Lake Corpus Christi and Choke Canyon Reservoir) in the region. The natural vegetation is a mixture of coastal prairie and mesquite chaparral savanna. Land use is largely devoted to rangeland (61%), with cropland and pastureland (27%) and other mixed uses (12%).

The region is semi-arid with a subtropical climate (average annual rainfall varies from 25 to 38 inches, and is highly variable from year to year). Summers are hot and humid, while winters are generally mild with occasional freezes. Hurricanes and tropical storms periodically affect the region.

On the following page is a regional map showing the three bay systems that comprise the CCBNEP study area.



Corpus Christi Bay National Estuary Program Study Area

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Executive Summary

Project Team:

Hudson R. DeYoe
: Project Coordinator, Corpus Christi Bay National Estuary Program

F. Charles Baird, P.E.
: Engineer, Natural Resources Conservation Service (NRCS), Principal Investigator

Marshall Jennings, P.E.
: Engineer, U.S. Geological Survey (USGS), Principal Investigator

Authors:

F. Charles Baird, P.E., NRCS
Timothy J. Dybala, P.E., NRCS
Marshall Jennings, P.E., USGS
Darwin J. Ockerman, USGS

The Corpus Christi Bay National Estuary Program (CCBNEP) study area encompasses an estuarine and near coastal environment of 75 miles (121 kilometers) of the south-central Texas coastline, and includes the 12 member counties of the Coastal Bend Council of Governments. This area includes all bays and saltwater bayous in the Aransas, Corpus Christi, Baffin, and Upper Laguna Madre bay systems. Drainage areas of 26,825 square miles (69,476 km^2) contribute inflow to the CCBNEP estuaries and include the Nueces river basin, the San Antonio-Nueces coastal basin, and the Nueces-Rio Grande coastal basin. The Nueces, Mission, Aransas, and San Antonio rivers contribute most of the fresh water inflow to the bays and estuaries of the study area.

The general objective of this investigation is to help define nonpoint source (NPS) pollution within the CCBNEP study area. This investigation provides a general overview of possible NPS pollution sources and related impacts to the CCBNEP study area. The work is directed at NPS pollutants originating from surface runoff and airborne pollutants, and is designed to provide loading estimates for geographic comparisons rather than absolute NPS loadings. These nonpoint sources of pollution contribute to loadings of receiving waters within the CCBNEP study area.

Literature and existing data was reviewed with respect to eight categories of land use and several pollutant parameters. Land use categories include:

> (1) industrial; (2) commercial; (3) transportation; (4) residential; (5) agricultural cropland and pastureland; (6) rangeland; (7) marinas; and (8) undeveloped/open.

Table ES.1 depicts the distribution of acreage in the study area.

This study is also designed to guide future efforts conducted at a more detailed scale of resolution. The additional studies will be necessary before area-wide implementation strategies can be developed.

Table ES.1 - Percentage of Land use in the CCBNEP Study Area (USGS, 1980)

Cropland and Pastureland	27 %
Rangeland	61 %
All other Uses	12 %

Nonpoint Source Event Mean Concentration (EMC) Values by Land Use Category

Data collected for the City of Corpus Christi National Pollutant Discharge Elimination System (NPDES) permitting process during 1992-1993 probably represents the most valuable source of EMC values for the urban portion of the CCBNEP study. Five sampling stations are included in this study.

Urban NPS pollution is generated by deposition, accumulation, and washoff by stormwater runoff. Generally, urban runoff includes suspended and dissolved solids, bacteria, metals, oxygen-demanding substances, nutrients, oil and grease, and pesticides. Nonpoint sources of these pollutants include vehicles, fertilizer and pesticide application, animal wastes, construction activities, erosion, and atmospheric deposition.

Possible nonpoint source pollutants associated with agricultural activities include nutrients, pesticides, organic matter, and animal wastes. Like urban NPS, these pollutants may be transported in solution with runoff water, suspended in runoff water, or adsorbed on eroded soil particles.

Water quality data from the Oso Creek U.S. Geological Survey stream gage and the Seco Creek USGS stream gages were used to develop EMC values for the agricultural land uses of the study area. The Oso Creek gage is immediately west of Corpus Christi and represents an area of mostly cropland. The Seco Creek gages are northwest of Hondo, Texas which is in the upper reaches of the Nueces River basin. The Seco gages represent the only data appropriate to rangeland for the study area.

In general, the potential for agricultural nonpoint source pollution is lower in the study area than in most other areas of the state. Nearly all of the soils classified as Highly Erodible Land by the NRCS are farmed under approved conservation systems. Slopes are relatively flat throughout the study area, especially in the agricultural cropland areas.

Table ES.2 is a summary of median EMC values by constituent and land use category for the CCBNEP study area. There is insufficient available data to further categorize the EMC values by watersheds or by seasonal variation.

Table ES.2 - Summary of Median EMC values by Constituent and Land Use Category for the CCBNEP Study Area

Constituent	Land Use						
	Residential	Commercial	Industrial	Transportation	Cropland	Rangeland	Undev/Open
Total Nitrogen (mg/L)	1.82	1.34	1.26	1.86	4.40	0.70	1.50
Total Kjeldahl Nitrogen (mg/L)	1.50	1.10	0.99	1.50	1.7	0.20	0.96
Nitrate + Nitrite (mg/L as N)	0.23	0.26	0.30	0.56	1.6	0.40	0.54
Total Phosphorus(mg/L)	0.57	0.32	0.28	0.22	1.3	<0.01	0.12
Dissolved Phosphorus(mg/L)	0.48	0.11	0.22	0.10	--	--	0.03
Suspended Solids(mg/L)	41.0	55.5	60.5	73.5	107	1.0	70
Dissolved Solids(mg/L)	134	185	116	194	1225	245.0	--
Total Lead (μg/L)	9.0	13.0	15.0	11.0	1.5	5.0	1.52
Total Copper (μg/L)	15.0	14.5	15.0	11.0	1.5	<10	--
Total Zinc (μg/L)	80	180	245	60	16	6.0	--
Total Cadmium (μg/L)	0.75	0.96	2.0	< 1	1.0	<1.0	--
Total Chromium (μg/L)	2.1	10.0	7.0	3.0	<10.0	7.5	--
Total Nickel (μg/L)	< 10	11.8	8.3	4.0	--	--	--
BOD (mg/L)	25.5	23.0	14.0	6.4	4.0	0.5	--
COD (mg/L)	49.5	116	45.5	59	--	--	40
Oil and Grease (mg/L)	1.7	9.0	3.0	0.4	--	--	--
Fecal Coliform(colonies/100 ml)	20,000	6,900	9,700	53,000	--	37	--
Fecal Strep.(colonies/100 ml)	56,000	18,000	6,100	26,000	--	--	--

-- *Data not available*
Time period for data is 1992-1993 except for cropland and rangeland (1970-1995)
Agricultural EMCs are based on limited information and may not be representative of the entire CCBNEP Study Area.
Values shown as <0.01, <1, and <10 indicate that all or most of the values were below the reporting limit.

Loadings Model Comparison Pilot Study

As part of this report, a pilot study is included for comparison of state of the art watershed models. The Oso Creek Watershed was selected for use in this pilot study comparison. From the original five models considered, the results of the Soil and Water Assessment Tool (SWAT) and Hydrologic Simulation Program-FORTRAN (HSPF) are included in the report. Table ES.3 presents the Oso Creek model results where annual runoff was combined with this report's EMC values for the land uses within Oso Creek watershed for three constituents; total nitrogen, total phosphorus, and suspended solids. Estimated runoff and loadings are shown to be highly variable, depending on annual rainfall.

Table ES.3 - Oso Creek Model Results - Annual Runoff and Loadings

Year	Rainfall, cm.	Runoff, hectare-m.	Total N, metric tons	Total P, metric tons	Suspended Solids, metric tons
1989	46.5	3,842	64.4	14.2	1,738.0
1990	57.4	6,631	166.0	43.4	4,159.0
1991	113.0	16,955	440.0	116.2	10,979.0
1992	90.4	16,030	448.0	121.1	11,100.0
1993	91.9	15,393	406.0	107.6	10,050.0

Data Limitations and Future Needs

The compilation of an EMC data base according to land use categories represents an important first step in characterizing stormwater runoff quality. As more data on runoff concentrations becomes available from ongoing studies, the EMC data base can be expanded and improved. Additional data from the Corpus Christi NPDES program may improve the reliability of the urban EMC values and allow for determination of seasonal trends. Ongoing studies at Edroy and the King Ranch of agricultural runoff loadings in the CCBNEP study area will also better characterize the EMC values for croplands and rangeland.

An essential factor in computation of loadings to the CCBNEP bays and estuaries is determination of runoff volumes. The origin and discharge point of runoff and constituent loadings is vital information for management of bay and estuary resources. This study documents the need for additional stream flow and rain gage data to accurately calculate runoff at the level needed for a comprehensive nonpoint source assessment.

Land use data used for this study represents conditions current in 1980. Updated land use information is needed for future nonpoint source assessments.

I. Introduction

The bays and estuaries in the CCBNEP study area are subject to undocumented impacts from nonpoint sources of pollution. Nonpoint source pollution includes a wide array of diffuse pollutant types and sources from major storm outfalls, land drainage, airborne materials, and other natural and human activities. Concerns include toxics, fecal coliforms, oxygen demand, nutrients, sediments, and salinity levels. Source activities include urban development and agricultural activities , improperly installed or maintained septic tanks, and runoff from landfills, industrial, and residential developments.

NPS pollution is a natural process that can never be entirely eliminated. Human activity, however, can have a significant influence on either speeding up or slowing down the rate at which nonpoint source pollution occurs (Daniel, et al). The challenge in dealing with nonpoint source pollution is to identify the activities that result in significant impairment of water quality and to design control programs to minimize the problems.

Some of the constituents normally associated with nonpoint source pollution are favorable to the ecosystem under certain conditions. Nutrients are compounds that stimulate plant growth, like nitrogen and phosphorus. Under normal conditions, nutrients are beneficial and necessary, but in high concentrations, they can become an environmental threat. Another component associated with nonpoint source pollution is sediment. Decreasing the amount of sediment entering a point in a stream may actually cause an increase in streambank erosion in downstream reaches. Under these conditions, the stream's net sediment load would not be reduced. As with nutrients, sediment from NPS pollution can result in positive or negative effects in receiving waters.

This project begins to identify waterborne pollutants from nonpoint sources contributing to loadings of receiving waters within the CCBNEP study area. Literature and existing water quality data were reviewed with respect to eight categories of land use and several parameters. Land use categories include: (1) industrial; (2) transportation; (3) commercial, (4) residential; (5) agricultural cropland (dryland and irrigated); (6) rangeland; (7) undeveloped/open; and (8) marinas. This first phase (Year 1) portion of the assessment of nonpoint source pollutant loadings focuses on the derivation of Event Mean Concentrations of various constituents associated with each of the above eight land use categories. A concurrent (non-CCBNEP funded) project produced land use/land cover maps of the project study area. It is envisioned that a Year 2 CCBNEP project will model the loadings of these pollutants based on variable conditions (e.g., wet/dry year, large/small storm) for watershed and subwatersheds within the study area. The result will be a comprehensive geographic analysis of the contribution of NPS pollutants to the CCBNEP study area, including an analysis of probable causes.

Runoff and Nonpoint Source Pollution

Runoff is a natural hydrologic phenomenon that is strongly influenced by land use, especially where activities of man have altered land use from natural conditions. Runoff also influences land use by helping to shape the land surface, providing water supply, and affecting the suitability of land for development. Runoff transports many substances, including contaminants, from one area to another and ultimately to a receiving water body such as a river, lake, bay, or ocean (Fisher and Katz, 1988).

Nonpoint source pollution is pollution generated during stormwater runoff events. Runoff erodes or transports pollutants from wide, diffuse areas and delivers them to receiving waters. According to Browne (1989), a definition of NPS pollution includes these elements:

- Nonpoint sources are diffuse, cover substantial areas, and act either in response to human activity or as “background pollution” from natural lands.
- Nonpoint sources pollution is related to land management, geologic, and hydrologic variables which can change from day to day or from year to year. Only the land management factors can be controlled by society.
- Nonpoint sources are generated and transported as part of the hydrologic cycle. Surface runoff transports eroded soil particles from pervious areas. It also picks up and transports pollutants deposited on impervious areas. Groundwater transports pollutants from septic tanks and landfills.
- Urban runoff includes suspended solids, bacteria, metals, oxygen-demanding substances, nutrients, and oil and grease. Sources of these pollutants include vehicles, fertilizer and pesticide application, animal wastes, construction activities, and road salting.
- Non-urban pollutants are often related to agricultural activities. Agricultural pollutants include pesticides, sediments, nutrients, and organic materials. NPS loading from agricultural areas tends to be seasonal with higher loading associated with planting and harvesting activities.

Descriptions of Selected NPS Runoff Constituents

Suspended Solids is the concentration of suspended material in water. Suspended solids interfere with the transmission of light which affects the seabed vegetation and, in turn, the overall health of an estuary system. Suspended solids also provide transport for other pollutants including organics and metals. Suspended solids are often related to the amount of erosion occurring in a watershed.

Dissolved Solids are in theory determined by evaporation of a filtered sample. More commonly, however, dissolved solids are calculated from the dissolved constituents of the sample analysis. In most water, the dissolved solids consist mainly of silica, calcium, magnesium, sodium, potassium, carbonate, bicarbonate, chloride, and sulfate, and trace quantities of other organic and inorganic constituents. Dissolved solids concentrations are often used as an indicator of water quality, since high values of dissolved solids affect taste in drinking water and may limit the use of water for irrigation or certain industrial applications, especially when chloride concentrations are high.

Nitrogen (N) containing compounds that are most important, from a water quality standpoint, are: organic N, ammonia, nitrate, nitrite, urea ($CO(NH_2)_2$), and nitrogen gas (N_2).

Total N (TN) includes all the various forms of organic and inorganic N found in water, except N_2 gas.

Total Kjeldahl N (TKN) refers to an analytical method where ammonia and organic N are combined.

Nitrate (NO_3) is indicative of fertilizer use.

Nitrite (NO_2) and organic species are indicators of pollution by sewage or organic waste.

Ammonia (NH_3) is generally a product of compounds containing organic nitrogen including sewage. Unionized ammonia is toxic to fish and other aquatic animals and consumes oxygen as it is converted to nitrate. At pH below about 9.2, ammonia nitrogen is largely of the form NH_4+.

Total Phosphorus (TP) includes dissolved and suspended phosphorus in both organic and inorganic forms. Orthophosphates are associated with fertilizers. Organic phosphates are formed primarily by biological processes. In instances where phosphate is a growth-limiting nutrient, the discharge of phosphates into an estuary or other water body may stimulate excess growth of algae or other organisms in nuisance quantities.

Dissolved Phosphorus includes orthophosphorus, which is available for phytoplankton growth, as well as complex organic forms of phosphorus.

Copper (Cu) is potentially toxic to many species of fish. Sources of copper include pesticides and water pipes and plumbing fixtures.

Zinc (Zn) is widely used in metallurgical processes. Zinc is an undesirable contaminant for some aquatic species even at low concentrations.

Lead (Pb) based paints and older water pipes and solder are sources of lead contamination. Although the use of leaded gasoline has declined, large quantities of lead, accumulated in soils, are a potential source of pollution to ground and surface waters.

Cadmium (Cd) is used for electroplating, for pigments, as a stabilizer for PVC plastic and in electrical batteries. Many of these uses will tend to make the element available to water that comes in contact with buried wastes.

Chromium (Cr) groundwater contamination has occurred in many localities where chromium is used in industrial applications including a documented case in Corpus Christi.

Nickel (Ni) is an important industrial metal, used extensively in stainless steel.

Biochemical Oxygen Demand (BOD) is a measure of the amount of oxygen required by aquatic organisms to decompose biodegradable organics during a five day test period. BOD pollutants deplete oxygen from the aquatic environment and affect the ability of the water body to support its desired usage (aquatic life, recreation, etc.).

Chemical Oxygen Demand (COD). The COD test measures the organic content of water. The COD test does not differentiate between biologically oxidizable matter and inert organic material.

Fecal Coliform (FC) bacteria are present in the feces of warm blooded animals and are indicators of bacteriological water quality. Coliform concentrations are measured in number of bacteria colonies per 100 ml of sample.

Fecal Streptococcus (FS) bacteria are also found in the intestines of humans and animals. Concentrations are measured in number of bacteria colonies per 100 ml of sample.

Pesticides are defined in most state and federal laws as any substance used for controlling, preventing, destroying, repelling, or mitigating any pest. The specific purposes consist of 21 pesticide categories. All but six of them have the suffix "-cide" which means to kill or killer (Bohmont, 1991). The 21 pesticide categories and their target species are listed in Table I.1.

Table I.1 - Pesticides as Classified by Their Target Species (Bohmont, 1991)

Pesticide	Target Species	Pesticide	Target Species
Acaricide	Mites, ticks	Miticide	Mites
Algaecide	Algae	Molluscicide	Snails, slugs
Attractant	Insects, birds, other vertebrates	Nematicide	Nematodes
Avicide	Birds	Piscicide	Fish
Bactericide	Bacteria	Predacide	Vertebrates
Defoliant	Unwanted plant leaves	Repellents	Insects, birds, other vertebrates
Desiccant	Unwanted plant tops	Rodenticide	Rodents
Fungicide	Fungi	Silvicide	Trees and woody vegetation
Growth Regulator	Insect and plant growth	Slimicide	Slime molds
Herbicide	Weeds	Sterilants	Insects, vertebrates
Insecticides	Insects		

Sources and Characteristics of Urban Nonpoint Source Pollution

Urban NPS pollution is generated by deposition, accumulation, and washoff by stormwater runoff. Because urban areas include large areas of impervious surface such as parking lots, roads, and rooftops, much of the rainfall does not infiltrate into the ground and is available to collect and transport pollutants. Urban watersheds produce much more volume of runoff than rural watersheds for a given volume of rainfall per unit of area. Larger volumes of runoff per unit area result in larger mass loads of pollutants for urban areas versus rural areas, assuming similar pollutant concentrations. In addition to the increase of impervious surface in urban areas, installation of drainage systems results in pollutant loads being delivered to receiving water bodies faster and more concentrated than with natural drainage.

Generally, urban runoff includes a wide range of water pollutants including, suspended and dissolved solids, bacteria, metals, oxygen-demanding substances, nutrients, oil and grease, and pesticides. Concentrations of these pollutants range from the quality of drinking water to raw sewage.

A significant source of accumulated pollutants in urban areas originate from atmospheric deposition. Atmospheric deposition can occur as dry deposition of airborne particles which may later be dissolved and carried by rainfall and runoff. Rainfall deposition includes constituents carried by precipitation which may be delivered directly to a receiving water body or impact upon the land surface where it may or may not become runoff. Constituents delivered from atmospheric sources include metals and nutrients such as nitrogen and phosphorus. For bays and estuaries that receive limited freshwater inflow, atmospheric sources can provide a significant portion of the total load of certain constituents.

Street litter is a significant source of urban NPS pollution with dust and dirt being the largest component by weight (U.S. Department of Interior, 1969). Other components include remnants of careless waste disposal and collection activities, wastes from pets and other animals, yard wastes, and construction debris. Sediment from denuded construction sites is often a concern.

Widespread use of fertilizers, pesticides, and herbicides in urban areas adds to the chemical burden of NPS runoff. Because many urban users of fertilizers and pesticides have little training or experience, misuse, over application, and improper handling and disposal of these chemicals can result in potential sources of NPS contamination.

Leaks of antifreeze and motor oil from vehicles are potential sources of contamination not only in surface runoff, but also soil and groundwater. Improper disposal of used oil, especially direct disposal into storm sewers, results in deterioration of the quality of the receiving waters.

Sources and Characteristics of Agricultural Nonpoint Source Pollution. *(Excerpts taken from A Comprehensive Study of Texas Watersheds and Their Impacts on Water Quality and Water Quantity, Texas State Soil and Water Conservation Board (TSSWCB), January, 1991)*

Possible nonpoint source pollutants associated with agricultural activities include nutrients, pesticides, organic matter, and animal wastes. These pollutants may be transported in solution with runoff water, suspended in runoff water, or adsorbed on eroded soil particles.

It is recognized that sediment at high enough concentrations may create some problems regarding certain uses of water. It is also recognized that sediment in streams is a natural occurrence and may be beneficial to the aquatic environment. The source of sediment is difficult to determine since geologic erosion, streambank erosion, and/or accelerated erosion from a variety of land disturbance activities could be involved. A decrease in sediment available to a stream may cause an increase in streambank erosion and not reduce the stream's sediment load. Many Texas streams are thought to have naturally carried high sediment loadings prior to man's *intensive use of the land for agricultural and other purposes. The natural ecosystem in many Texas streams is therefore adapted to high sediment loads.*

Nutrients of primary concern as possible nonpoint source pollutants are nitrogen, phosphorus, and to a lesser extent, potassium. The transport of these nutrients to streams is a complex process with the transport mode being dependent on chemical, biological, and hydrologic processes.

Nitrogen can be found in many different forms in the soil. It is derived from several natural sources such as geologic weathering, microbial reactions, precipitation, and chemical fixation. Addition of chemical fertilizers and organic material is another source. Each form of nitrogen has different characteristics that determine its mode of transport. The nitrate form of nitrogen is water soluble and is readily leached or transported in runoff water. Ammonium nitrogen is adsorbed to soil particles, and is therefore transported with sediment. Urea is highly water soluble and could be transported in solution with water, but is converted to ammonium within four to seven days. Sediment provides the major transport mechanism for organic nitrogen.

Phosphorus can be found in soils in both organic and inorganic forms. The inorganic forms normally occur in surface soils where organic matter accumulates. Erosion is the primary mover of phosphorus because of its strong adsorption to soil particles. In some soils, mainly sands and peats which provide little reaction with phosphorus, transport via runoff is possible.

Another source of nutrients in surface runoff is nutrients lost from both dead and living plant tissues on the soil surface. This occurs mainly where plant residues are left on the soil surface from such practices as conservation tillage. However, the importance of plant residues in reducing erosion losses of nutrients is probably more significant than the contribution of pollutants obtained through losses from vegetal matter.

Pesticides may be transported from their application site either on soil particles or in solution with runoff. Many pesticides undergo chemical degradation or evaporation, or they are taken up by plants and removed in the harvested crop. Such pesticides present minimum potential for water quality problems.

The primary factors affecting the mode of transport of a pesticide are the organic matter and clay content of the soil and water characteristics of the particular pesticide. Other important soil properties affecting pesticide adsorption are pH, cation exchange capacity, moisture content, and temperature. Generally, the more water soluble a pesticide is, the more likely it will be transported by rainfall runoff rather than by the erosion-sedimentation process. The solubility of many pesticides is dependent on their formulation. For example, amines are far more soluble than esters which have the same active ingredients. The degree of adsorption of pesticides by soil is highly dependent on soil properties. Adsorption can vary by as much as fifteen fold over a range of soil types. The quantity of pesticide removed by each process is also dependent on the amount of runoff in relation to the amount of sediment transported.

Organic matter is the portion of the topsoil made up of decaying and decomposed plant and animal residues. Organic matter may be transported to water bodies through the erosion-sedimentation process.

Possible pollutants associated with animal wastes include organic matter, plant nutrients, and infectious agents. The primary areas of concern relative to possible nonpoint source pollution are small animal concentrations such as dairies, poultry operations, and small feedlots. Normally, animals on pasture do not produce enough waste concentrations to be of concern. Large animal concentrations are considered point sources and are regulated under permit programs. The transport mechanisms involved in any pollution from small animal concentrations would require rainfall coming in contact with animal waste and transporting it to water bodies. Liquid waste could also be discharged directly into streams or lakes.

One of the greatest needs to properly assess the impact of nonpoint source pollution on the water quality of Texas is water quality data reflective of nonpoint source loadings. Such data at the present time is lacking or nonexistent.

The preceding excerpts describe some of the characteristics and sources of agricultural NPS pollution in 1991. The general discussion still applies to the study area. Very little specific information has been added to any agricultural data bases for the Corpus Christi area since that time. Concurrent studies being conducted at Edroy, Texas and on the King Ranch will provide more definitive information that can be used for the refinement of agricultural EMC values.

Event Mean Concentration

In studies of stormwater runoff, it is important to express results from various studies in terms that facilitate comparison. Water quality is usually expressed in terms of concentrations of particular constituents. Scientists often express concentrations in milligrams per liter (mg/L) or micrograms per liter (μg/L), but the almost equivalent terms of parts per million (ppm) and parts per billion (ppb), respectively are sometimes used. When the concentration of a particular substance in water is sufficient to produce detrimental effects for the intended use of the water, the substance is called a pollutant, and the resulting condition is known as water pollution. Apart from man-made organic chemicals, toxins, or radioactive elements, many substances occur naturally in a wide range of concentrations. It is not necessarily the presence of a substance by itself that is harmful but rather the relatively high concentration of that substance. Copper, for example, is an essential nutrient for both plants and animals but is potentially toxic to many freshwater species at concentrations of a few hundredths of a milligram per liter (Hem, 1985). Thus water quality evaluation generally involves comparisons of substance concentrations with water quality standards and criteria.

Concentrations often provide a measure of water quality at a discrete point in time. Sometimes, an average concentration is used to represent conditions over a period of time. An important measure of water quality is the constituent load, which is a total amount of a substance in terms of mass. For runoff studies, a technique is needed to compare constituent loads at different locations and between different storms. Total load, or washoff, alone cannot be used for comparison, because large watersheds will generally yield more mass of a particular constituent than a similar small watershed, for similar storm characteristics. For comparison of loads between storms with varying characteristics another method of comparison is needed. The total constituent load during a runoff event divided by runoff volume during the event yields an average concentration or Event Mean Concentration. An EMC can be determined by collecting multiple runoff samples during a storm event while also measuring flow over the course of the event and flow-weight averaging the measured constituent concentrations. Alternatively, because of the expense in analyzing multiple samples, automatic samplers are usually employed to sample runoff at a frequency proportional to the runoff or flow rate so that the samples can be combined to yield a single flow-averaged sample. The constituent concentration of the flow-averaged sample represents an Event Mean Concentration.

The concentration of an NPS constituent varies not only according to land use, precedent conditions, storm intensity, and storm duration, but may vary considerably during the course of a single event. For example, the oil and grease concentration measured from a sample collected at an urban site during the first thirty minutes of runoff may be much higher than the concentration measured several hours later during the same event. A single sample collected at an instantaneous point in time may not be representative of the event's average constituent concentration. Therefore, EMCs are more reliable for determining average concentrations and calculating constituent loads.

Generally, EMC values from an individual site follow a lognormal distribution (USEPA, 1983). For comparing EMCs from different sites or land uses, the appropriate statistic to employ is the median value. In statistics, the median is the middle value in a distribution, above and below which lie an equal number of values. The median is less influenced by the small number of large values, typical of lognormal distributions, and is a more robust measure of the central tendency. For this report, median values are reported as the "typical" concentrations. Mean, or average, values can also be found in the EMC analysis in Appendices A & B.

II. Description of Study Area

Physical Characteristics

The Corpus Christi Bay National Estuary Program study area is comprised of the network of rivers, bays, and drainage areas of the twelve county Coastal Bend area of South Texas (Figure II.1). Three estuary systems are included in the study area: the Mission - Aransas, the Nueces, and the upper Laguna Madre estuaries. These estuary systems include Copano Bay, Aransas Bay, Nueces Bay, Corpus Christi Bay, and the upper Laguna Madre as well as many smaller bays. The entire CCBNEP estuary system covers approximately 550 mi^2 (1425 km^2). The total drainage area of the CCBNEP study area including the Upper Nueces watershed is approximately 26,825 mi^2 (69,476 km^2).

The estuary system is relatively shallow with average water depths varying from 2 ft (0.6 m) in Mission Bay to 13 ft (4.0 m) in Corpus Christi Bay. Mean depth in the Laguna Madre is about 4 ft (1.2 m). Total volume of the entire estuary system is 2.08 million acre-feet (256,600 hectare-m.).

Drainage areas contributing to inflow to the CCBNEP estuaries include the Nueces river basin (17,000 mi^2 or 44,030 km^2), the San Antonio - Nueces coastal basin (2,625 mi^2 or 6,799 km^2), and the Nueces - Rio Grande coastal basin (7,200 mi^2 or 18,648 km^2). The Nueces, Mission, Aransas, and San Antonio rivers contribute most of the fresh water inflow to the bays and estuaries of the study area. The estuary features a high drainage area to volume ratio compared to many estuary systems and coastal water bodies. As a comparison, the Chesapeake Bay system drainage area to volume ratio is 2,743 while the CCBNEP drainage area /volume ratio is 27,000. The ratio for the entire Gulf of Mexico is only 2.5. However, the limited (and intermittent) fresh water inflows and restricted exchanges with the Gulf of Mexico contribute to high residence time for bay and estuary water. Table II.1 shows the mean inflows and residence time for the three major estuaries of the CCBNEP study area.

Table II.1 - Freshwater Inflows and Residence Times for CCBNEP Estuaries (Adapted from TNRCC, 1994)

Estuary	Minimum Annual Inflow		Maximum Annual Inflow		Mean Inflow		Residence Time
	acre-ft.	hectare-m.	acre-ft.	hectare-m	acre-ft.	hectare-m	Years
Mission-Aransas	7,503	925	1,542,142	190,223	429,189	52,940	1.6
Nueces	42,551	5,249	2,744,260	338,504	633,597	78,154	1.4
Upper Laguna Madre	0	0	818,000	100,900	156,928	19,357	3.3

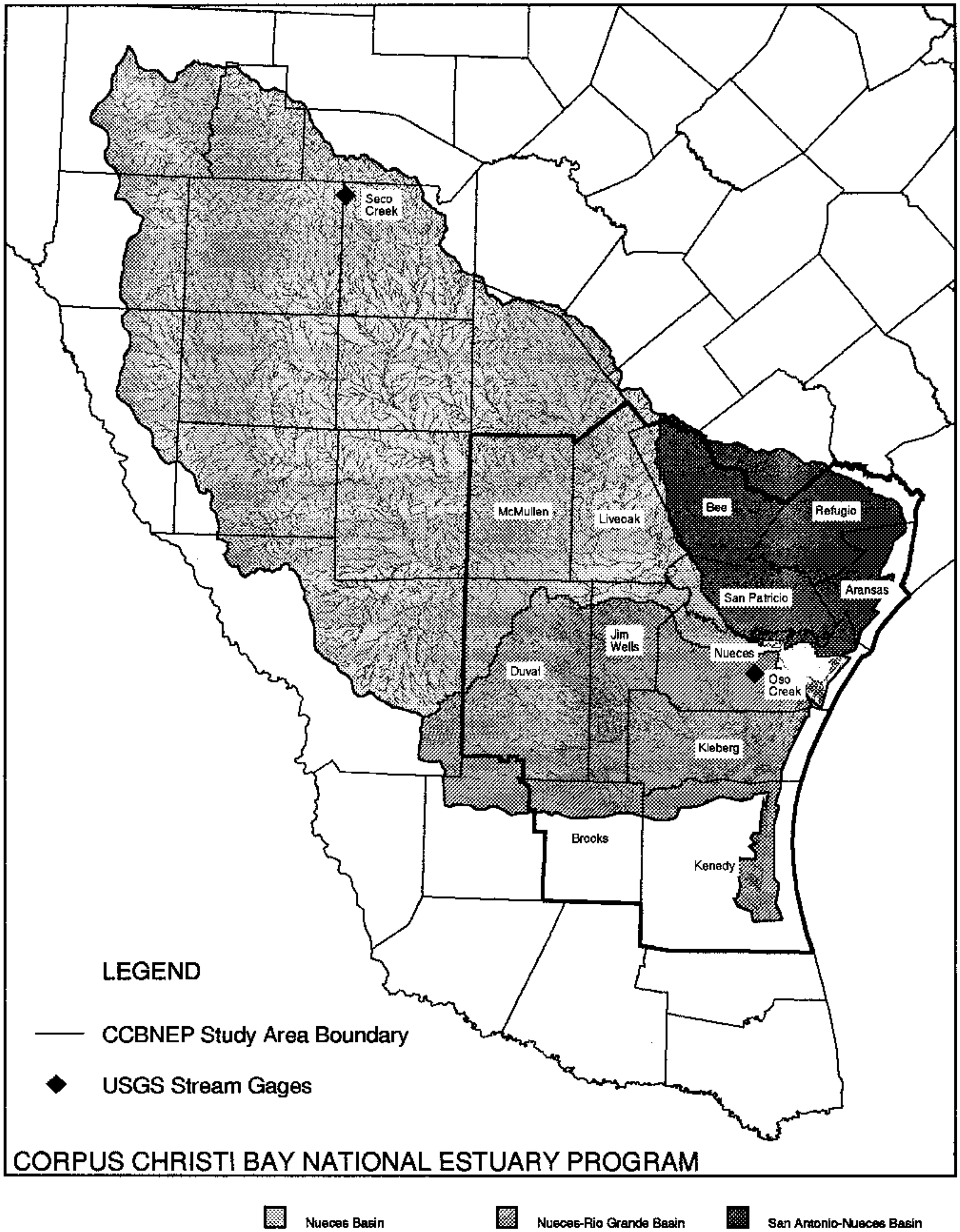


Figure II.1 - Corpus Christi Bay National Estuary Program Study Area and Drainage Area

Climate

The climate of the study area is classified as subtropical (short, mild winters and long, hot, and humid summers). Prevailing winds are southeasterly throughout the year. Warm, tropical air from the Gulf of Mexico is responsible for the mild, winter temperatures and hot, humid summer weather. Rainfall varies from about 40 inches (102 cm) per year near the coast to 25 inches (58 cm) per year further inland and south (see Figure II.2). The normal rainfall for Corpus Christi (based upon the standard 1961-1990 reporting period is 30.13 inches (76.53 cm.).

Average annual rainfall for each of the 12 counties in the CCBNEP study area is given in Table II.2.

Table II.2 - Average Annual Rainfall in the CCBNEP Study Area by County
(NOAA, 1951 to 1980)

County	Rainfall (in/cm)
Aransas	33.2 / 84.3
Bee	28.9 / 73.4
Brooks	24.2 / 61.5
Duval	23.2 / 58.9
Jim Wells	27.0 / 68.6
Kenedy	26.6 / 67.6
Kleberg	26.5 / 67.3
Live Oak	25.6 / 65.0
McMullen	25.3 / 64.3
Nueces	28.5 / 72.4
Refugio	33.8 / 85.8
San Patricio	30.6 / 77.7

An average annual total does not completely describe the nature of rainfall within the CCBNEP study area. For the period 1961 to 1993, annual rainfall varied from 18.85 in. (47.88 cm) in 1989 to 48.07 in. (122.1 cm) in 1991. The standard deviation of annual rainfall during this period was about 8.5 in. (20.3 cm), which indicates that from year to year the annual rainfall is highly variable, deviating an average of more than 8 in. (20 cm) from the normal rainfall.

Also, rainfall is not equally distributed throughout the year. Table II.3 shows average precipitation by month for Corpus Christi (1961 - 1990 avg.).

Table II.3 - Average Corpus Christi Monthly Precipitation
(NOAA, 1961 to 1990)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
in.	1.71	1.96	0.94	1.72	3.33	3.38	2.39	3.31	5.52	3.02	1.59	1.26
cm.	4.34	4.98	2.39	4.37	8.46	8.58	6.07	8.41	14.02	7.67	4.04	3.20

Evaporation rates depend upon temperature, precipitation, wind speed, and humidity. High evaporation and limited freshwater inflow contribute to the high salinity values in the CCBNEP bays and estuaries. Average monthly evaporation rates, based upon pan evaporation data collected at Beeville, Texas from 1979 to 1992 are shown in Table II.4. The average annual evaporation for the period of record was 79.94 inches (203.05 cm.).

Table II.4 - Average Monthly Pan Evaporation
Beeville, TX. - 1979 to 1992 (NOAA)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
in.	3.38	3.89	5.83	7.35	8.34	9.06	10.01	9.95	7.83	6.54	4.32	3.44
cm.	8.58	9.88	14.81	18.67	21.18	23.01	25.42	25.27	19.89	16.61	10.97	8.74

Severe tropical storms occur about once in every 10 years, and less severe storms occur about once every five years. Hurricanes strike chiefly in August and September, though have occurred as early as June and as late as October.

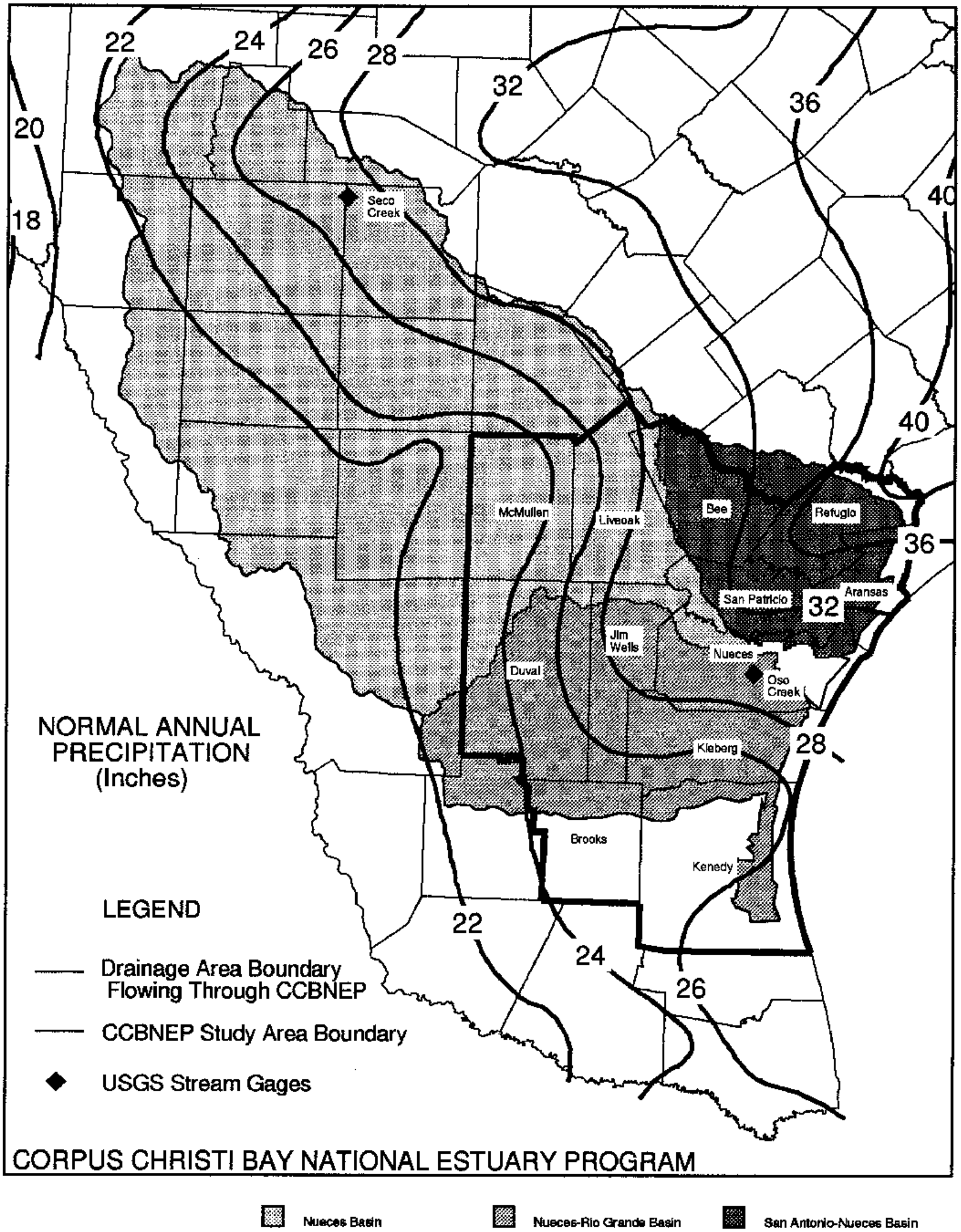


Figure II.2 - Normal Annual Precipitation

Soils

The Natural Resources Conservation Service (NRCS) has established three geographic data bases representing different intensities and scales of mapping. Each data base links digitized soil map unit delineations with computerized data for each map unit, giving the proportionate extent of the component soils and their properties. The State Soil Geographic Data Base (STATSGO) map for the 12 county study area was developed at a scale of 1:250,000. Each colored polygon in this data base indicates soil associations which may include as many as 20 or 30 soil series. The Soil Survey Geographic Data Base (SSURGO), normally developed at 1:24,000 scale, is currently available for only four of the twelve counties. These include Aransas, Bee, Jim Wells, and San Patricio. Each SSURGO map unit is usually represented by a single soil component, typically a soil series phase.

Detailed soil survey information has been published by the United States Department of Agriculture's (USDA) NRCS on seven of the twelve counties in the study area. The published soil survey reports with year of publication are available on Aransas (1979), Bee (1981), Brooks (1993), Jim Wells (1979), Nueces (1965), Refugio (1984), and San Patricio (1979) counties. Properties of soils in the study area can have a significant impact on storm runoff depending on their permeability, erodability, and the hydrologic cover condition associated with land use or cover. The physical characteristics of soils change drastically from the eastern or coastal counties toward the western counties of the study area. Generally they change from clays, clay loams and fine sandy loams on the east to loamy sands, sands, and deep sands on the west.

The major soil series occurring in the counties included in the Corpus Christi Bay National Estuary Program study area are Victoria, Orelia, Papalote, Nueces, Sarita, Falfurrias, Clareville, Olmos, Edroy, Pettus, and Pernitas series. These series represent those with the most areal coverage in the study area. A brief description of these soil series is included below. Additional information on these prominent soil series or any of the other numerous soil series may be found in the published county soil survey reports or at the local Natural Resources Conservation Service office.

> VICTORIA SERIES - The Victoria clays are the dominant soils in the coastal counties comprising the eastern portion of the study area. This series consists of dark, calcareous, crumbly soils that are called blackland. These soils crack when they dry, and when wet, they swell and take in water slowly.
>
> Most of the Victoria soils are nearly level, but a few small areas near the Nueces River are on slopes of 0 to 5 percent. Because Victoria soils dry and crack almost every summer, their subsoil can take in and store much water in a short time during heavy rains in the fall.
>
> Nearly all of the Victoria soils are cultivated and produce moderate to high yields of locally grown crops.
>
> ORELIA SERIES - The Orelia fine sandy loams and Orelia clay loams consist of deep, dark-colored, crusty soils that contain a hardpan and are locally called hardpan soils. The

largest areas of these soils are nearly level and occur in the eastern part of the study area, but many small areas are scattered throughout most of the mainland.

Because their subsoil is dense, these soils take in water very slowly. The Orelia fine sandy loam is lower in natural fertility than Orelia clay loam. The clay loam occupies shallow valleys of small creeks and because the channels of these creeks are shallow and narrow, this nearly level soil is flooded when rains are heavy locally or in the counties to the west.

PAPALOTE SERIES - The Papalote soil series includes loamy fine sands and fine sandy loams. These are deep soils on nearly level to gently sloping uplands. They are moderately well drained with slow to medium surface runoff. Permeability is slow with medium water holding capacity.

These soils are used mainly as rangeland and wildlife habitat with only a few areas in cropland and improved pasture due to limitations such as low fertility, erosion potential, low organic material and water holding capacity.

NUECES SERIES - The Nueces fine sand series consists of deep, light-colored soils that have a loose, sandy surface soil and a sandy clay loam subsoil. These soils seldom yield runoff because the surface layer takes in water so rapidly. The subsoil, however, takes in water slowly, and the thin surface layer remains saturated for a short time after heavy rains.

Nueces soils are not used for most locally grown crops, because they are low in natural fertility and are susceptible to wind erosion. This fine sand lies at the western edge of the strip of coastal sand in the eastern counties.

SARITA SERIES - Sarita fine sand series is a very deep soil on broad upland plains. The surface is plane or hummocky with slopes ranging from 0 to 5 percent. This soil is well drained and runoff is very slow. Permeability is rapid in the upper part of the profile and moderately rapid in the lower part. The available water capacity is low. The root zone is deep and can be easily penetrated by plant roots. In areas where the soil is bare of vegetation, the hazard of water erosion is slight and the hazard of wind erosion is severe.

The Sarita soil is used mainly as rangeland or wildlife habitat. A few areas are used as an improved pasture of coastal bermudagrass. The soil is not suited to cultivated crops because of the hazard of wind erosion and the low available water capacity. The climax plant community consists of open grassland plants interspersed with a few mesquite trees and an occasional live oak tree.

FALFURRIAS SERIES - Falfurrias fine sand is a very deep soil on uplands, mainly in a series of long, discontinuous ridges. Because of the prevailing southeast winds, the ridges are oriented in a southeast to northwest direction. The soil is somewhat excessively drained. Runoff is very slow. Permeability is rapid, and the available water capacity is low. Where the soil is bare of vegetation, the hazard of water erosion is slight and the hazard of wind erosion is severe.

The Falfurrias soil is used mainly as rangeland or wildlife habitat. A few acres are used as an improved pasture of coastal bermudagrass. The soil is not suited to cultivated crops because of the hazard of wind erosion and the low available water capacity. The climax plant community consists of open grassland plants interspersed with motts of live oak or mesquite trees.

CLAREVILLE SERIES - The Clareville loam series consists of deep, dark-colored, loamy soils generally in the northern portion of the study area. These soils are nearly level or gently sloping.

Typically, Clareville soils have slow surface drainage and moderately slow internal drainage. They are moderately high in natural fertility and are easily penetrated by roots, air, and water. Clareville soils are less clayey throughout than the Victoria soils. Nearly all the acreage of Clareville soils is cultivated. These soils are well suited to cotton, grain sorghum, and flax, which are the crops generally grown in the area.

OLMOS SERIES - The Olmos gravelly loam is a very shallow soil on low ridges and on upper side slopes of knolls and ridges on uplands. It is a dark grayish brown very gravelly loam about 10 inches thick. The soil is well drained with medium to rapid runoff and low available water capacity. It is not suited to use as cropland or improved pasture. The Olmos soil is used mainly as rangeland. Water erosion is a moderate to severe hazard.

EDROY SERIES - The Edroy clay series is a deep, poorly drained, nearly level soil. The surface layer is dark gray with a medium available water capacity and very slow permeability. It occupies weakly defined and discontinuous watercourses. This soils has low potential for cropland and pasture use due to wetness.

PETTUS SERIES - The Pettus loam series consists of nearly level to gently sloping, loamy soils that formed in beds of calcareous loamy sediments. They are very dark grayish brown on the surface. Because it is shallow and has restricted water storage capacity, this soil is droughty. The Pettus series is mainly used for range and has a low potential for pasture and cropland production.

PERNITAS SERIES - The Pernitas sandy clay loam is a deep soil on gently sloping uplands. The surface layer is dark brown sandy clay loam about 10 inches thick. The soil is well drained with medium surface runoff, moderate permeability and medium available water capacity. This soil is used about equally as cropland, rangeland, and improved pasture. Conservation practices are generally needed on cropland to control runoff and protect against erosion.

Population and Land Use

The population of the study area was approximately 500,000 in 1990 with about 250,000 people living in the Corpus Christi area (the major urban center in the study area). Other towns in the coastal counties of the study area include Kingsville, Portland, Robstown, Ingleside, and Aransas Pass. The 1990 populations of the major cities and towns in the study area are shown in Table II.5 below. Figure II.3 shows the distribution of population within the Corpus Christi Bay study area based on data from the U.S. Census Bureau, 1990.

Table II.5 - Population of Major Cities in the CCBNEP Study Area (U.S. Census Bureau, 1990)

City or Town	County	Population
Corpus Christi	Nueces	257,453
Kingsville	Kleberg	25,276
Robstown	Nueces	12,849
Portland	San Patricio	12,224
Aransas Pass	San Patricio	7,180
Ingleside	San Patricio	5,696
Sinton	San Patricio	5,549
Rockport	Aransas	4,753
Refugio	Refugio	3,158

Land use in the area is dominated by agricultural and ranching activities with only minor amounts of irrigated crops. Grain sorghum, corn, small grains, vegetables, and cotton are dryland crops produced in the region. Table II.6 lists the percentages of land use by counties within the CCBNEP study area by six major categories. The percentages were derived from the Geographic Information Service (GIS) land use data base compiled by the USGS around 1980. The key difference between counties is the percentage of agricultural land (which includes both cropland and pastureland) versus rangeland. Several counties have substantial percentages of water or wetlands. The category of “all other” land use includes transportation, marinas, and undeveloped/open.

The Port of Corpus Christi is a major shipping and transportation center. A heavily industrialized area centered around the port includes petroleum refining and metal processing. The land use for the study area can be displayed graphically from the digital USGS data base.

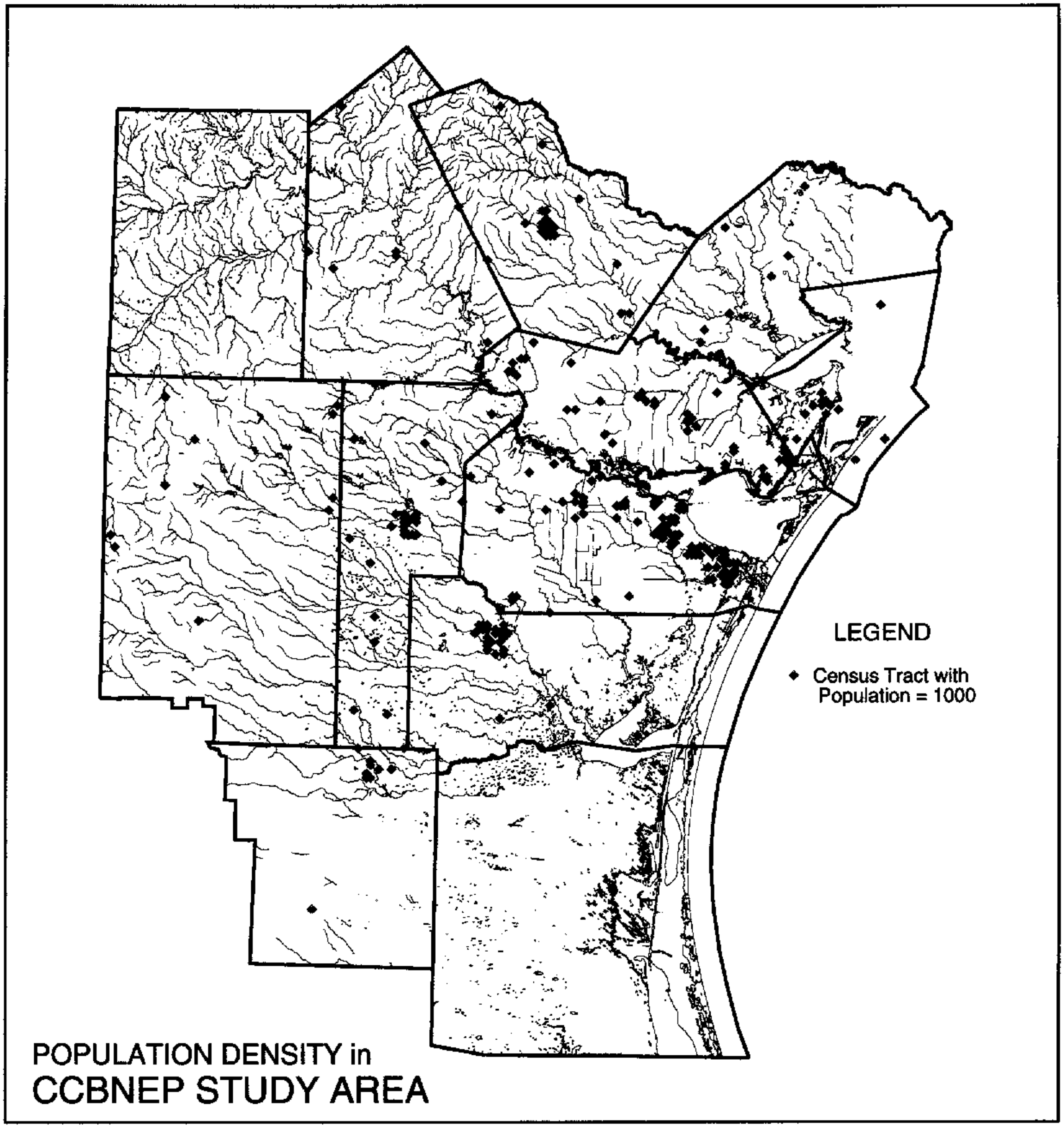


Figure II.3 - Population Density in CCBNEP Study Area (USCB, 1990)

Table II.6 - Percent Land Use by Counties in the CCBNEP Study Area (USGS, 1980)

County	Urban, (percent)	Agricultural, (percent)	Range, (percent)	Water, (percent)	Wetland, (percent)	All Other, (percent)
Aransas	7	4	30	37	21	1
Bee	1	42	56	0	0	1
Brooks	0	6	92	0	0	1
Duval	1	12	87	0	0	0
Jim Wells	2	49	49	0	0	0
Kenedy	0	1	73	9	11	5
Kleberg	1	23	56	12	6	2
Live Oak	1	33	62	2	0	1
McMullen	0	5	94	0	0	0
Nueces	7	57	11	21	4	1
Refugio	5	21	64	5	5	0
San Patricio	2	67	20	3	4	1
Study Area	2	27	61	6	3	1

Dams and Reservoirs

Dams and reservoirs, especially those on the main stem of the Nueces river, affect the quantity and timing of fresh-water inflows as well as loadings of nutrients and other constituents to the estuary system. Reservoirs have a large impact on associated estuarine systems. Reservoirs reduce nutrient and other nonpoint constituents normally delivered to the bays during runoff events. Reservoirs also have the effect of reducing the sediment load to the bays which is important in delta habitat formation.

Within the lower part of the basin, three major structures (normal capacity over 5,000 acre-feet) regulate surface water flow. Lake Corpus Christi, near Mathis, was formed by the construction of Mathis Dam in the early 1930's. The reservoir was enlarged by construction of the Wesley Seal Dam in 1958. Choke Canyon Dam and reservoir are located in the Frio river valley near Three Rivers, Texas and about 10 miles (16 km) above the confluence of the Frio and Nueces rivers. The dam was completed in 1982. The Choke Canyon/Lake Corpus Christi system provides water for a significant portion of the Texas Coastal Bend area. The Barney M. Davis Cooling Reservoir withdraws water from the Laguna Madre and discharges waters into Oso Bay.

Although it is not classified as a major reservoir, Calallen Diversion Dam and reservoir, 35 miles (56 km) downstream of Lake Corpus Christi, is the point from which most of the water released from Lake Corpus Christi is diverted for municipal and industrial use. This dam also serves as a saltwater intrusion barrier. Figure II.4 is a map of the study area showing dams and reservoirs taken from the USDA NRCS and TNRCC data bases.

Table II.7 - Capacity of Major Reservoirs in the CCBNEP Study Area (TNRCC)

Reservoir Name	Normal Storage Capacity (Acre-feet)
Barney M. Davis Cooling Reservoir	6,600
Choke Canyon Reservoir	714,000
Lake Corpus Christi	300,000
Upper Nueces Reservoir	7,590

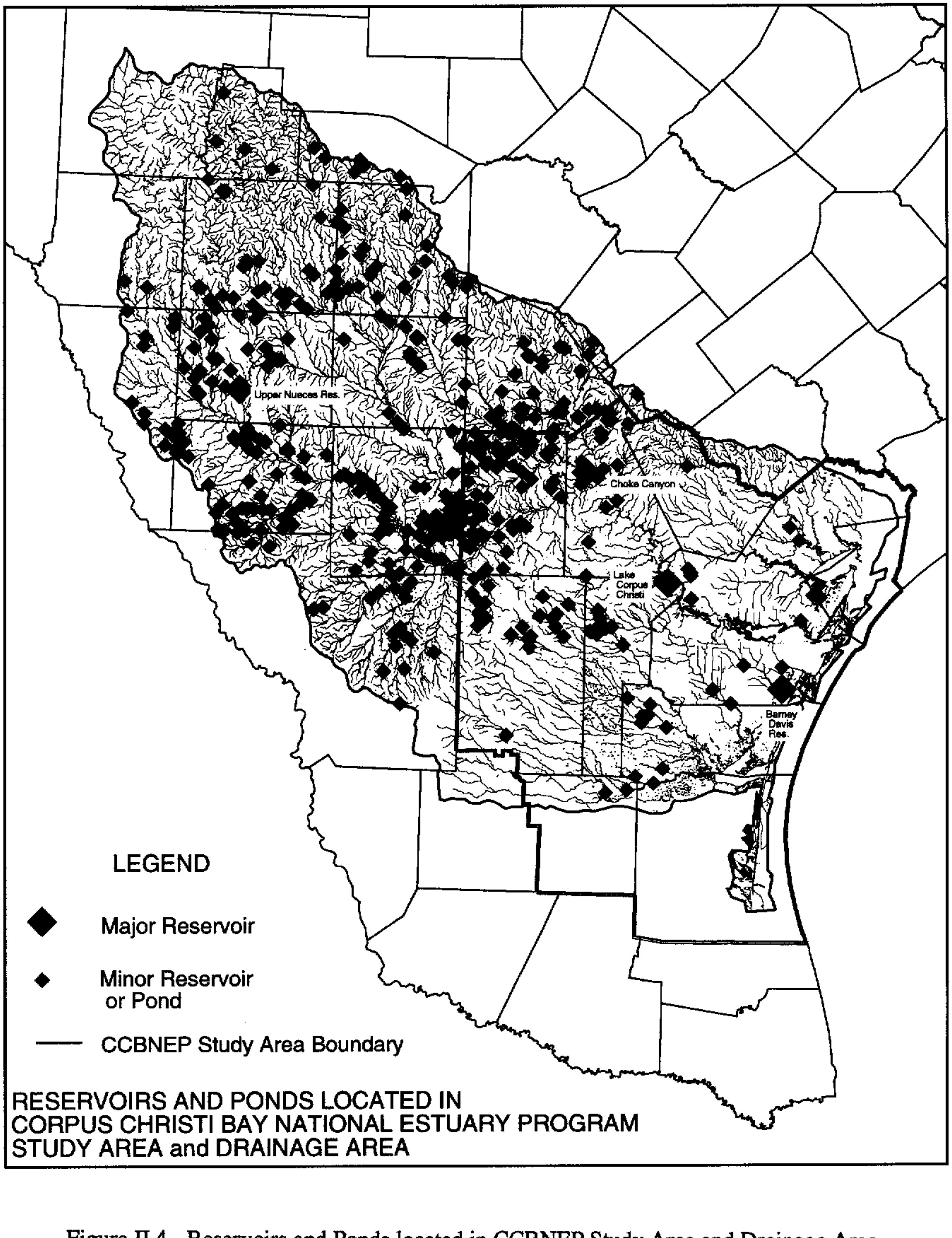


Figure II.4 - Reservoirs and Ponds located in CCBNEP Study Area and Drainage Area

III. Literature Review

Previous and Ongoing NPS Studies related to the CCBNEP Study Area

This portion of the report includes a review of studies or projects which include information on actual NPS runoff concentrations, especially local data within the study area. Other literature reviewed, but not included here is presented in the reference and bibliography sections.

Nationwide Urban Runoff Program

The Nationwide Urban Runoff Program (NURP) was conducted by the United States Environmental Protection Agency (USEPA) and many cooperating federal, state, regional, and local agencies, across the United States. Individual project studies were conducted during the period of 1978 - 1982. The NURP data base represents over 2300 separate storm events at 81 sites in 22 cities. The NURP report includes EMC values for various constituents and land use categories. NURP EMC values are included and presented in comparison with local and regional data. NURP data was also used to derive EMC values for undeveloped/open land use in the CCBNEP study area.

National Pollutant Discharge Elimination System Permit Application Sampling

Cities of 100,000 population and greater have been identified in the amended Federal Water Pollution Control Act as entities that must obtain federal permits for controlling the quality of storm water discharges from their boundaries. As part of the permit application process, cities must conduct wet weather sampling to characterize the quantity and quality of storm water from watersheds within the cities' boundaries. The USEPA has developed regulations and guidelines for the collection and analysis of stormwater samples. NPDES protocol calls for the collection of flow-weighted samples and determination of EMCs. NPDES data from several Texas cities were reviewed for use in developing EMCs for the CCBNEP study area.

Corpus Christi NPDES data of 1993

Data collected for the City of Corpus Christi NPDES permitting process during 1992 - 1993 probably represents the most valuable source of EMC values for the CCBNEP study. This data represents actual EMCs and was collected and analyzed according to EPA criteria. This data represents the best available local source of urban EMC values available for this study. Five sampling stations are included in this study: Two residential sites, two industrial sites, and one commercial land use site. Six samples were collected at each of the five stations for a total of 30 samples. The water quality samples were analyzed for 133 constituents, including nutrients, organic compounds, pesticides, and metals. Additional data collected during 1994 were not available in time for this study but will become available and will be very valuable in helping to better define average runoff concentrations.

Dallas - Ft. Worth NPDES Data

As part of the NPDES permit application process for the Dallas - Ft. Worth Metroplex, Texas, the USGS established a network of 26 stormwater data collection stations in single land use, urban drainage areas. From February 1993 through June 1993, rainfall, runoff, and water quality data were collected for seven storms at each of the 26 stations. The resulting 182 stormwater samples include 77 from residential land use sites, 42 from commercial sites, and 63 from industrial land use sites. From the samples collected, a maximum of 188 constituents were identified, yielding a data set of approximately 34,000 values. This is one of the most extensive NPDES data sets ever developed for a single urban area.

In addition to the above data, four additional stormwater stations were established for urban highway transportation sites. Data collected at these sites during 1994 represent 26 sampling events.

San Antonio NPDES Data

As part of the NPDES permit application process for San Antonio, Texas, the USGS collected and analyzed stormwater runoff samples from six urban sites, representing a total of 34 storm events, collected from August 1992 to June 1993. The land use categories of the sampling sites include 3 residential sites, 2 commercial sites, and 1 industrial land use site. The water quality constituents analyzed include the USEPA's priority pollutant list and most standard constituents and measurements. Six storm events were sampled at each site during the period August 1992 to June 1993.

Galveston Bay National Estuary Program NPS Study

One of the goals of the Galveston Bay National Estuary Program (GBNEP) study was to develop EMC values for various land uses. The GBNEP study relies heavily upon local data collected during studies by Rice University, USGS (Austin and Houston), and the Texas Natural Resource Conservation Commission (TNRCC, formerly the Texas Water Commission). Although values from the GBNEP study were not used to determine EMC values for the CCBNEP study, the GBNEP values are considered valuable and included for comparison purposes.

USGS Provisional Information

Oso Creek Gage #08211520 (primarily cropland watershed).

The USGS gage number 08211520 located on Oso Creek at Corpus Christi was considered most applicable to the study area for agricultural cropland. It is located in the watershed used in the pilot study for the CCBNEP. Gage records analyzed cover the time period from October 1977 to September 1988. Other sources for exclusively cropland watersheds is extremely limited. This gage has the advantage of being located in the CCBNEP study area. The combination of coastal location, climate, and type and level of agricultural activity makes this gage the logical choice to represent the area.

Miller Ranch Gage #08201500 (primarily rangeland watershed).

The USGS gage number 08201500 (Miller Ranch) in the Seco Creek watershed near Utopia, Texas was used to obtain representative concentration values for rangeland for the following reasons: 1) The Seco Creek watershed is in the upper watershed of the Nueces River system. 2) It is situated below a watershed consisting almost exclusively of rangeland. 3) It has been in place for a number of years and a large variety of constituents have been measured. The literature search did not uncover other sources for agricultural EMC data which could be identified as originating from a rangeland watershed. Information from other gages in the Seco Creek area (#08202450 - Seco Creek Reservoir Inflow, #08202700 - Rowe Ranch, and #08202900 - Yancy Gage) was used to provide information for comparison and where the primary information source was lacking.

NAWQA Gages #321017096400099 and #321313096415201

In 1991, the U.S. Geological Survey began to implement a full-scale National Water-Quality Assessment (NAWQA) program. The long-term goals of the NAWQA program are to describe the status and trends in the quality of a large, representative part of the Nation's surface and ground-water resources and to provide a sound, scientific understanding of the primary natural and human factors affecting the quality of these resources. (Land, 1991)

A major design component of the program is study-unit investigations. In 1991, the Trinity River basin study was among the first 20 NAWQA study units selected for study under the full-scale implementation plan. The Trinity River basin drains about 18,000 square miles, all in Texas. The Trinity River flows into Trinity Bay, whose waters then flow into Galveston Bay and finally into the Gulf of Mexico near Houston.

NAWQA gages #321017096400099 (Mill Creek, primarily cropland watershed) and #321313096415201 (Big Onion Creek, primarily cropland watershed) are included in the appendix for agricultural constituents as comparison values for cropland.

Local Conditions

Confined Animal Feeding Operations (CAFOs)

Table III.1 lists those CAFOs that were permitted by Texas Natural Resource Conservation Commission as of February 1995. There are numerous other CAFOs that have animal numbers less than that requiring a permit. All CAFOs have the potential to convey nutrients and fecal coliform into stream runoff if not managed properly.

It is important to note that all CAFOs, regardless of size, are mandated by TNRCC rules to implement all necessary best management practices to assure a "no discharge" operation. "No discharge" is defined in the rules as the absence of flow of waste, process generated wastewater, contaminated runoff or other wastewater from the premises of the CAFO, except for overflows which result from rainfall events greater than the 25-year, 24-hour rainfall event.

Efforts of state and federal agencies have intensified the past six years to assist CAFO operators in development of agricultural waste management plans which, if implemented, would assure compliance with TNRCC regulations. The key to "no discharge" is proper management by the landowners in collecting and storing wastes as well as proper utilization of those wastes in land application.

Table III.1 - TNRCC Waste Permits for CAFOs in the CCBNEP Study Area (TNRCC, 1995)

PERMIT NUMBER	CLIENT DOING BUSINESS AS NAME	Stream Segment ID	COUNTY	Permit Category	EXTENSION OUTFALL
WQ0003172-000	HENRY P KNOLLE FARMS	2102	Jim Wells	Agricultural	SOIL MON 201 ANN 6-18 IN.
WQ0003172-000	HENRY P KNOLLE FARMS	2102	Jim Wells	Agricultural	SOIL MON 301 ANN 18-30
WQ0003172-000	HENRY P KNOLLE FARMS	2102	Jim Wells	Agricultural	SOIL MON 101 ANN 0-6 IN.
WQ0003172-000	HENRY P KNOLLE FARMS	2102	Jim Wells	Agricultural	DAIRY 900 KNOLLE FARMS
WQ0003330-000	HOWELL JESSE W	2492	Jim Wells	Agricultural	SOIL MON 101 ANN 0-6
WQ0003330-000	HOWELL JESSE W	2492	Jim Wells	Agricultural	SOIL MON 201 ANN 6-18
WQ0003330-000	HOWELL JESSE W	2492	Jim Wells	Agricultural	SOIL MON 301 ANN 18-30
WQ0003330-000	HOWELL JESSE W	2492	Jim Wells	Agricultural	CATTLE FEEDLOT 10000 HD
WQ0003009-000	KNOLLE CATTLE COMPANY	2102	Jim Wells	Agricultural	SOIL MONITOR. ANNUAL
WQ0003009-000	KNOLLE CATTLE COMPANY	2102	Jim Wells	Agricultural	DAIRY FARM 650
WQ0003435-000	SANDIA AGRICULTURAL ENTP INC	2102	Jim Wells	Agricultural	SOIL MON 201 ANN 6-18 IN
WQ0003435-000	SANDIA AGRICULTURAL ENTP INC	2102	Jim Wells	Agricultural	SOIL MON 301 ANN 18-30 IN
WQ0003435-000	SANDIA AGRICULTURAL ENTP INC	2102	Jim Wells	Agricultural	DAIRY FARM 450 HEAD
WQ0003435-000	SANDIA AGRICULTURAL ENTP INC	2102	Jim Wells	Agricultural	SOIL MON 101 ANN 0-6 IN
WQ0003463-000	WOHLGEMUTH PAUL	2492	Jim Wells	Agricultural	SOIL MON 101 ANNUAL 0-6
WQ0003463-000	WOHLGEMUTH PAUL	2492	Jim Wells	Agricultural	OTFL 001/DAIRY 500 HEAD
WQ0003463-000	WOHLGEMUTH PAUL	2492	Jim Wells	Agricultural	SOIL MON 301 ANN 12-24
WQ0003463-000	WOHLGEMUTH PAUL	2492	Jim Wells	Agricultural	SOIL MON 201 ANNUAL 6-12
WQ0001837-000	KING RANCH INC.	2492	Kleberg	Agricultural	CATTLE FEEDLOT 20000
WQ0001497-000	LYKES BROS. INC. FEED YARD	2102	San Patricio	Agricultural	CATTLE FEEDLOT 10500

Farming Practices

Interviews were conducted with agricultural producers in several counties as well as with county-level professionals with state and federal agencies to assess local management of agricultural land. The data gathered is not specific enough to develop an EMC for the crop or land use, however, it provides insight for what practices may or may not contribute to NPS loadings.

Climate, especially precipitation and the resulting runoff, is the dominate factor which affects quantities and timing of NPS loadings to the CCBNEP bays and estuaries. Also, the climate of the study area determines the kind of farming and the timing of the practices used. Normally, only one crop is grown in a field each year. Immediately after the crop is harvested, the soils are prepared so that they can conserve moisture from the rains in late summer, fall, and winter.

The acreage of most concern is that receiving applications of nutrients and pesticides. Irrigation does not play a large role in NPS loadings since the percentage of acreage irrigated (<1 percent) within the study area is so small and the fact that it is normally only supplemental irrigation (applied only to supplement rainfall during critical crop growth periods).

The major crops or land use receiving applications of nutrients and chemicals are cotton, corn, grain sorghum, melons, and improved pasture. Table III.2 lists the general practices and management level for the study area.

Table III.2 - General Cropping Management in the CCBNEP Study Area

OPERATION OR PRACTICE	COTTON	SORGHUM	CORN	MELONS	PASTURE
Plant Date	Early March	Feb.-March	Feb.-March	Mid Feb.	
Harvest Date	Late July	Early July	Late July	Late May	Growing Season
Fertilizer Initial (Approximate) per acre application	70# Nitrogen, Liquid or Anhydrous	70# Nitrogen, Liquid or Anhydrous	70# Nitrogen, Liquid or Anhydrous	30# Nitrogen & 60# Phosphorus Liquid	60# Nitrogen Granule
Fertilizer Sidedress or Topdress per acre			20-30# Nitrogen, Liquid or Anhydrous	30# Nitrogen & 60# Phosphorus Liquid	30# Nitrogen Granule
Crop Rotation	1 Crop/Yr.	1 Crop/Yr.	1 Crop/Yr.	1 Crop/Yr.	

Table III.3 gives a comparison of commercial fertilizer and nutrients in this fertilizer for three of the counties within the CCBNEP study area. This information was obtained from the office of the state chemist, Texas Agricultural Experiment Station (TAES) in 1994. San Patricio, Nueces, and Kleberg county are located on the coastline and represent areas that have direct runoff into the bays and estuaries for the study area.

Figures III.1, III.2, and III.3 also portrays this information in a graphical format that aids in comparisons between the three counties. Average applications of fertilizer are consistently higher in Nueces and San Patricio counties than in Kleberg county. It is unknown to what degree these application rates have on the ambient water quality in the adjacent bays and estuaries.

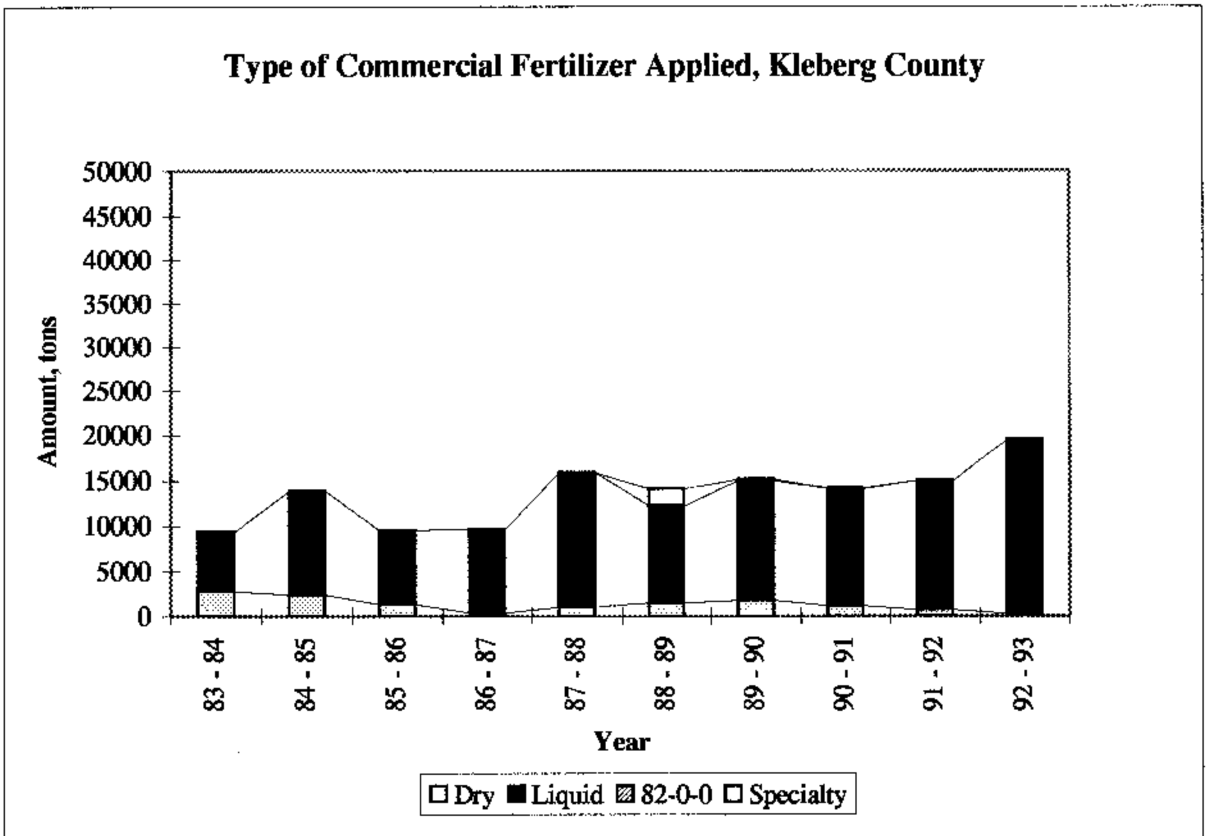
Cropping management in most cases leaves the land fallow during the fall and winter months. This makes it more susceptible to water erosion from heavy rainfall during that time. In the sandy soils in the western portion of the study area, the cropland is normally protected by windstrips to reduce wind erosion during this period.

A substantial data gap exists on specific agricultural practices such as tillage practices, fertilizer, & pesticide applications and how they relate to NPS pollution. A concurrent study is being done by TAES personnel at the Corpus Christi station to fill this gap.

Table III.3 - Fertilizer Amounts for Coastal Counties, CCBNEP (TAES, 1994)

County	Year	Form of Fertilizer, tons				Nutrients, tons			Total
		Dry	Liquid (Less 82-0-0)	82-0-0	Specialty *	Nitrogen, (N)	Phosphorus, (P)	Potassium, (K)	Total Tons
Kleberg	92 - 93	281	19177			4854	1843	65	19458
	91 - 92	748	14196			3626	1217	68	14944
	90 - 91	1173	12829		121	3161	1189	311	14123
	89 - 90	1706	13284		129	3250	1438	72	15119
	88 - 89	1411	10733		1850	2754	1194	77	13994
	87 - 88	991	14820		44	3265	2156	65	15855
	86 - 87	374	9258			2133	1025	24	9632
	85 - 86	1294	8190			2150	1075	52	9484
	84 - 85	2403	11385			2984	1663	21	13788
	83 - 84	2757	6624			2263	1074	84	9381
	Sub-total	13138	120496		2144	30440	13874	839	135778
Nueces	92 - 93	1531	21053	7486		11501	2013	220	30070
	91 - 92	1460	27594	5814		11493	2689	174	34868
	90 - 91	828	20217	7323	90	10859	1834	55	28458
	89 - 90	561	17988	4532	139	8167	1418	80	23220
	88 - 89	840	28766	4990	1	10899	2596	121	34597
	87 - 88	547	34336	3189	55	10701	2987	85	38127
	86 - 87	3127	40527	2681	2	12437	3561	253	46337
	85 - 86	495	29410	2894	5	9425	2367	117	32804
	84 - 85	243	33924	2222	71	9787	2819	41	36460
	83 - 84	867	31789	4033	22	10581	3277	59	36711
	Sub-total	10499	285604	45164	385	105850	25561	1205	341652
San Patricio	92 - 93	2251	33509	2035		9934	3390	171	37795
	91 - 92	1326	34858	1443		9111	3826	115	37627
	90 - 91	870	30546	1582	576	8102	3243	173	33574
	89 - 90	1388	30147	1315	181	8411	2673	191	33031
	88 - 89	1465	30038	2125	75	8577	3243	174	33703
	87 - 88	1797	31764	796	564	7954	3554	180	34921
	86 - 87	866	31576	477	278	7434	3481	162	33197
	85 - 86	1058	32040	479	133	7318	3446	183	33710
	84 - 85	1487	37033	508	18	8634	4208	240	39046
	83 - 84	1891	35493	1213		8631	4453	256	38597
	Sub-total	14399	327004	11973	1825	84106	35517	1845	355201
TOTALS		38036	733104	57137	4354	220396	74952	3889	832631

* *Specialty fertilizer reflects bagged, non-farm use type fertilizer such as lawn and garden fertilizers.*



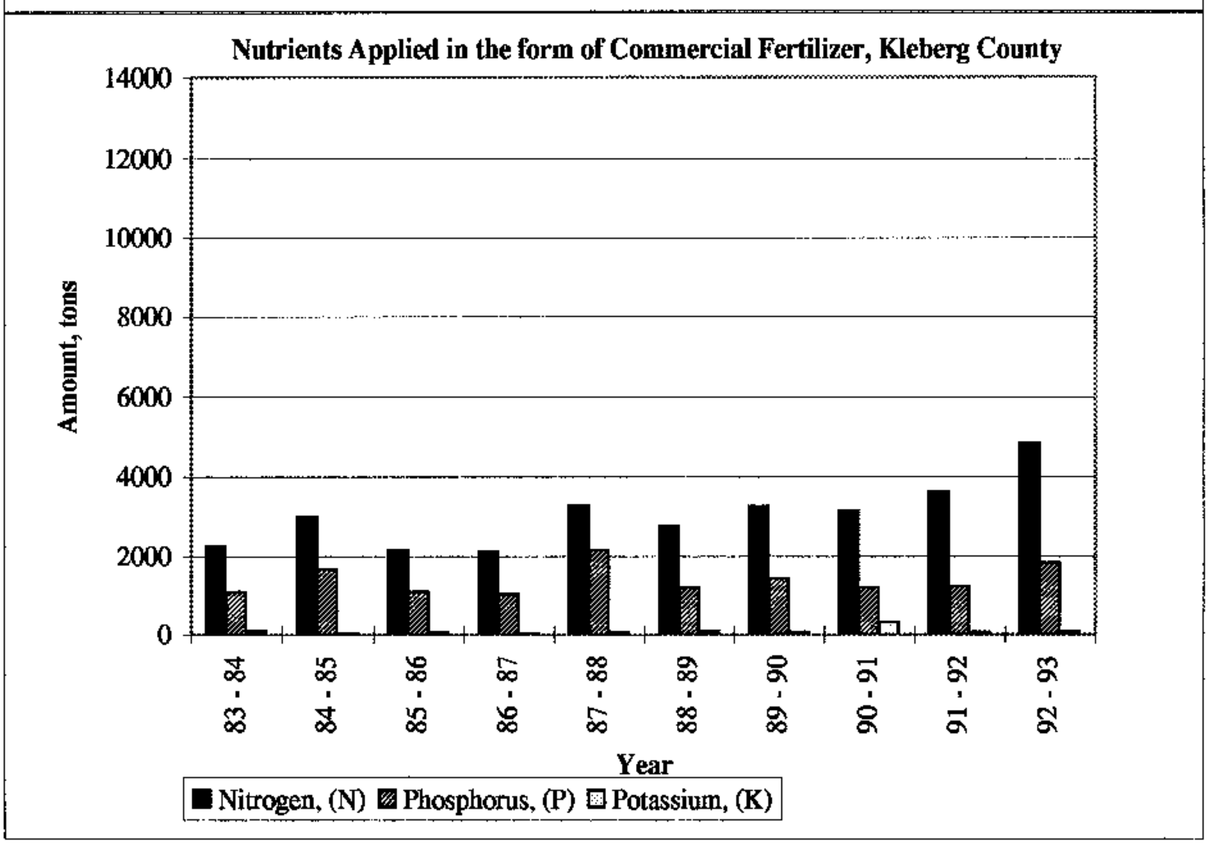
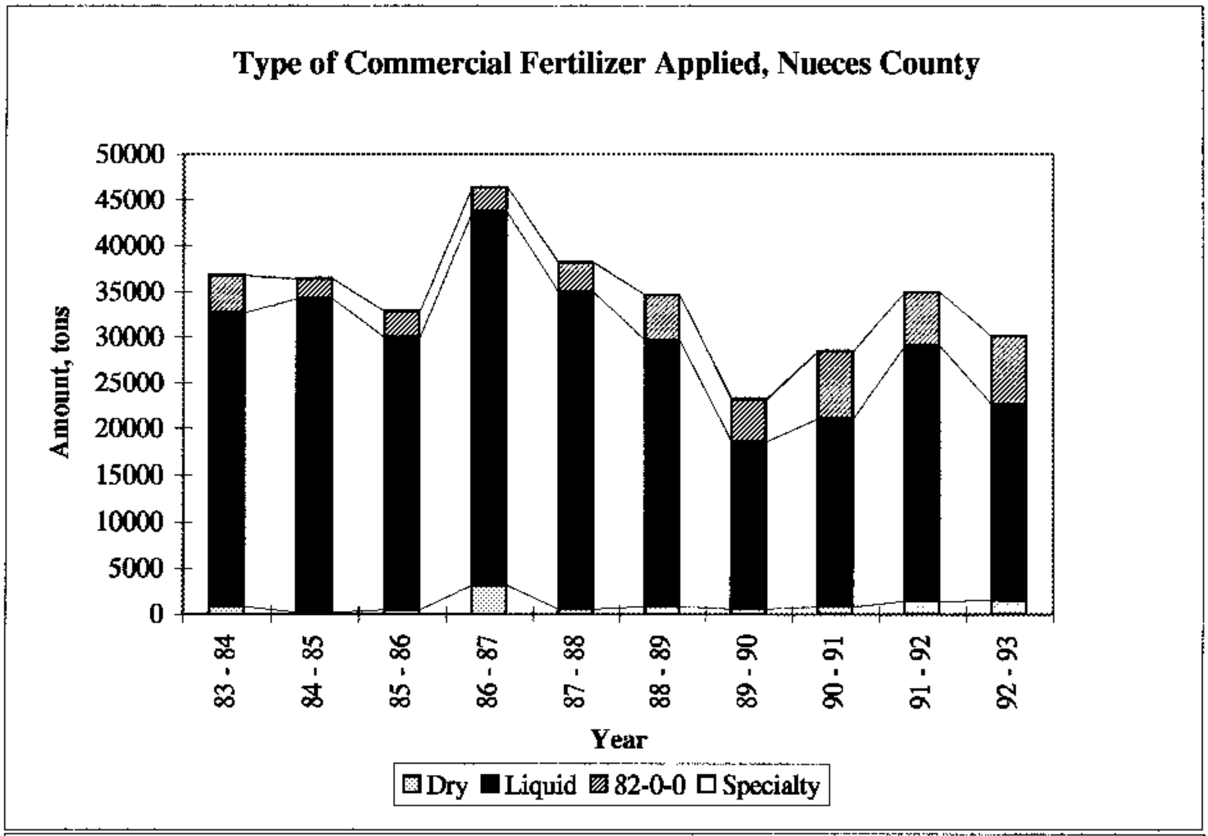


Figure III.1 - Type of Fertilizer and Nutrients Applied in Kleberg County



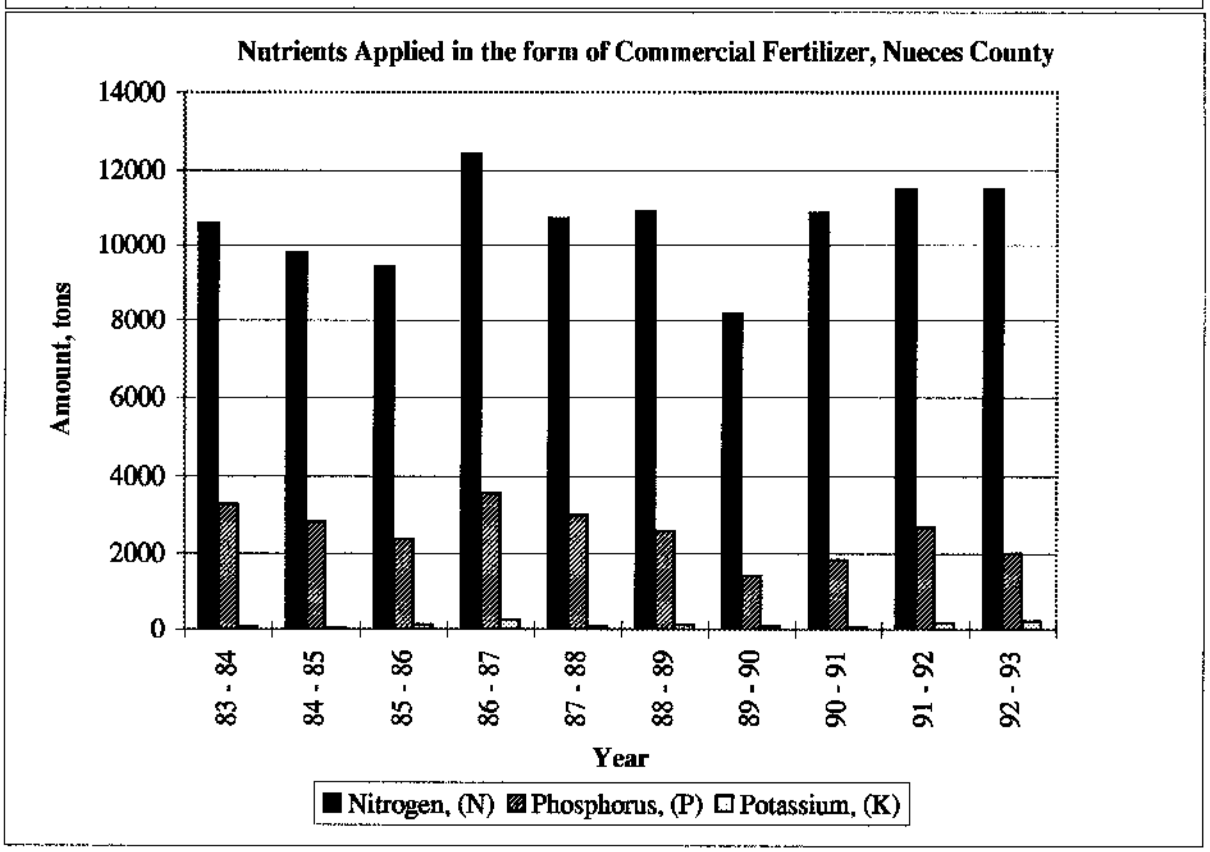


Figure III.2 - Type of Fertilizer and Nutrients Applied in Nueces County

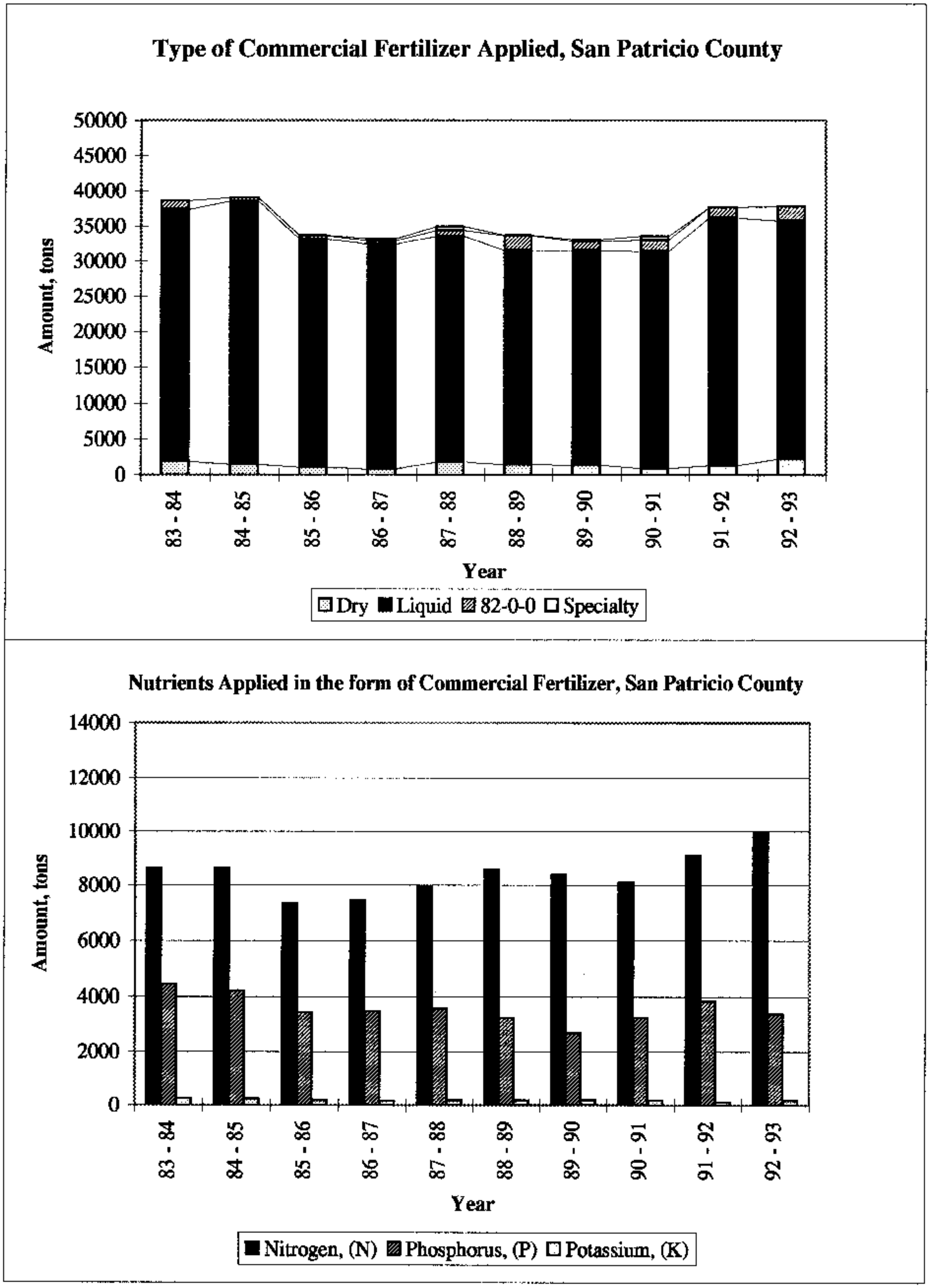


Figure III.3 - Type of Fertilizer and Nutrients Applied in San Patricio County

Highly Erodible Land (HEL)

These lands have been defined by NRCS in order to identify areas on which erosion control efforts should be concentrated. This classification was used to determine needed conservation treatment on farms to comply with provisions of the 1985 Farm Bill. The definition is based on Erosion Indexes derived from certain variables of the Universal Soil Loss Equation and the Wind Erosion Equation. The indexes are the quotient of tons of soil loss by erosion predicted for bare ground divided by the sustainable soil loss (T factor).

A definition of potentially highly erodible due to water erosion is applied to a soil series phase which has a range of slope (i.e., 5 to 8 percent) where the higher values of that slope range would be classed as highly erodible but the lower values of the slope range would not be highly erodible. Only an on-site determination of slope for that particular soil delineation would allow a determination of highly erodible or not highly erodible.

Out of the coastal tier of counties in the CCBNEP study area, San Patricio and Aransas counties were contained in the digitized SSURGO soils data base. This GIS layer was reclassed to reflect those soils defined by NRCS to be HEL. The land use GIS layer for these same counties was overlain, which resulted in a report of all cropland in the two counties that is designated as (1) highly erodible land, (2) potentially highly erodible land, or (3) not highly erodible. The acreages and percent of the highly erodible land definitions is included in Table III.4. The table indicates that cultivated land in these two coastal counties is located on soils that, for the most part, are not highly erodible due to either water or wind erosion.

Table III.4 - Land Erodibility Classification for Aransas and San Patricio Counties (NRCS)

Erodibility Classification - Water Erosion - Cropland			
County	Classification	Acres	Hectares
Aransas	Highly Erodible	0	0
	Potentially Highly Erodible	445	180
	Not Highly Erodible	5,031	2,036
San Patricio	Highly Erodible	59	24
	Potentially Highly Erodible	1,512	612
	Not Highly Erodible	253,633	102,643
Total		260,681	105,495
Erodibility Classification - Wind Erosion - Cropland			
Aransas	Highly Erodible	662	268
	Not Highly Erodible	4,814	1,948
San Patricio	Highly Erodible	1,443	584
	Not Highly Erodible	253,762	102,695
Total		260,681	105,495

The classifications of highly erodible, potentially highly erodible, and not highly erodible do not take into consideration management practices applied to the soil surface. Most of the fields classified as HEL are farmed under USDA approved management systems which provide significant reductions in their erosion potential.

Marinas

Marinas are desirable coastal facilities which, when properly located, designed and managed, provide a valuable recreational and commercial function (NOAA, 1976). However, marinas and associated activities can potentially contribute NPS pollution to estuary waters. Potential effects from marinas include:

- Increased turbidity due to dredging activities and boat propellers which act to re-suspend sediment, trapped pollutants, nutrients and organic matter into the water column.
- Release of sewage and treatment chemicals can contribute to contamination of waters with coliform bacteria.
- Oil and fuel spills introduce substances which are toxic to some marine organisms.
- Land runoff from parking and other improved areas can carry a wide array of substances including oil, sediment, metals, nutrients, and bacteria.
- Leaching of preservatives from marine lumber directly into the bays and estuaries,
- The leaching of biocides such as tributyl tin and copper from boat paints.

One potential source of NPS pollution is leaching of preservatives used in marine lumber. Sources of this type of contamination are not limited to only commercial marinas but include residential docks, piers, and backyard decks. Chromated copper arsenate (CCA) is the most common preservative used in pressure-treated wood and studies have shown evidence of leaching of this compound and resulting toxic effects on marine organisms (Weis and others, 1993).

Another potential source of NPS pollution is the leaching of tributyl tin, copper, and other paint biocides (NCDEHNR, 1991). Tributylin is an effective biocide used in some antifouling paints (Huggett and others, 1992). It has been used to control the attachment and growth of organisms such as barnacles and mussels on the hulls of vessels. The biocide is released from the paint film and a thin envelope of concentrated Tributylin is formed around the vessel hull. The larvae of nuisance organisms are killed or repelled when they encounter the layer, thus protecting the vessel. However, tributylin further diffuses into adjacent waters where other plants and animals may be exposed. The extent of Tributylin use (and other antifouling substances) and possible impacts on marine organisms in the CCBNEP area waters is not known. No EMCs were assigned for this land use.

A list of marina facilities services has been compiled by Dewayne Hollin through the Sea Grant College Program, Texas A&M. Portions of the 1994 report applicable to the CCBNEP study area are included in appendix H. The report includes information such as location, wet slip and storage capacity, and available services such as fueling and waste pumping.

Septic Tanks

The magnitude of domestic sewage disposal through the use of septic tanks is indicated in Table III.5 based on 1990 U.S. Census Bureau data. There are scattered data bases which deal with numbers of septic systems permitted, but these do not portray the overall numbers of systems within a particular area. There is no known data set within the study area assessing loadings of nonpoint constituents from septic tanks. Proper siting and installation of septic systems is critical for desired operation. Experience with on-site conditions shows that soil conditions and water table levels can cause severe limitations to the performance of septic systems if not properly sited.

Table III.5 - Domestic Sewage Disposal in the CCBNEP Study Area (US Census Bureau, 1990)

County	Housing Units with Public Sewer	Housing Units with Septic Tank or Cesspool	Housing Units with Other Means
Aransas	4305	6456	128
Bee	6226	3859	123
Brooks	2143	939	22
Duval	3336	1477	314
Jim Wells	9278	4419	251
Kenedy	20	182	11
Kleberg	9946	1949	113
Live Oak	1833	3630	56
McMullen	25	502	38
Nueces	107977	5918	431
Refugio	2634	1033	72
San Patricio	16186	5722	218

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IV. Analysis and Compilation of Event Mean Concentrations

Analysis of Constituent Concentrations

This study focuses on the water quality of runoff resulting from rainfall events. The collection of runoff Event Mean Concentrations compiled in this study were determined from analysis of existing data. No data collection was conducted for this study.

NPS Event Mean Concentrations were determined by land use category and constituent. The land use categories considered in this study are described below.

	Category	Description
1.	Residential	Includes residential developments as well as parks, golf courses, cemeteries, etc.
2.	Urban	Business districts, shopping developments and institutional units such as schools, hospitals, etc.
3.	Industrial/Commercial	A wide array of land use ranging from light to heavy industry.
4.	Transportation	Major transportation routes, communications and utilities areas.
5.	Cropland	Land used primarily for the production of adapted cultivated and close-growing crops for harvest, alone or in association with sod crops.
6.	Rangeland	Land used for grazing by livestock and big game animals on which the climax (natural potential) plant community is dominated by grasses, grass-like plants, forbs, and shrubs.
7.	Open/Undeveloped	Lands with sparse vegetative cover, thin and/or rocky soils, and limited ability to support life due to natural or man-induced conditions. This category includes beaches, spoil dumps, quarry and mining lands, and transitional areas which have been cleared but not yet developed.
8.	Marinas	The Marina land use category is intended to cover smaller, recreational and commercial marina operations rather than larger, industrial and shipping facilities. Since practically no information is available on runoff characteristics for marina land use, no NPS concentration values for marina land use are given.

The types of studies and amount of data that pertain to urban land use are different from the data available for agricultural land use. Therefore, EMC determination for urban and agricultural land use categories are addressed separately.

The constituents evaluated in this study are shown below. For certain combinations of constituents and land use categories, EMC values are not available.

Total Nitrogen	Fecal Coliform
Total Kjeldahl Nitrogen	Fecal Streptococcus
Nitrate + Nitrite	Oil and Grease
Chemical Oxygen Demand	Total Nickel
Biochemical Oxygen Demand	Total Lead
Total Phosphorus	Total Copper
Dissolved Phosphorus	Total Zinc
Total Suspended Solids	Total Cadmium
Total Dissolved Solids	Total Chromium

Table IV.9 (page 56) summarizes the median EMC values of all these constituents according to land use category where data were available.

Analysis of Urban Constituent Concentrations

Methodology of EMC Determination

Urban land use categories comprise residential, commercial, industrial and transportation. The methods used to select representative constituent concentrations from among the available data bases are described below.

Among the available data bases for obtaining urban EMCs -- those from NPDES studies for Corpus Christi, Dallas-Fort Worth, and San Antonio; the Galveston Bay National Estuary Program NPS study; and the Nationwide Urban Runoff Program -- the Corpus Christi NPDES data base is considered the most directly applicable to the CCBNEP study area. The combination of size and population, coastal location, climate, and type and degree of industrialization makes the Corpus Christi area unique among urban areas of the country. Thus available and reliable local data, rather than data from other areas of the country, are probably the most appropriate to characterize urban NPS pollution for the study area.

If local data were not available for certain combinations of constituents and land uses, data from other areas were used. For example, EMCs for transportation land use were determined from Dallas-Fort Worth NPDES data.

The Corpus Christi NPDES data base comprises samples collected at five urban stations. Each of the stations monitors runoff from areas that consist primarily of a single land-use. Two of the stations monitor residential land-use runoff; one area is an older residential neighborhood and the other a newer residential development. Two of the stations monitor industrial land-use runoff.

The industrial areas consist of industrial park development rather than heavy industry. One station monitors commercial land-use runoff; the area includes a strip shopping center. A summary of the urban drainage characteristics of each of these areas is shown in Table IV.1.

Table IV.1 - Site Characteristics for Corpus Christi NPDES Sampling Stations (Corpus Christi, 1993)

Site Location	Land Use	Drainage Area		Percent Impervious
		Acres	Hectares	
Florence and Viola	Residential	84	34	40
Bellmeade and Gollihar	Residential	64	26	45
McBride and Steel	Industrial	162	66	60
Ambassador and Columbia	Industrial	20	8	65
Monette and Staples	Commercial	37	15	85

For each of the five stations, samples were collected for six storm events; thus a total of 30 runoff samples were collected. The samples were collected during the period November 1992 through April 1993.

For each constituent in this study, the Corpus Christi NPDES data are presented, including minimum, maximum, median, mean and standard error for each land use (Appendix A). The data are aggregated by land-use category. In addition, medians for the Corpus Christi, Dallas-Fort Worth, San Antonio, GBNEP, and NURP data also are presented (Table IV.2). For runoff EMCs the median value is considered a more appropriate measure of the central tendency of the concentrations than the mean because the median is not affected as strongly as the mean by extreme observations. Both medians and means are included in Appendix A.

NPDES sampling procedures require that certain constituents (in this study, oil and grease, fecal coliform, and fecal streptococcus) be sampled by grab sampling rather than flow-averaged sampling. For these constituents, the concentrations do not represent averages during an entire runoff event. In fact, the purpose of NPDES grab sampling is to obtain the “first flush” or runoff sample during the early stages of an event. In practice, grab samples collected at a particular site during several storms do not usually represent the same point on the associated storm hydrograph and therefore, over a number of samples, some averaging occurs. The relation between grab sample concentrations and flow-averaged concentrations was not determined.

Data sets in which the concentrations of some constituents are below the detection or reporting limits are common. For such data sets, several options are available to estimate the missing data in order to calculate summary statistics. Some common options are substitution of the detection limit, or one-half the detection limit, or zero. For this study, a robust method, combining observed data above the reporting limit with below-limit values extrapolated assuming a distributional shape was used (Helsel and Hirsch, 1992). In the method, the regression of the logarithm of the observed concentrations above the reporting limit against the normalized score (quantile) is used to extrapolate estimated values below the reporting limit. Extrapolated values are retransformed into original units and summary statistics are computed on the entire data set. This method was used to compute summary statistics for data sets in which the majority of concentrations were above the reporting threshold. For data sets where all or most of the concentrations were below the reporting limit, either no estimate of mean and (or) median was made, or the median was listed as below the reporting limit.

Results of EMC analysis for Urban Land Use

The constituent concentrations measured in Corpus Christi NPDES urban runoff samples show variability similar to that observed in constituent concentrations from other runoff studies such as NURP. Concentrations for certain constituents in the Corpus Christi data base vary more than others. For example, the range of concentrations of fecal streptococcus bacteria was very large, ranging from 200 to 50,000,000 (measured in colonies/100ml). Also, concentrations of certain constituents associated with a series of rainfall runoff events at the same sampling station may vary widely. Because of the small number of samples, definitive tests for statistically significant differences among concentrations grouped between factors such as land use or rainfall were not made.

Generally, the Corpus Christi EMCs were similar to EMCs from other studies (Table IV.2), with a few exceptions. Comments on EMCs of selected constituents and comparisons with EMCs from other studies are given below.

Total phosphorus EMCs for residential and industrial land use are comparable to those from other studies. However, the EMC for commercial land use is much higher than EMCs for commercial land use from other studies -- 1.4 mg/L compared to 0.32 and 0.14 mg/L for San Antonio and Dallas-Fort Worth, respectively. For the Corpus Christi study, commercial land use was characterized by only six samples at a single sampling location. Also, samples from this site included one value of 7.3 mg/L. It is possible that the higher concentrations observed at the Corpus Christi NPDES commercial land use study area are site specific and not representative of commercial land use in the area. Median values from the San Antonio and Dallas-Fort Worth NPDES studies were considered as alternatives (0.32 mg/L and 0.14 mg/L, respectively). Although the Dallas-Fort Worth EMC is based on a larger number of samples than the San Antonio EMC, the San Antonio value was selected because it represents a smaller reduction from the Corpus Christi NPDES concentration. The San Antonio EMC is also more consistent with the Galveston Bay EMC of 0.37 mg/L.

The CCBNEP EMC for dissolved phosphorus for commercial land use (1.35 mg/L) is also appreciably higher than reported EMCs for other studies. The San Antonio NPDES EMC (0.11 mg/L) was selected as a more appropriate EMC for commercial land use (based on criteria similar to total phosphorus EMC selection).

EMCs for total copper and total lead compare reasonably well with EMCs from the San Antonio and Dallas-Fort Worth NPDES studies (Table IV.2). The NPDES data for these metals from Corpus Christi, San Antonio, and Dallas-Fort Worth all show reductions from the NURP data collected in the late 1970’s.

The total zinc EMC for industrial land use is higher than that from other NPDES studies (Table IV.2). However, the Corpus Christi data is based upon samples from two industrial areas. Medians for each of the two sites are 210 and 320 μg/L (the overall median from both sites is 245 μg/L). Both of these values are higher than EMCs from the other NPDES studies (Table IV.2).

Chemical oxygen demand EMCs from the Corpus Christi NPDES study also are similar to those from other studies (Table IV.2). However, BOD values are substantially higher. For example, residential land use EMCs from the San Antonio and Dallas-Fort Worth NPDES studies were 7.2 and 7.3 mg/L, respectively compared to 25.5 mg/L for residential areas monitored in Corpus Christi.

Fecal coliform and especially Fecal streptococcus concentrations are higher than those from other studies (Table IV.2). Higher medians and the occurrence of several very high concentrations at all of the sampling sites indicates possible contamination due to sanitary sewer overflow. The Dallas-Fort Worth fecal coliform and fecal streptococcus data are judged more appropriate EMCs for urban land-use categories than the Corpus Christi data based upon the larger Dallas-Ft. Worth data base.

Table IV.2 - Median Concentrations from Selected Studies (Urban)

Constituent	Nationwide Urban Runoff Program	Galveston Bay National Estuary Program	San Antonio NPDES	Dallas - Ft. Worth NPDES	Corpus Christi NPDES	Land Use
Suspended Solids (mg/L)	101	100	84	78.0	41	Residential
	69	166	135	42.0	55.5*	Commercial
	--	--	118	104	60.5*	Industrial
	--	--	--	97*	--	Transportation
Dissolved Solids (mg/L)	--	--	--	59	134*	Residential
	--	--	--	50	185*	Commercial
	--	--	--	69	116*	Industrial
	--	--	--	194*	--	Transportation
Total Nitrogen (mg/L)	2.64	3.41	1.7	1.7	1.82*	Residential
	1.75	2.10	1.7	1.2	1.34*	Commercial
	--	--	1.2	1.4	1.26*	Industrial
	--	--	--	1.86*	--	Transportation
Total Kjeldahl Nitrogen (mg/L)	1.9	1.62	1.1	1.1	1.5*	Residential
	1.18	2.88	1.35	0.8	1.1*	Commercial
	--	--	0.6	0.8	1.2*	Industrial
	--	--	--	1.5*	--	Transportation
Nitrate plus Nitrite (mg/L)	0.74	0.36	--	0.58	0.23*	Residential
	0.57	0.57	--	0.52	0.26*	Commercial
	--	--	--	0.63	0.30*	Industrial
	--	--	--	0.56*	--	Transportation
Total Phosphorus (mg/L)	0.38	0.79	0.34	0.33	0.57*	Residential
	0.20	0.37	0.32*	0.14	1.4	Commercial
	--	--	0.20	0.21	0.28*	Industrial
	--	--	--	0.22*	--	Transportation
Dissolved Phosphorus (mg/L)	0.14	--	0.16	0.21	0.48*	Residential
	0.08	--	0.11*	0.06	1.35	Commercial
	--	--	0.15	0.09	0.22*	Industrial
	--	--	--	0.10*	--	Transportation
Oil and Grease (mg/L)	--	4.0	--	1.0	1.7*	Residential
	--	13.0	--	2.0	9.0*	Commercial
	--	--	--	<1.0	3.0*	Industrial
	--	--	--	0.4*	--	Transportation
Biochemical Oxygen Demand (mg/L)	10.0	15	7.2	7.3	25.5*	Residential
	9.3	9.0	4.8	6.6	23.0*	Commercial
	--	--	8.8	7.5	14.0*	Industrial
	--	--	--	6.4*	--	Transportation
Chemical Oxygen Demand (mg/L)	73	--	95	70	49.5*	Residential
	57	--	115	56.5	116*	Commercial
	--	--	60	66	45.5*	Industrial
	--	--	--	59*	--	Transportation

-- Data not available
* Selected for CCBNEP EMC value
⊕ Values are for dissolved constituent

Table IV.2 - Median Concentrations from Selected Studies (Urban), cont.

Constituent	Nationwide Urban Runoff Program	Galveston Bay National Estuary Program	San Antonio NPDES	Dallas - Ft. Worth NPDES	Corpus Christi NPDES	Land Use
Total	29	4.16$^{\oplus}$	15.5	8.0	15.0*	Residential
Copper	33	3.97$^{\oplus}$	8.0	8.0	14.5*	Commercial
(µg/L)	--	--	14.0	12.0	15.0*	Industrial
	--	--	--	11.0*	--	Transportation
Total	135	35.37$^{\oplus}$	115	60	80*	Residential
Zinc	226	55.2$^{\oplus}$	230	80	180*	Commercial
(µg/L)	--	--	145	140	245*	Industrial
	--	--	--	60*	--	Transportation
Total	144	2.18$^{\oplus}$	31	13.0	9.0*	Residential
Lead	104	4.16$^{\oplus}$	14	29.5	13.0*	Commercial
(µg/L)	--	--	46	29.0	15.0*	Industrial
	--	--	--	11.0*	--	Transportation
Total	--	1.0$^{\oplus}$	--	<1	0.75*	Residential
Cadmium	--	1.0$^{\oplus}$	--	<1	0.96*	Commercial
(µg/L)	--	--	--	<1	2.0*	Industrial
	--	--	--	<1*	--	Transportation
Total	--	5.0$^{\oplus}$	--	4.0	2.1*	Residential
Chromium	--	5.0$^{\oplus}$	--	4.0	10*	Commercial
(µg/L)	--	--	--	4.0	7.0*	Industrial
	--	--	--	3.0*	--	Transportation
Total	--	--	--	4.0	<10*	Residential
Nickel	--	--	--	3.0	11.8*	Commercial
(µg/L)	--	--	--	6.0	8.3*	Industrial
	--	--	--	4.0*	--	Transportation
Fecal	101	22,000	37,500	20,000*	40,500	Residential
Coliform	21,000	22,000	6,150	6,900*	14,800	Commercial
(cfu/100 ml)	--	--	--	9,700*	31,500	Industrial
	--	--	--	53,000*	--	Transportation
Fecal	--	--	64,500	56,000*	200,000	Residential
Streptococcus	--	--	35,000	18,000*	1,650,000	Commercial
(cfu/100 ml)	--	--	5,000	6,100*	90,000	Industrial
	--	--	--	26,000*	--	Transportation

-- Data not available
* Selected for CCBNEP EMC value
$^{\oplus}$ Values are for dissolved constituent

Urban Pesticides and Organic Compounds

The Corpus Christi NPDES permit sampling program included analyses for pesticides and organic compounds. No pesticides were detected in any of the samples. However, the list of NPDES pesticides analytes does not include some common pesticides now in use in urban and residential areas, such as Diazinon and Malathion. The 30 pesticides samples were analyzed for:

- Aldrin
- Aroclor
- Chlordane
- Dieldrin
- DDT, DDD, and DDE
- Endosulfan
- Endrin
- Heptachlor
- Lindane
- Toxaphene

The NPS study conducted by the Coastal Bend Council of Governments in 1982 included sampling for pesticides. Fifteen sampling sites were included in that study although most of the sites were in receiving waters (bays) where runoff is diluted. Some of the sampled effluent included base flows, the specific source of which is unknown. Also, some of the drainage area above some sites includes agricultural land. A total of 54 samples were collected and analyzed for pesticides:

- 2-4 D
- Aldrin
- Chlordane
- Diazinon
- Dieldrin
- Malathion

Aldrin, Dieldrin, and 2-4 D were not detected in any of the samples. Diazinon, Malathion, and Chlordane were detected in trace amounts in some of the samples. Diazinon was detected at concentrations of 0.5, 0.6, and 1.1 μg/L during three heavy rainfall runoff events. During six other rainfall runoff events, Diazinon was not detected or was below the detection limit of 0.5 μg/L. Among 18 base flow samples that were collected, Diazinon was detected in 8. Malathion was detected in four samples that were collected after small amounts of rainfall (concentrations of 1.7, 2.5, 2.5, and 2.6 μg/L). No detections above the detection limit, 1.0 μg/L, of Diazinon and Malathion were reported in samples that were collected after heavy rainfall runoff events. Chlordane was detected in 3 of the 18 samples (concentrations of 1.1, 1.9, and 2.6 μg/L) collected during base flow. No detections above the detection limit of 1.0 μg/L were reported in samples collected after rainfall runoff events.

The Council of Governments study also included some bay bottom sediment analysis. All of the sediment samples were collected in receiving bay waters. No pesticides were detected in any of the sediment samples.

The Corpus Christi NPDES permit requirements also mandate sampling for more than 80 volatile, organic acid, and base/neutral compounds. Few of these compounds were detected. The following were detected in samples from 30 rainfall runoff events:

Chlorobromomethane - 1 detect (160 μg/L).
Ethylbenzene - 1 detect (8.6 μg/L).
Tolulene - 2 detects (23 and 31 μg/L).
1,1,1 - Trichloroethane - 3 detects (30, 46, and 65 μg/L).

Analysis of Agricultural Constituent Concentrations

Methodology of EMC Determination

This study also focuses on the water quality of agricultural runoff resulting from rainfall events. The collection of runoff concentrations were compiled in this study from analysis of existing data. Previous and ongoing studies of agricultural NPS concentrations were reviewed to determine applicability to the study area.

Agricultural NPS concentration values are defined for two land use categories: cropland and rangeland.

The median concentration values included in this section are derived from data sets that consist of individual measurements, or “grab” samples. Since these samples are not usually collected at the same point on the storm hydrograph, some averaging, or “flow-weighting”, occurs. Since no apparent correlation exists between flow rate and concentrations, the resulting median values may be considered concentrations that are representative of both single events and annual periods in the CCBNEP study area.

The USGS gage number 08211520 located on Oso Creek at Corpus Christi was most representative of the study area’s agricultural cropland. USGS gage 08281500 in the Seco Creek watershed near Utopia, Texas was used to obtain representative concentration values for rangeland. Although this USGS information is still provisional and subject to revision, these gages were selected for the following reasons.

The Oso Creek gage is located in the CCBNEP study area below a land use which is predominately agricultural cropland.   The cropping patterns in this watershed consists mainly of grain sorghum, cotton, and corn, which are fairly representative of the entire CCBNEP study area. It is located in the watershed selected as one to be used in the pilot study for the CCBNEP. Gage records analyzed cover the time period from October 1977 to September 1988. Data for watersheds that are exclusively cropland is extremely limited. The combination of coastal location, climate, and type and level of agricultural activity makes this gage the logical choice to represent the typical cropland area.

This gage does have the disadvantage of being located below a point from which the city of Robstown discharges its treated wastewater effluent. Analyses of this discharge reveal that total suspended solids average 7 mg/L, ammonium nitrogen averages less than 0.2 mg/L, and fecal coliforms are extremely low (Robstown Wastewater Treatment Plant). Detailed analyses of other constituents are not available. The Robstown treatment facility is regulated under a permit from the TNRCC and, on the average, it discharges one to one and a half million gallons per day (3.8 million to 5.7 million liters per day) or about 1.5 to 2.3 cubic feet per second (cfs). The low flow (<5.0 cfs) values from the Oso gage were not used in the calculation of cropland EMC values because it was assumed that much of the low flow was from the treatment plant.

The Seco Creek gage (#08201500) is in the upper watershed of the Nueces River. It is situated below a watershed consisting almost exclusively of rangeland. This rangeland area is very similar to that found within the study area. It has been in place for a number of years and a large variety of constituents have been measured. The time period analyzed for this study was from March 1970 to February 1995. The literature search did not uncover other sources for agricultural EMC data from a rangeland watershed. Information from other gages in the Seco Creek area (08202450, 08202700, and 08202900) was used to provide information for comparison.

For each constituent evaluated in this study an analysis of the Oso Creek and Seco Creek data is presented in Appendix B including minimum, maximum, median, mean, and standard error for each land use. In addition, a comparison of median values for the GBNEP and the NAWQA data sets is also presented. The EMC data compiled for the Galveston Bay National Estuary Program and the NAWQA program was not used to obtain concentration values for this study because of differing land uses, soils, and climate that are not representative of the study area. Some of the data from these studies are included here for comparison purposes only. Appendix C contains a listing of all the constituent data analyzed for the agricultural land uses.

Results of EMC analysis for Agricultural Land Use

The same constituents as shown in the urban section above were compared when the data was available. The median and mean values are presented in Appendix B whenever available. Median concentrations are considered to be the more appropriate measure of EMCs than the mean value. The median is not affected to the same degree as the mean by inordinately high or low values.

An analysis of this data was made by flow rate, time of year, and location. There was no discernible correlation between the constituent values, flow rates, and time of year for each location.

Table IV.3 is a comparison of EMC values for individual constituents for the cropland (including pastureland) and rangeland land uses. Sources for agricultural EMC data are limited. The main "yardstick" for comparison of the EMC values is the data contained in the GBNEP study. All other values in Table IV.3 were developed from USGS provisional information for gages located in Texas.

Care should be exercised when making comparisons between the data sets. Each collection has a different number of samples and they are often collected over different time periods. For instance, the data set for the Oso gage 08211520 consists of 77 samples taken over the time period from 1977 to 1988. The data for Mill Creek and Big Onion Creek (Trinity River Watershed, Texas) consists of five samples each taken in 1994 and 1995. Mill Creek and Big Onion Creek data, though limited, was used for comparison because of its reliability and the similarity of land use. The Seco gage 08201500 information represents 81 samples taken over the time period from 1970 through 1995, while gage 08202450 covers 17 samples taken from 1991 through 1994. A few general comments are offered in the following paragraphs.

Some constituent values recommended for use in the CCBNEP area have noticeably "higher" or "lower" values when a direct comparison against the other data sets is made. The rangeland value for suspended solids (1 mg/L) is substantially less than that reported for the GBNEP study (70 mg/L). The cropland value for dissolved solids (1,225 mg/L) exceeds values from other studies by a factor of four to six. The EMC value for cropland total nitrogen appears high until compared to Big Onion Creek information (4.4 mg/L vs. 3.4 mg/L). Cropland total Kjeldahl nitrogen exceeds it nearest comparison value by more than a factor of three, while the values reported for nitrate + nitrite are comparable across sources. The cropland value for total phosphorus is higher when compared to other data sets.

The literature review for agricultural EMCs emphasizes the need for additional collection of specific land use data. Available information is inadequate to allow for more valid comparisons of constituent EMC values. Also the literature values are taken from data sets representing different time periods when the sophistication of testing equipment and reporting procedures varied. These values do, however, represent that data most applicable to the CCBNEP study area.

Table IV.3 - Median Concentrations from Selected Sources (Agricultural)

Constituent	USGS 08211520 Oso Creek	USGS 08201500 Seco Creek	Galveston Bay National Estuary Program	USGS 08202450 Seco Creek	USGS 32101709-6420099 Mill Creek	USGS 32131309-6415201 Big Onion Creek	Land Use
Suspended Solids (mg/L)	107* --	-- 1*	201 70	-- --	48 --	37 --	Cropland Rangeland
Dissolved Solids (mg/L)	1,225* --	-- 245*	-- --	-- 198	278 --	215 --	Cropland Rangeland
Total Nitrogen (mg/L)	4.4* --	-- 0.7*	1.56 1.51	-- 0.62	1.80 --	3.40 --	Cropland Rangeland
Total Kjeldahl N (mg/L)	1.70* --	-- 0.2*	-- --	-- 0.35	0.30 --	0.50 --	Cropland Rangeland
Nitrate + Nitrite (mg/L)	1.60* --	-- 0.4*	-- --	-- 0.25	1.60 --	2.90 --	Cropland Rangeland
Total Phosphorus (mg/L)	1.30* --	-- <0.01*	0.36 0.12	-- 0.03	0.03 --	0.04 --	Cropland Rangeland
BOD (mg/L)	4.0* --	-- 0.5*	4.0 6.0	-- 2.0	-- --	-- --	Cropland Rangeland
Total Copper (μg/L)	1.5* --	-- <10.0*	3.1⊕ 3.0⊕	-- <10.0	-- --	-- --	Cropland Rangeland
Total Zinc (μg/L)	16.0* --	-- 6.0*	18.3⊕ 18.3⊕	-- 7.0	-- --	-- --	Cropland Rangeland
Total Lead (μg/L)	1.5* --	-- 5.0*	2.40⊕ 2.40⊕	-- <10.0	-- --	-- --	Cropland Rangeland
Total Cadmium (μg/L)	1.0* --	-- <1.0*	0.50⊕ 0.50⊕	-- <1.0	-- --	-- --	Cropland Rangeland
Total Chromium (μg/L)	<10.0* --	-- 7.5*	5.0⊕ 5.0⊕	-- <5.0	-- --	-- --	Cropland Rangeland
Fecal Coliforms cfu/100ml	--* --	-- 37*	2,500 2,500	-- 13,000	-- --	-- --	Cropland Rangeland

-- Data not available
* Selected for CCBNEP EMC value
⊕ Values are for dissolved constituent

Agricultural Pesticides

For agricultural cropland and rangeland, values measured for selected pesticides from the USGS gages located at Oso Creek and Seco Creek (@ Miller Ranch) are given in Appendix D. The pesticides listed include:

- ametyn
- atrazine
- diazinon
- disyston
- endosulfan
- ethion
- lindane
- malathion
- methomyl
- methyl parathion
- phorate
- prometryn
- carbaryl
- simazene
- toxephene
- 2,4-D
- 1,3 Dichloropropene

These particular chemicals were selected because they have been monitored at the USGS gages and they are found in common agricultural chemicals that have been used (at the present time or in the past) in the Corpus Christi bay area. They do not necessarily represent all of the commonly used agricultural chemicals in use in the area.

These chemicals also represent several different classes of pesticides including organchlorine insecticides (i.e., toxephene), organophosphorus insecticides (i.e., methyl parathion), carbamate insecticides (i.e., carbaryl), and triazine herbicides (i.e., atrazine). Pesticide transport mechanisms are highly dependent on the physical and chemical properties of the pesticide which are generally similar within a class.

Because very limited information exists in the agricultural pesticide data base, no EMC values were assigned for pesticides to the various land uses. A rudimentary analysis of the Oso and Seco gages for the selected pesticides is given in Table IV.4.

Table IV.4 - Number of Measurements and Pesticide Concentrations at Oso and Seco Gages from 1970 to 1995 (USGS)

Pesticide	Type	Seco Gage #08201500 (primarily rangeland)		Oso Gage #08211520 (primarily cropland)	
		No.	Amount	No.	Amount
Ametryn	Herbicide	3	<0.10	*NA*	*NA*
Atrazine	Herbicide	3	<0.10	*NA*	*NA*
Cyanazine	Herbicide	1 2	<0.10 <0.20	*NA*	*NA*
Diazinon	Insecticide	22 19	<0.01 *ND*	9 *NA*	0.20* *NA*
Disyston	Insecticide	9	<0.01	*NA*	*NA*
Endosulfan	Insecticide	22 9	<0.01 *ND*	1 8	<0.01 *ND*
Ethion	Insecticide	22 12	<0.01 *ND*	1 8	<0.01 *ND*
Lindane	Insecticide	22 18	<0.01 *ND*	5 1 4	0.05* <0.01 *ND*
Malathion	Insecticide	22 19	<0.01 *ND*	1 1 7	<0.01 0.01 *ND*
Methomyl	Insecticide	1	<2.0	*NA*	*NA*
Methyl Parathion	Insecticide	21 1 19	<0.01 0.02 *ND*	1 8	0.05 *ND*
Phorate	Insecticide	1 9	<0.10 <0.01	*NA*	*NA*
Prometryn	Herbicide	3	<0.10	*NA*	*NA*
Carbaryl	Insecticide	1	<2.0	*NA*	*NA*
Simazene	Herbicide	3	<0.10	*NA*	*NA*
Toxephene	Insecticide	22 17	<1.0 *ND*	1 8	<0.10 *ND*
2,4-D	Herbicide	1 24 18	0.01 <0.01 *ND*	3 1 5	0.02* <0.01 *ND*
1,3 Dichloropropene	Fungicide	2	<0.20	*NA*	*NA*

* *Average value of detectable measurements*
All amount values are given in µg/L
NA represents Not Applicable (Not sampled for)
ND represents No Detection during analysis (Below limit at the time of test)
81 different samples taken for gage #08201500 and 35 samples for gage #08211520

Analysis of Constituent Concentrations for Undeveloped/Open Land Use

The undeveloped/open land use category can include a number of different characteristics that contribute to a wide variation in the amount and quality of runoff. Data from local monitoring (Corpus Christi NPDES) does not address this type of land use. The NURP study does include data from 8 such land use sites. This data was used for this report in the absence of other data. The NURP study sites can be generally described as larger than typical NPDES basins and exhibiting small (less than 10 percent) percentages of impervious area. The NURP results for this land use type do not include values for all of the constituents included for other urban land use categories. The values from the NURP data are shown below in Table IV.5.

Table IV.5 - EMC Values for Undeveloped/Open Land Use (NURP)

Constituent	EMC Value
Total Nitrogen (mg/L)	1.5
Total Kjeldahl Nitrogen (mg/L)	0.96
Nitrate + Nitrite (mg/L as N)	0.54
Total Phosphorus(mg/L)	0.12
Dissolved Phosphorus(mg/L)	0.03
Suspended Solids(mg/L)	70
Dissolved Solids(mg/L)	--
Total Lead (μg/L)	1.52
Total Copper (μg/L)	--
Total Zinc (μg/L)	--
Total Cadmium (μg/L)	--
Total Chromium (μg/L)	--
Total Nickel (μg/L)	--
BOD (mg/L)	--
COD (mg/L)	40
Oil and Grease (mg/L)	--

-- *Data not available*

Upper-Watershed NPS Contributions

Upper-watershed NPS concentrations may be attenuated by the time they reach the estuary. A USGS sampling station located on the Nueces river at Three Rivers, TX., downstream from the Choke Canyon reservoir, provides water quality data on runoff from 15,400 square miles (39,886 km^2) of drainage area. The water-quality constituent concentrations measured at this site are affected by transport and reservoir storage. Also, these concentrations are not indicative solely of NPS runoff, but include the influence of point-source inputs in the watershed. Land use for the upper watershed is largely agricultural and rangeland.

The upper-watershed concentrations, for selected constituents, were calculated using data from the USGS gage at Three Rivers, TX. for water-years 1990 - 1994 (Oct., 1989 to Sept., 1994). This data set includes 30 samples over the five-year period. The samples were collected over a range of flow conditions. Table IV.6 shows a summary of constituent concentrations from the upper watershed.

Table IV.6 - CCBNEP Upper-Watershed Constituent Concentrations (USGS)

Constituent	Minimum (mg/L)	Maximum (mg/L)	Median (mg/L)	Mean (mg/L)	Std Error of Mean
Total Nitrogen	0.44	2.29	0.96	1.01	0.08
Total Phosphorus	0.04	0.38	0.12	0.14	0.016
Suspended Sediment	16	907	38	109	34.9
Dissolved Solids	103	712	401	395	23.8
Chloride	9.0	170	96	91	6.9
BOD - 5	0.6	6.2	1.8	2.28	0.25

During consultations with the principal investigator of the concurrent CCBNEP study on ambient water/sediment quality in bay waters, it was determined that there is no perceptible correlation between the results of these two studies. The concurrent study focuses on the ambient water, sediment, fish, and, and shellfish tissue quality in the CCBNEP study area. There are numerous parameters which affect water quality in the bay waters which are not associated with freshwater inflows.

Atmospheric Deposition

Atmospheric deposition, rainfall and dry deposition, is a significant source of some constituents, especially nitrogen (Ebbert and Wagner, 1987). In fact, in a study of rainfall contributions to constituent loads in urban areas, Ebbert and Wagner reported that 74 percent of the nitrate plus nitrite nitrogen loadings from urban catchments originated from rainfall. For land use types which generate runoff during rainfall events, the runoff, in theory, includes the loadings from atmospheric deposition. The EMC values determined in this study for these land use types, therefore, include the effects of atmospheric deposition. For certain land use types which do not generate runoff, such as wetlands or water bodies, atmospheric loadings must be taken into account.

For this study, only wet (rainfall) deposition estimates are presented for a limited set of constituents. The primary source of data used in this study comes from the National Atmospheric Deposition Program (NADP) which operates a network of atmospheric deposition stations across the United States. The NADP conducts its collection, analysis, and reporting of data according to a strict protocol (NADP, 1994) and is considered an appropriate source of data for this project. However, the only station in the NADP network within the CCBNEP study area is near Beeville, Texas. The Beeville data for 1991 - 1993 is very complete and consistent.

Published concentration and loading isopleths developed for the United States in the 1992 and 1993 NADP reports, suggest that the Beeville station values are very appropriate for use as regional values for the CCBNEP study area. The 1991-1993 data set represents 107 samples.

The NADP sample analyses include the following constituents: hydrogen ion (as pH), sulfate, nitrate, ammonium, calcium, magnesium, potassium, sodium, and chloride. The NADP annual reports provide seasonal and annual precipitation weighted concentrations and estimated loadings. Annual concentrations and loadings based upon a 1991-1993 average are given in the Table IV.7 for selected constituents.

Table IV.7 - Annual rainfall concentrations and loadings
for selected constituents for 1991 - 1993 from Beeville NADP Station (NADP, 1994)

Constituent	Concentration (mg/L)	Loading (kg/ha)
Sulfate	1.08	10.24
Nitrate	0.72	6.89
Ammonium	0.26	2.37
Chloride	0.76	6.93

The values from the Beeville NADP station are compared with literature values in Table IV.8. The literature values are based on data from a study in the Houston area (Browne, 1989) and include values for urban and rural areas.

Table IV.8 - Comparison of Beeville Rainfall Deposition Concentrations and Literature Values
(NADP, 1994)

Constituent	Beeville Concentrations (mg/L)	Houston-Urban Concentrations (mg/L)	Houston-Rural Concentrations (mg/L)
Sulfate	1.08	--	--
Nitrate	0.72	0.52	1.39
Ammonium	0.26	0.30	--
Chloride	0.76	--	--
PO_4 - P	--	0.012	0.025

-- *Data not available*

Summary of EMC Values

The investigators of this study compiled a data base of Event Mean Concentration values for various NPS constituents and different land use categories. The data base was compiled using data applicable to the CCBNEP study area obtained during the literature review. These values for each land use category and 18 NPS constituents are given in Table IV.9 below.

Table IV.9 - Summary of Median EMC values by Constituent and Land Use Category for the CCBNEP Study Area

Constituent	Land Use					
	Residential	Commercial	Industrial	Transportation	Cropland	Rangeland	Undev/Open
Total Nitrogen (mg/L)	1.82	1.34	1.26	1.86	4.40	0.70	1.50
Total Kjeldahl Nitrogen (mg/L)	1.50	1.10	0.99	1.50	1.7	0.20	0.96
Nitrate + Nitrite (mg/L as N)	0.23	0.26	0.30	0.56	1.6	0.40	0.54
Total Phosphorus(mg/L)	0.57	0.32	0.28	0.22	1.3	<0.01	0.12
Dissolved Phosphorus(mg/L)	0.48	0.11	0.22	0.10	--	--	0.03
Suspended Solids(mg/L)	41.0	55.5	60.5	73.5	107	1.0	70
Dissolved Solids(mg/L)	134	185	116	194	1225	245.0	--
Total Lead (μg/L)	9.0	13.0	15.0	11.0	1.5	5.0	1.52
Total Copper (μg/L)	15.0	14.5	15.0	11.0	1.5	<10	--
Total Zinc (μg/L)	80	180	245	60	16	6.0	--
Total Cadmium (μg/L)	0.75	0.96	2.0	< 1	1.0	<1.0	--
Total Chromium (μg/L)	2.1	10.0	7.0	3.0	<10.0	7.5	--
Total Nickel (μg/L)	< 10	11.8	8.3	4.0	--	--	--
BOD (mg/L)	25.5	23.0	14.0	6.4	4.0	0.5	--
COD (mg/L)	49.5	116	45.5	59	--	--	40
Oil and Grease (mg/L)	1.7	9.0	3.0	0.4	--	--	--
Fecal Coliform(colonies/100 ml)	20,000	6,900	9,700	53,000	--	37	--
Fecal Strep.(colonies/100 ml)	56,000	18,000	6,100	26,000	--	--	--

-- *Data not available*
Time period for data is 1992-1993 except for cropland and rangeland (1970-1995)
Agricultural EMCs are based on limited information and may not be representative of the entire CCBNEP Study Area
Values shown as <0.01, <1, and <10 indicate that all or most of the values were below the reporting limit.

V. Geographic Information System

As one of the objectives of this study, the Geographic Information System coverages used in this project were organized into a data base which is available for use with future CCBNEP related projects and mapping studies. Two coverages are provided, a soils classification coverage and a land use coverage. Documentation files are included with the data files delivered to the CCBNEP.

Various other coverages were used to develop maps and figures used throughout this report. These include Topologically Integrated Geographic Encoding and Referencing system (TIGER) files (county lines, population, and roads), a layer for dams and reservoirs, stream gages, climatological stations, and 8 digit hydrologic unit boundaries. These coverages can be provided if a need exists.

Soils

A soils data base helps to describe the surface and upper subsurface of a watershed. Older models only use the soil surface moisture and infiltration parameters to determine rainfall runoff. Models such as SWAT and HSPF use information about each soil horizon. Parameters describing horizon thickness, depth, texture, water holding capacity, dispersion, etc. must be available to the model. These parameters are used to determine a water budget for the soil profile, daily runoff and erosion. Movement of nutrients, pesticides and herbicides on the surface and within the soil horizons are also modeled.

The NRCS soils data base currently available for all of the counties of Texas is the STATSGO 1:250,000-scale soils data base. The 1:250,000-scale USGS topographic map series was used as the base map for the compilation of this data base. The STATSGO data base covers the entire United States and all STATSGO soils are defined in the same way. Therefore, for any area within the United States, the STATSGO data base can be used by models without a great deal of effort to prepare the soil GIS layer. This data base is available for the entire CCBNEP study area and was used for the modeling in the Oso Creek watershed.

While this data base is usually adequate for predicting erosion from very large watersheds, it usually does not give adequate accuracy for watershed subbasins smaller that the eight digit Hydrologic Unit Code (HUC). However, it is an excellent tool for initial screening of a large watershed to identify subbasins showing high potential for contributing to nonpoint source pollution in streams and reservoirs.

Another NRCS soils data base, the Soil Survey Geographic (SSURGO) is the digital soil data from the published soil survey, and is the most detailed soil data base available. This 1:24,000-scale soils data base is available as printed county soil surveys for over 90 percent of Texas counties. Aransas, Bee, Jim Wells, and San Patricio counties are currently available in this format. They are the only counties within the CCBNEP study area that have been completed in the SSURGO data base. It is currently not available as a vector or high resolution cell (grid) data base. However, the tabular data describing the properties of each soil is available in electronic form, and a grid GIS with lower resolution has been created. The Computer Based Mapping System (CBMS) or Map Information Assembly Display System (MIADS) data base was created from 1:24,000-scale soil sheets with a cell resolution of 250 meters (820 feet). (Normally, a cell resolution of 20 meters would be used for information taken from a 1:24,000-scale base map to adequately show the detail, but it is a lengthy and costly process.)

The SSURGO was designed to be used primarily for farm and ranch conservation planning, range and timber management, and county and watershed resource planning, management, and monitoring. Interpretive maps can be developed from any attribute element on the soil interpretation record. However, because the SSURGO data base has been developed over a period of many years, soil definition and delineation is not very consistent for areas made up of more than one county.

The CBMS data base differs from some grid GIS data bases in that the attribute of each cell is determined by the soil that occurs under the center point of the cell instead of the soil that makes up the largest percentage of the cell. This method of cell attribute labeling has the advantage of a more accurate measurement of the various soils in an area. The disadvantage is for any given cell the attribute of that cell may not reflect the soil that actually makes up the largest percentage of that cell.

There is one main difference between the STATSGO and a SSURGO data bases. In the SSURGO data base, each soil delineation (mapping unit) is a soil which is described a single soil series. In the STATSGO data base, each soil delineation of a STATSGO soil is a made up of more than one soil series. Some STATSGO soils are made up of as many as twenty SSURGO soil series. Usually there is one SSURGO soil series that dominates a STATSGO soil.

Computer models use the soil series name as the data link between the soils GIS layer and the soils properties tabular data base. The SWAT model can use the STATSGO soil name in a GIS soil layer to look up the soil series name that is the dominant series for a specific STATSGO soil. The soils properties tabular data base is a component of the computer model and is not developed by the model user.

Land Use Classification

The USGS Land Use and Land Cover data base is available for all of Texas. This data base was developed from the National Aeronautics and Space Administration (NASA) and National High-Altitude Photography (NHAP) high-altitude aerial photographs, usually at scales smaller than 1:60,000. The 1:250,000-scale topographic map series was generally used as the base map for the compilation of this data base.

The NRCS 1:24,000-scale Land Use and Land Cover data base is the most detailed land use/cover data base presently available. This data base is available only in CBMS format. Over

90 percent of Texas counties have been mapped using this format. Within the CCBNEP study area only four counties are currently available: Aransas, Bee, Jim Wells, and San Patricio. The CBMS Land Use and Land Cover data base format is the same as the format used for the CBMS soils data base.
The USGS Land Use - Land Classification data base was the source for the land use information used in this study. This data was acquired around 1980. The coverage still provides an excellent resource for large scale work. The coverage may require updates for use in urban areas that have experienced development. The only update to the original data base included in this coverage is the inclusion of approximately 60,000 acres (24,281 hectares) of Kleberg county croplands put into production since the land use data was acquired. Detailed description of the land use and classification system is described by Anderson (1976).

Land use and cover affects surface erosion, water runoff, constituent concentrations, and loadings and are a necessary input of a watershed model.

Topographical Data Base

Another data base that describes the surface of a watershed comes in the form of a topographical or Digital Elevation Model (DEM) data base. The DEM data base is a grid representation of elevation contour lines. The only DEM data base that is currently available for all of Texas is the 1:250,000 scale data. This scale corresponds to a cell resolution of three arc seconds or about 100 meters. This data base is usually very adequate for computer models such as SWAT except in very flat watersheds. When using this data base, manual digitizing or scanning of subbasins in a watershed may be necessary. The subbasin boundaries developed for this study were manually digitized.

Where the sub-basin size is less that a few hundred acres or in areas that are almost flat, the more detailed 1:24,000 scale DEM should be used for computer delineation of subbasins. The 1:24,000 scale corresponds to a cell resolution of one arc second or about 30 meters. If this data base is used in watershed modeling, computer time and storage requirements can become an obstacle. The 1:24,000 scale DEM was not available for use within the CCBNEP study area.

Historical Climatic Data

Historical climatic data is available from the United States Weather Bureau. The SWAT and HSPF models have built in weather generators that generate daily weather based on historical weather from the nearest weather station. The user can also input daily precipitation and daily maximum and minimum temperatures.

Historical Stream Flow Data

Historical stream flow data is available from the USGS. Table V.1 shows the gages that have been used to gather historical surface water information within the CCBNEP study area. Historical stream flow data should be compared to model output whenever possible. Usually historical climatic data for the same time period is needed for this comparison.

Table V.1 - USGS Surface Water Gages in the CCBNEP Study Area (USGS, 1995)

Station Number	Station Name	County
08189060	Aransas Bay near Dunham Point near Fulton, Texas	Aransas
08189300	Medio Creek near Beeville, Texas (Discontinued)	Bee
08189700	Aransas River near Skidmore, Texas	Bee
08212400	Los Olmos Creek near Falfurrias, Texas	Brooks
08211800	San Diego Creek at Alice, Texas	Jim Wells
08211900	San Fernando Creek at Alice, Texas	Jim Wells
08212000	San Fernando Creek near Alice, Texas (Discontinued)	Jim Wells
08194600	Nueces River at Simmons, Texas (Discontinued)	Live Oak
08206910	Choke Canyon Reservoir OWC near Three Rivers, Texas	Live Oak
08208000	Atascosa River at Whitsett, Texas	Live Oak
08210000	Nueces River near Three Rivers, Texas	Live Oak
08210300	Ramirena Creek near George West, Texas (Discontinued)	Live Oak
08210400	Lagarto Creek near George West, Texas	Live Oak
08194500	Nueces River near Tilden, Texas	McMullen
08206600	Frio River at Tilden, Texas	McMullen
08206700	San Miguel Creek near Tilden, Texas	McMullen
08207000	Frio River at Calliham, Texas (Discontinued)	McMullen
08211500	Nueces River at Calallen, Texas	Nueces
08211520	Oso Creek at Corpus Christi, Texas	Nueces
08211530	Laguna Madre near Corpus Christi, Texas	Nueces
08188800	Guadalupe River near Tivoli, Texas	Refugio
08189200	Copano Creek near Refugio, Texas	Refugio
08189500	Mission River at Refugio, Texas	Refugio
08189800	Chiltipin Creek at Sinton, Texas	San Patricio
08211000	Nueces River near Mathis, Texas	San Patricio
08211100	Nueces River below Mathis, Texas (Discontinued)	San Patricio
08211200	Nueces River above Calallen, Texas	San Patricio

Geographic and Cartographic Features

The Census Bureau's TIGER files can be converted into a GIS data base. The resulting GIS layers consist of features such as highways, roads, city streets, streams, rivers and county lines. Names and classification of many of the features are available in the TIGER files. Statistical area boundaries are also included in the TIGER files. The TIGER lines are grouped into county files and available by state for all of the United States. Stream density and road designations may change when crossing county lines. TIGER files are comparable to 1:100,000 scale topographic maps.

Another source of geographic and cartographic features are the 1:100,000 scale USGS Digital Line Graph (DLG) files. These files have recently become available for almost all of Texas. Unlike the TIGER files, 1:100,000 scale DLG files do not contain political boundaries.

GIS Data Layer Information

The GIS layers used in this study are available from several different sources. They represent data from different time periods and are available in distinct scales. Table V.2 is a compilation of the layers used in this CCBNEP study.

Table V.2 - GIS Layers Scales, Sources, and Time Frames

Data Layer	Base Scale	Organization	Date of Data
Soils - STATSGO Map	1:250,000	USDA-NRCS	1994
Soils - CBMS Map	1:24,000	USDA-NRCS	1980
Land Use/Cover Map	1:250,000	USDI-USGS	1980-1984
Land Use/Cover Map	1:24,000	USDA-NRCS	1980-1984
Digital Elevation Map	1:250,000	USDI-USGS	1990
Geographic Features (TIGER files)	Variable	U.S. Census Bureau	1990
Climatological Data	--	USDI-USGS	1994
Stream Flow Data	--	USDA-NRCS	1994

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VI. Loadings Model Comparison Pilot Study

Pilot Study Approach

Several state of the art watershed models were used to model runoff and NPS loadings of selected constituents for a single watershed in the CCBNEP study area. The Oso Creek watershed was selected for use in this pilot study comparison.

Five models were originally proposed for this study: the NRCS Soil and Water Assessment Tool model, the USGS Hydrologic Simulation Program - FORTRAN Model, the USGS Urban Loading Model, the GBNEP-15 Loading Model, and a GIS model developed by the University of Texas (UT) Center for Research in Water Resources (CRWR).

Three models were eliminated from the comparison. The USGS urban loading model is applicable to urban watersheds. Since the Oso Creek basin is primarily agricultural, this model was dropped from consideration. The GBNEP-15 model was also dropped from the comparison. The GBNEP-15 model is a GIS based model which determines annual runoff from average annual rainfall. This model is not equipped to handle input of actual time-series precipitation, evaporation, and other hydrological data, and was considered inappropriate for comparison with the remaining models. Also, the University of Texas GIS model is still undergoing development and results for this study were not available. . Although results of the UT-GIS model were not available, a description of this model is also included. The remaining models used in this comparison are the SWAT model and the HSPF model. A description of the SWAT and HSPF models and modeling results are included. Model results include runoff and loadings for suspended solids, total nitrogen, and total phosphorus for the period 1989 through 1993

Oso Creek Watershed Description

The Oso Creek watershed is located in southern Nueces county. The creek originates near Robstown and flows through Corpus Christi to empty into Oso Bay. The watershed covers an area of about 240 square miles (622 km^2). The predominant land use in the basin is agriculture, specifically corn, cotton and grain sorghum production. The lower portion of the watershed includes some urban development.

The flow from the upper 90 square miles (233 km^2) of the Oso Creek watershed has been gaged by the USGS since 1972. The gaged portion of the watershed is predominantly agricultural and receives wastewater effluent from the Robstown treatment plant. The larger, ungaged portion of the watershed includes a wide range of land uses and receives discharges from the two Corpus Christi treatment plants as well as the Central Power and Light (CPL) power generating facility. Land use characteristics for the entire Oso Creek watershed are shown in Table VI.1. The figures in Table VI.1 reflect more recent land use not incorporated into the GIS land use coverage.

Oso Creek exhibits very low flow except during significant rainfall events. For the period 1973 - 1993, for the gaged portion of the watershed, the median daily flow rate was 2.4 cubic feet per second (cfs) (0.07 m^3 per second). However, during and after major rainfall events, average daily flows of over 3000 cfs (85 m^3 per second) can occur. Most of the low flow in Oso Creek is due to discharge of treated wastewater. Oso Bay and Oso Creek receive treated wastewater discharges from three municipal sewage treatment plants: Robstown, Corpus Christi West, and Corpus Christi Oso Bay. The combined permitted flow from these three facilities is 22.2 million gallons per day (MGD) (84.0 million liters per day). However, average flow from these plants is approximately 15 MGD (56.8 MLD).

The Central Power and Light Barney Davis facility also discharges cooling water to Oso bay. The permitted discharge from the CPL plant is 540 MGD (2,044 MLD). The cooling water is initially withdrawn from the Laguna Madre.

Table VI.1 - Oso Creek Basin Land Use

Land Use Category	Acres	Hectares	% of Area
Agriculture	116,206	47,027	72.6
Rangeland	14,989	6,066	9.4
Residential	12,202	4,938	7.7
Commercial	5,540	2,242	3.5
Industrial	2,536	1,026	1.6
Transportation	3,209	1,299	2.0
Undeveloped/Open	729	295	0.4
Water	4,600	1862	2.8
Total	160,011	64,755	100%

The Oso Creek watershed, including rain and stream flow gaging stations, is shown in Figure VI.1. Gaged and ungaged portions of the watershed are also illustrated.

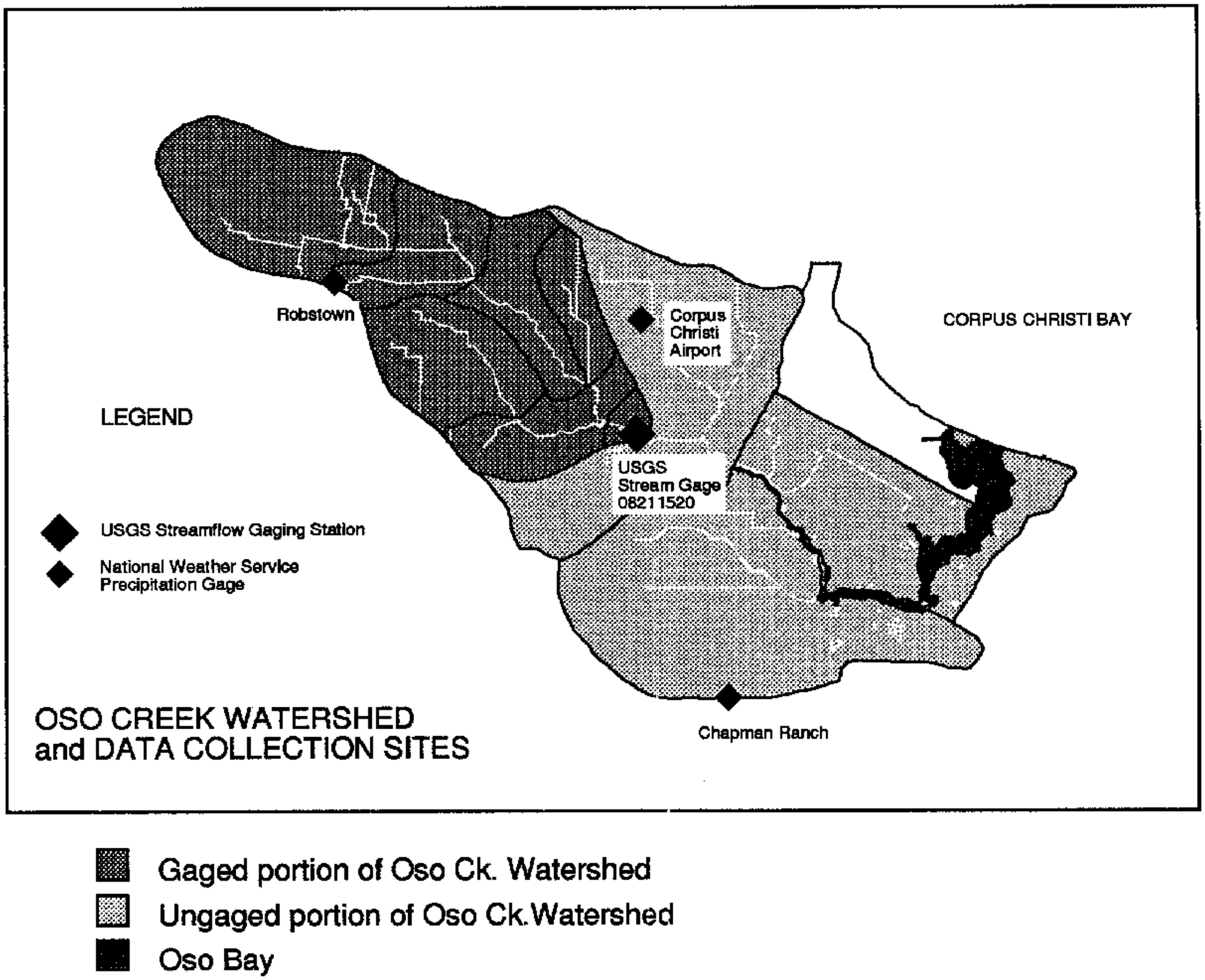

Figure VI.1 - Oso Creek Watershed and Data Collection Sites

Model Description and Calibration

SWAT Model

The Soil and Water Assessment Tool model is the continuation of a long term effort of nonpoint source pollution modeling with the USDA-Agricultural Research Service (ARS). In the early 1970's, in response to the Clean Water Act, ARS assembled a team of interdisciplinary scientists from across the United States to develop a process-based, nonpoint source simulation model. From that effort , a model called CREAMS (Chemicals, Runoff, and Erosion from Agricultural Management Systems) was developed (Knisel, 1980). CREAMS is a field scale model developed to simulate the impact of land management on water, sediment, nutrients, and pesticides leaving the edge of a field. By the early and mid-1980's, several models were being developed with origins from the original CREAMS model.

Several of these efforts involved modifying CREAMS to simulate complex watersheds with varying soils, land use, and management. One effort was the SWRRB (Simulator for Water Resources in Rural Basins) (Williams et al., 1985; Arnold et al., 1990) model. This model was developed to simulate nonpoint source loadings from watersheds. SWRRB is a continuous time (daily time step) model that allows a basin to be subdivided into a maximum of ten subbasins. In response to needs to simulate stream flow from much large basins, ROTO (Routing Outputs to Outlet) (Arnold et al., 1995) was developed to take output from multiple SWRRB runs and route the flows through channels and reservoirs. This reach routing approach overcame the SWRRB subbasin limitation by linking multiple SWRRB runs together.

SWAT is a result of the merging of the SWRRB and ROTO models into one basin scale model. The objective in model development was to predict the impact of management on water, sediment, and agricultural chemical yields in large ungaged basins. To satisfy the objective, the model (a) is physically based (calibration is not possible on ungaged basins); (b) uses readily available inputs; (c) is computationally efficient to operate on large basins in a reasonable time; and (d) is continuous time and capable of simulating long periods for computing the effects of management changes. SWAT allows a basin to be divided into hundreds or thousands of grid cells or subwatersheds. It is still a continuous time model (daily time step) that is required to look at long-term impacts of management (i.e., reservoir sedimentation over 50-100 years) and also timing of agricultural practices within a year (i.e., crop rotations, planting and harvest dates, irrigation, fertilizer, and pesticide application rates and timing).

In recent years, there has been considerable effort devoted to utilizing GIS to extract inputs (soils, land use, and topography) for comprehensive simulation models and spatially display model outputs. Much of the initial research was devoted to linking single-event, grid models with raster-based GIS (Srinivasan and Engel, 1991; Rewerts and Engel, 1991). An interface was developed for SWAT (Srinivasan and Arnold, 1993) using the Graphical Resources Analysis Support System (GRASS) (U.S. Army, 1988). The input interface will automatically subdivide a basin (grids or subwatersheds) and then extract model input data from map layers and associated relational data bases for each subbasin. Soils, land use, weather, management, and topographic data are collected and written to appropriate model input files. The output interface allows the user to display output maps and graph output data by selecting a subbasin from a GIS map.

The SWAT features that provide water quality constituent loadings were not used in this study due to the severe limitations in calibration data. SWAT runoff loadings at the Oso Creek stream gage were compared with the other models.

Since the HSPF model was the first to be calibrated, the SWAT model was calibrated using the same criteria. Calibration was made for the period 1987 through 1992 using the Oso Creek USGS gage. Calibration results for SWAT in Table VI.2 are based on the basin area upstream of the Oso Creek gage only.

Figure VI.2 provides a graphical representation of the predicted runoff versus measured flow at the Oso Creek stream gage. Several factors were investigated in the period where SWAT over predicted or under predicted flow measured at the gage. For this pilot study, the assumption was made that all land use designated as "cropland and pasture" was cropped with cotton, corn, and sorghum. Obtaining actual detailed cropping and management could affect the predicted runoff. Tillage operations carried out during the fallow period affect the infiltration and runoff during that period of the year. It is likely that SWAT calibration would have been much better if performed over a longer period of climatic record. Due to its carryover from day to day and year to year of water balance, soil moisture condition, return flow, and cropping rotations, the model seems to give better results with long term simulations.

There is some difference in precipitation input for each of the models. SWAT can be assigned one weather station for the entire watershed or each subbasin can be assigned the weather station nearest the basin. The latter case was selected for use in the SWAT simulation as opposed to using a single station of averaged precipitation from Robstown and Corpus Christi Airport gages as used in HSPF. SWAT experiences the same problems as HSPF in using daily time step input which does not always accurately represent variations in rainfall intensity and distribution. Figure VI.1 indicates the locations of gages relative to the watershed and SWAT subbasin delineation of Oso Creek.

SWAT loadings are provided by subbasin and thus can not tabulate runoff by each land use type as is furnished by HSPF for this study. SWAT does encompass complex analyses of nearly every conceivable factor that deals with the hydrologic cycle. This detail of modeling requires a comparable detail of the input parameters. That detail of many of the inputs is simply not available for the study area at present. Most existing data such as digitized soils, land use and crop data, and topography is available at a scale of 1:250,000. Data developed at a scale of 1:24,000 is preferable for modeling of a watershed the size of Oso Creek. As input data and calibration data become available in detail, the SWAT model should significantly improve predicted runoff and water quality loadings.

Table VI.2 - SWAT Model Results for Upper Oso Watershed 1986 - 1993

Period	Average Rainfall,		Stream flow		Predicted Stream flow		% Error
	inches	Cm..	Acre Feet	Hectare-m.	Acre Feet	Hectare-m.	
1987-1992	29.8	75.7	91,103	11,242	81,354	10,039	-10.7
1986*	21.6	54.9	12,235	1,510	1,998	247	-83.7
1987	31.4	79.8	22,064	2,723	16,823	2,009	-23.8
1988	20.2	51.3	3,526	435	2,305	284	-34.6
1989	18.3	46.5	1,697	209	3,103	383	82.8
1990	22.6	57.4	13,491	1,665	6,423	793	-52.4
1991	44.5	113.0	21,714	2,680	12,330	1,522	-43.2
1992	35.6	90.4	28,611	3,531	40,370	4,982	41.1
1993*	36.2	91.9	37,805	4,665	7,524	928	-80.1

* *These years not used in model calibration.*

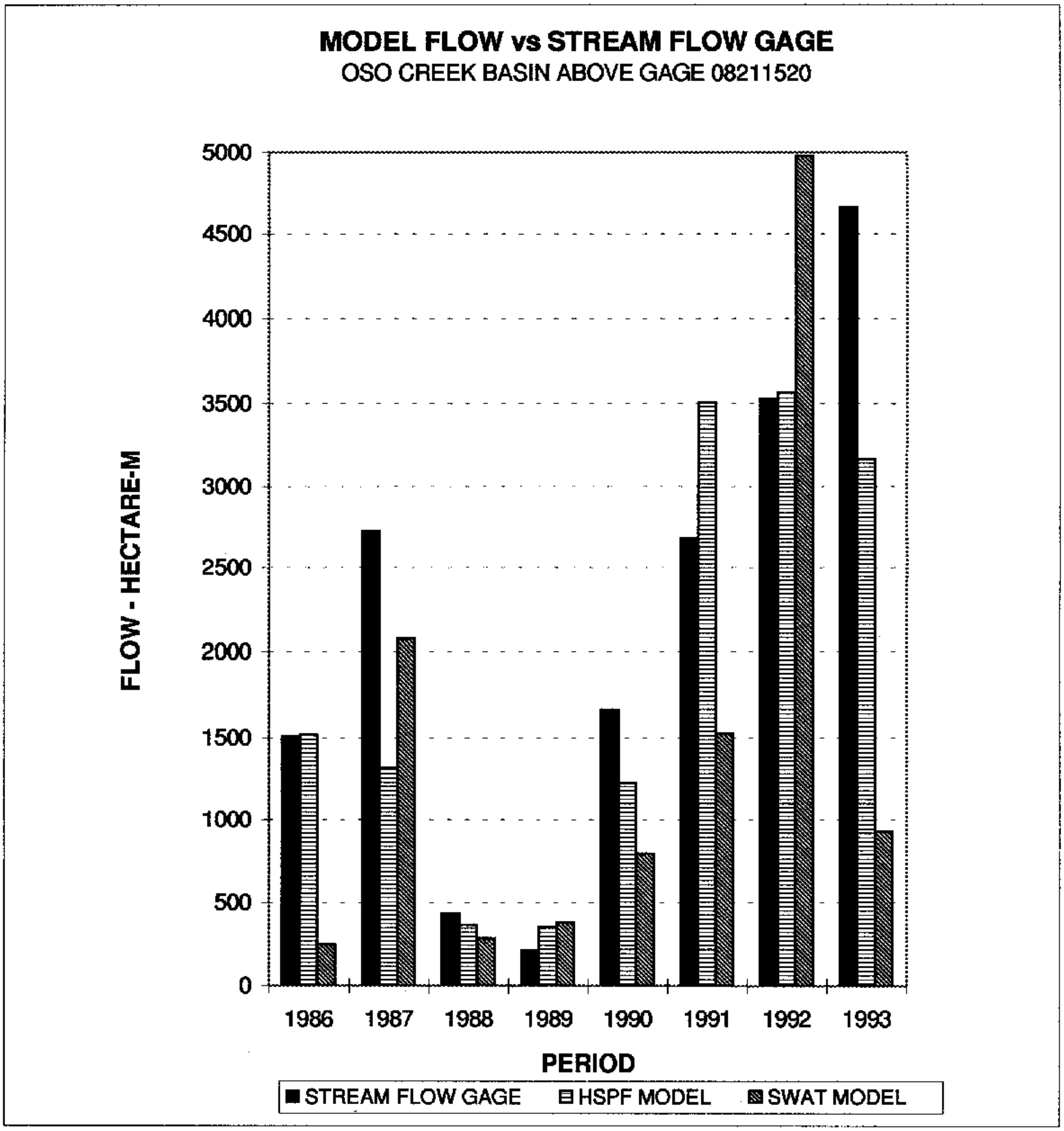

Figure VI.2 - Model Flow vs. Stream Flow Gage

HSPF Model

The Hydrologic Simulation Program-FORTRAN is a computerized, distributed parameter, mathematical model developed under USEPA sponsorship to simulate hydrologic and water quality processes that occur in natural and man made watersheds (Donigian, Bicknell, and Imhoff, 1995). HSPF uses information such as the historical records of rainfall, temperature, evaporation, and watershed characteristics related to land use, soil characteristics, and agricultural practices to simulate the runoff and processes that occur in a watershed. Each land segment in the model is associated with unique hydrologic and basin characteristics. Runoff from each land segment is generated using kinematic wave theory on an assumed overland flow plane. The flows from each segment are then routed through a system of stream reaches and (or) reservoirs using storage routing. From this information, HSPF generates water quantity and water quality (including constituent loads) records at any point in the watershed.

The HSPF stream flow model was calibrated for the period 1987 through 1992 (calendar years) with daily stream flow data collected at the USGS gaging station on Oso Creek at Corpus Christi. Only the upper 39 percent of the Oso watershed is gaged. Sixty one percent of the watershed is below the gage site. The years 1986 and 1993 were not used for the model calibration but were used to test and verify the model calibrations. The calibration results are shown in Table VI.3.

Table VI.3 - HSPF Model Results for Upper Oso Watershed 1986 - 1993

Period	Average Rainfall		Stream flow		Predicted Stream flow		% Error
	Inches	Cm.	Acre-ft.	Hectare-m.	Acre-ft.	Hectare-m.	
1987 - 1992	29.8	75.7	91,103	11,242	91,457	11,281	0.4
1986*	21.6	54.9	12,235	1,510	12,291	1,516	0.5
1987	31.4	79.8	22,064	2,723	10,686	1,318	-51.6
1988	20.2	51.3	3,526	435	2,960	365	-16.1
1989	18.3	46.5	1,697	209	2,860	353	68.3
1990	22.6	57.4	13,491	1,665	9,893	1,220	-26.8
1991	44.5	113.0	21,714	2,680	28,445	3,509	31.0
1992	35.6	90.4	28,611	3,531	28,896	3,564	1.0
1993*	36.2	91.9	37,805	4,665	25,685	3,168	-32.1

* *These years not used in model calibration*

The total runoff for the calibration period (1987-92) is in close agreement with the actual gaged runoff. However, there are large percentage errors in annual values, especially in 1987 and 1989, which were relatively dry years. The errors in simulated stream flow most likely result from inadequate rain gage coverage for the watershed. The average of the Robstown and Corpus Christi airport rainfall was used as input for the calibration of the upper Oso watershed. Over the calibration period, this average rainfall input could be representative. However, from year to year, the spatial distribution of rainfall over the upper watershed is apparently not always represented by the average gaged values. Also, the rainfall time series used for modeling is daily total rainfall. Variations in runoff due to varying rainfall intensity cannot be accounted for with this type of rainfall data.

The HSPF calibration for the upper Oso watershed includes an average discharge of 1.0 MGD (3.8 MLD) from the Robstown wastewater treatment plant. The treatment plant effluent is included in the calibration data but is removed from the estimates of runoff and constituent loads. The calibrated model parameters for the upper Oso watershed were used for the entire Oso watershed to estimate runoff and loadings for the period 1989-93. The monthly and annual estimates include runoff and constituent loads for storm runoff only. Model estimates of runoff and loads for selected constituents for the period 1989- 93 are presented in Appendix F. Monthly and annual totals are categorized by land use.

Estimates of loadings using the HSPF model were done by configuring the model according to land use categories to simulate runoff from each land use type. The EMCs determined as part of this project were then multiplied by the runoff (and appropriate conversion factors) to obtain loads. Direct rainfall deposition on the water surface of Oso Bay was determined independently from the HSPF model. The direct precipitation onto the water surface accounts for runoff and loads listed in the “water” category (Appendix F). Total nitrogen concentrations in rainfall of 0.98 mg/L and total phosphorus concentrations in rainfall of 0.015 mg/L were used to compute constituent loads from rainfall directly to Oso Bay.

GIS Model

The University of Texas Center for Research in Water Resources method of nonpoint source pollution assessment is performed using the Arc/Info Geographic Information System and is partitioned into 4 steps:

1) Data accumulation/digital watershed description.
2) GRID delineation within the basin.
3) Establishment of mean discharge per unit area grids.
4) Application of expected constituent concentrations to the basin for establishment of loadings at watershed and subwatershed outlets.

A digital description of the Oso Creek watershed geography is first required. The data that comprises this description includes:

a) USGS 3 arc-second Digital Elevation Map files for terrain.
b) Digital Line Graph files for stream and road networks.
c) USGS Land use/Land cover file for land use.
d) Rainfall & stream flow gage locations and historical measurement data.
e) Subwatershed boundaries within the Oso Creek watershed.
f) Mean annual and monthly precipitation grid data for the region.
g) Observed water quality data at existing stream flow gages and other points within the basin.
h) Literature based constituent loading rates associated with land use types within the basin.
i) STATSGO soil type data for the watershed.

Stream networks and drainage areas (from outlet points and gaging stations) are then established (delineated) using ARC/Info GRID manipulations of the original DEM. The GRID-delineated streams are actually used to represent the surface hydrology of the watershed for all subsequent manipulations. A comparison of these “GRID streams” with the DLG stream network is performed at this point to check for any major inconsistencies.

Next, grids of mean annual and monthly discharge per unit area are produced for the watershed, using either predetermined data from a precipitation grid of the United States or precipitation data observed within the watershed and averaged over the areas between rainfall gaging stations. Once precipitation grids are established, the discharge per unit area grids are created, using the observed stream flow gage data and the drainage areas delineated from each stream gage (as in step 2). The correlation between precipitation and discharge per unit area can be established by either a numeric runoff coefficient or application of the Thornthwaite water balance model.

Finally, expected mean constituent concentrations are established for each cell on the watershed grid. Loadings can then be calculated for each cell as the product of the expected concentration and the mean discharge per unit area. These cell-based loadings can then be accumulated to derive estimates of loadings at watershed and sub-watershed outlet points.

Model Results

The pilot study approach described above did not result with a recommendation of any one model. Each model evaluated has advantages and disadvantages and fulfills specific needs. Future use of SWAT, HSPF, or any model for the simulation of different management schemes will depend on the goals of the model user. Multiple models may be required to meet these goals. The loadings given in Appendix F of this report were calculated from the predicted stream flow as calculated by the HSPF model. The SWAT model does not readily output this flow by land use.

The lower, ungaged portion of the Oso Creek watershed contributes a much larger percentage of the runoff and loadings than the upper, gaged portion of the watershed. The lower portion of the watershed is about 1.7 times larger than the upper portion, yet annually contributes 10 to 15 times the runoff due to the larger percentage of developed (impervious) land use.

Runoff and loadings are highly variable. For each year modeled, a single month would contribute from 20 percent to over 50 percent of the total annual runoff or loadings.

Direct precipitation is a substantial contribution to freshwater inflows to Oso Bay. During the 5-year model period, 12.7 percent of the freshwater input to Oso Bay was from direct precipitation on the bay. For nutrient loading, 4.8 percent of the total nitrogen and only 0.2 percent of the total phosphorus were delivered from rainfall deposition.
Table VI.4 shows contributions of total nitrogen according to land use category. Agricultural lands (croplands) contribute the largest percentage of loadings. However, the agricultural contribution is a smaller proportion than the actual percentage of total cropland.

Table VI.4 - Land Use vs. Estimated Nitrogen Loadings

Land Use Category	% of Total Land Use	% of Nitrogen Loading
Agriculture	72.6	67.4
Rangeland	9.4	1.5
Residential	7.7	12.6
Commercial	3.5	6.0
Industrial	1.6	2.6
Transportation	2.0	5.1
Undeveloped/Open	0.4	--
Water	2.8	4.8
Total	100%	100%

-- Less than 0.1% of loading

It was observed from the model results that agricultural runoff and loadings are relatively small during a small or medium storm event. The agricultural land will potentially absorb a large amount of rainfall depending on antecedent soil moisture. However, during large events, after the infiltration capacity of the ground has been exceeded, agricultural contributions of runoff and loadings can be very large.

Modeling Recommendations

Many data needs for nonpoint source modeling efforts in the CCBNEP study area have become evident as a result of the Oso Creek pilot study. Modeling constituent loads to the CCBNEP bays and estuaries requires determining both runoff volumes and the constituent concentrations contained in the runoff. Calibration of both components of loadings is required for accurate and useful simulations.

Efforts to model the Oso Creek watershed revealed that uncalibrated predicted runoff could be in error by several hundred percent compared to known gaged values. The availability of a stream flow gage in the Oso watershed allowed for runoff calibration. Without the gage data, estimates of model accuracy would be impossible.

Several watersheds in the CCBNEP study area lack stream flow gages. Perhaps the most significant watershed lacking a stream flow gage is the San Fernando Creek watershed. A stream flow gage below Kingsville and the confluence of the San Fernando and Santa Gertrudis Creeks would account for runoff from the entire watershed that includes Alice, Benavides, Kingsville, and San Diego. Not only would stormwater runoff be gaged, but also municipal and industrial wastewater discharges. This watershed provides a large percentage of the inflow into Baffin Bay.

Calibrating urban watersheds in the CCBNEP study area can be very difficult, but is very important. In urbanized watersheds adjacent to the bays, large volumes of runoff are quickly delivered to the receiving waters with little or no attenuation of the potential impacts of pollutants. Because stormwater drainage is accomplished directly to the bay through literally hundreds of pipes, stream flow gaging is not feasible. However, some stream flow measurements for representative urban basins would provide useful data to help select model parameters (impervious percentage, infiltration, hydraulic resistance, etc.).

The watershed models evaluated in the Oso pilot study are very appropriate for most of the watersheds in the CCBNEP study area. For the heavily developed urban areas, which discharge directly to the bays, several urban stormwater models such as the USEPA Storm Water Management Model (SWMM), the USGS Distributed Rainfall Runoff Model (DR3M). and the Corps of Engineers Storage, Treatment, Overflow and Runoff Model (HEC STORM) are also appropriate models. The availability of calibration data, rather than the specific model used, is the key to accurate model results.

Adequate rainfall data is essential for modeling input to accurately predict runoff and loads. For the Oso Creek study, data from three rain gages was used for the 240 sq. mi. watershed. Roughly 80 square miles of precipitation input to the watershed was estimated by each gage. Also, the gages were located on the edges of the watershed boundaries. This areal coverage was unsatisfactory and resulted in poor representation of actual rainfall on the watershed. At least double the rain gage density was needed for the Oso study. Similar coverage is recommended for the other watersheds in the CCBNEP study area.

The rainfall data used for the study was daily rainfall totals. For modeling on a daily time-step, the total daily rainfall was distributed across a 24 hour period. This distribution probably rarely represented actual temporal rainfall patterns. Hourly (or more frequent) rainfall is needed to better model short, high intensity storm events, especially for urban watersheds. Availability of Next Generation Weather Radar (NEXRAD) system data may provide for excellent rainfall data for the entire CCBNEP study area. The NEXRAD Doppler system may not provide a stand-alone source of accurate rainfall data but will probably have to be calibrated with the existing network of standard rainfall gages.

Adequate water-quality data for calibration of stormwater runoff quality is lacking for most watersheds in the study area. Much water-quality data has been collected for low-flow conditions in most of the stream and bay segments in the area. However, this data does not represent the average constituent concentrations that occur during a stormwater runoff event. Flow-averaged samples collected during the course of a storm event are needed to model runoff concentrations and loads. Along with stream flow data at the outlet of major watersheds, storm event samples are also needed, corresponding with the flow data. A network of gages to provide water quantity and water quality data will provide not only calibration data for models but will greatly aid in monitoring the effects of best-management practices and other implemented management plans.

A model which uses “typical concentrations” or EMCs and uncalibrated runoff estimates to determine loadings may be suitable for relative predictions (one management scheme vs.

another) but will not provide accurate absolute values of loads (needed for input to receiving water quality models).

A comprehensive watershed model of water quality and quantity should include point source inputs as well as nonpoint source. To reliably simulate hydraulic and water-quality in-stream processes, all flows and loadings need to be included in the model.

Table of Contents

II. Summary and Conclusions

Methodology

1. A literature review was conducted to assemble all nonpoint source pollution literature and data that pertain to the CCBNEP study area. As a result of the literature review, an annotated bibliography was developed.

2. Using the available data and "literature values" applicable to the CCBNEP study area, a data base of Event Mean Concentration values for various NPS constituents and different land use categories was compiled. For each land use category, up to 18 NPS constituents were compiled. Comparison of EMC data from a number of sources is included in the report. Also, upper-watershed constituent concentrations, which may more accurately account for transport and reservoir effects on upper-watershed runoff, were determined separately. Finally, rainfall deposition concentrations were also presented.

3. Land use, digital elevation model, and soil coverages for the CCBNEP study area were included in GIS format as part of the study. Refer to GIS details beginning on page 57.

Project Results

Urban NPS Pollution

The Corpus Christi NPDES permit sampling data was the primary source of EMC values for urban land use within the CCBNEP study area. Generally, the Corpus Christi data shows very good agreement with data collected in similar NPDES programs in San Antonio and Dallas-Ft. Worth, especially considering the inherent variability of EMC data and the relatively small sample size of the Corpus Christi data. Some characteristics of the urban concentration data are noted below:

- Corpus Christi (also, San Antonio and Dallas-Ft. Worth) EMC values for metals (copper, lead, and zinc) are generally lower than values reported by the Nationwide Urban Runoff Program.
- The Corpus Christi NPDES data showed urban areas to be relatively free of pesticides and organic compounds. During the permit sampling program, no pesticide detections were encountered.
- Total and dissolved phosphorus concentrations, especially for commercial land use, are higher than for other studies examined. Commercial land use in the CCBNEP NPDES study is characterized by samples from a single commercial land use site.
- BOD values reported for the Corpus Christi NPDES program were higher in all land use categories than for other studies reviewed.

Agricultural NPS Pollution

Agricultural EMC values fall in the same general range as those reported in other studies. Since agricultural EMC data are limited, the primary comparison of the EMC values is the data contained in the GBNEP study. The remainder of the EMC values were developed from USGS provisional information for gages located in Texas. Some characteristics of the agricultural data are listed below:

- The nutrient (nitrogen and phosphorus) values for cropland at Oso Creek gage are higher than those for GBNEP and for the gages in the Trinity river basin. The municipal wastewater effluent originating at Robstown could explain this in part; however, an analysis of flow values at the Oso gage in excess of 50 cfs revealed that total nitrogen was 3.80 mg/l and total phosphorus was 0.54 mg /l. These median values are still higher than those reported from other similar studies.
- The rangeland value for suspended solids is substantially less than that reported for the GBNEP study.
- The cropland value for dissolved solids exceeds other comparison values by a factor of four to six.
- BOD and fecal coliform values for rangeland are substantially lower than those reported in the GBNEP study.
- The Oso Creek water quality samples show low levels of pesticides, even though insufficient information exists for the calculation of an EMC value.

The agricultural EMC literature review underscores the need for additional collection of specific land use data. The values do represent the available data most applicable to the CCBNEP study area.

Upper Watershed Contributions

Selected constituent concentrations from upper-watershed runoff, measured below the Choke Canyon reservoir, are significantly lower than concentrations from urban and cropland runoff. These lower concentrations are probably due to the large percentage of rangeland in the upper watershed and transport and reservoir effects on water quality.

Atmospheric Deposition

Rainfall deposition is a significant source of direct freshwater input and total nitrogen loadings to CCBNEP bays and estuaries. Also, atmospheric deposition on land surfaces is a major source of certain NPS constituents found in runoff.

Pilot Modeling Study

The pilot study HSPF model results are included in Table VII.1. Model results for annual runoff, total nitrogen, total phosphorus, and suspended solids are highly variable and depend on annual rainfall.

Table VII.1 - Oso Creek Model Results
Annual Runoff and Loadings

Year	Rainfall, cm.	Runoff, hectare-m.	Total N, metric tons	Total P metric tons	Suspended Solids, metric tons
1989	46.5	3,842	64.4	14.2	1,738.0
1990	57.4	6,631	166.0	43.4	4,159.0
1991	113.0	16,955	440.0	116.2	10,979.0
1992	90.4	16,030	448.0	121.1	11,100.0
1993	91.9	15,393	406.0	107.6	10,050.0

Data Limitations and Future Needs

Land Use Data

The USGS Land use/Land cover GIS files included as part of this study represent conditions from 1980. Many areas of the CCBNEP study area have changed little since that time, however, other areas have changed significantly. As examples, the lower Oso Creek basin has seen significant shifts from agricultural to residential land use while conversion of rangeland to cropland has occurred in Kleberg county. These differences in land use could result in significant changes in runoff quantity and quality. An updated land use coverage is needed for future NPS assessments.

Urban EMC Values

The Corpus Christi NPDES permit sampling data was the primary source of urban EMC values. Data available for inclusion in this study consists of data from the period November, 1992 to April, 1993, a relatively small sample. Since that period, more data have been collected. Additional data may have a significant effect on the median and/or mean EMC values for some constituents, given the variable nature of urban runoff concentrations. Additional data may also allow for determination of seasonal variation in EMCs.

Runoff concentrations for heavy industrial sites, such as refineries, are not characterized by the Corpus Christi NPDES data. The NPDES sites which represent industrial land use are more characteristic of commercial and industrial park areas.

Open/undeveloped land use EMC values were obtained from literature values (NURP). This land use category includes a wide range of land use and land cover. Runoff characteristics from these types of areas could be very site specific, both in terms of quantity and quality.

Agricultural EMC Values

The agricultural land use EMC values were derived primarily from water quality samples at the Oso Creek stream gage just west of Corpus Christi, TX and from the Seco Creek Water Quality

Demonstration Project sampling northwest of Hondo, TX. A limited amount of data is available at both sites. The Oso Creek gage samples were taken at random over several years. The Seco Creek data is more comprehensive, but some of these gages are limited to the last three or four years and the sampling is taken from an area which included a mixture of rangeland, pastureland, and cropland.

Unfortunately, cropping rotations along with market and economic conditions sometime dictates a different cultivated crop being grown on a particular field in a particular year. A further complication is the management of each crop may be quite different, such as the amount of crop residue left in the soil or the amount of pesticides applied to a given crop. This makes it difficult to get "representative" data for determining EMC values on cultivated cropland. There is a need for many more sampling sites in the agricultural watersheds to build an adequate data base for support of EMC values. The number and location of sites will be driven by what intensity or level of EMC values are desired (i.e., whether data is desired for individual crops , or just an average of all cropland data). Care should be taken to separate discreet areas so that samples represent only constituents from a single land use if that level of sampling is desired.

Soils Data

The GIS soils data file provided is the STATSGO data base which is comprised of soils associations. As work progresses in the CCBNEP study area there will be a need for soils information at a higher resolution, especially when looking at smaller parcels, or subbasins, of the project area. Seven of the twelve counties have published detailed soil survey reports but only Aransas, Bee, Jim Wells, and San Patricio are in digitized format at the higher resolution. This study did not attempt to assemble a composite of these four counties which would cover only a portion of the study area. Full coverage of the twelve counties would be desirable for future work. Consultation with the soil survey staff of the Texas NRCS office can provide information on the most recent progress in development of soils information in the project area.

Marinas

No information on runoff characteristics from marinas in the CCBNEP study area was found during this study. A study involving the collection of surface water and sediment samples was completed for the Galveston Bay NEP during May and June of 1992. Dissolved arsenic, lead, and copper were measured in these samples. Data on dissolved oxygen and fecal coliforms were obtained from each site. Based on the preliminary results of this study, it appeared that most water quality impacts associated with marinas are localized within the immediate vicinity of each marina (Guillen, 1993).

A similar study may be needed in the CCBNEP study area to determine what constituents associated with marinas constitute a potential source of NPS pollution and what management practices can be used to minimize their impacts. For future studies, marina land use could be modeled as some combination of commercial or industrial land use plus point source inputs from vessels or other sources. A concurrent CCBNEP study on the ambient water quality within the bay may provide information on the effects of marinas.

Atmospheric Deposition

The Oso Creek model results indicate that direct rainfall deposition contributes a significant portion of loadings to Oso Bay. These atmospheric loading estimates are based on data from the NADP site near Beeville, Texas and other literature values. Atmospheric deposition data needs for the CCBNEP study area include: 1) data from a site near the coast, 2) more extensive list of constituents than available from the Beeville site, and 3) inclusion of dryfall deposition data.

Septic Tanks

This study focused on characteristics of surface water runoff from storm events. Significant loadings of certain constituents to the bays and estuaries may occur via groundwater from individual treatment systems. Data on groundwater quality and flow rates from areas where septic systems are common are needed. Such sources and loadings may also be addressed through a point-source assessment.

Pesticides and Organics

Data on urban and agricultural pesticide concentrations in the CCBNEP study area is extremely limited. Although the NPDES sampling did not indicate the presence of pesticides, the earlier study by Oppenheimer in 1980, indicated the presence of Diazinon and Malathion (not sampled for by NPDES) in runoff samples. If possible, the NPDES sampling should be enhanced to include analysis for urban and residential pesticides used in the area. Other sampling efforts should be updated to include a wider array of chemicals (especially commonly applied chemicals). There is a concurrent study that does address the amount and timing of agricultural pesticide applications within the CCBNEP study area. Available information indicates that pesticides occur in small (or trace) amounts and probably do not constitute a concern with biotics.

Landfills

Loadings to the bays and estuaries may also occur from individual landfills by way of surface water runoff or groundwater transport of leachate. Since no data exists for the landfills in the study area, a broad suite of testing is needed to determine what constituents exist and which are potential NPS pollution sources. Such sources and loadings could only be defined after water quality sampling from these sites has been implemented and analyzed.

Stream flow and Rainfall Data

The Oso Creek model pilot study demonstrates the importance of stream flow and rain gage networks for model calibration. In the Oso Creek basin, runoff was very difficult to model and stream flow data, for calibration, was essential for accurate modeling. Rainfall is possibly the most important model input required for accurate estimation of both runoff and constituent loadings.

One locale in the CCBNEP study area where stream flow and rain gage data is needed is the Baffin Bay area. The two major streams flowing to Baffin Bay, Petronilla Creek and San

Fernando Creek are both ungaged. The Petronila Creek watershed drains a large agricultural area while the San Fernando Creek basin includes agricultural drainage as well as runoff from Kingsville, Alice, and other smaller towns.

Exact numbers and location of monitoring sites need to be determined “on site”. All-weather vehicle access and suitable locations for monitoring equipment are necessary. Location criteria will be driven by the need for additional data for input to drive computer models or where NPS sampling will be intensified. Stream sampling needs good precipitation data and a flow gage to reconstruct the storm hydrograph in order to determine NPS loading.

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Publisher:	Texas Water Commission
Key Words:	Water quality, nonpoint source pollution, runoff
Summary:	The Texas Surface Water Quality Standards recognize the diversity of the state by dividing major water bodies into classified segments which have been assigned site specific uses and water quality criteria. However, smaller streams, which comprise the majority of stream miles in the state, are not classified. Only limited information pertaining to uses and water quality of these streams has been previously available. Historically, these streams were afforded only limited protection under the water quality standards based on the presumption that higher uses were generally precluded because of their smaller size. Recently, the 1990 water quality standards raised the presumptive use to a “high” aquatic life use based in part on the emerging results from this study. Seventy-two least disturbed streams in 11 different ecoregions have been sampled since 1986. This report presents the results of the sampling effort and data analyses completed to date. Preliminary analyses pertaining to the physical habitat, water quality and biological assemblages of fish and benthic macroinvertibrates indicate that the presumptive “high” aquatic life use is justified for many of the smaller perennial streams in the state. However, adjustments to the aquatic life use classes and supporting criteria contained in the current water quality standards will be necessary to reflect regional or site specific characteristics. The results of this study are also pertinent to the future development of biological criteria.

Chosen values listed in this report are tabulated in the appendix on selected constituent values from the literature search. These constituent values were listed for seven watersheds in the Western Gulf Coast Plains of Texas. Placedo Creek, Garcitas Creek, and Arenosa Creek lie within the Lavaca-Guadalupe River Basin. West Carancahua Creek is within the Colorado-Lavaca Basin. Big Creek is within the Brazos River Basin. West Mustang Creek lies within the Lavaca River Basin. And, West Bernard Creek is within the Brazos-Colorado Basin.

The watersheds for these streams are heavily agricultural in nature. Adequate information was not available to directly relate constituent values to a specific land use. The constituent values are listed for comparison purposes.

Author: Bowman, J. and Jensen, D. A.
Date: 1985
Title: Corpus Christi Inner Harbor Water Quality Survey. August 1982
Pages: 66 p.
Publisher: Texas Water Commission
Key Words: Corpus Christi, water quality
Summary: A water quality survey of the Corpus Christi Inner Harbor (Segment 2484) was conducted August 8-14, 1982 by the staff of the District 12 office of the Texas Department of Water Resources. The Corpus Christi Inner Harbor is a dredged, man-made, dead-end channel approximately 8.6 miles in length. Water and Sediment quality data were collected at 15 locations during this survey. Benthic macroinvertibrate data were collected at 6 of the 15 survey locations. Water quality data were also collected from all known and permitted discharges to the Corpus Christi Inner Harbor. Data from previous Texas Department of Water Resources studies of the Inner Harbor were compared to data collected during this survey. Water quality has improved in the Inner Harbor over the past 10 years. Sediments in the Inner Harbor, however, are still contaminated with heavy metals, organics, and PCBs.

Most of the sample sites in this study were located in the harbor and therefore did not measure constituent concentrations in the actual runoff. However, runoff samples were collected at 4 drainage sites following a storm event. This data does not necessarily represent Event Mean Concentrations and is useful for identification of constituents, qualitative comparisons, and possible aid in selecting future sample locations. The physical description of the harbor and figures showing sample locations are also helpful.

Author: City of Corpus Christi
Date: May, 1993
Title: City of Corpus Christi, Part II NPDES Permit Application, Wet weather sampling program
Publisher: City of Corpus Christi
Key Words: Nonpoint source pollution, Corpus Christi
Summary: Data for this study was conducted from November 1992 to April 1993 and includes a total of 30 sampled events (6 storms sampled at each of 5 stations). The data was collected and analyzed according to EPA regulatory criteria. This data represents actual Event Mean Concentrations and is likely the most valuable information to date for estimating nonpoint source concentrations and loads. A description of the drainage area for each station is included in the study.

Author: Compton, J. L. and Ditton, R. E.
Date: Sept., 1975
Title: A Feasibility, Management and Economic Study of Marinas on the Gulf Coast
Publisher: TAMU-SG-76-201, College Station, Texas
Key Words: Marinas, gulf coast
Summary: This study presents results and conclusions from a series of interviews with 29 public and commercial marina operators along the Texas coast. Chapters consider the effects of restricted supply of marinas, profitability, construction costs, location factors, environmental controls, physical planning, management constraints, economic impacts, and others.

Author: Ebbert, J. C., and Wagner, R. J.
Date: October, 1987
Title: Contributions of Rainfall to Constituent Loads in Storm Runoff from Urban Catchments
Journal: Water Resources Bulletin, American Water Resources Association, Vol. 23, No. 5, October, 1987
Key Words: Storm runoff, rainfall deposition
Summary: Rainfall is a significant source of some constituents, particularly nitrogen species, in storm runoff from urban catchments. Median contributions of rainfall to storm runoff loads of 12 constituents from 31 urban catchments, representing eight geographic locations within the United States, ranged from 2 percent for suspended solids to 74 percent for total nitrate plus nitrite nitrogen. The median contribution of total nitrogen in rainfall to runoff loads was 41 percent. Median contributions of total recoverable lead in rainfall to runoff loads varied by as much as an order of magnitude between catchments in the same geographical location. This indicates that average estimates of rainfall contributions to constituent loading in storm runoff may not be suitable in studies requiring accurate mass-balance computations.

Author: Frevert, Kathleen; Crowder, Bradley M.
Date: June 1987
Title: Analysis of Agricultural Nonpoint Pollution Control Options in the St. Albans Bay Watershed
Journal: USDA - Economic Research Service (ERS), Natural Resource Economics Division, Staff Report No. AGES870423, 38 p.
Key Words: Nonpoint source pollution, agriculture, water quality
Summary: This report used a computer model, the Agricultural Nonpoint Source Pollution Model (AGNPS), to estimate nutrient losses both within the watershed at the field scale and at the watershed outlet. The capability of AGNPS to evaluate problem sites within a watershed can assist nonpoint source pollution program administrators in targeting best management practices (BMPs). It was concluded that substantial water quality improvements are possible from barnyard runoff

control, animal waste storage structures, and timely nutrient applications. The St. Albans Bay Rural Clean Water Program (RCWP) project (Franklin County, VT) was one of five projects selected for comprehensive monitoring and evaluation of physical and economic effects of the RCWP projects. The Economic Research Service, USDA, is cooperating with the Consolidated Farm Services Agency (CFSA) (Burlington, VT), NRCS (Winooski, VT), and the University of Vermont, Water Resources Research Center and Extension Service (Burlington, VT) in conducting the economic evaluation.

Values listed in this report are tabulated in the appendix on selected constituent values from the literature search. These constituent values were listed for the Jewett Brook watershed in Vermont. The values given in the appendix are annual mean values.

Jewett Brook flows through 5 miles of flatlands composed of mainly lacustrine sands, silts, clays, and glacial tills. This watershed is consists of 807 acres of corn, 1,547 acres of hay, 485 acres of pastureland, and 597 acres of woodland and marshes. Adequate information was not available to directly relate constituent values to a specific land use. Because of the study's location and other limitations, constituent values are listed for comparison purposes only.

Author: Hollin, Dewayne
Date: 1994
Title: Texas Recreational Boating Facilities Data base
Publisher: Texas A&M University, Sea Grant College Program
Key Words: Marinas
Summary: The summary reports of this data base include available information on recreational boating facilities throughout Texas, including coastal and inland facilities. The reports present a compilation of information on each facility including water body, facility/company name, telephone, location, and details on facility capacity and services.

Appendix H is an abbreviated listing taken from this report. Only facilities within the 12 county study area were included in this listing.

Author: Land, L.F.
Date: 1991
Title: National Water Quality Assessment Program -The Trinity River Basin
Journal: USGS Open-File Report 91-158
Key Words: Water quality, nonpoint source pollution, runoff
Summary: In 1991, the U.S. Geological Survey began to implement a full-scale National Water-Quality Assessment program. The long-term goals of the NAWQA program are to describe the status and trends in the quality of a large, representative art of the Nation's surface- and ground-water resources and to

provide a sound, scientific understanding of the primary natural and human factors affecting the quality of these resources. In meeting these goals, the program will produce a wealth of water-quality information that will be useful to policy makers and managers at the national, State, and local levels.

Some of the major water-quality issues for the Trinity River basin are: eutrophication of reservoirs, urban stormwater runoff and wastewater effluent from the Dallas-Fort Worth Metroplex, nutrient and freshwater inflow into Galveston Bay, landfills in the vicinity of major streams, nutrients and pesticides from agricultural activities, oil-field effluents, and erosion.

Specific values listed in this report are tabulated in the appendix on selected constituent values from the literature search. They are referenced as USGS Provisional Information for Chambers Creek Watershed.

Water Quality analyses (provisional) for several gages (#0864100, 315801096282999, 321017096420099, 321313096415201, and 321441096442601) were obtained from the U.S. Geological Survey. Because of the ongoing USGS project, the land use above some of the gages is known. Information from gages in Mill Creek (#321017096420099) and Big Onion Creek (#321313096415201) was used to provide information for comparison of cropland EMC values.

Author:	Longley, W. L.
Date:	1994
Title:	Freshwater Inflows to Texas Bays and Estuaries: Ecological Relationships and Methods for determination of Needs
Pages:	386 p.
Publisher:	Texas Water Development Board and Texas Parks and Wildlife Department, Austin TX.
Key Words:	Freshwater inflows, estuaries, bays
Summary:	Chapter 4 of this work includes an estimate of nutrient loads to Texas estuaries. Nutrients considered in the study include total nitrogen, total phosphorus, and total organic carbon. Nutrient load estimates were made for the Mission-Aransas and Nueces estuaries. No estimate was included for the Laguna Madre estuary. Also, the nutrient load estimates include breakdowns according to source: river, return flows, and rainfall. Estimates of total loadings were made by including data from gaged sites and estimates of runoff and concentrations from unmonitored watersheds.

Author: NADP/NTN Coordination Office
Date: August, 1994
Title: NADP/NTN Annual Data Summary - Precipitation Chemistry in the United States 1991-1993
Publisher: NADP/NTN Coordination Office, Fort Collins, CO.
Key Words: Atmospheric Deposition, Precipitation Chemistry.
Summary: These reports summarize the chemistry of precipitation samples collected at sites in the National Atmospheric Deposition Program/National Trends Network (NADP/NTN) monitoring network. The main body of the report contains annual and seasonal statistical summaries and weekly precipitation chemistry data for each site that operated during the reporting period. In addition, geographical distributions of selected ionic constituents of precipitation are illustrated by annual isopleth maps.

One NADP site is located in the CCBNEP study area near Beeville, Texas. This data was used to develop some of the rainfall EMC values for CCBNEP study area.

Author: National Oceanic and Atmospheric Administration
Date: August, 1976
Title: Coastal Facility Guidelines: A methodology for development with environmental case studies on marinas and power plants
Journal: Working Paper. Washington, DC
Key Words: Marinas
Summary: This paper outlines general methodology for coastal planners and managers for development of facilities, specifically, marinas and power plants. General information on environmental impacts of marina location, construction, and operation is included. It also contains an excellent bibliography. It is not useful as a source of actual loadings or EMC values for marina land use.

Author: Natural Resources Conservation Service and others
Date: November 1, 1994
Title: Seco Creek Water Quality Demonstration Project, Annual Project Report, Fiscal Year 1994
Pages: 178 p.
Publisher: USDA NRCS, TAES, USDA CFSA, TSSWCB, USGS, USEPA, TNRCC
Key Words: Water quality, best management practices
Summary: The overall purpose of the Seco Creek Project is to demonstrate to land and water users the potential benefits of implementing best management practices. The adoption and implementation of BMPs by land and water users is intended to (1) reduce the transport of agricultural chemicals and sediment, (2) increase the quantity of water available for use, (3) improve the quality of the land, (4) improve the quality of downstream surface water, (5) improve the quantity and quality of groundwater, and (6) improve the quantity and quality of the vegetative

cover. In 1991, the U.S. Geological Survey, in a cooperative effort with the Texas State Soil and Water Conservation Board, began a hydrologic investigation to evaluate the effects of BMPs on water quantity and quality within the Seco Creek watershed. The study components include the gaging of precipitation, stream flow, and the collection and analysis of water-quality samples. These samples are collected periodically to provide data used to evaluate the effects of BMPs on storm water runoff within the study area.

Specific values listed in this report are tabulated in the appendix on selected constituent values from the literature search. The values reported for Flatrock Crossing were the current water quality conditions as of fiscal year 1994.

Water Quality analyses (provisional) for several other gages (#08201500, 08202450, 08202700, 08202790, and 08202900) were obtained from the U.S. Geological Survey. Because of the ongoing NRCS project, the land use above the gages is known. The Seco Creek gage (#08201500) is in the upper watershed of the Corpus Christi Bay. It is situated below a watershed consisting almost exclusively of rangeland and has been in place for a number of years. This gage was used as the main source for rangeland EMCs in this characterization study. Information from other gages in the Seco Creek area was used to provide information for comparison.

Author: Newell, Charles J.; Rifai, Hanadi S.; Bedient, Philip B.
Date: March 1992
Title: Characterization of Nonpoint Sources and Loadings to Galveston Bay
Pages: 221 p.
Publisher: Galveston Bay National Estuary Program
Key Words: Nonpoint source pollution, Galveston Bay
Summary: This study, initiated in November 1990, and completed by Groundwater Services, Inc. (GSI), and the Department of Environmental Science and Engineering at Rice University (RU) as subcontractor, was aimed at characterizing nonpoint sources and loads into Galveston Bay. Nonpoint sources include a wide array of diffuse pollutant types and sources from major storm water outfalls, land drainage, and human activity. Pollutants include toxics, fecal coliform bacteria, oxygen demand, nutrients, and sediments. Source activities include urban development, agricultural activities, and runoff from industrial and residential developments. One important aspect regarding nonpoint pollutants is that they occur intermittently and are very dependent on the volume and distribution of local rainfall in the watershed. The objective of this work was to conduct a geographic analysis and priority ranking of possible nonpoint sources and loads to Galveston Bay. The study area was defined by GBNEP to include the entire Galveston Bay drainage area with the exception of the Lake Houston and Lake Livingston watersheds; loadings from these upper watersheds were not mapped but were subjected to a separate pollutant loading analysis. The primary elements for the nonpoint analysis included watershed

hydrology, load estimates, ranking of subwatersheds, upper watershed influences, and mapping.

The study includes a compilation of Event Mean Concentrations for the Houston/Galveston Bay area. The values reported in the study were based on an analysis of existing data from studies by Rice University, USGS studies in Houston and Austin, and the Texas Water Commission. The Galveston Bay report also includes the results of a GIS-based model used to calculate runoff and loadings of selected constituents to Galveston Bay. Information from this study was used to provide information for comparison of EMC values.

Author: NOAA/EPA Team on Near Coastal Waters
Date: June, 1989
Title: Strategic Assessment of Near Coastal Waters - Susceptibility and Status of Gulf of Mexico Estuaries to Nutrient Discharges
Pages: 36 pp.
Publisher: NOAA/EPA
Key Words: Gulf of Mexico, estuary, nutrient
Summary: This report summarizes the estimated relative susceptibility and estimated status of 23 estuaries in the Gulf of Mexico with respect to nutrient related pollution. Estimates of annual nutrient loads entering each estuary along with each estuaries' flushing/dilution characteristics as indicated by flushing time, estuary volume, and susceptibility parameters. Susceptibility is quantified by two parameters: dissolved concentration potential (DCP) and particle retention efficiency (PRE). The DCP estimates the relative ability of an estuary to concentrate dissolved substances. The PRE estimates the relative ability of an estuary to retain suspended particles and attached pollutants. A susceptibility classification scheme relating the DCP and PRE was developed to provide a relative ranking of estuaries in terms of susceptibility to pollution.

A one page summary is included for each of the 23 estuaries in the Gulf of Mexico. Each summary contains information on significant physical and hydrologic features, estimates of nutrient loading, pollution susceptibility, nutrient concentrations, and a narrative to assist the reader to interpret the data. It is important to note that assessments made in the report are based on estimated estuarine characteristics and nutrient loadings and do not reflect actual estuarine measurements or documented symptoms of eutrophication.

Author: Nueces River Authority, TNRCC, Alan Plummer and Associates, Inc.
Date: October 1, 1994
Title: Final Report - Regional Assessment of Water Quality, Nueces River Basin
Pages: 327 p.
Publisher: Nueces River Authority
Key Words: Water quality, coastal basins, Nueces
Summary: As a part of the Texas Clean Rivers Program (CRP), a Regional Water Quality Assessment of the Nueces Basin was performed in 1992 by the Nueces River Authority (NRA) under contract with the Texas Natural Resource Conservation Commission (TNRCC). That assessment, which also included the adjoining Coastal Basins and the Lower Rio Grande Valley, provided an initial review of the available data. Due to the limited time available to produce that report, detailed analysis and interpretations of the water quality data were not possible.

As a part of this 1994 Regional Water Quality Assessment, a much more detailed analysis was conducted. This analysis included the following new aspects: a basin-wide assessment of nutrient data, an assessment of metals using site specific data for hardness, an assessment of dissolved oxygen data by season, an analysis of historical trends in the concentrations of several pollutants, and a comparison of the quantity of flow in a stream to the concentration of pollutants.

Most of the water quality data that was assessed indicated that the water quality within the Nueces Basin is generally very good. However, several specific areas of concern were identified. Perhaps the most noteworthy concern is the inadequate amount of data available within the basin. In addition to the lack of stream sampling stations, the frequency with which samples are taken and the parameters that are analyzed are also inadequate. Without additional data, the assessment of the water quality within this basin cannot be completed satisfactorily.

Values listed in this report are tabulated in the appendix on selected constituent values from the literature search. The constituent values are listed for two stream segments, 2101 and 2102. Segment 2101 is the Nueces River Tidal segment and Segment 2102 is the Nueces River below Lake Corpus Christi. The values given in the appendix are median values.

Adequate information was not available to directly relate constituent values to a specific land use. Because of this limitation, constituent values are listed for comparison purposes only.

Author: Oppenheimer, C. H.
Date: July, 1992
Title: Corpus Christi Area Wide Waste Treatment Management Nonpoint Source Evaluation Corpus Christi Bay System.
Pages: 59 p.
Publisher: Coastal Bend Council of Governments
Key Words: Corpus Christi Bay, Nonpoint source pollution, water quality.
Summary: This data was collected in 1980. A wide variety of sampling stations were included in this study. These data do not necessarily represent true Event Mean Concentrations. No flow data is associated with the samples and some of the sampling sites are in receiving waters where concentrations of runoff are diluted. Analysis of the samples was rather extensive and included nutrients, bacteria, metals, and pesticides.

Author: Pudar, R. S. and Petri, B. L.
Date: 1994
Title: Characterization of Urban Stormwater Quality and Estimation of Stormwater Pollutant Loadings in the San Antonio Metropolitan Area, Texas
Journal: August 1992 - June 1993, unpublished USGS report
Key Words: Water quality, San Antonio, NPDES
Summary: This study is the source for documentation of EMC values obtained from the San Antonio NPDES permit application sampling program. In this study, a total of 36 water-quality samples were collected from a wet-weather monitoring network of six sampling sites. The six sites were small, single land use type urban watersheds, including three residential sites, two commercial sites, and one industrial site.

Author: Raines, T. H., and Baldys, S.
Date: 1994
Title: Analysis of the Dallas - Fort Worth Regional NPDES Stormwater Data Base and Data Collection Network
Journal: Unpublished USGS report
Key Words: Water quality, Dallas-Ft.-Worth, NPDES
Summary: This study is the source for documentation of EMC values obtained from the Dallas-FT. Worth NPDES permit application sampling program. Data from this study includes 182 stormwater samples from 26 urban monitoring stations. A maximum of 188 constituents were analyzed from the samples yielding approximately 34,000 values. This is one of the most extensive urban water-quality data sets ever developed for a single area.

Author: Sarasota Bay National Estuary Program
Date: 1992
Title: Framework for Action - Sarasota Bay National Estuary Program
Publisher: Sarasota Bay National Estuary Program
Key Words: National Estuary Program, nonpoint source pollution, Sarasota Bay
Summary: The Point and Nonpoint Source Loading Assessment Study compiled Event Mean Concentrations for a more extensive list of land use classifications than the CCBNEP. However, the list of constituents included only nutrients and metals. The study includes information on EMCs and loadings from golf courses based on actual data collected at the local golf course. Also mentioned in the report are estimates of nutrient loadings from septic tanks which were relatively low. Atmospheric loadings were also considered in the report. The atmospheric nutrient loadings were very significant and interestingly, rainfall was the greatest source of zinc to the estuary system.

Author: Stenstrom, M. K., Silverman, G. S., Bursztynsky, T. A.
Date: 1984
Title: Oil and grease in urban stormwaters
Journal: Journal of Environmental Engineering, Vol. 110, No. 1, February, 1984
Key Words: Oil, grease, urban, stormwater
Summary: A study of oil and grease in urban stormwaters was performed on a small watershed in Richmond, California, with the objective of determining the amount of oil and grease discharged into San Francisco Bay. Five sampling stations were selected at various places in the watershed that were indicative of specific land uses, and runoff from seven storms was sampled and analyzed. The results of the survey indicated that oil and grease concentration was highly dependent on land use, ranging from 4.1 mg/l in residential areas to 15.3 mg/l in parking lots. A statistical analysis of oil and grease and storm characteristics showed that oil and grease concentration was independent of all storm characteristics, except that mass of oil and grease discharged was proportional to total rainfall. Qualitative analysis of the oil and grease by gas chromatography indicated that it most resembled used automobile crankcase oil. Several samples showed evidence of spills of specific compounds. A simulation of management techniques indicated that a 90 percent reduction in discharge from commercial properties and parking lots, which represented only 9.6 percent of the total surface area, would result in a 53 percent reduction in total oil and grease discharge. Growth simulation predicted a potential 27 percent increase in discharge if 5 percent of the watershed were converted from open land to commercial property.

Author: Texas Department of Water Resources
Date: 1982
Title: The State of Texas Water Quality Inventory - 6th Edition, LP-59
Pages: 549 p.
Publisher: Texas Department of Water Resources
Key Words: Water quality, Texas
Summary: The State of Texas Water Quality Inventory, 6th Edition, was prepared in accordance with Section 305 (b) of the Federal Water Pollution Control Act Amendments of 1977. The purpose of this inventory is to present and evaluate water quality conditions, trends, and projections of the State's navigable waters to determine whether: the water quality is adequate to provide for the protection and propagation of a balanced population of shellfish, fish, and wildlife; the water quality is suitable to allow recreation activities in and on the water; those levels of water quality can be expected to be obtained by 1983; and/or, those levels of water quality can reasonably be obtained at some later date. Included is an assessment of the nature and extent of nonpoint source pollutant problems and general information concerning the State's major and minor aquifers, current ground water uses, availability and quality, and activities which may be impacting ground water resources. Information used in preparing the Inventory was obtained from the Department's water quality management plans, waste load evaluations, intensive monitoring surveys, and stream, reservoir, and estuary monitoring data. Additionally, data from the United States Geological Survey was used.

Values listed in this report are tabulated in the appendix on selected constituent values from the literature search. These constituent values were listed for various stream segments in different river basins. The values given in the appendix are annual mean values. Adequate information was not available to directly relate constituent values to a specific land use. They are listed for comparison purposes only.

Author: Texas Natural Resource Conservation Commission
Date: October 1994
Title: 1994 Regional Assessment of Water Quality in the Nueces Coastal Basins, San Antonio-Nueces, Nueces-Rio Grande, AS-35
Pages: 567 p.
Publisher: Texas Natural Resource Conservation Commission
Key Words: Water quality, Texas, Nueces, coastal basins
Summary: This assessment of water quality focuses on two coastal watersheds in south Texas; the San Antonio-Nueces and the Nueces-Rio Grande. Collectively these two basins are referred to as the Nueces Coastal Basins. The Nueces Coastal Basins cover 10,000 mi2 (25,900 km2) in all or portions of twelve counties in south Texas. The Texas Clean Rivers Act requires that assessments of water quality be conducted in each river basin in the state. The purpose of the biennial assessment reports is to provide information on the management and status of water quality. The act is not the first attempt in Texas to systematically address water quality, nor even the first attempt to address water quality by river basin

rather than by political boundary. However, the act is the first attempt in this state to assess water quality by river basin in conjunction with two elements that are essential to the long-term success of water resource management: 1) The reliance on public input through steering committees, and 2) Funding of the program through fees assessed on wastewater and water rights permit holders. This 1994 Regional Assessment of Water Quality in the Nueces Coastal Basins contains an analysis of more than ten years of surface water quality data (1982-1991). The data were collected by the sampling networks of both the TNRCC and the U.S. Geological Survey. The analysis compares, or screens, the data against the State of Texas Water Quality Standards (TSWQS) or other appropriate screening levels. The screening analysis identifies water quality problems and shows where and how often pollutants appear at elevated levels. The classification of an identified water quality problem is based on the percentage of measurements exceeding the screening level or standard. Where an inadequate number of measurements are available, a determination of insufficient data is made to indicated that more data are needed for a thorough analysis.

Values listed in this report are tabulated in the appendix on selected constituent values from the literature search. These constituent values were listed for various stream segments and bays in different watersheds. The values given in the appendix are mean values. Adequate information was not available to directly relate constituent values to a specific land use. They are listed for comparison purposes only.

Author: Texas State Soil and Water Conservation Board
Date: January, 1991
Title: A Comprehensive Study of Texas Watersheds and Their Impacts on Water Quality and Water Quantity
Pages: 208 p.
Publisher: Texas State Soil and Water Conservation Board, Temple, Texas
Key Words: Water quality, Texas, agriculture
Summary: This report is in response to a mandate in SB222, Acts of the Seventy-First Legislature R.S. directing the Texas State Soil and Water Conservation Board to conduct a comprehensive study of the physical conditions of the watersheds in this State that affect the surface and underground water quality and quantity, to determine corrective measures, and to report its recommendations to the Seventy-Second Legislature. The focus of the study centers around the impact of land management activities on water quality and quantity. Because ninety-two percent of the land area in Texas is agricultural land, this report concerns itself primarily with agriculture. The impact of non-agricultural areas is recognized and the report describes activities of other agencies responsible for these issues.

Author: Texas Water Commission

Date: October 1986
Title: The State of Texas Water Quality Inventory - 8th Edition, LP-86-07
Pages: 614 p.
Publisher: Texas Water Commission
Key Words: Texas, water quality, nonpoint source pollution
Summary: The State of Texas Water Quality Inventory, 8th Edition, was prepared in accordance with Section 305 (b) of the Federal Clean Water Act, as amended. The purpose of this inventory is to present and evaluate water quality conditions, trends, and projections of the State's navigable waters to determine the following: whether the water quality is adequate to provide for the protection and propagation of a balanced population of shellfish, fish, and wildlife; whether the water quality is suitable to allow recreation activities in and on the water; and whether the water quality is adequate to support other desirable designated uses. Included is a qualitative assessment of the nature and extent of nonpoint source pollutant problems and general information concerning the State's major and minor aquifers, including current ground water uses, availability and quality. Information used in preparing the Inventory was obtained from the Commission's water quality management plans, waste load evaluations, intensive monitoring surveys, and stream, reservoir, and estuary monitoring data. Additionally, data from the United States Geological Survey was used.

Values listed in this report are tabulated in the appendix on selected constituent values from the literature search. These constituent values were listed for various stream segments in different river basins. The values given in the appendix are annual mean values. Adequate information was not available to directly relate constituent values to a specific land use. They are listed for comparison purposes only.

Author: Texas Water Commission
Date: April 1988
Title: The State of Texas Water Quality Inventory - 9th Edition, LP-88-04
Pages: 606 p.
Publisher: Texas Water Commission
Key Words: Nonpoint source pollution, water quality, Texas
Summary: The Texas Water Quality Inventory was prepared and submitted by the Texas Water Commission in accordance with Section 305 (b) of the Federal Clean Water Act and as required by federal guidelines for the preparation of the 1988 state water quality assessment report. Ninety percent of stream miles with designated standards meet the federal goal for swimmable waters while more than 99 percent of classified reservoir and bay waters meet the federal goal for swimmable waters. Treated domestic wastewater discharges that lower dissolved oxygen levels and elevate fecal coliform bacteria concentrations are the primary factor impairing uses in Texas streams. The productivity of significant public reservoirs is listed using Secchi disc transparency as an indicator of productivity. Estuaries exhibiting high productivity, most of which are located in the Galveston Bay system, are also

listed. The water quality data that provide the basis for the surface water quality analysis are collected by the TWC's Stream Monitoring, Intensive Survey and Fish Kill Reporting Programs. The most recent four years of monitoring data are reviewed and summarized for waters that have been designated as segments and that have designated standards.

Values listed in this report are tabulated in the appendix on selected constituent values from the literature search. These constituent values were listed for various stream segments in different river basins. The values given in the appendix are annual mean values. Adequate information was not available to directly relate constituent values to a specific land use. They are listed for comparison purposes only.

Author: Texas Water Commission
Date: June 1990
Title: The State of Texas Water Quality Inventory - 10th Edition, LP-90-06
Publisher: Texas Water Commission
Key Words: Texas, water quality
Summary: The State of Texas Water Quality Inventory, 10th Edition, was prepared in accordance with Section 305 (b) of the Federal Clean Water Act, as amended. The purpose of this inventory is to present and evaluate water quality conditions, trends, and projections of the State's navigable waters. Included is a qualitative assessment of the nature and extent of nonpoint source pollutant problems and general information concerning the State's major and minor aquifers, including current ground water uses, availability and quality. The water quality data that provide the basis for the surface water quality analysis are collected by the TWC's Stream Monitoring, Intensive Survey and Fish Kill Reporting Programs. The most recent four years of monitoring data are reviewed and summarized for waters that have been designated as segments and that have designated

Values listed in this report are tabulated in the appendix on selected constituent values from the literature search. These constituent values were listed for various stream segments in different river basins. The values given in the appendix are annual mean values. Adequate information was not available to directly relate constituent values to a specific land use. They are listed for comparison purposes only.

Author: Texas Water Commission
Date: August 1992
Title: The State of Texas Water Quality Inventory - 11th Edition, LP-92-16
Pages: 682 p.
Publisher: Texas Water Commission
Key Words: Water quality, Texas, Gulf of Mexico
Summary: The Texas Water Quality Inventory was prepared and submitted to the United States Environmental Protection Agency (EPA) by the Texas Water Commission (TWC) in accordance with Section 305 (b) of the Clean Water Act. The report, which is prepared every two years, describes the status of the State's waters based on the most recent four years of monitored surface and ground water quality data. An overview is provided of water quality trends, the extent to which surface water quality standards are attained, the relative impacts of pollutants from various sources, waterbodies where additional actions are needed, and existing and planned water pollution control programs. Surface water quality data are summarized for individual stream, river, reservoir, bay, and estuary and Gulf of Mexico segments. Information is provided on the State's wetlands. Groundwater quality within each major river basin is described.

Values listed in this report are tabulated in the appendix on selected constituent values from the literature search. These constituent values were listed for various stream segments in different river basins. The values given in the appendix are annual mean values. Adequate information was not available to directly relate constituent values to a specific land use. They are listed for comparison purposes only.

Author: U.S. Environmental Protection Agency
Date: December, 1983
Title: Results of Nationwide Urban Runoff Program, Vol. 1 - Final Report
Publisher: U.S. Environmental Protection Agency
Key Words: Urban runoff
Summary: The Nationwide Urban Runoff Program was conducted by the USEPA and many cooperating federal, state, regional, and local agencies across the United States. Individual project studies were conducted during the period of 1978 - 1982. The NURP data base represents over 2300 separate storm events at 81 sites in 22 cities. The NURP report includes EMC values for various constituents and land use categories.

One interesting finding of the NURP study is that comparisons between sites using loading data can be distorted because mass loads are influenced by the volume of a storm event. Event Mean Concentration values, on the other hand, were uncorrelated with runoff volume. Site comparisons, therefore, are more reliable using EMC values. The most meaningful load comparisons are made using concentrations, area rainfall volumes, and rainfall-runoff volumes.

Author: U.S. Geological Survey
Date: 1995
Title: Spatial Data in Geographic Information System Format on Agricultural Chemical Use, Land Use, and Cropping Practices in the United States
Journal: USGS, Water Resources Investigations Report 94-4176, 87 p.
Key Words: Agriculture, chemicals, cropping practices
Summary: The spatial data in geographic information system format described in this report consist of estimates for all counties in the coterminous United States of the annual use of 96 herbicides in 1989: annual sales of nitrogen fertilizer for 1985-1991: and agricultural expenses, land use, chemical use, livestock holdings, and cropping practices in 1987. The source information, originally in tabular form, is summarized as digital polygon attribute data in the 18 GIS spatial data layers provided. The information in these coverages can be used in estimating regional agricultural - chemical use or agricultural practices and in producing visual displays and mapping relative rates of agricultural - chemical use or agricultural practices across broad regions of the United States.

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Results of Corpus Christi NPDES permit application sampling.
Suspended Solids

Land Use	Minimum (mg/L)	Maximum (mg/L)	Median (mg/L)	Mean (mg/L)	Standard Error of Mean
Residential	17	162	41	55.4	11.3
Commercial	22	94	55.5	57.7	11.1
Industrial	21	424	60.5	108	32.5

Comparison of Median Suspended Solids Concentration values from selected studies.

Land Use	Nationwide Urban Runoff Program (mg/L)	Galveston Bay National Estuary Program (mg/L)	San Antonio NPDES (mg/L)	Dallas - Ft. Worth NPDES (mg/L)	Corpus Christi NPDES (mg/L)
Residential	101	100	84	78.0	41
Commercial	69	166	135	42.0	55.5*
Industrial	--	--	118	104	60.5*
Transportation	--	--	--	97*	--

-- Data not available
* Selected for CCBNEP EMC value

Results of the Corpus Christi NPDES permit application sampling.
Dissolved Solids

Land Use	Minimum (mg/L)	Maximum (mg/L)	Median (mg/L)	Mean (mg/L)	Standard Error of Mean
Residential	56	511	134	168	36.7
Commercial	76	600	185	266	85.9
Industrial	44	175	116	113	12.4

Comparison of Median Dissolved Solids concentration values from selected studies.

Land Use	Nationwide Urban Runoff Program (mg/L)	Galveston Bay National Estuary Program (mg/L)	San Antonio NPDES (mg/L)	Dallas - Ft. Worth NPDES (mg/L)	Corpus Christi NPDES (mg/L)
Residential	--	--	--	59	134*
Commercial	--	--	--	50	185*
Industrial	--	--	--	69	116*
Transportation	--	--	--	194*	--

-- Data not available
* Selected for CCBNEP EMC value

Results of the Corpus Christi NPDES permit application sampling.
Total Nitrogen

Land Use	Minimum (mg/L)	Maximum (mg/L)	Median (mg/L)	Mean (mg/L)	Standard Error of Mean
Residential	0.7	4.3	1.82	2.0	0.25
Commercial	0.5	2.0	1.34	1.4	0.24
Industrial	0.5	3.3	1.26	1.4	0.21

Comparison of Median Total Nitrogen concentration values from selected studies.

Land Use	Nationwide Urban Runoff Program (mg/L)	Galveston Bay National Estuary Program (mg/L)	San Antonio NPDES (mg/L)	Dallas-Ft. Worth NPDES (mg/L)	Corpus Christi NPDES (mg/L)
Residential	2.64	3.41	1.7	1.7	1.82*
Commercial	1.75	2.10	1.7	1.2	1.34*
Industrial	--	--	1.2	1.4	1.26*
Transportation	--	--	--	1.86*	--

-- Data not available
* Selected for CCBNEP EMC value

Results of the Corpus Christi NPDES permit application sampling.
Total Kjeldahl Nitrogen

Land Use	Minimum (mg/L)	Maximum (mg/L)	Median (mg/L)	Mean (mg/L)	Standard Error of Mean
Residential	0.59	3.4	1.5	1.66	0.19
Commercial	0.45	1.7	1.1	1.2	0.20
Industrial	0.46	3.1	0.99	1.07	0.20

Comparison of Median Total Kjeldahl Nitrogen concentration values from selected studies.

Land Use	Nationwide Urban Runoff Program (mg/L)	Galveston Bay National Estuary Program (mg/L)	San Antonio NPDES (mg/L)	Dallas-Ft. Worth NPDES (mg/L)	Corpus Christi NPDES (mg/L)
Residential	1.9	1.62	1.1	1.1	1.5*
Commercial	1.18	2.88	1.35	0.8	1.1*
Industrial	--	--	0.6	0.8	1.2*
Transportation	--	--	--	1.5*	--

-- Data not available
* Selected for CCBNEP EMC value

Results of the Corpus Christi NPDES permit application sampling.
Nitrate + Nitrite

Land Use	Minimum (mg/L)	Maximum (mg/L)	Median (mg/L)	Mean (mg/L)	Standard Error of Mean
Residential	0.02	0.94	0.23	0.32	0.09
Commercial	0.005	0.42	0.26	0.22	0.06
Industrial	0.01	0.75	0.30	0.30	0.07

Comparison of median Nitrate + Nitrite concentration values from selected studies.

Land Use	Nationwide Urban Runoff Program (mg/L)	Galveston Bay National Estuary Program (mg/L)	San Antonio NPDES (mg/L)	Dallas-Ft. Worth NPDES (mg/L)	Corpus Christi NPDES (mg/L)
Residential	0.74	0.36	--	0.58	0.23*
Commercial	0.57	0.57	--	0.52	0.26*
Industrial	--	--	--	0.63	0.30*
Transportation	--	--	--	0.56*	--

-- Data not available
* Selected for CCBNEP EMC value

Comparison of median Ammonia concentration values from selected studies.

Land Use	Nationwide Urban Runoff Program (mg/L)	Galveston Bay National Estuary Program (mg/L)	San Antonio NPDES (mg/L)	Dallas-Ft. Worth NPDES (mg/L)	Corpus Christi NPDES (mg/L)
Residential	--	--	--	0.18	--
Commercial	--	--	--	0.18	--
Industrial	--	--	--	0.14	--
Transportation	--	--	--	--	--

-- Data not available

The Corpus Christi NPDES data does not include a separate analysis of ammonia. The Dallas-Ft. Worth data set does include ammonia EMCs. These values are presented for comparison/reference.

Results of the Corpus Christi NPDES permit application sampling.
Total Phosphorus

Land Use	Minimum (mg/L)	Maximum (mg/L)	Median (mg/L)	Mean (mg/L)	Standard Error of Mean
Residential	0.22	0.89	0.57	0.59	0.05
Commercial	0.36	7.3	1.35	2.24	1.06
Industrial	0.16	1.0	0.28	0.47	0.09

Comparison of Median Total Phosphorus concentration values from selected studies.

Land Use	Nationwide Urban Runoff Program (mg/L)	Galveston Bay National Estuary Program (mg/L)	San Antonio NPDES (mg/L)	Dallas-Ft. Worth NPDES (mg/L)	Corpus Christi NPDES (mg/L)
Residential	0.38	0.79	0.34	0.33	0.57*
Commercial	0.20	0.37	0.32*	0.14	1.4
Industrial	--	--	0.20	0.21	0.28*
Transportation	--	--	--	0.22*	--

-- Data not available
* Selected for CCBNEP EMC value

Results of the Corpus Christi NPDES permit application sampling.
Dissolved Phosphorus

Land Use	Minimum (mg/L)	Maximum (mg/L)	Median (mg/L)	Mean (mg/L)	Standard Error of Mean
Residential	0.04	0.86	0.48	0.50	0.06
Commercial	0.31	7.3	1.35	2.23	1.07
Industrial	0.016	1.0	0.22	0.37	0.08

Comparison of Median Dissolved Phosphorus concentrations from selected studies.

Land Use	Nationwide Urban Runoff Program (mg/L)	Galveston Bay National Estuary Program (mg/L)	San Antonio NPDES (mg/L)	Dallas-Ft. Worth NPDES (mg/L)	Corpus Christi NPDES (mg/L)
Residential	0.14	--	0.16	0.21	0.48*
Commercial	0.08	--	0.11*	0.06	1.35
Industrial	--	--	0.15	0.09	0.22*
Transportation	--	--	--	0.10*	--

-- Data not available
* Selected for CCBNEP EMC value

Results of the Corpus Christi NPDES permit application sampling.
Total Copper.

Land Use	Minimum (µg/L)	Maximum (µg/L)	Median (µg/L)	Mean (µg/L)	Standard Error of Mean
Residential	6.0	29	15.0	15.7	2.28
Commercial	9.0	40	14.5	19.0	5.0
Industrial	7.0	120	15.0	25.1	8.8

Comparison of Median Total Copper concentration values from selected studies.

Land Use	Nationwide Urban Runoff Program (µg/L)	Galveston Bay National Estuary Program (µg/L)	San Antonio NPDES (µg/L)	Dallas-Ft. Worth NPDES (µg/L)	Corpus Christi NPDES (µg/L)
Residential	29	4.16⊕	15.5	8.0	15.0*
Commercial	33	3.97⊕	8.0	8.0	14.5*
Industrial	--	--	14.0	12.0	15.0*
Transportation	--	--	--	11.0*	--

-- Data not available
* Selected for CCBNEP EMC value
⊕ Values are for dissolved copper

Results of the Corpus Christi NPDES permit application sampling.
Total Zinc

Land Use	Minimum (μg/L)	Maximum (μg/L)	Median (μg/L)	Mean (μg/L)	Standard Error of Mean
Residential	40	140	80	82	9
Commercial	80	310	180	185	33
Industrial	110	1200	245	333	84

Comparison of Median Total Zinc concentration values from selected studies.

Land Use	Nationwide Urban Runoff Program (μg/L)	Galveston Bay National Estuary Program (μg/L)	San Antonio NPDES (μg/L)	Dallas-Ft. Worth NPDES (μg/L)	Corpus Christi NPDES (μg/L)
Residential	135	35.37$^{\oplus}$	115	60	80*
Commercial	226	55.2$^{\oplus}$	230	80	180*
Industrial	--	--	145	140	245*
Transportation	--	--	--	60*	--

-- Data not available
* Selected for CCBNEP EMC value
$^{\oplus}$ Values are for dissolved zinc

Results of the Corpus Christi NPDES permit application sampling.
Total Lead

Land Use	Minimum (μg/L)	Maximum (μg/L)	Median (μg/L)	Mean (μg/L)	Standard Error of Mean
Residential	3	22	9	10.5	1.9
Commercial	5	62	13	22	8.5
Industrial	5	190	15	28	15

Comparison of Median Total Lead concentration values from selected studies.

Land Use	Nationwide Urban Runoff Program (μg/L)	Galveston Bay National Estuary Program (μg/L)	San Antonio NPDES (μg/L)	Dallas-Ft. Worth NPDES (μg/L)	Corpus Christi NPDES (μg/L)
Residential	144	2.18$^{\oplus}$	31	13.0	9.0*
Commercial	104	4.16$^{\oplus}$	14	29.5	13.0*
Industrial	--	--	46	29.0	15.0*
Transportation	--	--	--	11.0*	--

-- Data not available
* Selected for CCBNEP EMC value
$^{\oplus}$ Values are for dissolved lead

Results of the Corpus Christi NPDES permit application sampling.
Total Cadmium

Land Use	Minimum (μg/L)	Maximum (μg/L)	Median (μg/L)	Mean (μg/L)	Standard Error of Mean
Residential	<1	11	0.75	1.7	0.88
Commercial	<1	2	0.96	1.19	0.27
Industrial	--	--	2.0	--	--

Comparison of Median Total Cadmium concentration values from selected studies.

Land Use	Nationwide Urban Runoff Program (μg/L)	Galveston Bay National Estuary Program (μg/L)	San Antonio NPDES (μg/L)	Dallas-Ft. Worth NPDES (μg/L)	Corpus Christi NPDES (μg/L)
Residential	--	1.0$^{\oplus}$	--	<1	0.75*
Commercial	--	1.0$^{\oplus}$	--	<1	0.96*
Industrial	--	--	--	<1	2.0*
Transportation	--	--	--	<1*	--

-- Data not available
* Selected for CCBNEP EMC value
$^{\oplus}$ Values are for dissolved cadmium

Results of the Corpus Christi NPDES permit application sampling.
Total Chromium

Land Use	Minimum (µg/L)	Maximum (µg/L)	Median (µg/L)	Mean (µg/L)	Standard Error of Mean
Residential	0.2	23.0	2.1	4.4	1.8
Commercial	4.0	30.0	10.0	12.3	4.0
Industrial	5.0	24.0	7.0	10.1	1.8

Comparison of Median Total Chromium concentration values from selected studies.

Land Use	Nationwide Urban Runoff Program (µg/L)	Galveston Bay National Estuary Program (µg/L)	San Antonio NPDES (µg/L)	Dallas-Ft. Worth NPDES (µg/L)	Corpus Christi NPDES (µg/L)
Residential	--	5.0⊕	--	4.0	2.1*
Commercial	--	5.0⊕	--	4.0	10*
Industrial	--	--	--	4.0	7.0*
Transportation	--	--	--	3.0*	--

-- Data not available
* Selected for CCBNEP EMC value
⊕ Values are for dissolved chromium

Results of the Corpus Christi NPDES permit application sampling.
Total Nickel

Land Use	Minimum (µg/L)	Maximum (µg/L)	Median (µg/L)	Mean (µg/L)	Standard Error of Mean
Residential	--	--	<10	--	--
Commercial	6.8	20	11.8	12.2	1.9
Industrial	2.1	35	8.3	11.1	2.7

Comparison of Median Total Nickel concentration values from selected studies.

Land Use	Nationwide Urban Runoff Program (µg/L)	Galveston Bay National Estuary Program (µg/L)	San Antonio NPDES (µg/L)	Dallas-Ft. Worth NPDES (µg/L)	Corpus Christi NPDES (µg/L)
Residential	--	--	--	4.0	<10*
Commercial	--	--	--	3.0	11.8*
Industrial	--	--	--	6.0	8.3*
Transportation	--	--	--	4.0*	--

-- Data not available
* Selected for CCBNEP EMC value

Results of the Corpus Christi NPDES permit application sampling.
Oil and Grease

Land Use	Minimum (mg/L)	Maximum (mg/L)	Median (mg/L)	Mean (mg/L)	Standard Error of Mean
Residential	0.18	10	1.7	3.1	1.0
Commercial	4.0	360	9.0	102	62.6
Industrial	0.6	8	3.0	3.5	0.73

Comparison of Median Oil and Grease concentration values from selected studies.

Land Use	Nationwide Urban Runoff Program (mg/L)	Galveston Bay National Estuary Program (mg/L)	San Antonio NPDES (mg/L)	Dallas-Ft. Worth NPDES (mg/L)	Corpus Christi NPDES (mg/L)
Residential	--	4.0	--	1.0	1.7*
Commercial	--	13.0	--	2.0	9.0*
Industrial	--	--	--	<1.0	3.0*
Transportation	--	--	--	0.4*	--

-- Data not available
* Selected for CCBNEP EMC value

Results of the Corpus Christi NPDES permit application sampling.
Biochemical Oxygen Demand

Land Use	Minimum (mg/L)	Maximum (mg/L)	Median (mg/L)	Mean (mg/L)	Standard Error of Mean
Residential	11	67	25.5	30.1	5.7
Commercial	14	112	23	49.8	19.9
Industrial	9	39	14	16.7	3.2

Comparison of Median Biochemical Oxygen Demand concentration values from selected studies.

Land Use	Nationwide Urban Runoff Program (mg/L)	Galveston Bay National Estuary Program (mg/L)	San Antonio NPDES (mg/L)	Dallas-Ft. Worth NPDES (mg/L)	Corpus Christi NPDES (mg/L)
Residential	10.0	15	7.2	7.3	25.5*
Commercial	9.3	9.0	4.8	6.6	23.0*
Industrial	--	--	8.8	7.5	14.0*
Transportation	--	--	--	6.4*	--

-- Data not available
* Selected for CCBNEP EMC value

Results of the Corpus Christi NPDES permit application sampling.
Chemical Oxygen Demand

Land Use	Minimum (mg/L)	Maximum (mg/L)	Median (mg/L)	Mean (mg/L)	Standard Error of Mean
Residential	32	250	49.5	85.3	21.7
Commercial	27	350	116	152	53.8
Industrial	14	377	45.5	86	30.9

Comparison of Median Chemical Oxygen Demand concentration values from selected studies.

Land Use	Nationwide Urban Runoff Program (mg/L)	Galveston Bay National Estuary Program (mg/L)	San Antonio NPDES (mg/L)	Dallas-Ft. Worth NPDES (mg/L)	Corpus Christi NPDES (mg/L)
Residential	73	--	95	70	49.5*
Commercial	57	--	115	56.5	116*
Industrial	--	--	60	66	45.5*
Transportation	--	--	--	59*	--

-- Data not available
* Selected for CCBNEP EMC value

Results of the Corpus Christi NPDES permit application sampling.
Fecal Coliforms

Land Use	Minimum (cfu/100 ml)	Maximum (cfu/100 ml)	Median (cfu/100 ml)	Mean (cfu/100 ml)	Standard Error of Mean
Residential	4,400	109,000	40,500	46,616	9,596
Commercial	2,500	130,000	14,800	31,880	19,765
Industrial	--	--	31,500	37,600	--

Comparison of Median Fecal Coliform concentration values from selected studies.

Land Use	Nationwide Urban Runoff Program (cfu/100 ml)	Galveston Bay National Estuary Program (cfu/100 ml)	San Antonio NPDES (cfu/100 ml)	Dallas-Ft. Worth NPDES (cfu/100 ml)	Corpus Christi NPDES (cfu/100 ml)
Residential	101	22,000	37,500	20,000*	40,500
Commercial	21,000	22,000	6,150	6,900*	14,800
Industrial	--	--	--	9,700*	31,500
Transportation	--	--	--	53,000*	--

-- Data not available
* Selected for CCBNEP EMC value

Results of the Corpus Christi NPDES permit application sampling.
Fecal Streptococcus

Land Use	Minimum (cfu/100 ml)	Maximum (cfu/100 ml)	Median (cfu/100 ml)	Mean (cfu/100 ml)	Standard Error of Mean
Residential	16,000	4,200,000	200,000	828,000	364,300
Commercial	200	5,900,000	1,654,000	2,203,000	1,042,100
Industrial	17,000	50,000,000	90,000	8,696,500	5,572,000

Comparison of Median Fecal Streptococcus concentration values from selected studies.

Land Use	Nationwide Urban Runoff Program (cfu/100 ml)	Galveston Bay National Estuary Program (cfu/100 ml)	San Antonio NPDES (cfu/100 ml)	Dallas-Ft. Worth NPDES (cfu/100 ml)	Corpus Christi NPDES (cfu/100 ml)
Residential	--	--	64,500	56,000*	200,000
Commercial	--	--	35,000	18,000*	1,650,000
Industrial	--	--	5,000	6,100*	90,000
Transportation	--	--	--	26,000*	--

-- Data not available
* Selected for CCBNEP EMC value

Compilation of Urban EMC Values

Constituent	Land Use Category			
	Residential	Commercial	Industrial	Transportation
Total Nitrogen (mg/L)	1.82	1.34	1.26	1.86
Total Kjeldahl Nitrogen (mg/L)	1.50	1.10	0.99	1.5
Nitrate + Nitrite (mg/L as N)	0.23	0.26	0.30	0.56
Total Phosphorus (mg/L)	0.57	0.32	0.28	0.22
Dissolved Phosphorus (mg/L)	0.48	0.11	0.22	0.10
Suspended Solids (mg/L)	41.0	55.5	60.5	73.5
Dissolved Solids (mg/L)	134	185	116	194
Total Lead (µg/L)	9.0	13.0	15.0	11.0
Total Copper (µg/L)	15.0	14.5	15.0	11.0
Total Zinc (µg/L)	80	180	245	60
Total Cadmium (µg/L)	0.75	0.96	2.0	< 1
Total Chromium (µg/L)	2.1	10.0	7.0	3.0
Total Nickel (µg/L)	< 10	11.8	8.3	4.0
BOD (mg/L)	25.5	23.0	14.0	6.4
COD (mg/L)	49.5	116	45.5	59
Oil and Grease (mg/L)*	1.7	9.0	3.0	0.4
Fecal Coliform(colonies/100 ml)*	20,000	6,900	9,700	53,000
Fecal Strep. (colonies/100 ml)*	56,000	18,000	6,100	26,000

***** *Average concentrations based on instantaneous rather than flow-averaged samples*

USGS provisional information.
Suspended Solids

Land Use	Minimum (mg/L)	Maximum (mg/L)	Median (mg/L)	Mean (mg/L)	Standard Error of Mean
Cropland	1.74	1440	107	337.8	131.9
Rangeland	*nd*	23	1	2.6	0.41

Comparison of Median Suspended Solids Concentration values from selected studies.

Location	Primary Land Use		
	Cropland (mg/L)	Rangeland (mg/L)	Mixed Ag. (mg/L)
USGS Provisional Information-Gage #08211520, Oso Creek @ Corpus Christi, TX.	107*	--	--
USGS Provisional Information-Gage #08201500, Seco Creek @ Miller Ranch near Utopia, TX.	--	1*	--
Galveston Bay National Estuary Program	201	70	--
USGS Provisional Information-Gage #08202700, Seco Creek @ Rowe Ranch near D Hanis, TX.	--	--	--
USGS Provisional Information-Gage #08202450, Seco Creek Reservoir Inflow near Utopia, TX.	--	--	--
USGS Provisional Information-Gage #321017096420099, Mill Creek at Ellis - Navarro County line	48	--	--
USGS Provisional Information-Gage #321313096415201, Big Onion Creek on FM 985 South of Bardwell, TX.	37	--	--
USGS Provisional Information-Gage #08202900, Seco Creek near Yancy, TX.	--	--	--

-- Data not available
nd Below detection limit
* Selected for CCBNEP EMC value

USGS provisional information.
Dissolved Solids

Land Use	Minimum (mg/L)	Maximum (mg/L)	Median (mg/L)	Mean (mg/L)	Standard Error of Mean
Cropland	133	5130	1225	1749	364.2
Rangeland	197	295	245	245	2.44

Comparison of Median Dissolved Solids Concentration values from selected studies.

Location	Primary Land Use		
	Cropland (mg/L)	Rangeland (mg/L)	Mixed Ag. (mg/L)
USGS Provisional Information-Gage #08211520, Oso Creek @ Corpus Christi, TX.	1,225*	--	--
USGS Provisional Information-Gage #08201500, Seco Creek @ Miller Ranch near Utopia, TX.	--	245*	--
Galveston Bay National Estuary Program	--	--	--
USGS Provisional Information-Gage #08202700, Seco Creek @ Rowe Ranch near D Hanis, TX.	--	--	90
USGS Provisional Information-Gage #08202450, Seco Creek Reservoir Inflow near Utopia, TX.	--	198	--
USGS Provisional Information-Gage #321017096420099, Mill Creek at Ellis - Navarro County line	278	--	--
USGS Provisional Information-Gage #321313096415201, Big Onion Creek on FM 985 South of Bardwell, TX.	215	--	--
USGS Provisional Information-Gage #08202900, Seco Creek near Yancy, TX.	--	--	232

-- Data not available
* Selected for CCBNEP EMC value

USGS provisional information.
Total Nitrogen

Land Use	Minimum (mg/L)	Maximum (mg/L)	Median (mg/L)	Mean (mg/L)	Standard Error of Mean
Cropland	1.4	11.3	4.4	4.4	0.58
Rangeland	0.2	3.2	0.7	0.8	0.06

Comparison of Median Total Nitrogen Concentration values from selected studies.

Location	Primary Land Use		
	Cropland (mg/L)	Rangeland (mg/L)	Mixed Ag. (mg/L)
USGS Provisional Information-Gage #08211520, Oso Creek @ Corpus Christi, TX.	4.4*	--	--
USGS Provisional Information-Gage #08201500, Seco Creek @ Miller Ranch near Utopia, TX.	--	0.67*	--
Galveston Bay National Estuary Program	1.56	1.51	--
USGS Provisional Information-Gage #08202700, Seco Creek @ Rowe Ranch near D Hanis, TX.	--	--	1.10
USGS Provisional Information-Gage #08202450, Seco Creek Reservoir Inflow near Utopia, TX.	--	0.62	--
USGS Provisional Information-Gage #321017096420099, Mill Creek at Ellis - Navarro County line	1.80	--	--
USGS Provisional Information-Gage #321313096415201, Big Onion Creek on FM 985 South of Bardwell, TX.	3.40	--	--
USGS Provisional Information-Gage #08202900, Seco Creek near Yancy, TX.	--	--	1.79

-- Data not available
* Selected for CCBNEP EMC value

USGS provisional information.
Total Kjeldahl Nitrogen

Land Use	Minimum (mg/L)	Maximum (mg/L)	Median (mg/L)	Mean (mg/L)	Standard Error of Mean
Cropland	0.44	6.0	1.7	2.0	0.29
Rangeland	0.01	1.6	0.2	0.31	0.04

Comparison of Median Total Kjeldahl Nitrogen Concentration values from selected studies.

Location	Primary Land Use		
	Cropland (mg/L)	Rangeland (mg/L)	Mixed Ag. (mg/L)
USGS Provisional Information-Gage #08211520, Oso Creek @ Corpus Christi, TX.	1.70*	--	--
USGS Provisional Information-Gage #08201500, Seco Creek @ Miller Ranch near Utopia, TX.	--	0.20*	--
Galveston Bay National Estuary Program	--	--	--
USGS Provisional Information-Gage #08202700, Seco Creek @ Rowe Ranch near D Hanis, TX.	--	--	0.80
USGS Provisional Information-Gage #08202450, Seco Creek Reservoir Inflow near Utopia, TX.	--	0.35	--
USGS Provisional Information-Gage #321017096420099, Mill Creek at Ellis - Navarro County line	0.30	--	--
USGS Provisional Information-Gage #321313096415201, Big Onion Creek on FM 985 South of Bardwell, TX.	0.50	--	--
USGS Provisional Information-Gage #08202900, Seco Creek near Yancy, TX.	--	--	0.90

-- Data not available
* Selected for CCBNEP EMC value

USGS provisional information.
Nitrate + Nitrite

Land Use	Minimum (mg/L)	Maximum (mg/L)	Median (mg/L)	Mean (mg/L)	Standard Error of Mean
Cropland	0.8	6.1	1.6	2.71	0.50
Rangeland	0.07	2.0	0.40	0.49	0.05

Comparison of Median Nitrate + Nitrite Concentration values from selected studies.

Location	Primary Land Use		
	Cropland (mg/L)	Rangeland (mg/L)	Mixed Ag. (mg/L)
USGS Provisional Information-Gage #08211520, Oso Creek @ Corpus Christi, TX.	1.60*	--	--
USGS Provisional Information-Gage #08201500, Seco Creek @ Miller Ranch near Utopia, TX.	--	0.40*	--
Galveston Bay National Estuary Program	--	--	--
USGS Provisional Information-Gage #08202700, Seco Creek @ Rowe Ranch near D Hanis, TX.	--	--	0.21
USGS Provisional Information-Gage #08202450, Seco Creek Reservoir Inflow near Utopia, TX.	--	0.25	--
USGS Provisional Information-Gage #321017096420099, Mill Creek at Ellis - Navarro County line	1.60	--	--
USGS Provisional Information-Gage #321313096415201, Big Onion Creek on FM 985 South of Bardwell, TX.	2.90	--	--
USGS Provisional Information-Gage #08202900, Seco Creek near Yancy, TX.	--	--	0.66

-- Data not available
* Selected for CCBNEP EMC value

USGS provisional information.
Total Phosphorus

Land Use	Minimum (mg/L)	Maximum (mg/L)	Median (mg/L)	Mean (mg/L)	Standard Error of Mean
Cropland	0.51	4.2	1.3	1.95	0.37
Rangeland	*nd*	0.17	<0.01	0.01	--

Comparison of Median Total Phosphorus Concentration values from selected studies.

Location	Primary Land Use		
	Cropland (mg/L)	Rangeland (mg/L)	Mixed Ag. (mg/L)
USGS Provisional Information-Gage #08211520, Oso Creek @ Corpus Christi, TX.	1.30*	--	--
USGS Provisional Information-Gage #08201500, Seco Creek @ Miller Ranch near Utopia, TX.	--	<0.01*	--
Galveston Bay National Estuary Program	0.36	0.12	--
USGS Provisional Information-Gage #08202700, Seco Creek @ Rowe Ranch near D Hanis, TX.	--	--	0.13
USGS Provisional Information-Gage #08202450, Seco Creek Reservoir Inflow near Utopia, TX.	--	0.03	--
USGS Provisional Information-Gage #321017096420099, Mill Creek at Ellis - Navarro County line	0.03	--	--
USGS Provisional Information-Gage #321313096415201, Big Onion Creek on FM 985 South of Bardwell, TX.	0.04	--	--
USGS Provisional Information-Gage #08202900, Seco Creek near Yancy, TX.	--	--	0.17

-- Data not available
nd Below detection limit
* Selected for CCBNEP EMC value

USGS provisional information.
Total Copper

Land Use	Minimum (µg/L)	Maximum (µg/L)	Median (µg/L)	Mean (µg/L)	Standard Error of Mean
Cropland	*nd*	18	1.5	4.5	2.79
Rangeland	*nd*	<10.0	<10.0	4.59	0.72

Comparison of Median Total Copper Concentration values from selected studies.

Location	Primary Land Use		
	Cropland (µg/L)	Rangeland (µg/L)	Mixed Ag. (µg/L)
USGS Provisional Information-Gage #08211520, Oso Creek @ Corpus Christi, TX.	1.50*	--	--
USGS Provisional Information-Gage #08201500, Seco Creek @ Miller Ranch near Utopia, TX.	--	<10.0*	--
Galveston Bay National Estuary Program	3.1[⊕]	3.0[⊕]	--
USGS Provisional Information-Gage #08202700, Seco Creek @ Rowe Ranch near D Hanis, TX.	--	--	<10.0
USGS Provisional Information-Gage #08202450, Seco Creek Reservoir Inflow near Utopia, TX.	--	<10.0	--
USGS Provisional Information-Gage #321017096420099, Mill Creek at Ellis - Navarro County line	--	--	--
USGS Provisional Information-Gage #321313096415201, Big Onion Creek on FM 985 South of Bardwell, TX.	--	--	--
USGS Provisional Information-Gage #08202900, Seco Creek near Yancy, TX.	--	--	<10.0

-- Data not available
nd Below detection limit
* Selected for CCBNEP EMC value
⊕ Values are for dissolved copper

USGS provisional information.
Total Zinc

Land Use	Minimum (µg/L)	Maximum (µg/L)	Median (µg/L)	Mean (µg/L)	Standard Error of Mean
Cropland	10.0	40.0	16.0	18.83	4.61
Rangeland	<3	46	6	9.94	1.49

Comparison of Median Total Zinc Concentration values from selected studies.

Location	Primary Land Use		
	Cropland (µg/L)	Rangeland (µg/L)	Mixed Ag. (µg/L)
USGS Provisional Information-Gage #08211520, Oso Creek @ Corpus Christi, TX.	16.0*	--	--
USGS Provisional Information-Gage #08201500, Seco Creek @ Miller Ranch near Utopia, TX.	--	6.0*	--
Galveston Bay National Estuary Program	18.30[⊕]	18.30[⊕]	--
USGS Provisional Information-Gage #08202700, Seco Creek @ Rowe Ranch near D Hanis, TX.	--	--	7.5
USGS Provisional Information-Gage #08202450, Seco Creek Reservoir Inflow near Utopia, TX.	--	7.0	--
USGS Provisional Information-Gage #321017096420099, Mill Creek at Ellis - Navarro County line	--	--	--
USGS Provisional Information-Gage #321313096415201, Big Onion Creek on FM 985 South of Bardwell, TX.	--	--	--
USGS Provisional Information-Gage #08202900, Seco Creek near Yancy, TX.	--	--	6.0

-- Data not available
* Selected for CCBNEP EMC value
[⊕] Values are for dissolved zinc

USGS provisional information.
Total Lead

Land Use	Minimum (µg/L)	Maximum (µg/L)	Median (µg/L)	Mean (µg/L)	Standard Error of Mean
Cropland	*nd*	10	1.5	3.16	1.54
Rangeland	*nd*	17	4.99	5.45	0.74

Comparison of Median Total Lead Concentration values from selected studies.

Location	Primary Land Use		
	Cropland (µg/L)	Rangeland (µg/L)	Mixed Ag. (µg/L)
USGS Provisional Information-Gage #08211520, Oso Creek @ Corpus Christi, TX.	1.50*	--	--
USGS Provisional Information-Gage #08201500, Seco Creek @ Miller Ranch near Utopia, TX.	--	4.99*	--
Galveston Bay National Estuary Program	2.40$^{\oplus}$	2.40$^{\oplus}$	--
USGS Provisional Information-Gage #08202700, Seco Creek @ Rowe Ranch near D Hanis, TX.	--	--	<10.0
USGS Provisional Information-Gage #08202450, Seco Creek Reservoir Inflow near Utopia, TX.	--	<10.0	--
USGS Provisional Information-Gage #321017096420099, Mill Creek at Ellis - Navarro County line	--	--	--
USGS Provisional Information-Gage #321313096415201, Big Onion Creek on FM 985 South of Bardwell, TX.	--	--	--
USGS Provisional Information-Gage #08202900, Seco Creek near Yancy, TX.	--	--	<10.0

-- Data not available
nd Below detection limit
* Selected for CCBNEP EMC value
$^{\oplus}$ Values are for dissolved lead

USGS provisional information.
Total Cadmium

Land Use	Minimum (μg/L)	Maximum (μg/L)	Median (μg/L)	Mean (μg/L)	Standard Error of Mean
Cropland	1.0	6.0	1.0	1.83	0.83
Rangeland	<1.0	<2.0	<1.0	1.06	0.04

Comparison of Median Total Cadmium Concentration values from selected studies.

Location	Primary Land Use		
	Cropland (μg/L)	Rangeland (μg/L)	Mixed Ag. (μg/L)
USGS Provisional Information-Gage #08211520, Oso Creek @ Corpus Christi, TX.	1.0*	--	--
USGS Provisional Information-Gage #08201500, Seco Creek @ Miller Ranch near Utopia, TX.	--	<1.0*	--
Galveston Bay National Estuary Program	0.50⊕	0.50⊕	--
USGS Provisional Information-Gage #08202700, Seco Creek @ Rowe Ranch near D Hanis, TX.	--	--	<1.0
USGS Provisional Information-Gage #08202450, Seco Creek Reservoir Inflow near Utopia, TX.	--	<1.0	--
USGS Provisional Information-Gage #321017096420099, Mill Creek at Ellis - Navarro County line	--	--	--
USGS Provisional Information-Gage #321313096415201, Big Onion Creek on FM 985 South of Bardwell, TX.	--	--	--
USGS Provisional Information-Gage #08202900, Seco Creek near Yancy, TX.	--	--	<1.0

-- Data not available
* Selected for CCBNEP EMC value
⊕ Values are for dissolved cadmium

USGS provisional information.
Total Chromium

Land Use	Minimum (μg/L)	Maximum (μg/L)	Median (μg/L)	Mean (μg/L)	Standard Error of Mean
Cropland	*nd*	70	<10	16.7	10.85
Rangeland	*nd*	19.99	7.49	7.43	0.85

Comparison of Median Total Chromium Concentration values from selected studies.

Location	Primary Land Use Cropland (μg/L)	Rangeland (μg/L)	Mixed Ag. (μg/L)
USGS Provisional Information-Gage #08211520, Oso Creek @ Corpus Christi, TX.	<10.0*	--	--
USGS Provisional Information-Gage #08201500, Seco Creek @ Miller Ranch near Utopia, TX.	--	7.49*	--
Galveston Bay National Estuary Program	5.0⊕	5.0⊕	--
USGS Provisional Information-Gage #08202700, Seco Creek @ Rowe Ranch near D Hanis, TX.	--	--	<5.0
USGS Provisional Information-Gage #08202450, Seco Creek Reservoir Inflow near Utopia, TX.	--	<5.0	--
USGS Provisional Information-Gage #321017096420099, Mill Creek at Ellis - Navarro County line	--	--	--
USGS Provisional Information-Gage #321313096415201, Big Onion Creek on FM 985 South of Bardwell, TX.	--	--	--
USGS Provisional Information-Gage #08202900, Seco Creek near Yancy, TX.	--	--	<5.0

-- Data not available
nd Below detection limit
* Selected for CCBNEP EMC value
⊕ Values are for dissolved chromium

USGS provisional information.
Biochemical Oxygen Demand

Land Use	Minimum (mg/L)	Maximum (mg/L)	Median (mg/L)	Mean (mg/L)	Standard Error of Mean
Cropland	2.1	15	4.0	4.84	0.70
Rangeland	*nd*	7	0.5	0.68	0.10

Comparison of Median Biochemical Oxygen Demand Concentration values from selected studies.

Location	Primary Land Use		
	Cropland (mg/L)	Rangeland (mg/L)	Mixed Ag. (mg/L)
USGS Provisional Information-Gage #08211520, Oso Creek @ Corpus Christi, TX.	4.0*	--	--
USGS Provisional Information-Gage #08201500, Seco Creek @ Miller Ranch near Utopia, TX.	--	0.50*	--
Galveston Bay National Estuary Program	4.0	6.0	--
USGS Provisional Information-Gage #08202700, Seco Creek @ Rowe Ranch near D Hanis, TX.	--	--	3.7
USGS Provisional Information-Gage #08202450, Seco Creek Reservoir Inflow near Utopia, TX.	--	2.0	--
USGS Provisional Information-Gage #321017096420099, Mill Creek at Ellis - Navarro County line	--	--	--
USGS Provisional Information-Gage #321313096415201, Big Onion Creek on FM 985 South of Bardwell, TX.	--	--	--
USGS Provisional Information-Gage #08202900, Seco Creek near Yancy, TX.	--	--	3.1

-- Data not available
nd Below detection limit
* Selected for CCBNEP EMC value

USGS provisional information.
Fecal Coliforms

Land Use	Minimum (cfu/100ml)	Maximum (cfu/100ml)	Median (cfu/100ml)	Mean (cfu/100ml)	Standard Error of Mean
Cropland	--	--	--	--	--
Rangeland	2	400	37	83.15	15.83

Comparison of Median Fecal Coliforms Concentration values from selected studies.

Location	Primary Land Use		
	Cropland (cfu/100ml)	Rangeland (cfu/100ml)	Mixed Ag. (cfu/100ml)
USGS Provisional Information-Gage #08211520, Oso Creek @ Corpus Christi, TX.	--	--	--
USGS Provisional Information-Gage #08201500, Seco Creek @ Miller Ranch near Utopia, TX.	--	37*	--
Galveston Bay National Estuary Program	2,500	2,500	--
USGS Provisional Information-Gage #08202700, Seco Creek @ Rowe Ranch near D Hanis, TX.	--	--	4,900
USGS Provisional Information-Gage #08202450, Seco Creek Reservoir Inflow near Utopia, TX.	--	13,000	--
USGS Provisional Information-Gage #321017096420099, Mill Creek at Ellis - Navarro County line	--	--	--
USGS Provisional Information-Gage #321313096415201, Big Onion Creek on FM 985 South of Bardwell, TX.	--	--	--
USGS Provisional Information-Gage #08202900, Seco Creek near Yancy, TX.	--	--	23,000

-- Data not available
* Selected for CCBNEP EMC value

Appendix B - Analysis and Comparison of Agricultural EMC Data by Constituent and Land Use

Compilation of Agricultural EMC Values

Constituent	Land Use	Category
	Cropland	Rangeland
Total Nitrogen (mg/L)	4.40	0.70
Total Kjeldahl Nitrogen (mg/L)	1.70	0.20
Nitrate + Nitrite (mg/L as N)	1.60	0.40
Total Phosphorus(mg/L)	1.30	<0.01
Dissolved Phosphorus(mg/L)	--	--
Suspended Solids(mg/L)	107	1.0
Dissolved Solids(mg/L)	1225	245
Total Lead (µg/L)	1.5	5.0
Total Copper (µg/L)	1.5	<10
Total Zinc (µg/L)	16	6.0
Total Cadmium (µg/L)	1.0	<1.0
Total Chromium (µg/L)	<10.0	7.5
Total Nickel (µg/L)	--	--
BOD (mg/L)	4.0	0.5
COD (mg/L)	--	--
Oil and Grease (mg/L)*	--	--
Fecal Coliform(colonies/100 ml)*	--	37
Fecal Strep.(colonies/100 ml)*	--	--

***** *Average concentrations based on instantaneous rather than flow-averaged samples*

Appendix C- Selected Constituent Values from Literature Search

Land Use Category/ Location	Total Suspended Solids, (TSS), mg/l	Total Nitrogen, (TN), mg/l	Total Phosphorus, (TP), mg/l	5 Day Biochemical Oxygen Demand, (BOD), mg/l	Oil & Grease, (O&G), mg/l	Fecal Coliform, (FC), cfu/100ml	Dissolved Copper, (Cu), µg/l	Chlorinated Hydrocarbon & Organophosphorus Pesticides, (Pesticide), mg/l	Source (See Footnote)
Agricultural	201	1.56	0.36	4	0	2,500	3.1	0.1	1
Open/Pasture	70	1.51	0.12	6	0	2,500	3.0	0.1	1
Wetlands	39	0.83	0.06	6	0	1,600	3.1	0.0	1
Segment 2485 - Oso Creek			0.37			74			2
Oso Creek Above Tide(Low)			3.14			600			2
Oso Creek Above Tide(High)						367			2
Segment 2002 - Mission River									2
Copano Creek			0.17						2
Segment 2004 - Aransas River									2
Poesta Creek			5.51						2
Segment 2462 - San Antonio Bay									2
Station 13028			2.37						2
Segment 2204 - Petronila Creek			0.27						2
Station 13033 - San Fernando Creek			5.26						2
Station 13028 - Oso Creek Tidal									2
Segment 2001 - Mission River (Tidal)									2
Segment 2003 - Aransas River									2
Segment 2462 - San Antonio Bay									2
Segment 2463 - Mesquite/Carlos/Ayres									2
Segment 2471 - Aransas Bay									2
Segment 2472 - Copano/Mission Bay									2
Segment 2473 - St. Charles Bay									2
Segment 2481 - Corpus Christi Bay									2
Segment 2482 - Nueces Bay									2
Segment 2482 - Corpus Inner Harbor									2
Segment 2491 - Upper Laguna Madre									2
Segment 2492 - Baffin Bay									2
Average	NA	NA	2.44	NA	NA	347.00	NA	NA	2
Placedo Creek	9		0.32	3		20			3
West Caranchua Creek	48		0.11	1.5		85			3
Big Creek	69		0.66	5		10			3

Appendix C- Selected Constituent Values from Literature Search

Land Use Category/ Location	Total Suspended Solids, (TSS), mg/l	Total Nitrogen, (TN), mg/l	Total Phosphorus, (TP), mg/l	5 Day Biochemical Oxygen Demand, (BOD), mg/l	Oil & Grease, (O&G), mg/l	Fecal Coliform, (FC), cfu/100ml	Dissolved Copper, (Cu), µg/l	Chlorinated Hydrocarbon & Organophosphorus Pesticides, (Pesticide), mg/l	Source (See Footnote)
Garcitas Creek	9		0.03	1		165			3
Arenosa Creek	10		0.52	3		95			3
West Mustang Creek	14		0.09	4		70			3
West Bernard Creek	67		0.21	2		520			3
Average	32		0.28	2.8		138			3
Seco Creek, Flatrock Crossing		0.20	<0.010	0.4		31	<10		4
Jewett Brook Watershed, Vt., 1982	7.7		0.72						5
Jewett Brook Watershed, Vt., 1983	21		0.76						5
Jewett Brook Watershed, Vt., 1984	25.2		0.68						5
Jewett Brook Watershed, Vt., 1985	20.2		0.75						5
Jewett Brook Watershed, Vt., Average	18.53	NA	0.73	NA	NA	NA	NA	NA	5
Segment 2001 San Antonio-Nueces						15			6
Segment 2002 San Antonio-Nueces						37			6
Segment 2003 San Antonio-Nueces						9			6
Segment 2004 San Antonio-Nueces						34			6
Average - San Antonio/Nueces	NA	NA	NA	NA	NA	23.75	NA	NA	6
Segment 2101 Nueces River Basin						46			6
Segment 2102 Nueces River Basin						38			6
Segment 2103 Nueces River Basin						14			6
Segment 2104 Nueces River Basin						71			6
Segment 2105 Nueces River Basin						32			6
Segment 2106 Nueces River Basin						47			6
Segment 2107 Nueces River Basin						166			6
Segment 2112 Nueces River Basin						11			6
Average - Nueces	NA	NA	NA	NA	NA	53.13	NA	NA	6
Segment 2203 Nueces - Rio Grande						0			6
Segment 2204 Nueces - Rio Grande						9			6
Average - Nueces/Rio Grande	NA	NA	NA	NA	NA	4.50	NA	NA	6
Segment 2485 - Oso Bay						10			6
Segment 2001 San Antonio-Nueces						15			7
Segment 2002 San Antonio-Nueces						220			7
Segment 2003 San Antonio-Nueces						48			7
Segment 2004 San Antonio-Nueces						55			7

Appendix C- Selected Constituent Values from Literature Search

Land Use Category/ Location	Total Suspended Solids, (TSS), mg/l	Total Nitrogen, (TN), mg/l	Total Phosphorus, (TP), mg/l	5 Day Biochemical Oxygen Demand, (BOD), mg/l	Oil & Grease, (O&G), mg/l	Fecal Coliform, (FC), cfu/100ml	Dissolved Copper, (Cu), µg/l	Chlorinated Hydrocarbon & Organophosphorus Pesticides, (Pesticide), mg/l	Source (See Footnote)
Average - San Antonio/Nueces	NA	NA	NA	NA	NA	84.50	NA	NA	7
Segment 2101 Nueces River Basin						90			7
Segment 2102 Nueces River Basin						35			7
Segment 2103 Nueces River Basin						9			7
Segment 2104 Nueces River Basin						43			7
Segment 2105 Nueces River Basin						23			7
Segment 2106 Nueces River Basin						58			7
Segment 2107 Nueces River Basin						113			7
Segment 2112 Nueces River Basin						8			7
Average - Nueces	NA	NA	NA	NA	NA	47.38	NA	NA	7
Segment 2203 Nueces - Rio Grande	Newly Created Segment								7
Segment 2204 Nueces - Rio Grande									7
Average - Nueces/Rio Grande	NA	NA	NA	NA	NA	NA	NA	NA	7
Segment 2485 - Oso Bay						6			7
Segment 2001 San Antonio-Nueces						13			8
Segment 2002 San Antonio-Nueces						42			8
Segment 2003 San Antonio-Nueces						15			8
Segment 2004 San Antonio-Nueces						37			8
Average - San Antonio/Nueces	NA	NA	NA	NA	NA	26.75	NA	NA	8
Segment 2101 Nueces River Basin						37			8
Segment 2102 Nueces River Basin						37			8
Segment 2103 Nueces River Basin						9			8
Segment 2104 Nueces River Basin						87			8
Segment 2105 Nueces River Basin						52			8
Segment 2106 Nueces River Basin						79			8
Segment 2107 Nueces River Basin						255			8
Segment 2112 Nueces River Basin						8			8
Average - Nueces	NA	NA	NA	NA	NA	70.50	NA	NA	8
Segment 2485 - Oso Bay						14			8
Segment 2001 San Antonio-Nueces						29			9
Segment 2002 San Antonio-Nueces						56			9
Segment 2003 San Antonio-Nueces						9			9
Segment 2004 San Antonio-Nueces						15			9

Appendix C- Selected Constituent Values from Literature Search

Land Use Category/ Location	Total Suspended Solids, (TSS), mg/l	Total Nitrogen, (TN), mg/l	Total Phosphorus, (TP), mg/l	5 Day Biochemical Oxygen Demand, (BOD), mg/l	Oil & Grease, (O&G), mg/l	Fecal Coliform, (FC), cfu/100ml	Dissolved Copper, (Cu), μg/l	Chlorinated Hydrocarbon & Organophosphorus Pesticides, (Pesticide), mg/l	Source (See Footnote)
Average - San Antonio/Nueces	NA	NA	NA	NA	NA	27.25	NA	NA	9
Segment 2101 Nueces River Basin						34			9
Segment 2102 Nueces River Basin						83			9
Segment 2103 Nueces River Basin						18			9
Segment 2104 Nueces River Basin						47			9
Segment 2105 Nueces River Basin						49			9
Segment 2106 Nueces River Basin						44			9
Segment 2107 Nueces River Basin						3373			9
Segment 2112 Nueces River Basin						2			9
Average - Nueces	NA	NA	NA	NA	NA	456.25	NA	NA	9
Segment 2485 - Oso Bay						19			9
Segment 2001 San Antonio-Nueces						17			10
Segment 2002 San Antonio-Nueces						135			10
Segment 2003 San Antonio-Nueces						10			10
Segment 2004 San Antonio-Nueces						43			10
Average - San Antonio/Nueces	NA	NA	NA	NA	NA	51.25	NA	NA	10
Segment 2101 Nueces River Basin						17			10
Segment 2102 Nueces River Basin						26			10
Segment 2103 Nueces River Basin						16			10
Segment 2104 Nueces River Basin						108			10
Segment 2105 Nueces River Basin						31			10
Segment 2106 Nueces River Basin						98			10
Segment 2107 Nueces River Basin						925			10
Segment 2112 Nueces River Basin						8			10
Average - Nueces	NA	NA	NA	NA	NA	153.63	NA	NA	10
0820150003-23-70143018	--	--	0.020	0.2		--	--		11
0820150004-10-73154510	--	--	<0.010	--		--	--		11
0820150001-21-7414357.4	0	--	<0.010	0		--	<2		11
0820150003-12-7412004.5	0	1.07	0.030	0.4		--	--		11
0820150005-15-74150020	2	1.32	0.050	0.2		--	ND		11
0820150007-10-7412003.1	7	1.22	<0.010	0.2		--	4		11
0820150009-09-74120015	0	1.41	0.010	0.5		--	--		11
0820150011-18-74152024	1	--	0.020	0.1		--	--		11

Appendix C- Selected Constituent Values from Literature Search

Land Use Category/ Location	Total Suspended Solids, (TSS), mg/l	Total Nitrogen, (TN), mg/l	Total Phosphorus, (TP), mg/l	5 Day Biochemical Oxygen Demand, (BOD), mg/l	Oil & Grease, (O&G), mg/l	Fecal Coliform, (FC), cfu/100ml	Dissolved Copper, (Cu), µg/l	Chlorinated Hydrocarbon & Organophosphorus Pesticides, (Pesticide), mg/l	Source (See Footnote)
0820150001-13-75154020	0	--	0.010	0.4		--	<2		11
0820150003-18-75140024	1	3.20	0.170	0		--	--		11
0820150005-19-7514459.0	1	0.91	<0.010	0.3		--	ND		11
0820150007-28-75133521	1	0.59	0.010	0.2		--	ND		11
0820150009-16-7514005.3	1	0.84	0.010	0		--	<2		11
0820150011-18-7513151.9	0	0.32	<0.010	0.1		--	--		11
0820150001-12-7614301.4	3	0.31	0.010	0.3		--	ND		11
0820150003-08-7614001.4	4	--	<0.010	0.6		--	--		11
0820150005-03-76135525	1	0.49	<0.010	0.3		--	--		11
0820150007-26-76150062	4	0.63	<0.010	0.2		--	--		11
0820150009-27-7614257.9	2	1.59	0.010	0.2		--	ND		11
0820150011-15-76135520	1	1.10	<0.010	0.3		3	--		11
0820150001-24-77143030	2	0.54	<0.010	0.5		6	ND		11
0820150003-21-77133522	1	1.14	<0.010	0.3		16	--		11
0820150005-23-77133570	0	1.36	<0.010	0.1		80	--		11
0820150007-25-7713258.0	1	0.67	0.020	0.1		11	--		11
0820150009-19-7714153.0	2	0.66	0.010	0.6		26	ND		11
0820150011-07-7714003.1	0	0.86	0.010	0.2		150	--		11
0820150001-04-7811057.4	--	--	--	--		--	--		11
0820150001-16-7814304.3	3	0.86	0.010	0.6		21	ND		11
0820150003-20-7813452.4	0	0.44	<0.010	0.3		96	--		11
0820150005-30-7814552.6	2	0.67	<0.010	0.5		170	--		11
0820150007-05-7816150.90	5	0.22	<0.010	0.6		--	--		11
0820150009-08-78115513	2	0.31	<0.010	0.3		200	ND		11
0820150011-22-78094314	0	0.94	<0.010	0.9		--	--		11
0820150001-04-7911057.4	0	1.04	0.010	0.4		20	<2		11
0820150003-28-79124577	0	0.75	0.010	1.5		47	--		11
0820150005-03-79115546	0	--	0.020	0.7		41	--		11
0820150006-14-791420107	0	0.97	<0.010	0.6		--	--		11
0820150001-08-8011352.6	4	1.02	0.00	0.8		34	0		11
0820150005-14-8011553.6	8	--	0.010	1.4		--	--		11
0820150007-31-8013270.29	<1	1.11	0.010	1.3		--	0		11

Appendix C- Selected Constituent Values from Literature Search

Land Use Category/ Location	Total Suspended Solids, (TSS), mg/l	Total Nitrogen, (TN), mg/l	Total Phosphorus, (TP), mg/l	5 Day Biochemical Oxygen Demand, (BOD), mg/l	Oil & Grease, (O&G), mg/l	Fecal Coliform, (FC), cfu/100ml	Dissolved Copper, (Cu), µg/l	Chlorinated Hydrocarbon & Organophosphorus Pesticides, (Pesticide), mg/l	Source (See Footnote)
0820150001-22-8111215.7	10	0.98	0.00	0.3		--	<10		11
0820150004-22-81104833	2	1.22	0.010	0.4		120	--		11
0820150008-12-81153221	5	1.12	0.010	0.4		--	<10		11
0820150001-19-8209483.1	2	1.14	<0.010	0.6		23	<1		11
0820150005-12-8210326.1	23	1.72	<0.010	0.6		--	--		11
0820150007-13-8210173.7	<2	0.54	0.030	1.3		--	<1		11
0820150001-18-8313092.0	<1	0.90	0.010	1.0		140	<1		11
0820150004-19-8309513.8	<1	0.60	0.020	1.1		--	--		11
0820150008-30-8310081.8	8	0.25	<0.010	0.3		--	<1		11
0820150001-25-8414185.5	2	0.70	<0.010	0.2		34	4		11
0820150004-20-8415401.3	2	0.35	<0.010	0.4		230	--		11
0820150008-17-8409520.29	<1	0.30	<0.010	0.6		200	<1		11
0820150001-09-85112746	2	1.50	<0.010	--		--	<1		11
0820150001-23-85160052	--	--	--	--		--	--		11
0820150004-30-85154555	5	1.10	<0.010	1.5		200	--		11
0820150008-23-8514301.5	--	0.50	0.010	1.3		--	<1		11
0820150002-12-8616207.4	3	0.60	<0.010	0.4		22	<1		11
0820150006-05-86132022	12	0.30	<0.010	0.1		--	--		11
0820150008-07-8615005.5	1	--	--	0.3		46	<1		11
0820150001-23-87120039	3	1.60	<0.010	0.6		--	<1		11
0820150005-07-87112213	<1	0.40	0.010	1.1		56	--		11
0820150009-01-87163011	3	0.40	0.010	0.7		--	<1		11
0820150001-06-8815005.3	<1	0.60	<0.010	0.3		31	--		11
0820150005-10-8814340.50	<1	0.65	0.010	1.0		400	--		11
0820150008-30-8814241.1	6	--	<0.010	0.5		200	1		11
0820150001-10-8914230.50	<1	0.55	<0.010	1.6		37	<1		11
0820150005-10-8915400.94	<1	--	<0.010	1.0		--	--		11
0820150002-07-9017081.3	<1	0.20	<0.010	0.9		20	<10		11
0820150005-24-90153715	3	0.40	<0.010	0.8		--	--		11
0820150008-30-90145814	1	0.60	<0.010	0.7		--	<10		11
0820150002-14-9109375.3	8	0.30	<0.010	1.4		--	<10		11
0820150005-28-91154514	3	0.28	<0.010	0.6		2	--		11

Appendix C- Selected Constituent Values from Literature Search

Land Use Category/ Location	Total Suspended Solids, (TSS), mg/l	Total Nitrogen, (TN), mg/l	Total Phosphorus, (TP), mg/l	5 Day Biochemical Oxygen Demand, (BOD), mg/l	Oil & Grease, (O&G), mg/l	Fecal Coliform, (FC), cfu/100ml	Dissolved Copper, (Cu), μg/l	Chlorinated Hydrocarbon & Organophosphorus Pesticides, (Pesticide), mg/l	Source (See Footnote)
0820150008-15-9110303.6	<1	0.19	<0.010	0.8		--	<10		11
0820150001-30-920958103	3	0.72	<0.010	0.8		33	<10		11
0820150005-14-92122730	<1	0.47	<0.010	1.1		29	--		11
0820150009-01-9214154.3	7	0.29	<0.010	0.4		--	<10		11
0820150001-28-93113013	<1	--	--	0.8		--	<10		11
0820150009-01-9312151.2	<1	--	--	7.0		--	<10		11
0820150008-17-9412453.6	--	--	--	--		--	<10		11
0820150008-17-9413003.6	--	--	--	--		--	<10		11
0820150002-06-9512054.9		--	--	<2.0		--	<10		11
0820245009-15-91034567		1.21	0.080	3.2		--	<10		11
0820245009-24-91135014		0.56	<0.010	1.6		--	<10		11
0820245012-19-91193067		0.50	0.020	1.4		--	<10		11
0820245012-20-911405424		0.92	0.040	1.3		--	<10		11
0820245003-04-921400250		0.65	0.020	2.4		--	<10		11
0820245003-27-921930845		0.65	0.050	2.5		18000	<10		11
0820245003-28-921640200		0.55	<0.010	4.2		13000	<10		11
0820245005-21-922130161		0.58	0.050	2.3		--	<10		11
0820245001-19-930001--		--	--	--		--	<10		11
0820245001-19-9312206.4		--	--	--		--	<10		11
0820245003-30-930001--		--	--	--		--	<10		11
0820245003-30-93113017		--	--	--		--	<10		11
0820245005-06-93145361		--	--	--		--	<10		11
0820245012-28-94142011		--	--	<2.0		--	<10		11
0820245012-28-941440--		--	--	--		--	<10		11
0820245012-29-94082529		--	--	<2.0		2700	<10		11
0820245012-29-94131623		--	--	2.0		--	<10		11
0820270009-20-911100423		1.50	0.090	2.9		--	<10		11
0820270009-20-911310701		1.01	0.160	4.2		--	<10		11
0820270009-20-911905223		1.01	0.110	3.0		--	<10		11
0820270012-20-9113301260		1.31	0.170	4.1		--	<10		11
0820270012-20-911740536		1.10	0.140	2.7		--	<10		11
0820270003-04-9208202850		1.42	0.170	5.8		--	<10		11

Appendix C- Selected Constituent Values from Literature Search

Land Use Category/ Location	Total Suspended Solids, (TSS), mg/l	Total Nitrogen, (TN), mg/l	Total Phosphorus, (TP), mg/l	5 Day Biochemical Oxygen Demand, (BOD), mg/l	Oil & Grease, (O&G), mg/l	Fecal Coliform, (FC), cfu/100ml	Dissolved Copper, (Cu), µg/l	Chlorinated Hydrocarbon & Organophosphorus Pesticides, (Pesticide), mg/l	Source (See Footnote)
0820270003-04-9210282900		1.27	0.130	4.5		--	<10		11
0820270003-04-921715341		0.60	0.020	3.3		--	<10		11
0820270003-27-922305248		0.87	0.060	0.2		--	<10		11
0820270003-28-92144549		0.92	0.040	--		4900	<10		11
0820270005-27-921730202		1.30	0.150	4.7		--	<10		11
0820270005-06-931005--		--	--	--		--	<50		11
0820279009-20-9117302.0		1.10	0.080	3.0		--	<10		11
0820279012-21-9116004.8		0.62	0.060	1.7		--	<10		11
0820279002-24-9214452.8		0.94	0.090	4.6		13000	<10		11
0820279003-27-9215302.0		1.21	0.140	5.0		--	<10		11
0820279003-28-9212451.7		1.15	0.080	4.6		--	<10		11
0820279005-27-9204002.0		1.14	0.120	4.2		--	<10		11
0820279006-02-9212006.0		0.80	0.080	4.8		6200	<10		11
0820279010-25-9400010.20		--	--	5.7		8000	<10		11
0820279010-25-9408242.7		--	--	6.5		--	<10		11
0820279010-25-940849--		--	--	--		--	<10		11
0820279010-25-9412150.40		--	--	6.1		--	<10		11
0820279010-25-9414250.60		--	--	5.8		8600	<10		11
0820279003-13-950100--		--	--	4.2		--	--		11
0820279003-13-9501172.5		--	--	4.2		--	--		11
0820279003-13-9513371.9		--	--	3.7		--	--		11
0820290009-16-91163559		1.79	0.120	2.4		250000	<10		11
0820290009-21-911100177		1.77	0.170	3.6		--	10		11
0820290012-21-911300285		5.80	0.420	4.3		--	<10		11
0820290012-23-911730116		1.28	0.190	1.6		--	<10		11
0820290003-28-921330303		2.90	0.170	2.9		29000	<10		11
0820290003-28-921545624		5.70	0.060	2.1		17000	<10		11
0820290003-29-92163041		1.31	0.140	3.1		17000	<10		11
0820290005-06-930001--		--	--	--		--	--		11
0820290005-06-9316002110		--	--	--		--	<10		11
0820290005-07-930001--		--	--	--		--	--		11
0820290005-07-93111547		--	--	--		--	<10		11

Appendix C- Selected Constituent Values from Literature Search

Land Use Category/ Location	Total Suspended Solids, (TSS), mg/l	Total Nitrogen, (TN), mg/l	Total Phosphorus, (TP), mg/l	5 Day Biochemical Oxygen Demand, (BOD), mg/l	Oil & Grease, (O&G), mg/l	Fecal Coliform, (FC), cfu/100ml	Dissolved Copper, (Cu), μg/l	Chlorinated Hydrocarbon & Organophosphorus Pesticides, (Pesticide), mg/l	Source (See Footnote)
0820290001-24-941549--		--	--	--		--	<10		11
0820290010-08-940835--		--	--	--		--	<10		11
0820290010-08-941635--		--	--	--		--	--		11
0820290010-08-941715--		--	--	--		--	<10		11
0820290010-08-941952--		--	--	--		--	<10		11
0820290010-11-9411450.40		--	--	--		--	<10		11
0820290003-13-950031--		--	--	4.6		--	--		11
0820290003-13-9509504.2		--	--	3.9		--	--		11
0820290003-15-9513151.4		--	--	--		--	--		11
0821152010-17-7713502.0	83	2.64	4.00	3.1			--		12
0821152011-28-7713152.0	97	10.30	5.60	2.5			5		12
0821152001-09-7812501.9	126	15.40	5.30	6.7			--		12
0821152002-23-7814001.7	48	3.90	4.60	4.3			2		12
0821152004-03-7813406.3	102	4.50	3.90	15			--		12
0821152005-15-7813151.4	94	7.30	3.10	11			2		12
0821152006-22-7814451.8	40	2.07	0.520	5.4			--		12
0821152008-09-7816302.2	89	3.40	2.90	7.8			--		12
0821152009-18-7813304.8	60	1.98	0.720	3.2			<2		12
0821152010-30-78141514	212	2.80	0.860	4.3			--		12
0821152012-11-7813121.9	20	17.00	2.20	2.6			<2		12
0821152001-25-7914105.5	15	8.00	3.90	3.6			--		12
0821152003-05-7911352.0	27	10.70	1.70	4.2			ND		12
0821152004-16-7912153.0	190	2.14	0.170	5.0			--		12
0821152005-21-7915502.4	30	7.80	1.50	4.9			<2		12
0821152007-02-7915102.7	47	7.80	0.150	4.8			--		12
0821152008-14-7909501.1	78	2.91	0.080	7.3			ND		12
0821152009-25-79101710	107	1.44	0.630	6.8			--		12
0821152011-06-7913502.8	51	7.40	2.40	5.4			0		12
0821152012-17-7916221.7	25	12.80	1.70	1.6			--		12
0821152001-28-8015353.3	27	6.92	2.10	2.6			1		12
0821152003-10-8016032.3	34	11.90	4.00	3.4			--		12
0821152004-21-8016221.7	32	10.40	1.80	5.6			2		12

Appendix C- Selected Constituent Values from Literature Search

Land Use Category/ Location	Total Suspended Solids, (TSS), mg/l	Total Nitrogen, (TN), mg/l	Total Phosphorus, (TP), mg/l	5 Day Biochemical Oxygen Demand, (BOD), mg/l	Oil & Grease, (O&G), mg/l	Fecal Coliform, (FC), cfu/100ml	Dissolved Copper, (Cu), µg/l	Chlorinated Hydrocarbon & Organophosphorus Pesticides, (Pesticide), mg/l	Source (See Footnote)
0821152006-02-8016181.7	--	4.70	2.10	6.2			--		12
0821152007-14-8018152.0	99	3.20	2.20	4.7			2		12
0821152008-26-8011193.5	50	2.29	1.20	3.5			--		12
0821152010-17-8011385.2	68	2.40	0.920	2.5			--		12
0821152011-17-8015452.1	32	13.90	5.10	1.3			0		12
0821152001-06-8111302.8	50	14.00	5.60	3.7			--		12
0821152002-09-8115309.0	32	6.26	0.650	4.0			18		12
0821152003-16-8116458.5	88	7.40	1.60	5.0			--		12
0821152005-05-811310333	344	3.80	0.540	2.9			0		12
0821152006-26-8109452.6	37	5.80	2.00	3.1			--		12
0821152007-28-8110583.0	56	6.10	3.00	2.5			50		12
0821152009-15-8110172.2	17	7.60	3.10	3.6			--		12
0821152010-20-8110302.7	57	5.50	5.00	2.3			2		12
0821152001-12-8215472.7	7	9.40	5.00	3.4			--		12
0821152004-06-8210032.2	84	9.10	4.40	6.6			--		12
0821152005-25-820950530	796	2.30	0.510	2.2			2		12
0821152006-29-8211382.9	52	4.50	3.20	4.0			--		12
0821152008-10-8211493.9	82	3.00	3.10	3.4			2		12
0821152010-26-8210482.9		7.80		3.6					12
0821152002-03-8314002.2		7.30		3.0					12
0821152003-17-831200104		4.50		4.5					12
0821152004-26-831215188		4.80		3.8					12
0821152006-09-83143511		1.70		3.4					12
0821152007-19-83113038		1.40		2.2					12
0821152012-13-8311242.1	--	8.60	5.20	2.2			--		12
0821152001-24-84112522	512	4.40	1.30	6.0			5		12
0821152003-06-8411344.2	12	6.90	3.70	2.5			--		12
0821152004-24-8411303.0	70	4.30	6.80	2.8			--		12
0821152006-14-8416541.9	74	2.70	3.70	5.9			1		12
0821152008-09-8415300.66	56	2.30	2.30	4.8			--		12
0821152012-05-8410351.7	11	8.90	6.00	2.4			--		12
0821152001-23-8513452.4	17	7.00	2.20	2.4			3		12

Appendix C- Selected Constituent Values from Literature Search

Land Use Category/ Location	Total Suspended Solids, (TSS), mg/l	Total Nitrogen, (TN), mg/l	Total Phosphorus, (TP), mg/l	5 Day Biochemical Oxygen Demand, (BOD), mg/l	Oil & Grease, (O&G), mg/l	Fecal Coliform, (FC), cfu/100ml	Dissolved Copper, (Cu), µg/l	Chlorinated Hydrocarbon & Organophosphorus Pesticides, (Pesticide), mg/l	Source (See Footnote)
0821152003-13-8511002.1	23	4.90	2.50	3.7			--		12
0821152004-24-8511253.4	53	2.50	1.90	4.4			--		12
0821152006-11-8511352.0	40	3.20	2.20	4.1			--		12
0821152008-22-8510001.3	73	1.85	1.70	4.4			3		12
0821152011-20-8511102.5	149	4.70	1.60	2.7			--		12
0821152001-08-86104060	1440	3.40	1.00	>7.8			1		12
0821152002-27-8609530.89	70	4.60	5.00	2.8			--		12
0821152005-07-8614072.2	1.74	2.90	5.80	4.7			--		12
0821152006-19-8611103.1	83	2.40	0.170	2.1			--		12
0821152008-19-8613252.7	165	1.80	2.50	0.9			1		12
0821152010-15-8617308.5		5.20	3.00	2.1			--		12
0821152012-05-8609462.0		12.10	3.50	2.2			--		12
0821152002-05-8711102.4		4.00	3.20	1.5			3		12
0821152005-13-8712306.0		5.00	2.40	5.1			--		12
0821152007-07-8715152.5		2.40	2.20	2.4			--		12
0821152008-31-87143020		2.50	3.80	3.0			1		12
0821152011-19-8708301.9		0.85	0.200	1.5			2		12
0821152001-11-88141510		11.30	4.20	7.6			--		12
0821152003-08-8812150.33		5.10	2.80	4.0			2		12
0821152005-04-8811001.4		4.10	6.70	8.5			--		12
0821152007-12-8812002.7		1.90	1.80	3.4			2		12
0821152008-24-8811003.2		1.60	1.80	1.9			1		12
8064100		--							13
8064100	221	1.13	0.04						13
8064100	82	0.74	0.06						13
8064100	80	0.63	0.03						13
8064100	55	--	0.03						13
8064100	15	3.44	2.8						13
8064100	56	--	0.02						13
8064100	419	0.62	0.06						13
8064100	61	0.97	0.06						13
8064100	115	0.71	0.02						13
8064100	34	0.94	< 0.010						13

Appendix C- Selected Constituent Values from Literature Search

Land Use Category/ Location	Total Suspended Solids, (TSS), mg/l	Total Nitrogen, (TN), mg/l	Total Phosphorus, (TP), mg/l	5 Day Biochemical Oxygen Demand, (BOD), mg/l	Oil & Grease, (O&G), mg/l	Fecal Coliform, (FC), cfu/100ml	Dissolved Copper, (Cu), µg/l	Chlorinated Hydrocarbon & Organophosphorus Pesticides, (Pesticide), mg/l	Source (See Footnote)
8064100	58	0.70	0.02						13
8064100	784	3.90	0.12						13
8064100	159	1.70	0.02						13
8064100	88	0.75	0.02						13
8064100	1810	7.50	0.2						13
8064100	613	6.40	0.04						13
8064100	1010	3.80	0.04						13
8064100	106	1.15	0.02						13
8064100	224	2.00	0.03						13
8064100	392	3.50	0.19						13
8064100	1030	1.13	0.13						13
8064100	58	--	0.06						13
8064100	125	--	< 0.010						13
8064100	39	--	0.02						13
8064100	660	0.78	0.07						13
8064100	86	0.93	0.04						13
8064100	758	1.33	0.08						13
8064100	515	1.08	0.13						13
8064100	57	0.88	0.02						13
8064100	873	2.40	0.04						13
8064100		1.20	< 0.010						13
8064100		2.20	0.03						13
315801096282999	9	0.70	0.03						13
315801096282999		1.49	0.14						13
315801096282999	109	2.40	0.08						13
315801096282999		1.43	0.13						13
315801096282999	245	2.00	0.13						13
321017096420099	28	1.50	0.03						13
321017096420099	54	1.50	0.01						13
321017096420099	42	1.80	0.02						13
321017096420099	395	4.70	0.05						13
321017096420099		2.90	0.05						13

Appendix C- Selected Constituent Values from Literature Search

Land Use Category/ Location	Total Suspended Solids, (TSS), mg/l	Total Nitrogen, (TN), mg/l	Total Phosphorus, (TP), mg/l	5 Day Biochemical Oxygen Demand, (BOD), mg/l	Oil & Grease, (O&G), mg/l	Fecal Coliform, (FC), cfu/100ml	Dissolved Copper, (Cu), µg/l	Chlorinated Hydrocarbon & Organophosphorus Pesticides, (Pesticide), mg/l	Source (See Footnote)
321313096415201	28	0.92	0.03						13
321313096415201		4.20	0.23						13
321313096415201	44	3.40	0.02						13
321313096415201	30	0.93	0.04						13
321313096415201	358	4.10	0.07						13
321441096442601	94	0.58	0.03						13
321441096442601	45	0.45	0.03						13
321441096442601	64	0.50	0.03						13
321441096442601	495	1.80	0.05						13
321441096442601		2.20	0.05						13
2101			0.6			33			14
2102			0.2			80			14

Source

1 Characterization of Nonpoint Sources and Loadings to Galveston Bay, GBNEP-15, March 1992
2 1994 Regional Assessment of Water Quality in the Nueces Coastal Basins, October 1994, mean values
3 Texas Aquatic Ecoregion Project, An Assessment of Least Disturbed Streams, TWC, 5/92
4 Seco Creek Water Quality Demonstration Project, Annual Project Report, Fiscal Year 1994
5 Analysis of Agricultural Nonpoint Pollution Control Options in the St. Albans Bay Watershed, USDA -ERS, 1987, mean values
6 The State of Texas Water Quality Inventory, 11th Edition, TWC, August 1992, LP 92-16, mean values
7 The State of Texas Water Quality Inventory, 10th Edition, TWC, June 1990, LP 90-06, mean values
8 The State of Texas Water Quality Inventory, 9th Edition, TWC, April 1988, LP 88-04, mean values
9 The State of Texas Water Quality Inventory, 8th Edition, TWC, October 1986, LP 86-07, mean values
10 The State of Texas Water Quality Inventory, 6th Edition, TDWR, LP 59, mean values
11 USGS Provisional Information, Seco Creek Watershed **Station no. is in the format 08202790(gage no.)03-28-92(date)1245(time)1.7(discharge).
12 USGS Provisional Information, Oso Creek Watershed **Station no. is in the format 08211520(gage no.)07-12-8(date)1200(time)2.7(discharge).
13 USGS Provisional Information, Chambers Creek Watershed
14 Final Report, Regional Assessment of Water Quality - Nueces River Basin, Nueces River Authority - October 1, 1994

Notes: NA represents Not Applicable
ND represents Not Detected
Values reported as 0 (zero) are actually below the detection limit of the laboratory at the time of testing.

Appendix C- Selected Constituent Values from Literature Search

Land Use Category/ Location	Additional Dissolved Minerals used to develop an annual NPS load							Additional Pollutants				
	(Pb) Lead (µg/L)	(Zn) Zinc (µg/L)	(As) Arsenic (µg/L)	(Cd) Cadmium (µg/L)	(Cr) Chromium (µg/L)	(Hg) Mercury (µg/L)	(Ag) Silver (µg/L)	Dissolved Barium (Ba), µg/l	Phosphate Total (PO4), mg/l	Phosphate Ortho (OP), mg/l	Dissolved Orthophosporus mg/l	
Agricultural	2.40	18.30	3.00	0.50	5.00	0.10	0.50					1
Open/Pasture	2.40	18.30	3.00	0.50	5.00	0.10	0.50					1
Wetlands	2.40	18.30	3.00	0.50	5.00	0.10	0.50					1
Segment 2485 - Oso Creek									1.69	0.97		2
Oso Creek Above Tide(Low)												2
Oso Creek Above Tide(High)												2
Segment 2002 - Mission River				0.68		0.24		559.7	0.32	0.13		2
Copano Creek												2
Segment 2004 - Aransas River									4.65	3.84		2
Poesta Creek									16.38	15.53		2
Segment 2462 - San Antonio Bay									0.43	0.27		2
Station 13028											1.85	2
Segment 2204 - Petronila Creek									1.01	0.57		2
Station 13033 - San Fernando Creek									12.33	9.8		2
Station 13028 - Oso Creek Tidal											1.85	2
Segment 2001 - Mission River (Tidal)									0.48	0.15		2
Segment 2003 - Aransas River									0.5	0.27		2
Segment 2462 - San Antonio Bay									0.43	0.27		2
Segment 2463 - Mesquite/Carlos/Ayres									0.44	0.26		2
Segment 2471 - Aransas Bay										0.07		2
Segment 2472 - Copano/Mission Bay									0.26	0.11		2
Segment 2473 - St. Charles Bay									0.26	0.13		2
Segment 2481 - Corpus Christi Bay									0.25			2
Segment 2482 - Nueces Bay									0.32	0.15		2
Segment 2482 - Corpus Inner Harbor									0.28	0.16		2
Segment 2491 - Upper Laguna Madre												2
Segment 2492 - Baffin Bay									0.26			2
Average	NA	NA	NA	0.68	NA	0.24	NA	559.70	2.37	2.04	1.85	2
Placedo Creek											0.24	3
West Caranchua Creek											0.04	3

Appendix C- Selected Constituent Values from Literature Search

Land Use Category/ Location	Additional Dissolved Minerals used to develop an annual NPS load							Additional Pollutants				
	(Pb) Lead (µg/L)	(Zn) Zinc (µg/L)	(As) Arsenic (µg/L)	(Cd) Cadmium (µg/L)	(Cr) Chromium (µg/L)	(Hg) Mercury (µg/L)	(Ag) Silver (µg/L)	Dissolved Barium (Ba), µg/l	Phosphate Total (PO4), mg/l	Phosphate Ortho (OP), mg/l	Dissolved Orthophosporus mg/l	
Big Creek											0.86	3
Garcitas Creek											0.01	3
Arenosa Creek											0.34	3
West Mustang Creek											0.15	3
West Bernard Creek											0.12	3
Average											0.25	3
Seco Creek, Flatrock Crossing	<10.0	<3.0	<1.0	<1.0	<5.0	<0.10	<1.0					4
Jewett Brook Watershed, Vt., 1982										0.53		5
Jewett Brook Watershed, Vt., 1983										0.49		5
Jewett Brook Watershed, Vt., 1984										0.33		5
Jewett Brook Watershed, Vt., 1985										0.49		5
Jewett Brook Watershed, Vt., Average	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.46	NA	5
Segment 2001 San Antonio-Nueces												6
Segment 2002 San Antonio-Nueces												6
Segment 2003 San Antonio-Nueces												6
Segment 2004 San Antonio-Nueces												6
Average - San Antonio/Nueces	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	6
Segment 2101 Nueces River Basin												6
Segment 2102 Nueces River Basin												6
Segment 2103 Nueces River Basin												6
Segment 2104 Nueces River Basin												6
Segment 2105 Nueces River Basin												6
Segment 2106 Nueces River Basin												6
Segment 2107 Nueces River Basin												6
Segment 2112 Nueces River Basin												6
Average - Nueces	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	6
Segment 2203 Nueces - Rio Grande												6
Segment 2204 Nueces - Rio Grande												6
Average - Nueces/Rio Grande	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	6
Segment 2485 - Oso Bay												6
Segment 2001 San Antonio-Nueces												7

Appendix C- Selected Constituent Values from Literature Search

Land Use Category/ Location	Additional Dissolved Minerals used to develop an annual NPS load (Pb) Lead (µg/L)	(Zn) Zinc (µg/L)	(As) Arsenic (µg/L)	(Cd) Cadmium (µg/L)	(Cr) Chromium (µg/L)	(Hg) Mercury (µg/L)	(Ag) Silver (µg/L)	Additional Pollutants Dissolved Barium (Ba), µg/l	Phosphate Total (PO4), mg/l	Phosphate Ortho (OP), mg/l	Dissolved Orthophosporus mg/l	
Segment 2002 San Antonio-Nueces												7
Segment 2003 San Antonio-Nueces												7
Segment 2004 San Antonio-Nueces												7
Average - San Antonio/Nueces	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7
Segment 2101 Nueces River Basin												7
Segment 2102 Nueces River Basin												7
Segment 2103 Nueces River Basin												7
Segment 2104 Nueces River Basin												7
Segment 2105 Nueces River Basin												7
Segment 2106 Nueces River Basin												7
Segment 2107 Nueces River Basin												7
Segment 2112 Nueces River Basin												7
Average - Nueces	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7
Segment 2203 Nueces - Rio Grande												7
Segment 2204 Nueces - Rio Grande												7
Average - Nueces/Rio Grande	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7
Segment 2485 - Oso Bay												7
Segment 2001 San Antonio-Nueces												8
Segment 2002 San Antonio-Nueces												8
Segment 2003 San Antonio-Nueces												8
Segment 2004 San Antonio-Nueces												8
Average - San Antonio/Nueces	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	8
Segment 2101 Nueces River Basin												8
Segment 2102 Nueces River Basin												8
Segment 2103 Nueces River Basin												8
Segment 2104 Nueces River Basin												8
Segment 2105 Nueces River Basin												8
Segment 2106 Nueces River Basin												8
Segment 2107 Nueces River Basin												8
Segment 2112 Nueces River Basin												8
Average - Nueces	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	8

Appendix C- Selected Constituent Values from Literature Search

Land Use Category/ Location	Additional Dissolved Minerals used to develop an annual NPS load (Pb) Lead (µg/L)	(Zn) Zinc (µg/L)	(As) Arsenic (µg/L)	(Cd) Cadmium (µg/L)	(Cr) Chromium (µg/L)	(Hg) Mercury (µg/L)	(Ag) Silver (µg/L)	Additional Pollutants Dissolved Barium (Ba), µg/l	Phosphate Total (PO4), mg/l	Phosphate Ortho (OP), mg/l	Dissolved Orthophosporus mg/l	
Segment 2485 - Oso Bay												8
Segment 2001 San Antonio-Nueces												9
Segment 2002 San Antonio-Nueces												9
Segment 2003 San Antonio-Nueces												9
Segment 2004 San Antonio-Nueces												9
Average - San Antonio/Nueces	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	9
Segment 2101 Nueces River Basin												9
Segment 2102 Nueces River Basin												9
Segment 2103 Nueces River Basin												9
Segment 2104 Nueces River Basin												9
Segment 2105 Nueces River Basin												9
Segment 2106 Nueces River Basin												9
Segment 2107 Nueces River Basin												9
Segment 2112 Nueces River Basin												9
Average - Nueces	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	9
Segment 2485 - Oso Bay												9
Segment 2001 San Antonio-Nueces												10
Segment 2002 San Antonio-Nueces												10
Segment 2003 San Antonio-Nueces												10
Segment 2004 San Antonio-Nueces												10
Average - San Antonio/Nueces	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	10
Segment 2101 Nueces River Basin												10
Segment 2102 Nueces River Basin												10
Segment 2103 Nueces River Basin												10
Segment 2104 Nueces River Basin												10
Segment 2105 Nueces River Basin												10
Segment 2106 Nueces River Basin												10
Segment 2107 Nueces River Basin												10
Segment 2112 Nueces River Basin												10
Average - Nueces	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	10
0820150003-23-70143018	--	--	--	--	--	--	--	--				11

Appendix C- Selected Constituent Values from Literature Search

Land Use Category/ Location	Additional Dissolved Minerals used to develop an annual NPS load (Pb) Lead (µg/L)	(Zn) Zinc (µg/L)	(As) Arsenic (µg/L)	(Cd) Cadmium (µg/L)	(Cr) Chromium (µg/L)	(Hg) Mercury (µg/L)	(Ag) Silver (µg/L)	Additional Pollutants Dissolved Barium (Ba), µg/l	Phosphate Total (PO4), mg/l	Phosphate Ortho (OP), mg/l	Dissolved Orthophosporus mg/l	
0820150004-10-73154510	--	--	--	--	--	--	--	--				11
0820150001-21-7414357.4	3	20	2	ND	ND	<0.5	--	--				11
0820150003-12-7412004.5	--	--	--	--	--	--	--	--				11
0820150005-15-74150020	ND	<20	<1	ND	ND	<0.5	--	--				11
0820150007-10-7412003.1	3	<20	1	<2.0	ND	<0.5	--	--				11
0820150009-09-74120015	--	--	--	--	--	--	--	--				11
0820150011-18-74152024	--	--	--	--	--	--	--	--				11
0820150001-13-75154020	2	20	<1	ND	ND	<0.5	--	--				11
0820150003-18-75140024	--	--	--	--	--	--	--	--				11
0820150005-19-7514459.0	<2	ND	<1	ND	ND	<0.5	--	--				11
0820150007-28-75133521	ND	<20	1	ND	ND	<0.5	--	--				11
0820150009-16-7514005.3	6	<20	<1	ND	<20	<0.5	--	--				11
0820150011-18-7513151.9	--	--	--	--	--	--	--	--				11
0820150001-12-7614301.4	ND	ND	<1	ND	ND	<0.5	--	--				11
0820150003-08-7614001.4	--	--	--	--	--	--	--	--				11
0820150005-03-76135525	--	--	--	--	--	--	--	--				11
0820150007-26-76150062	--	--	--	--	--	--	--	--				11
0820150009-27-7614257.9	ND	<20	1	ND	2	<0.5	ND	<100				11
0820150011-15-76135520	--	--	--	--	--	--	--	--				11
0820150001-24-77143030	ND	ND	<1	ND	ND	<0.5	ND	<100				11
0820150003-21-77133522	--	--	--	--	--	--	--	--				11
0820150005-23-77133570	--	--	--	--	--	--	--	--				11
0820150007-25-7713258.0	--	--	--	--	--	--	--	--				11
0820150009-19-7714153.0	ND	<20	<1	ND	ND	<0.5	ND	<100				11
0820150011-07-7714003.1	--	--	--	--	--	--	--	--				11
0820150001-04-7811057.4	--	--	--	--	--	--	--	--				11
0820150001-16-7814304.3	ND	ND	<1	ND	ND	<0.1	ND	<100				11
0820150003-20-7813452.4	--	--	--	--	--	--	--	--				11
0820150005-30-7814552.6	--	--	--	--	--	--	--	--				11
0820150007-05-7816150.90	--	--	--	--	--	--	--	--				11
0820150009-08-78115513	ND	ND	2	ND	ND	<0.1	ND	--				11
0820150011-22-78094314	--	--	--	--	--	--	--	--				11

Appendix C- Selected Constituent Values from Literature Search

Land Use Category/ Location	Additional Dissolved Minerals used to develop an annual NPS load							Additional Pollutants				
	(Pb) Lead (µg/L)	(Zn) Zinc (µg/L)	(As) Arsenic (µg/L)	(Cd) Cadmium (µg/L)	(Cr) Chromium (µg/L)	(Hg) Mercury (µg/L)	(Ag) Silver (µg/L)	Dissolved Barium (Ba), µg/l	Phosphate Total (PO4), mg/l	Phosphate Ortho (OP), mg/l	Dissolved Orthophosporus mg/l	
0820150001-04-7911057.4	3	<3	1	<2.0	<20	<0.1	ND	20				11
0820150003-28-79124577	--	--	--	--	--	--	--	--				11
0820150005-03-79115546	--	--	--	--	--	--	--	--				11
0820150006-14-791420107	--	--	--	--	--	--	--	--				11
0820150001-08-8011352.6	0	<3	0	<1.0	0	0.2	0	20				11
0820150005-14-8011553.6	--	--	--	--	--	--	--	--				11
0820150007-31-8013270.29	1	<3	1	<1.0	0	0	0	30				11
0820150001-22-8111215.7	<10	<3	0	<1.0	0	0.1	0	30		--		11
0820150004-22-81104833	--	--	--	--	--	--	--	--		--		11
0820150008-12-81153221	17	5	0	<1.0	10	0.2	0	30		--		11
0820150001-19-8209483.1	1	<3	<1	1.0	<10	<0.1	<1.0	25		--		11
0820150005-12-8210326.1	--	--	--	--	--	--	--	--		--		11
0820150007-13-8210173.7	1	17	<1	<1.0	10	<0.1	<1.0	26		--		11
0820150001-18-8313092.0	<1	9	<1	<1.0	<10	<0.1	<1.0	23		--		11
0820150004-19-8309513.8	--	--	--	--	--	--	--	--		--		11
0820150008-30-8310081.8	<1	4	<1	<1.0	<10	<0.1	<1.0	27		--		11
0820150001-25-8414185.5	<1	3	<1	<1.0	<10	<0.1	<1.0	28		--		11
0820150004-20-8415401.3	--	--	--	--	--	--	--	--		--		11
0820150008-17-8409520.29	<1	7	<1	<1.0	<10	<0.1	<1.0	27		--		11
0820150001-09-85112746	<1	9	<1	<1.0	<10	<0.1	<1.0	35		--		11
0820150001-23-85160052	--	--	--	--	--	--	--	--		--		11
0820150004-30-85154555	--	--	--	--	--	--	--	--		--		11
0820150008-23-8514301.5	<1	16	<1	<1.0	<10	<0.1	<1.0	32		--		11
0820150002-12-8616207.4	1	6	<1	<1.0	<10	<0.1	<1.0	36		--		11
0820150006-05-86132022	--	--	--	--	--	--	--	--		--		11
0820150008-07-8615005.5	<5	4	<1	<1.0	<10	<0.1	<1.0	33		--		11
0820150001-23-87120039	<5	7	<1	<1.0	<10	<0.1	<1.0	31		--		11
0820150005-07-87112213	--	--	--	--	--	--	--	--		--		11
0820150009-01-87163011	<5	6	<1	<1.0	<10	0.4	<1.0	34		--		11
0820150001-06-8815005.3	--	--	--	--	--	--	--	--		--		11
0820150005-10-8814340.50	--	--	--	--	--	--	--	--		--		11
0820150008-30-8814241.1	5	7	<1	<1.0	<1	<0.1	<1.0	32		--		11

Appendix C- Selected Constituent Values from Literature Search

Land Use Category/ Location	Additional Dissolved Minerals used to develop an annual NPS load							Additional Pollutants				
	(Pb) Lead (µg/L)	(Zn) Zinc (µg/L)	(As) Arsenic (µg/L)	(Cd) Cadmium (µg/L)	(Cr) Chromium (µg/L)	(Hg) Mercury (µg/L)	(Ag) Silver (µg/L)	Dissolved Barium (Ba), µg/l	Phosphate Total (PO4), mg/l	Phosphate Ortho (OP), mg/l	Dissolved Orthophosporus mg/l	
0820150001-10-8914230.50	<5	46	<1	<1.0	10	<0.1	1.0	24		--		11
0820150005-10-8915400.94	--	--	--	--	--	--	--	--		--		11
0820150002-07-9017081.3	<10	<3	<1	<1.0	<5	<0.1	<1.0	28		--		11
0820150005-24-90153715	--	--	--	--	--	--	--	--		--		11
0820150008-30-90145814	<10	5	<1	<1.0	<5	<0.1	1.0	28		--		11
0820150002-14-9109375.3	<10	19	<1	<1.0	<5	<0.1	<1.0	28		0.020		11
0820150005-28-91154514	--	--	--	--	--	--	--	--		<0.010		11
0820150008-15-9110303.6	<10	3	<1	<1.0	<5	<0.1	<1.0	25		<0.010		11
0820150001-30-920958103	<10	<3	<1	<1.0	<5	<0.1	<1.0	30		<0.010		11
0820150005-14-92122730	--	--	--	--	--	--	--	--		<0.010		11
0820150009-01-9214154.3	<10	<3	<1	<1.0	<5	<0.1	<1.0	26		<0.010		11
0820150001-28-93113013	<10	<3	<1	<1.0	<5	<0.1	<1.0	26		--		11
0820150009-01-9312151.2	<10	5	<1	1.0	<5	<0.1	<1.0	23		--		11
0820150008-17-9412453.6	<10	<3	<1	<1.0	<5	<0.1	<1.0	22		--		11
0820150008-17-9413003.6	<10	<3	<1	<1.0	<5	<0.1	<1.0	22		--		11
0820150002-06-9512054.9	<10	6	<1	<1.0	<5	<0.1	<1.0	28	--	--		11
0820245009-15-91034567	<10	6	1	<1.0	<5	<0.1	<1.0	7	--	0.060		11
0820245009-24-91135014	<10	11	<1	<1.0	<5	<0.1	<1.0	27	--	<0.010		11
0820245012-19-91193067	<10	7	1	<1.0	<5	<0.1	<1.0	22	--	0.010		11
0820245012-20-911405424	<10	29	<1	<1.0	<5	0.2	<1.0	27	--	0.010		11
0820245003-04-921400250	<10	8	<1	<1.0	<5	<0.1	<1.0	14	--	0.010		11
0820245003-27-921930845	<10	31	<1	<1.0	<5	<0.1	<1.0	11	--	0.070		11
0820245003-28-921640200	<10	<3	<1	<1.0	<5	<0.1	<1.0	24	--	<0.010		11
0820245005-21-922130161	<10	6	<1	<1.0	<5	<0.1	<1.0	18	--	0.020		11
0820245001-19-930001--	<10	<3	1	<1.0	<5	<0.1	<1.0	25	--	--		11
0820245001-19-9312206.4	<10	<3	<1	<1.0	<5	<0.1	<1.0	10	--	--		11
0820245003-30-930001--	<10	21	<1	<1.0	<5	0.1	<1.0	25	--	--		11
0820245003-30-93113017	<10	9	<1	<1.0	<5	<0.1	<1.0	15	--	--		11
0820245005-06-93145361	<10	3	<1	<1.0	<5	<0.1	<1.0	22	--	--		11
0820245012-28-94142011	<10	3	<1	<1.0	<5	<0.1	<1.0	17	--	--		11
0820245012-28-941440--	10	6	<1	4.0	<5	<0.1	<1.0	18	--	--		11
0820245012-29-94082529	10	12	<1	<1.0	<5	<0.1	<1.0	17	--	--		11

Appendix C- Selected Constituent Values from Literature Search

Land Use Category/ Location	Additional Dissolved Minerals used to develop an annual NPS load							Additional Pollutants				
	(Pb) Lead (µg/L)	(Zn) Zinc (µg/L)	(As) Arsenic (µg/L)	(Cd) Cadmium (µg/L)	(Cr) Chromium (µg/L)	(Hg) Mercury (µg/L)	(Ag) Silver (µg/L)	Dissolved Barium (Ba), µg/l	Phosphate Total (PO4), mg/l	Phosphate Ortho (OP), mg/l	Dissolved Orthophosporus mg/l	
0820245012-29-94131623	40	8	<1	1.0	<5	16	<1.0	18	--	--		11
0820270009-20-911100423	<10	26	18	<1.0	<5	0.1	<1.0	25	--	0.020		11
0820270009-20-911310701	<10	6	2	<1.0	<5	<0.1	<1.0	10	--	0.050		11
0820270009-20-911905223	<10	16	<1	<1.0	<5	0.1	<1.0	11	--	0.040		11
0820270012-20-9113301260	<10	24	<1	<1.0	<5	0.2	<1.0	17	--	0.030		11
0820270012-20-911740536	<10	8	<1	<1.0	<5	<0.1	<1.0	17	--	0.050		11
0820270003-04-9208202850	<10	30	<1	<1.0	<5	0.1	<1.0	<2	--	0.070		11
0820270003-04-9210282900	<10	6	<1	<1.0	<5	<0.1	3.0	10	--	0.060		11
0820270003-04-921715341	<10	<3	<1	<1.0	<5	<0.1	7.0	11	--	<0.010		11
0820270003-27-922305248	<10	7	1	<1.0	<5	0.2	<1.0	14	--	0.090		11
0820270003-28-92144549	<10	7	<1	<1.0	<5	<0.1	<1.0	12	--	0.040		11
0820270005-27-921730202	<10	<3	<1	<1.0	<5	0.7	<1.0	14	--	<0.010		11
0820270005-06-931005--	<50	20	<1	<5.0	<30	0.1	<5.0	12	0.31	--		11
0820279009-20-9117302.0	<10	9	<1	1.0	<5	<0.1	<1.0	15	--	0.040		11
0820279012-21-9116004.8	<10	6	<1	<1.0	<5	<0.1	<1.0	12	--	0.030		11
0820279002-24-9214452.8	<10	20	<1	<1.0	<5	<0.1	<1.0	8	--	0.060		11
0820279003-27-9215302.0	<10	7	2	<1.0	<5	<0.1	<1.0	8	--	0.100		11
0820279003-28-9212451.7	<10	3	<1	<1.0	<5	<0.1	1.0	12	--	0.050		11
0820279005-27-9204002.0	<10	12	5	<1.0	<5	<0.1	<1.0	8	--	0.050		11
0820279006-02-9212006.0	<10	9	<1	<1.0	<5	<0.1	<1.0	17	--	0.100		11
0820279010-25-9400010.20	<10	<3	<1	<1.0	<5	<0.1	<1.0	10	0.15	--		11
0820279010-25-9408242.7	<10	4	<1	<1.0	<5	<0.1	2.0	5	0.12	--		11
0820279010-25-940849--	<10	<3	<1	<1.0	<5	<0.1	<1.0	5	0.12	--		11
0820279010-25-9412150.40	<10	<3	1	<1.0	<5	<0.1	<1.0	10	0.18	--		11
0820279010-25-9414250.60	<10	<3	1	<1.0	<5	<0.1	<1.0	10	0.15	--		11
0820279003-13-950100--	--	--	--	--	--	--	--	--	0.06	--		11
0820279003-13-9501172.5	--	--	--	--	--	--	--	--	0.09	--		11
0820279003-13-9513371.9	--	--	--	--	--	--	--	--	0.12	--		11
0820290009-16-91163559	<10	6	<1	<1.0	<5	0.1	<1.0	20	--	0.010		11
0820290009-21-911100177	<10	10	2	<1.0	<5	<0.1	<1.0	28	--	0.030		11
0820290012-21-911300285	<10	8	<1	<1.0	<5	0.3	<1.0	53	--	0.020		11
0820290012-23-911730116	10	<3	<1	<1.0	<5	<0.1	<1.0	29	--	0.080		11

Appendix C- Selected Constituent Values from Literature Search

Land	Additional Dissolved Minerals used to develop an annual NPS load							Additional Pollutants				
Use Category/ Location	(Pb) Lead (µg/L)	(Zn) Zinc (µg/L)	(As) Arsenic (µg/L)	(Cd) Cadmium (µg/L)	(Cr) Chromium (µg/L)	(Hg) Mercury (µg/L)	(Ag) Silver (µg/L)	Dissolved Barium (Ba), µg/l	Phosphate Total (PO4), mg/l	Phosphate Ortho (OP), mg/l	Dissolved Orthophosporus mg/l	
0820290003-28-921330303	<10	7	1	<1.0	<5	0.2	<1.0	69	--	<0.010		11
0820290003-28-921545624	<10	6	<1	<1.0	<5	<0.1	<1.0	69	--	0.010		11
0820290003-29-92163041	<10	8	<1	<1.0	<5	<0.1	<1.0	27	--	0.090		11
0820290005-06-930001--	--	--	--	--	--	--	--	--	--	--		11
0820290005-06-9316002110	<10	12	<1	<1.0	<5	<0.1	<1.0	18	0.03	--		11
0820290005-07-930001--	--	--	--	--	--	--	--	--	--	--		11
0820290005-07-93111547	<10	<3	<1	<1.0	<5	0.1	<1.0	19	--	--		11
0820290001-24-941549--	<10	4	2	<1.0	<5	<0.1	1.0	47	0.03	--		11
0820290010-08-940835--	<10	22	<1	<1.0	<5	<0.1	<1.0	36	0.31	--		11
0820290010-08-941635--	--	--	--	--	--	--	--	--	--	--		11
0820290010-08-941715--	<10	<3	2	<1.0	<5	<0.1	<1.0	23	0.15	--		11
0820290010-08-941952--	<10	<3	2	<1.0	<5	<0.1	<1.0	27	0.18	--		11
0820290010-11-9411450.40	<10	<3	2	<1.0	<5	<0.1	<1.0	52	0.09	--		11
0820290003-13-950031--	--	--	--	--	--	--	--	--	0.12	--		11
0820290003-13-9509504.2	--	--	--	--	--	--	--	--	--	--		11
0820290003-15-9513151.4	--	--	--	--	--	--	--	--	--	--		11
0821152010-17-7713502.0	--	--	--	--	--	--	--	--				12
0821152011-28-7713152.0	<2	20	14	2.0	ND	<0.1	ND	1000				12
0821152001-09-7812501.9	--	--	--	--	--	--	--	--				12
0821152002-23-7814001.7	ND	<20	8	ND	ND	<0.1	ND	400				12
0821152004-03-7813406.3	--	--	--	--	--	--	--	--				12
0821152005-15-7813151.4	ND	20	17	ND	20	<0.1	ND	300				12
0821152006-22-7814451.8	--	--	--	--	--	--	--	--				12
0821152008-09-7816302.2	--	--	--	--	--	--	--	--				12
0821152009-18-7813304.8	ND	<20	59	ND	<20	<0.1	ND	200				12
0821152010-30-78141514	--	--	--	--	--	--	--	--				12
0821152012-11-7813121.9	ND	40	11	ND	ND	<0.1	ND	300				12
0821152001-25-7914105.5	--	--	--	--	--	--	--	--				12
0821152003-05-7911352.0	ND	30	14	ND	<20	<0.1	ND	300				12
0821152004-16-7912153.0	--	--	--	--	--	--	--	--				12

Appendix C- Selected Constituent Values from Literature Search

Land Use Category/ Location	Additional Dissolved Minerals used to develop an annual NPS load							Additional Pollutants				
	(Pb) Lead (µg/L)	(Zn) Zinc (µg/L)	(As) Arsenic (µg/L)	(Cd) Cadmium (µg/L)	(Cr) Chromium (µg/L)	(Hg) Mercury (µg/L)	(Ag) Silver (µg/L)	Dissolved Barium (Ba), µg/l	Phosphate Total (PO4), mg/l	Phosphate Ortho (OP), mg/l	Dissolved Orthophosporus mg/l	
0821152005-21-7915502.4	ND	<20	17	ND	<20	<0.1	ND	600				12
0821152007-02-7915102.7	--	--	--	--	--	--	--	--				12
0821152008-14-7909501.1	ND	<20	19	<2.0	ND	0.2	ND	200				12
0821152009-25-79101710	--	--	--	--	--	--	--	--				12
0821152011-06-7913502.8	0	10	15	0	0	0	0	500				12
0821152012-17-7916221.7	--	--	--	--	--	--	--	--				12
0821152001-28-8015353.3	0	20	16	1.0	0	0.3	0	500				12
0821152003-10-8016032.3	--	--	--	--	--	--	--	--				12
0821152004-21-8016221.7	0	10	10	0	10	0.9	0	600				12
0821152006-02-8016181.7	--	--	--	--	--	--	--	--				12
0821152007-14-8018152.0	7	10	16	0	10	0.3	0	200				12
0821152008-26-8011193.5	--	--	--	--	--	--	--	--				12
0821152010-17-8011385.2	--	--	--	--	--	--	--	--				12
0821152011-17-8015452.1	100	20	14	10	0	0.3	0	200				12
0821152001-06-8111302.8	--	--	--	--	--	--	--	--				12
0821152002-09-8115309.0	<10	20	45	<1.0	0	0.2	0	200				12
0821152003-16-8116458.5	--	--	--	--	--	--	--	--				12
0821152005-05-811310333	0	20	60	6.0	0	0.1	0	200				12
0821152006-26-8109452.6	--	--	--	--	--	--	--	--				12
0821152007-28-8110583.0	0	40	17	0	0	0.2	0	300				12
0821152009-15-8110172.2	--	--	--	--	--	--	--	--				12
0821152010-20-8110302.7	1	20	12	1.0	10	0.2	<1.0	200				12
0821152001-12-8215472.7	--	--	--	--	--	--	--	--				12
0821152004-06-8210032.2	--	--	--	--	--	--	--	--				12
0821152005-25-820950530	<1	12	31	<1.0	10	<0.1	<1.0	37				12
0821152006-29-8211382.9	--	--	--	--	--	--	--	--				12
0821152008-10-8211493.9	<1	20	20	1.0	<10	0.1	<1.0	100				12
0821152010-26-8210482.9												12
0821152002-03-8314002.2												12
0821152003-17-831200104												12
0821152004-26-831215188												12
0821152006-09-83143511												12

Appendix C- Selected Constituent Values from Literature Search

Land Use Category/ Location	Additional Dissolved Minerals used to develop an annual NPS load (Pb) Lead (µg/L)	(Zn) Zinc (µg/L)	(As) Arsenic (µg/L)	(Cd) Cadmium (µg/L)	(Cr) Chromium (µg/L)	(Hg) Mercury (µg/L)	(Ag) Silver (µg/L)	Additional Pollutants Dissolved Barium (Ba), µg/l	Phosphate Total (PO4), mg/l	Phosphate Ortho (OP), mg/l	Dissolved Orthophosporus mg/l	
0821152007-19-83113038												12
0821152012-13-8311242.1	--	--	--	--	--	--	--	--				12
0821152001-24-84112522	2	40	16	<1.0	70	<0.1	<1.0	300				12
0821152003-06-8411344.2	--	--	--	--	--	--	--	--				12
0821152004-24-8411303.0	--	--	--	--	--	--	--	--				12
0821152006-14-8416541.9	<1	40	13	<1.0	<10	<0.1	<1.0	100				12
0821152008-09-8415300.66	--	--	--	--	--	--	--	--				12
0821152012-05-8410351.7	--	--	--	--	--	--	--	--				12
0821152001-23-8513452.4	<1	10	10	<1.0	40	<0.1	<1.0	200				12
0821152003-13-8511002.1	--	--	--	--	--	--	--	--				12
0821152004-24-8511253.4	--	--	--	--	--	--	--	--				12
0821152006-11-8511352.0	--	--	--	--	--	--	--	--				12
0821152008-22-8510001.3	<1	60	17	1.0	<10	0.2	<1.0	<100				12
0821152011-20-8511102.5	--	--	--	--	--	--	--	--				12
0821152001-08-86104060	<1	11	11	<1.0	<10	<0.1	2.0	70				12
0821152002-27-8609530.89	--	--	--	--	--	--	--	--				12
0821152005-07-8614072.2	--	--	--	--	--	--	--					12
0821152006-19-8611103.1	--	--	--	--	--	--	--	--				12
0821152008-19-8613252.7	<5	20	21	1.0	<10	<0.1	<1.0	200				12
0821152010-15-8617308.5	--	--	--	--	--	--	--	--				12
0821152012-05-8609462.0	--	--	--	--	--	--	--	--				12
0821152002-05-8711102.4	<5	20	12	<1.0	10	0.2	1.0	<100				12
0821152005-13-8712306.0	--	--	--	--	--	--	--	--				12
0821152007-07-8715152.5	--	--	--	--	--	--	--	--				12
0821152008-31-87143020	<5	10	13	1.0	<10	0.2	<1.0	200				12
0821152011-19-8708301.9	<5	10	12	<1.0	<1	0.2	<1.0	300				12
0821152001-11-88141510	--	--	--	--	--	--	--	--				12
0821152003-08-8812150.33	<5	10	17	1.0	1	0.2	1.0	300				12
0821152005-04-8811001.4	--	--	--	--	--	--	--	--				12
0821152007-12-8812002.7	<5	10	18	2.0	<1	0.1	<1.0	<100				12
0821152008-24-8811003.2	<5	10	21	1.0	<1	0.2	<1.0	400				12

Appendix C- Selected Constituent Values from Literature Search

Land Use Category/ Location	Additional Dissolved Minerals used to develop an annual NPS load							Additional Pollutants				
	(Pb) Lead (µg/L)	(Zn) Zinc (µg/L)	(As) Arsenic (µg/L)	(Cd) Cadmium (µg/L)	(Cr) Chromium (µg/L)	(Hg) Mercury (µg/L)	(Ag) Silver (µg/L)	Dissolved Barium (Ba), µg/l	Phosphate Total (PO4), mg/l	Phosphate Ortho (OP), mg/l	Dissolved Orthophosporus mg/l	
8064100										< 0.010		13
8064100										< 0.010		13
8064100										< 0.010		13
8064100										< 0.010		13
8064100										< 0.010		13
8064100										2.5		13
8064100										0.01		13
8064100										0.09		13
8064100										0.02		13
8064100										< 0.010		13
8064100										< 0.010		13
8064100										< 0.010		13
8064100										0.04		13
8064100										< 0.010		13
8064100										< 0.010		13
8064100										0.04		13
8064100										0.01		13
8064100										0.03		13
8064100										< 0.010		13
8064100										0.01		13
8064100										0.07		13
8064100										0.06		13
8064100										< 0.010		13
8064100										< 0.010		13
8064100										< 0.010		13
8064100										0.01		13
8064100										0.01		13
8064100										0.05		13
8064100										0.04		13
8064100										< 0.010		13
8064100										0.02		13
8064100										< 0.010		13

Appendix C- Selected Constituent Values from Literature Search

Land Use Category/ Location	Additional Dissolved Minerals used to develop an annual NPS load							Additional Pollutants				
	(Pb) Lead (µg/L)	(Zn) Zinc (µg/L)	(As) Arsenic (µg/L)	(Cd) Cadmium (µg/L)	(Cr) Chromium (µg/L)	(Hg) Mercury (µg/L)	(Ag) Silver (µg/L)	Dissolved Barium (Ba), µg/l	Phosphate Total (PO4), mg/l	Phosphate Ortho (OP), mg/l	Dissolved Orthophosporus mg/l	
8064100										< 0.010		13
315801096282999										< 0.010		13
315801096282999										0.09		13
315801096282999										0.03		13
315801096282999										0.04		13
315801096282999										0.08		13
321017096420099										< 0.010		13
321017096420099										< 0.010		13
321017096420099										< 0.010		13
321017096420099										0.02		13
321017096420099										0.03		13
321313096415201										< 0.010		13
321313096415201										0.06		13
321313096415201										< 0.010		13
321313096415201										< 0.010		13
321313096415201										0.04		13
321441096442601										< 0.010		13
321441096442601										< 0.010		13
321441096442601										< 0.010		13
321441096442601										0.02		13
321441096442601										0.02		13
2101												14
2102												14

Source

1 Characterization of Nonpoint Sources and Loadings to Galveston Bay, GBNEP-15, March 1992
2 1994 Regional Assessment of Water Quality in the Nueces Coastal Basins, October 1994, mean values
3 Texas Aquatic Ecoregion Project, An Assessment of Least Disturbed Streams, TWC, 5/92
4 Seco Creek Water Quality Demonstration Project, Annual Project Report, Fiscal Year 1994
5 Analysis of Agricultural Nonpoint Pollution Control Options in the St. Albans Bay Watershed, USDA -ERS, 1987, mean values
6 The State of Texas Water Quality Inventory, 11th Edition, TWC, August 1992, LP 92-16, mean values
7 The State of Texas Water Quality Inventory, 10th Edition, TWC, June 1990, LP 90-06, mean values
8 The State of Texas Water Quality Inventory, 9th Edition, TWC, April 1988, LP 88-04, mean values
9 The State of Texas Water Quality Inventory, 8th Edition, TWC, October 1986, LP 86-07, mean values

10 The State of Texas Water Quality Inventory, 6th Edition, TDWR, LP 59, mean values
11 USGS Provisional Information, Seco Creek Watershed **Station no. is in the format 08202790(gage no.)03-28-92(date)1245(time)1.7(discharge).
12 USGS Provisional Information, Oso Creek Watershed **Station no. is in the format 08211520(gage no.)07-12-8(date)1200(time)2.7(discharge).
13 USGS Provisional Information, Chambers Creek Watershed
14 Final Report, Regional Assessment of Water Quality - Nueces River Basin, Nueces River Authority - October 1, 1994

Notes: NA represents Not Applicable
ND represents Not Detected
Values reported as 0 (zero) are actually below the detection limit of the laboratory at the time of testing.

Appendix C- Selected Constituent Values from Literature Search

Land Use Category/ Location	Additional Pollutants: Phosphorus Dissolved Orthophosphorus mg/l	Orthophosphorus as Phosphorus Dissolved mg/l	Chloride (Cl), mg/l	Nitrogen, Kjeldahl Total (TKN), mg/l	Nitrate Nitrogen Total (NO3), mg/l	Nitrogen, Ammonia Total (NH4), mg/l	Nitrite plus Nitrate, Total (NO2+NO3), mg/l	Sulfate (SO4), mg/l	Total Dissolved Solids (TDS), mg/l	Oxygen, Dissolved (DO), mg/l	
Agricultural											1
Open/Pasture											1
Wetlands											1
Segment 2485 - Oso Creek	0.22					0.46					2
Oso Creek Above Tide(Low)	2.88		1271.59		2.65		2.71		3947.17		2
Oso Creek Above Tide(High)											2
Segment 2002 - Mission River			792.56	0.68				49.47			2
Copano Creek				1.91						6.83	2
Segment 2004 - Aransas River	1.29		304.86	1.14	0.52			54.03			2
Poesta Creek	5.17			5.76	3.81	4.25				5.96	2
Segment 2462 - San Antonio Bay		0.13									2
Station 13028					0.77	6.27				8.9	2
Segment 2204 - Petronila Creek	0.13		3671.9					780.71	6936.3		2
Station 13033 - San Fernando Creek	4.14				4.06			992.61			2
Station 13028 - Oso Creek Tidal					0.77	6.27				8.9	2
Segment 2001 - Mission River (Tidal)											2
Segment 2003 - Aransas River											2
Segment 2462 - San Antonio Bay		0.13									2
Segment 2463 - Mesquite/Carlos/Ayres											2
Segment 2471 - Aransas Bay											2
Segment 2472 - Copano/Mission Bay											2
Segment 2473 - St. Charles Bay											2
Segment 2481 - Corpus Christi Bay											2
Segment 2482 - Nueces Bay											2
Segment 2482 - Corpus Inner Harbor						0.22					2
Segment 2491 - Upper Laguna Madre						0.07					2
Segment 2492 - Baffin Bay						0.07					2
Average	2.31	0.13	1510.23	2.37	2.10	2.52	2.71	469.21	5441.74	7.65	2
Placedo Creek			333	0.6		0.02		13	968		3
West Caranchua Creek			158	1.2		0.05		10	530		3

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Big Creek			403	1.4		0.02		39	974		3
Garcitas Creek			44	0.5		0.02		41	386		3
Arenosa Creek			204	3.6		0.03		10	890		3
West Mustang Creek			178	0.1		0.02		45	580		3
West Bernard Creek			144	1		0.04		93	568		3
Average			209	1.2		0.03		36	699		3
Seco Creek, Flatrock Crossing			17			<0.01	0.12	48	240	8.9	4
Jewett Brook Watershed, Vt., 1982				2.45		0.53					5
Jewett Brook Watershed, Vt., 1983				3.18		0.79				7.7	5
Jewett Brook Watershed, Vt., 1984				2.29		0.5				8.5	5
Jewett Brook Watershed, Vt., 1985				2.16		0.53				7	5
Jewett Brook Watershed, Vt., Average	NA	NA	NA	2.52	NA	0.59	NA	NA	NA	7.73	5
Segment 2001 San Antonio-Nueces			9525					1274	11367	8	6
Segment 2002 San Antonio-Nueces			1905					87	2981	7.3	6
Segment 2003 San Antonio-Nueces			11631					1776	17712	7.9	6
Segment 2004 San Antonio-Nueces			841					141	1404	7	6
Average - San Antonio/Nueces	NA	NA	5975.50	NA	NA	NA	NA	819.50	8366.00	7.55	6
Segment 2101 Nueces River Basin			7156					994	10463	9	6
Segment 2102 Nueces River Basin			122					56	436	8.3	6
Segment 2103 Nueces River Basin			76					41	318	7.7	6
Segment 2104 Nueces River Basin			111					39	406	7.3	6
Segment 2105 Nueces River Basin			87					61	272	6.7	6
Segment 2106 Nueces River Basin			112					62	381	8.1	6
Segment 2107 Nueces River Basin			232					113	633	6.6	6
Segment 2112 Nueces River Basin			25					17	240	8.9	6
Average - Nueces	NA	NA	990.13	NA	NA	NA	NA	172.88	1643.63	7.83	6
Segment 2203 Nueces - Rio Grande			36350					5350	39025	6.5	6
Segment 2204 Nueces - Rio Grande			4953					660	7891	10	6
Average - Nueces/Rio Grande	NA	NA	20651.50	NA	NA	NA	NA	3005.00	23458.00	8.25	6
Segment 2485 - Oso Bay			17808					2735	24965	7.4	6
Segment 2001 San Antonio-Nueces			6277					909	9401	7.6	7

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	Additional Pollutants										
Segment 2002 San Antonio-Nueces			2210					55	2	7	7
Segment 2003 San Antonio-Nueces			11477					1455	15531	8	7
Segment 2004 San Antonio-Nueces			310					66	1008	6.9	7
Average - San Antonio/Nueces	NA	NA	5068.50	NA	NA	NA	NA	621.25			7
Segment 2101 Nueces River Basin			6897					944	10356	9.2	7
Segment 2102 Nueces River Basin			120					51	454	8.7	7
Segment 2103 Nueces River Basin			55					32	262	8	7
Segment 2104 Nueces River Basin			223					46	485	7.6	7
Segment 2105 Nueces River Basin			101					76	382	7.3	7
Segment 2106 Nueces River Basin			159					93	544	8	7
Segment 2107 Nueces River Basin			270					202	656	7.4	7
Segment 2112 Nueces River Basin			19					16	231	8.9	7
Average - Nueces	NA	NA	980.50	NA	NA	NA	NA	182.50	1671.25	8.14	7
Segment 2203 Nueces - Rio Grande											7
Segment 2204 Nueces - Rio Grande			2772					382	4720	9.7	7
Average - Nueces/Rio Grande	NA	NA	2772.00	NA	NA	NA	NA	382.00	4720.00	9.70	7
Segment 2485 - Oso Bay			19591					2620	25480	7.8	7
Segment 2001 San Antonio-Nueces			3878					479	4746	7.6	8
Segment 2002 San Antonio-Nueces			534					48	1000	7.3	8
Segment 2003 San Antonio-Nueces			9197					1164	11408	8	8
Segment 2004 San Antonio-Nueces			241					41	681	8.3	8
Average - San Antonio/Nueces	NA	NA	3462.50	NA	NA	NA	NA	433.00	4458.75	7.80	8
Segment 2101 Nueces River Basin			8264					1139	11534	9.8	8
Segment 2102 Nueces River Basin			157					65	515	8.8	8
Segment 2103 Nueces River Basin			71					35	284	8	8
Segment 2104 Nueces River Basin			224					47	549	7.9	8
Segment 2105 Nueces River Basin			103					70	374	9.2	8
Segment 2106 Nueces River Basin			238					126	692	7.9	8
Segment 2107 Nueces River Basin			253					189	643	7.6	8
Segment 2112 Nueces River Basin			26					15	215	9.2	8
Average - Nueces	NA	NA	1167.00	NA	NA	NA	NA	210.75	1850.75	8.55	8

Appendix C- Selected Constituent Values from Literature Search

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Segment 2485 - Oso Bay			20118					2739	25123	7.3	8
Segment 2001 San Antonio-Nueces			2404					306	3772	8.4	9
Segment 2002 San Antonio-Nueces			494					64	945	7.7	9
Segment 2003 San Antonio-Nueces			6460					917	8600	9	9
Segment 2004 San Antonio-Nueces			349					48	1011	8.6	9
Average - San Antonio/Nueces	NA	NA	2426.75	NA	NA	NA	NA	333.75	3582.00	8.43	9
Segment 2101 Nueces River Basin			7779					1125	10981	10.1	9
Segment 2102 Nueces River Basin			197					82	587	9.2	9
Segment 2103 Nueces River Basin			121					55	406	8.8	9
Segment 2104 Nueces River Basin			244					54	728	8.3	9
Segment 2105 Nueces River Basin			72					39	289	8.2	9
Segment 2106 Nueces River Basin			296					155	800	8.4	9
Segment 2107 Nueces River Basin			231					154	706	5.2	9
Segment 2112 Nueces River Basin			22					13	218	8.7	9
Average - Nueces	NA	NA	1120.25	NA	NA	NA	NA	209.63	1839.38	8.36	9
Segment 2485 - Oso Bay			17782					2598	23064	7.9	9
Segment 2001 San Antonio-Nueces			956					65	1469	7.9	10
Segment 2002 San Antonio-Nueces			475					41	1064	8.3	10
Segment 2003 San Antonio-Nueces			4194					556	7647	8.9	10
Segment 2004 San Antonio-Nueces			187					30	542	8.3	10
Average - San Antonio/Nueces	NA	NA	1453.00	NA	NA	NA	NA	173.00	2680.50	8.35	10
Segment 2101 Nueces River Basin			5773					771	9493	9.8	10
Segment 2102 Nueces River Basin			224					76	544	9.3	10
Segment 2103 Nueces River Basin			143					79	470	9.5	10
Segment 2104 Nueces River Basin			721					139	1351	9.2	10
Segment 2105 Nueces River Basin			130					100	508	7.6	10
Segment 2106 Nueces River Basin			265					160	748	8.1	10
Segment 2107 Nueces River Basin			207					210	820	8.3	10
Segment 2112 Nueces River Basin			23					24	244	9.5	10
Average - Nueces	NA	NA	935.75	NA	NA	NA	NA	194.88	1772.25	8.91	10
0820150003-23-70143018			13	--	1.50	0.00	1.50	39	243	--	11

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	Phosphorus Dissolved Orthophosphorus mg/l	Orthophosphorus as Phosphorus Dissolved mg/l	Chloride (Cl), mg/l	Nitrogen, Kjeldahl Total (TKN), mg/l	Nitrate Nitrogen Total (NO3), mg/l	Nitrogen, Ammonia Total (NH4), mg/l	Nitrite plus Nitrate, Total (NO2+NO3), mg/l	Sulfate (SO4), mg/l	Total Dissolved Solids (TDS), mg/l	Oxygen, Dissolved (DO), mg/l	
0820150004-10-73154510			15	--	1.30	<0.010	1.30	51	--	9.8	11
0820150001-21-7414357.4			18	--	1.50	<0.010	--	44	252	10.2	11
0820150003-12-7412004.5			16	0.21	0.860	0.080	0.860	46	245	10.0	11
0820150005-15-74150020			12	0.12	1.19	0.140	1.20	41	259	8.2	11
0820150007-10-7412003.1			18	0.50	0.720	0.080	0.720	47	244	9.5	11
0820150009-09-74120015			12	0.45	0.960	0.130	0.960	44	245	9.0	11
0820150011-18-74152024			12	0.35	0.030	0.040	--	41	269	9.6	11
0820150001-13-75154020			13	0.09	1.10	<0.010	--	41	286	11.0	11
0820150003-18-75140024			16	1.60	1.59	0.180	1.60	38	286	9.9	11
0820150005-19-7514459.0			15	0.19	0.720	<0.010	0.720	41	246	9.6	11
0820150007-28-75133521			13	0.16	0.420	0.030	0.430	36	241	8.4	11
0820150009-16-7514005.3			14	0.38	0.450	0.040	0.460	33	220	9.0	11
0820150011-18-7513151.9			13	0.07	0.250	<0.010	0.250	40	242	9.7	11
0820150001-12-7614301.4			14	0.01	0.300	0.010	0.300	47	271	10.4	11
0820150003-08-7614001.4			14	0.18	0.490	<0.010	--	56	240	10.5	11
0820150005-03-76135525			11	0.12	0.370	<0.010	0.370	44	247	9.1	11
0820150007-26-76150062			11	0.10	0.530	0.010	0.530	26	261	8.2	11
0820150009-27-7614257.9			13	1.10	0.490	<0.010	0.490	37	224	9.3	11
0820150011-15-76135520			11	0.10	1.00	0.010	1.00	33	267	9.9	11
0820150001-24-77143030			11	0.14	0.400	<0.010	0.400	35	270	10.4	11
0820150003-21-77133522			15	0.14	1.00	0.010	1.00	36	261	10.0	11
0820150005-23-77133570			12	0.55	0.800	0.010	0.810	29	276	8.2	11
0820150007-25-7713258.0			15	0.10	0.560	<0.010	0.570	32	234	8.8	11
0820150009-19-7714153.0			17	0.18	0.480	<0.010	0.480	35	208	9.4	11
0820150011-07-7714003.1			14	0.20	0.660	<0.010	0.660	50	242	9.6	11
0820150001-04-7811057.4			--	--	--	--	--	--	--	--	11
0820150001-16-7814304.3			15	0.10	0.750	0.020	0.760	58	255	10.0	11
0820150003-20-7813452.4			14	0.30	0.130	<0.010	0.140	62	247	9.8	11
0820150005-30-7814552.6			16	0.40	0.260	0.010	0.270	61	221	10.2	11
0820150007-05-7816150.90			13	0.10	0.110	<0.010	0.120	55	216	7.8	11
0820150009-08-78115513			9.9	0.31	0.320	<0.010	0.320	44	226	9.2	11
0820150011-22-78094314			8.3	0.15	0.780	0.010	0.790	52	253	9.6	11

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0820150001-04-7911057.4			11	0.20	0.830	0.010	0.840	46	274	11.6	11
0820150003-28-79124577			10	0.09	0.660	0.010	0.660	29	265	8.7	11
0820150005-03-79115546			14	--	0.820	0.010	--	29	270	8.2	11
0820150006-14-791420107			10	0.06	0.910	0.010	0.910	25	259	7.9	11
0820150001-08-8011352.6			13	0.41	0.590	0.010	0.610	52	239	10.2	11
0820150005-14-8011553.6			12	0.54	--	0.030	--	61	223	8.0	11
0820150007-31-8013270.29			17	0.90	0.200	0.050	0.210	76	229	9.0	11
0820150001-22-8111215.7	--		11	0.29	0.690	0.030	0.690	56	264	11.4	11
0820150004-22-81104833	--		8.9	0.68	0.540	0.020	0.540	37	249	8.8	11
0820150008-12-81153221	--		15	0.50	0.620	0.130	0.620	29	245	7.4	11
0820150001-19-8209483.1	--		12	0.45	0.690	0.120	0.690	53	260	11.2	11
0820150005-12-8210326.1	--		10	1.30	0.420	0.190	0.420	48	221	8.9	11
0820150007-13-8210173.7	--		12	0.40	0.140	<0.060	0.140	38	212	8.1	11
0820150001-18-8313092.0	--		11	0.60	0.300	<0.060	0.300	49	227	10.7	11
0820150004-19-8309513.8	--		11	0.50	0.100	0.430	0.100	58	250	9.8	11
0820150008-30-8310081.8	--		13	0.20	--	0.050	<0.100	50	239	8.1	11
0820150001-25-8414185.5	--		12	0.30	0.400	<0.010	0.400	55	264	10.5	11
0820150004-20-8415401.3	--		12	0.30	--	0.100	<0.100	66	231	9.3	11
0820150008-17-8409520.29	--		13	0.20	0.100	0.040	0.100	54	226	7.4	11
0820150001-09-85112746	--		11	0.20	1.30	<0.010	1.30	37	284	10.0	11
0820150001-23-85160052	--		--	--	--	--	--	--	--	--	11
0820150004-30-85154555	--		10	0.40	0.700	0.050	0.700	43	267	7.4	11
0820150008-23-8514301.5	--		15	0.40	0.100	0.030	0.100	47	217	9.5	11
0820150002-12-8616207.4	--		8.3	0.10	0.500	0.020	0.500	55	266	10.8	11
0820150006-05-86132022	--		8.4	0.10	0.200	0.020	0.200	37	224	8.4	11
0820150008-07-8615005.5	--		11	--	0.200	--	0.200	36	218	8.0	11
0820150001-23-87120039	--		10	0.80	0.800	0.010	0.800	29	281	10.8	11
0820150005-07-87112213	--		15	0.20	0.200	0.010	0.200	35	249	9.2	11
0820150009-01-87163011	--		15	0.10	0.300	<0.010	0.300	33	238	8.3	11
0820150001-06-8815005.3	--		13	0.10	0.500	0.020	0.500	49	258	11.1	11
0820150005-10-8814340.50	--		16	0.60	--	0.010	<0.100	64	239	7.9	11
0820150008-30-8814241.1	--		14	0.10	--	<0.010	<0.100	61	226	10.3	11

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0											11
0820150001-10-8914230.50	--		14	0.50	--	0.020	<0.100	66	241	12.0	11
0820150005-10-8915400.94	--		13	0.10	--	0.020	<0.100	76	242	11.0	11
0820150002-07-9017081.3	--		11	0.10	0.100	0.010	0.100	79	264	10.6	11
0820150005-24-90153715	--		11	0.10	0.300	<0.010	0.300	45	232	7.7	11
0820150008-30-90145814	--		10	0.30	0.300	<0.010	0.300	31	225	8.1	11
0820150002-14-9109375.3	--		11	0.20	0.090	<0.010	0.100	51	250	9.2	11
0820150005-28-91154514	--		11	0.10	0.170	<0.010	0.180	34	227	8.7	11
0820150008-15-9110303.6	--		13	0.10	0.081	0.030	0.091	38	221	8.4	11
0820150001-30-920958103	--		14	0.10	0.620	0.020	0.620	27	295	9.9	11
0820150005-14-92122730	--		15	0.10	0.370	<0.010	0.370	34	261	8.6	11
0820150009-01-9214154.3	--		17	0.10	0.190	0.020	0.190	30	224	9.8	11
0820150001-28-93113013	<0.010		12	--	0.460	--	0.480	37	260	11.2	11
0820150009-01-9312151.2	<0.010		13	--	0.071	--	0.071	39	216	9.2	11
0820150008-17-9412453.6	<0.010		10	--	0.150	--	0.150	51	197	8.9	11
0820150008-17-9413003.6	<0.010		9.6	--	0.120	--	0.120	50	197	8.9	11
0820150002-06-9512054.9	<0.010		9.7	--	0.300	--	0.300	44	256	11.0	11
0820245009-15-91034567	--		1.7	1.10	0.050	0.020	0.110	2.2	60	--	11
0820245009-24-91135014	--		8.1	0.20	0.360	<0.010	0.360	20	224	7.7	11
0820245012-19-91193067	--		8.3	0.20	0.280	0.010	0.300	32	219	--	11
0820245012-20-911405424	--		6.2	0.50	0.400	0.030	0.420	17	249	9.1	11
0820245003-04-921400250	--		7.1	0.30	0.330	<0.010	0.350	13	199	9.6	11
0820245003-27-921930845	--		3.4	0.50	0.100	0.070	0.150	6.1	102	--	11
0820245003-28-921640200	--		16	0.10	0.450	0.030	0.450	24	239	6.5	11
0820245005-21-922130161	--		5.4	0.40	0.150	0.060	0.180	12	--	7.4	11
0820245001-19-930001--	--		12	--	--	--	--	41	237	--	11
0820245001-19-9312206.4	<0.010		3.2	--	0.210	--	0.220	9.3	84	8.0	11
0820245003-30-930001--	<0.010		10	--	0.220	--	0.220	37	219	--	11
0820245003-30-93113017	<0.010		5.7	--	0.240	--	0.240	21	132	8.6	11
0820245005-06-93145361	<0.010		6.6	--	0.500	--	0.500	25	174	--	11
0820245012-28-94142011	<0.010		7.3	--	0.270	--	0.270	43	197	--	11
0820245012-28-941440--	<0.010		7.5	--	0.250	--	0.250	42	204	--	11

Appendix C- Selected Constituent Values from Literature Search

Land Use Category/ Location	Additional Pollutants: Phosphorus Dissolved Orthophosphorus mg/l	Orthophosphorus as Phosphorus Dissolved mg/l	Chloride (Cl), mg/l	Nitrogen, Kjeldahl Total (TKN), mg/l	Nitrate Nitrogen Total (NO3), mg/l	Nitrogen, Ammonia Total (NH4), mg/l	Nitrite plus Nitrate, Total (NO2+NO3), mg/l	Sulfate (SO4), mg/l	Total Dissolved Solids (TDS), mg/l	Oxygen, Dissolved (DO), mg/l	
0820245012-29-94082529	<0.010		5.0	--	0.220	--	0.220	26	171	--	11
0820245012-29-94131623	<0.010		5.3	--	0.220	--	0.220	28	179	10.4	11
0820270009-20-911100423	--		5.2	0.90	0.570	0.080	0.600	12	124	--	11
0820270009-20-911310701	--		1.5	0.80	0.190	0.010	0.210	1.7	73	8.8	11
0820270009-20-911905223	--		1.7	0.80	0.190	<0.010	0.210	2.6	77	8.7	11
0820270012-20-9113301260	--		2.6	1.20	0.070	0.080	0.110	2.8	86	8.7	11
0820270012-20-911740536	--		3.6	0.90	0.150	0.050	0.200	9.4	113	8.8	11
0820270003-04-9208202850	--		2.2	1.30	0.060	0.050	0.120	2.4	60	--	11
0820270003-04-9210282900	--		3.0	0.80	0.420	0.040	0.470	4.2	87	8.8	11
0820270003-04-921715341	--		2.8	0.40	0.200	0.020	0.200	4.4	90	9.6	11
0820270003-27-922305248	--		7.3	0.50	0.281	0.100	0.371	10	117	--	11
0820270003-28-92144549	--		5.2	0.50	0.370	0.060	0.420	6.3	105	8.3	11
0820270005-27-921730202	--		4.0	0.90	0.370	0.030	0.400	8.2	117	8.2	11
0820270005-06-931005--	0.100		--	--	--	--	--	--	--	--	11
0820279009-20-9117302.0	--		2.1	1.00	0.078	0.040	0.098	2.6	90	--	11
0820279012-21-9116004.8	--		2.3	0.50	0.100	0.030	0.120	2.1	82	--	11
0820279002-24-9214452.8	--		1.6	0.80	0.080	0.070	0.140	2.3	59	9.3	11
0820279003-27-9215302.0	--		1.7	1.00	0.130	0.070	0.210	1.6	53	--	11
0820279003-28-9212451.7	--		2.2	1.00	0.110	0.050	0.150	2.0	77	6.2	11
0820279005-27-9204002.0	--		2.6	1.00	0.090	0.090	0.140	2.1	57	--	11
0820279006-02-9212006.0	--		2.9	0.80	--	0.090	<0.050	1.6	87	7.8	11
0820279010-25-9400010.20	0.050		0.80	--	0.200	--	0.210	1.3	63	6.8	11
0820279010-25-9408242.7	0.040		0.70	--	0.250	--	0.260	1.2	34	--	11
0820279010-25-940849--	0.040		0.70	--	0.230	18.0	0.230	1.1	34	--	11
0820279010-25-9412150.40	0.060		0.90	--	0.270	--	0.280	1.2	58	7.5	11
0820279010-25-9414250.60	0.050		0.80	--	0.210	--	0.220	1.2	62	6.8	11
0820279003-13-950100--	0.020		--	--	0.120	--	0.130	--	--	--	11
0820279003-13-9501172.5	0.030		--	--	0.100	--	0.110	--	--	--	11
0820279003-13-9513371.9	0.040		--	--	0.080	--	0.090	--	--	--	11
0820290009-16-91163559	--		15	1.30	0.470	0.040	0.490	26	142	7.1	11
0820290009-21-911100177	--		36	1.30	0.450	0.060	0.470	44	216	--	11
0820290012-21-911300285	--		62	1.60	4.15	0.060	4.20	86	466	9.1	11

Appendix C- Selected Constituent Values from Literature Search

Land Use Category/ Location	Additional Pollutants										
	Phosphorus Dissolved Orthophosphorus mg/l	Orthophosphorus as Phosphorus Dissolved mg/l	Chloride (Cl), mg/l	Nitrogen, Kjeldahl Total (TKN), mg/l	Nitrate Nitrogen Total (NO3), mg/l	Nitrogen, Ammonia Total (NH4), mg/l	Nitrite plus Nitrate, Total (NO2+NO3), mg/l	Sulfate (SO4), mg/l	Total Dissolved Solids (TDS), mg/l	Oxygen, Dissolved (DO), mg/l	
0820290012-23-911730116	--		15	0.70	0.500	0.060	0.580	19	209	9.3	11
0820290003-28-921330303	--		230	0.90	1.98	0.040	2.00	310	977	7.8	11
0820290003-28-921545624	--		210	0.70	4.97	0.050	5.00	310	1010	8.0	11
0820290003-29-92163041	--		35	0.50	0.720	0.100	0.810	57	248	8.0	11
0820290005-06-930001--	--		--	--	--	--	--	--	--	--	11
0820290005-06-9316002110	0.010		17	--	0.640	--	0.660	31	158	7.8	11
0820290005-07-930001--	--		--	--	--	--	--	--	--	--	11
0820290005-07-93111547	<0.010		36	--	0.550	--	0.570	39	197	8.7	11
0820290001-24-941549--	0.010		200	--	1.04	--	1.10	480	1190	8.7	11
0820290010-08-940835--	0.100		2.8	--	1.54	--	1.60	7.5	77	--	11
0820290010-08-941635--	--		--	--	--	--	--	--	--	--	11
0820290010-08-941715--	0.050		34	--	0.740	--	0.790	47	191	--	11
0820290010-08-941952--	0.060		49	--	0.490	--	0.530	100	306	--	11
0820290010-11-9411450.40	0.030		110	--	0.780	--	0.820	400	888	7.4	11
0820290003-13-950031--	0.040		--	--	0.280	--	0.300	--	--	--	11
0820290003-13-9509504.2	<0.010		--	--	0.110	--	0.110	--	--	8.1	11
0820290003-15-9513151.4	<0.010		--	--	0.510	--	0.520	--	--	8.5	11
0821152010-17-7713502.0			1200	0.94	1.66	0.190	1.70	170	2360	8.2	12
0821152011-28-7713152.0			1700	1.10	9.07	0.310	9.20	220	3240	7.8	12
0821152001-09-7812501.9			1400	1.40	13.8	0.180	14.0	330	2860	11.5	12
0821152002-23-7814001.7			1800	1.80	1.94	0.300	2.10	250	3410	13.1	12
0821152004-03-7813406.3			2000	2.90	1.27	0.410	1.60	260	3820	11.7	12
0821152005-15-7813151.4			1300	2.70	3.70	0.250	4.60	240	2580	9.7	12
0821152006-22-7814451.8			2200	1.80	0.210	0.120	0.270	280	4140	10.5	12
0821152008-09-7816302.2			1300	2.00	1.23	0.100	1.40	200	2580	4.4	12
0821152009-18-7813304.8			1200	1.20	0.740	0.150	0.780	160	2350	7.4	12
0821152010-30-78141514			330	1.50	1.21	0.330	1.30	78	782	6.8	12
0821152012-11-7813121.9			1800	2.00	14.6	0.290	15.0	290	3510	10.7	12
0821152001-25-7914105.5			2100	1.90	5.33	0.950	6.10	350	4040	11.3	12
0821152003-05-7911352.0			1800	1.60	8.44	0.510	9.10	330	3670	12.5	12

Appendix C- Selected Constituent Values from Literature Search

Land Use Category/ Location	Additional Pollutants										
	Phosphorus Dissolved Orthophosphorus mg/l	Orthophosphorus as Phosphorus Dissolved mg/l	Chloride (Cl), mg/l	Nitrogen, Kjeldahl Total (TKN), mg/l	Nitrate Nitrogen Total (NO3), mg/l	Nitrogen, Ammonia Total (NH4), mg/l	Nitrite plus Nitrate, Total (NO2+NO3), mg/l	Sulfate (SO4), mg/l	Total Dissolved Solids (TDS), mg/l	Oxygen, Dissolved (DO), mg/l	
0821152004-16-7912153.0			120	2.00	0.120	0.090	0.140	24	392	9.6	12
0821152005-21-7915502.4			2100	1.40	5.96	0.150	6.40	340	4030	7.9	12
0821152007-02-7915102.7			1900	1.40	5.93	0.180	6.40	300	3700	10.0	12
0821152008-14-7909501.1			1400	2.10	0.600	0.950	0.810	230	2720	4.3	12
0821152009-25-79101710			540	0.44	0.910	0.180	1.00	94	1180	7.4	12
0821152011-06-7913502.8			1900	1.80	5.25	0.350	5.60	270	3690	9.2	12
0821152012-17-7916221.7			1300	1.80	10.7	0.370	11.0	220	2600	11.8	12
0821152001-28-8015353.3			1400	0.62	6.15	0.270	6.30	230	2720	11.6	12
0821152003-10-8016032.3			1600	1.90	9.66	0.390	10.0	270	3100	13.6	12
0821152004-21-8016221.7			1500	2.20	7.96	0.130	8.20	230	2910	19.0	12
0821152006-02-8016181.7			1200	2.20	2.38	0.020	2.50	220	2430	13.5	12
0821152007-14-8018152.0			1000	1.60	1.46	0.190	1.60	170	2020	9.4	12
0821152008-26-8011193.5			1800	1.50	0.740	0.470	0.790	220	3340	7.0	12
0821152010-17-8011385.2			1000	1.10	1.21	0.120	1.30	130	1980	7.8	12
0821152011-17-8015452.1			1300	1.90	11.9	0.190	12.0	220	2540	12.8	12
0821152001-06-8111302.8			1500	1.00	12.8	0.350	13.0	250	2890	11.3	12
0821152002-09-8115309.0			460	0.96	5.03	0.480	5.30	95	1020	8.9	12
0821152003-16-8116458.5			490	1.80	5.30	0.400	5.60	96	1070	7.7	12
0821152005-05-811310333			16	1.50	2.24	0.00	2.30	22	172	6.6	12
0821152006-26-8109452.6			1300	1.60	4.11	0.380	4.20	160	2420	5.9	12
0821152007-28-8110583.0			1700	2.10	3.82	0.480	4.00	220	3190	5.2	12
0821152009-15-8110172.2			1400	2.10	5.22	0.720	5.50	200	2660	4.4	12
0821152010-20-8110302.7			730	1.60	3.78	0.380	3.90	150	1580	6.1	12
0821152001-12-8215472.7			1400	2.80	6.37	1.40	6.60	240	2770	10.3	12
0821152004-06-8210032.2			1800	2.70	5.96	0.680	6.40	280	3480	5.6	12
0821152005-25-820950530			25	1.50	0.460	0.430	0.800	11	133	6.8	12
0821152006-29-8211382.9			920	1.90	2.35	0.450	2.60	180	1880	3.9	12
0821152008-10-8211493.9			930	2.00	0.900	0.410	1.00	170	1920	7.4	12
0821152010-26-8210482.9				3.00						6.6	12
0821152002-03-8314002.2				1.80						11.4	12
0821152003-17-831200104				3.60						8.0	12
0821152004-26-831215188				2.40						8.5	12

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0821152006-09-83143511				1.20						6.0	12
0821152007-19-83113038				1.10						7.3	12
0821152012-13-8311242.1			1300	2.10	6.34	0.120	6.50	250	2620	7.0	12
0821152001-24-84112522			580	2.90	1.38	1.30	1.50	140	1270	8.6	12
0821152003-06-8411344.2			1600	2.20	3.72	0.340	4.70	290	3230	11.7	12
0821152004-24-8411303.0			1300	2.40	1.79	0.090	1.90	240	2680	8.6	12
0821152006-14-8416541.9			1000	1.90	0.790	0.050	0.800	190	2140	7.2	12
0821152008-09-8415300.66			2000	1.60	0.650	<0.010	0.700	280	3820	9.4	12
0821152012-05-8410351.7			2100	1.30	7.41	0.200	7.60	310	3970	11.0	12
0821152001-23-8513452.4			1200	1.50	5.27	0.340	5.50	200	2380	11.0	12
0821152003-13-8511002.1			1600	1.80	2.94	0.170	3.10	250	3100	10.4	12
0821152004-24-8511253.4			1200	1.10	1.38	0.140	1.40	190	2820	7.9	12
0821152006-11-8511352.0			1500	2.00	1.16	0.150	1.20	270	3010	7.4	12
0821152008-22-8510001.3			1300	1.80	--	0.110	<0.100	390	2900	6.9	12
0821152011-20-8511102.5			1700	2.20	2.47	0.240	2.50	270	3310	8.2	12
0821152001-08-86104060			200	1.90	1.43	0.490	1.50	44	429	12.5	12
0821152002-27-8609530.89			1900	1.50	3.06	0.110	3.10	370	3760	9.2	12
0821152005-07-8614072.2			2000	1.10		--	1.80	290	3780	6.8	12
0821152006-19-8611103.1			1000	1.20	1.16	0.110	1.20	180	2110	5.8	12
0821152008-19-8613252.7			1400	0.70	1.04	0.190	1.10	230	2740	6.4	12
0821152010-15-8617308.5			--	1.30	3.85	0.130	3.90	--	--	7.4	12
0821152012-05-8609462.0			1900	2.30	9.28	0.510	9.80	290	3620	8.6	12
0821152002-05-8711102.4			2700	1.40	2.53	0.220	2.60	380	5130	9.1	12
0821152005-13-8712306.0			1500	2.70	1.93	0.270	2.30	230	2880	7.9	12
0821152007-07-8715152.5			2200	1.60	0.720	0.180	0.800	360	4190	6.3	12
0821152008-31-87143020			970	1.70	0.740	0.180	0.800	180	1990	5.7	12
0821152011-19-8708301.9			1800	0.80	--	0.020	<0.100	290	3520	7.8	12
0821152001-11-88141510			1900	6.00	5.08	5.00	5.30	300	3720	12.5	12
0821152003-08-8812150.33			2100	2.20	2.78	0.180	2.90	330	4090	7.6	12
0821152005-04-8811001.4			800	1.80	1.94	0.930	2.30	180	1770	4.4	12
0821152007-12-8812002.7			770	1.30	0.540	0.210	0.600	130	1570	4.3	12

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0821152008-24-8811003.2			1000	1.10	0.450	0.200	0.500	190	2090	3.6	12
8064100				--		0	0			8.6	13
8064100				0.50		0.03	0		287	8.6	13
8064100				0.40		0.04	0		488	7.3	13
8064100				0.30		0.05	0		206	6.5	13
8064100				0.40		0.02	< 0.050		565	4.3	13
8064100				2.80		0.03	0		547	5.1	13
8064100				0.30		0.03	< 0.050		1350	2.9	13
8064100				0.30		< 0.010	0		140	8	13
8064100				0.40		0.01	0		283	9	13
8064100				0.30		0.03	0		302	9.7	13
8064100				0.30		0.02	0		399	11.2	13
8064100				0.20		0.02	0		374	10	13
8064100				0.70		0.06	3		256	10.3	13
8064100				0.40		0.04	1		245	10.1	13
8064100				0.20		0.05	0		395	7.4	13
8064100				0.80		0.08	7		221	8.7	13
8064100				0.60		0.03	6		316	7.4	13
8064100				0.50		0.04	3		303	7.2	13
8064100				0.40		0.05	0		205	7.8	13
8064100				1.10		0.04	0		394	6.2	13
8064100				0.70		0.04	3		241	6	13
8064100				0.50		0.03	0		166	5.3	13
8064100				0.50		< 0.010	< 0.050		481	5.2	13
8064100				0.40		0.03	< 0.050		611	3.7	13
8064100				0.30		0.03	< 0.050		890	4.4	13
8064100				0.50		< 0.015	0		185	8.3	13
8064100				0.40		< 0.015	0		258	9.6	13
8064100				0.40		0.03	0		218	10.4	13
8064100				0.60		0.03	0		233	10.9	13
8064100				0.30		0.04	0		368	9.2	13

Appendix C- Selected Constituent Values from Literature Search

Land Use Category/ Location	Additional Pollutants: Phosphorus Dissolved Orthophosphorus mg/l	Orthophosphorus as Phosphorus Dissolved mg/l	Chloride (Cl), mg/l	Nitrogen, Kjeldahl Total (TKN), mg/l	Nitrate Nitrogen Total (NO3), mg/l	Nitrogen, Ammonia Total (NH4), mg/l	Nitrite plus Nitrate, Total (NO2+NO3), mg/l	Sulfate (SO4), mg/l	Total Dissolved Solids (TDS), mg/l	Oxygen, Dissolved (DO), mg/l	
8064100				0.60		0.09	2		235	8.9	13
8064100				0.40		0.03	0		242	9.5	13
8064100				0.50		0.03	2		302		13
315801096282999				0.40		0.01	0		282	10.2	13
315801096282999				0.90		0.02	0				13
315801096282999				0.50		0.04	2		219		13
315801096282999				0.80		0.03	0		244		13
315801096282999				0.80		0.05	1		166	8.6	13
321017096420099				0.20		0.02	1		278	11	13
321017096420099				0.30		0.02	1		280	8.1	13
321017096420099				0.20		< 0.015	2		313	11.4	13
321017096420099				0.60		0.1	4		186	9.3	13
321017096420099				0.40		0.02	3		158		13
321313096415201				0.30		0.04	0		291	10.2	13
321313096415201				0.90		0.03	3		151		13
321313096415201				0.50		0.02	3		215	7.2	13
321313096415201				0.40		< 0.015	0		266	10.4	13
321313096415201				0.60		0.07	4		201	9.6	13
321441096442601				0.30		0.02	0		411	10.6	13
321441096442601				0.30		0.02	0		343	7.5	13
321441096442601				0.30		< 0.015	0		528	7.3	13
321441096442601				0.60		0.08	1			9.4	13
321441096442601				0.60		0.04	2		252		13
2101					0	0.1				9.3	14
2102			124.8		0	0		50	637	8.4	14

Source

1 Characterization of Nonpoint Sources and Loadings to Galveston Bay, GBNEP-15, March 1992
2 1994 Regional Assessment of Water Quality in the Nueces Coastal Basins, October 1994, mean values
3 Texas Aquatic Ecoregion Project, An Assessment of Least Disturbed Streams, TWC, 5/92
4 Seco Creek Water Quality Demonstration Project, Annual Project Report, Fiscal Year 1994
5 Analysis of Agricultural Nonpoint Pollution Control Options in the St. Albans Bay Watershed, USDA -ERS, 1987, mean values

6 The State of Texas Water Quality Inventory, 11th Edition, TWC, August 1992, LP 92-16, mean values
7 The State of Texas Water Quality Inventory, 10th Edition, TWC, June 1990, LP 90-06, mean values
8 The State of Texas Water Quality Inventory, 9th Edition, TWC, April 1988, LP 88-04, mean values
9 The State of Texas Water Quality Inventory, 8th Edition, TWC, October 1986, LP 86-07, mean values
10 The State of Texas Water Quality Inventory, 6th Edition, TDWR, LP 59, mean values
11 USGS Provisional Information, Seco Creek Watershed **Station no. is in the format 08202790(gage no.)03-28-92(date)1245(time)1.7(discharge).
12 USGS Provisional Information, Oso Creek Watershed **Station no. is in the format 08211520(gage no.)07-12-8(date)1200(time)2.7(discharge).
13 USGS Provisional Information, Chambers Creek Watershed
14 Final Report, Regional Assessment of Water Quality - Nueces River Basin, Nueces River Authority - October 1, 1994

Notes: -- Data not available.
NA represents Not Applicable
ND represents Not Detected
Values reported as 0 (zero) are actually below the detection limit of the laboratory at the time of testing.

Station Number	Date	Time	Discharge, Inst. Cubic Feet Per Second	Ametryn, Total (µg/l)	Atrazine Water Unfltrd Rec (µg/l)	Cyanazine, Total (µg/l)	Diazinon, Total (µg/l)	Disyston, Total (µg/l)	Endosulfan, Total (µg/l)	Ethion, Total (µg/l)	Lindane, Total (µg/l)	Malathion, Total (µg/l)
08201500	03-23-70	1430	18									
08201500	04-10-73	1545	10									
08201500	01-21-74	1435	7.4				ND				ND	ND
08201500	03-12-74	1200	4.5									
08201500	05-15-74	1500	20				ND				ND	ND
08201500	07-10-74	1200	3.1									
08201500	09-09-74	1200	15				ND				ND	ND
08201500	11-18-74	1520	24									
08201500	01-13-75	1540	20									
08201500	03-18-75	1400	24				ND				ND	ND
08201500	05-19-75	1445	9.0				ND				ND	ND
08201500	07-28-75	1335	21				ND				ND	ND
08201500	09-16-75	1400	5.3				ND				ND	ND
08201500	11-18-75	1315	1.9									
08201500	01-12-76	1430	1.4				ND			ND	ND	ND
08201500	03-08-76	1400	1.4									
08201500	05-03-76	1355	25									
08201500	07-26-76	1500	62									
08201500	09-27-76	1425	7.9				ND			ND	ND	ND
08201500	11-15-76	1355	20									
08201500	01-24-77	1430	30				ND		ND	ND	ND	ND
08201500	03-21-77	1335	22									
08201500	05-23-77	1335	70									
08201500	07-25-77	1325	8.0									
08201500	09-19-77	1415	3.0				ND			ND		ND
08201500	11-07-77	1400	3.1									
08201500	01-04-78	1105	7.4									
08201500	01-16-78	1430	4.3				ND		ND	ND	ND	ND
08201500	03-20-78	1345	2.4									
08201500	05-30-78	1455	2.6									
08201500	07-05-78	1615	0.90									
08201500	09-08-78	1155	13				ND		ND	ND	ND	ND
08201500	11-22-78	0943	14									
08201500	01-04-79	1105	7.4				ND		ND	ND	ND	ND
08201500	03-28-79	1245	77									
08201500	05-03-79	1155	46									

Station Number	Date	Time	Dis-charge, Inst. Cubic Feet Per Second	Ame-tryn, Total (µg/l)	Atra-zine Water Unfltrd Rec (µg/l)	Cyan-azine, Total (µg/l)	Di-azinon, Total (µg/l)	Di-syston, Total (µg/l)	Endo-sulfan, Total (µg/l)	Ethion, Total (µg/l)	Lindane, Total (µg/l)	Mala-thion, Total (µg/l)
08201500	06-14-79	1420	107									
08201500	01-08-80	1135	2.6				ND		ND	ND	ND	ND
08201500	05-14-80	1155	3.6									
08201500	07-31-80	1327	0.29				ND		ND	ND	ND	ND
08201500	01-22-81	1121	5.7				ND		ND	ND	ND	ND
08201500	04-22-81	1048	33									
08201500	08-12-81	1532	21				ND		ND	ND	ND	ND
08201500	01-19-82	0948	3.1				ND		ND	ND	ND	ND
08201500	05-12-82	1032	6.1									
08201500	07-13-82	1017	3.7				<0.01		<0.010	<0.01	<0.010	<0.01
08201500	01-18-83	1309	2.0				<0.01		<0.010	<0.01	<0.010	<0.01
08201500	04-19-83	0951	3.8									
08201500	08-30-83	1008	1.8				<0.01		<0.010	<0.01	<0.010	<0.01
08201500	01-25-84	1418	5.5				<0.01		<0.010	<0.01	<0.010	<0.01
08201500	04-20-84	1540	1.3									
08201500	08-17-84	0952	0.29				<0.01		<0.010	<0.01	<0.010	<0.01
08201500	01-09-85	1127	46				<0.01		<0.010	<0.01	<0.010	<0.01
08201500	01-23-85	1600	52	<0.10	<0.1	<0.10						
08201500	04-30-85	1545	55									
08201500	08-23-85	1430	1.5				<0.01		<0.010	<0.01	<0.010	<0.01
08201500	02-12-86	1620	7.4				<0.01		<0.010	<0.01	<0.010	<0.01
08201500	06-05-86	1320	22									
08201500	08-07-86	1500	5.5				<0.01	<0.01	<0.010	<0.01	<0.010	<0.01
08201500	01-23-87	1200	39				<0.01		<0.010	<0.01	<0.010	<0.01
08201500	05-07-87	1122	13									
08201500	09-01-87	1630	11				<0.01		<0.010	<0.01	<0.010	<0.01
08201500	01-06-88	1500	5.3				<0.01		<0.010	<0.01	<0.010	<0.01
08201500	05-10-88	1434	0.50									
08201500	08-30-88	1424	1.1				<0.01		<0.010	<0.01	<0.010	<0.01
08201500	01-10-89	1423	0.50				<0.01		<0.010	<0.01	<0.010	<0.01
08201500	05-10-89	1540	0.94									
08201500	02-07-90	1708	1.3				<0.01	<0.01	<0.010	<0.01	<0.010	<0.01
08201500	05-24-90	1537	15									
08201500	08-30-90	1458	14				<0.01	<0.01	<0.010	<0.01	<0.010	<0.01
08201500	02-14-91	0937	5.3				<0.01	<0.01	<0.010	<0.01	<0.010	<0.01
08201500	05-28-91	1545	14									
08201500	08-15-91	1030	3.6				<0.01	<0.01	<0.010	<0.01	<0.010	<0.01
08201500	01-30-92	0958	103				<0.01	<0.01	<0.010	<0.01	<0.010	<0.01
08201500	05-14-92	1227	30									

Appendix D - Pesticide Values from Literature Search

Station Number	Date	Time	Dis-charge, Inst. Cubic Feet Per Second	Ame-tryn, Total (µg/l)	Atra-zine Water Unfltrd Rec (µg/l)	Cyan-azine, Total (µg/l)	Di-azinon, Total (µg/l)	Di-syston, Total (µg/l)	Endo-sulfan, Total (µg/l)	Ethion, Total (µg/l)	Lindane, Total (µg/l)	Mala-thion, Total (µg/l)
08201500	09-01-92	1415	4.3				<0.01	<0.01	<0.010	<0.01	<0.010	<0.01
08201500	01-28-93	1130	13				<0.01	<0.01	<0.010	<0.01	<0.010	<0.01
08201500	09-01-93	1215	1.2				<0.01	<0.01	<0.010	<0.01	<0.010	<0.01
08201500	08-17-94	1245	3.6	<0.10	<0.1	<0.20						
08201500	08-17-94	1300	3.6	<0.10	<0.1	<0.20						
08201500	02-06-95	1205	4.9									
8211520	28415	1350	2.0									
8211520	28457	1315	2.0									
8211520	28499	1250	1.9									
8211520	28544	1400	1.7				0.12		ND	ND	0.14	ND
8211520	28583	1340	6.3									
8211520	28625	1315	1.4									
8211520	28663	1445	1.8									
8211520	28711	1630	2.2									
8211520	28751	1330	4.8									
8211520	28793	1415	14									
8211520	28835	1312	1.9				0.23		ND	ND	0.080	ND
8211520	28880	1410	5.5									
8211520	28919	1135	2.0				0.03		ND	ND	0.010	ND
8211520	28961	1215	3.0									
8211520	28996	1550	2.4				0.06		ND	ND	ND	ND
8211520	29038	1510	2.7									
8211520	29081	0950	1.1				0.57		ND	ND	ND	ND
8211520	29123	1017	10									
8211520	29165	1350	2.8									
8211520	29206	1622	1.7									
8211520	29248	1535	3.3				0.17		ND	ND	ND	ND
8211520	29290	1603	2.3									
8211520	29332	1622	1.7									
8211520	29374	1618	1.7									
8211520	29416	1815	2.0				0.07		ND	ND	ND	ND
8211520	29459	1119	3.5									
8211520	29511	1138	5.2									
8211520	29542	1545	2.1									
8211520	29592	1130	2.8									
8211520	29626	1530	9.0				0.01		<0.010	<0.01	<0.010	<0.01
8211520	29661	1645	8.5									

Appendix D - Pesticide Values from Literature Search

Station Number	Date	Time	Discharge, Inst. Cubic Feet Per Second	Ametryn, Total (µg/l)	Atrazine Water Unfltrd Rec (µg/l)	Cyanazine, Total (µg/l)	Diazinon, Total (µg/l)	Disyston, Total (µg/l)	Endosulfan, Total (µg/l)	Ethion, Total (µg/l)	Lindane, Total (µg/l)	Malathion, Total (µg/l)
8211520	29711	1310	333									
8211520	29763	0945	2.6									
8211520	29795	1058	3.0				0.55		ND	ND	0.010	0.01
8211520	29844	1017	2.2									

Station Number	Date	Time	Dis-Charge, Inst. Cubic Feet Per Second	Metho-myl, Total (µg/l)	Methyl Para-thion, Total (µg/l)	Phorate Total (µg/l)	Prome-tryn, Total (µg/l)	Sevin, Total (µg/l)	Sima-zine, Total (µg/l)	Tox-aphene, Total (µg/l)	2,4-D, Total (µg/l)	Cis 1,3-Di-Chloro-propene, Total (µg/l)	Trans-1,3-Di-Chloro-propene, Total (µg/l)
08201500	03-23-70	1430	18										
08201500	04-10-73	1545	10										
08201500	01-21-74	1435	7.4		ND						ND		
08201500	03-12-74	1200	4.5										
08201500	05-15-74	1500	20		ND					ND	ND		
08201500	07-10-74	1200	3.1										
08201500	09-09-74	1200	15		ND					ND	ND		
08201500	11-18-74	1520	24										
08201500	01-13-75	1540	20										
08201500	03-18-75	1400	24		ND					ND	ND		
08201500	05-19-75	1445	9.0		ND					ND	ND		
08201500	07-28-75	1335	21		ND					ND	0.01		
08201500	09-16-75	1400	5.3		ND					ND	ND		
08201500	11-18-75	1315	1.9										
08201500	01-12-76	1430	1.4		ND					ND	ND		
08201500	03-08-76	1400	1.4										
08201500	05-03-76	1355	25										
08201500	07-26-76	1500	62										
08201500	09-27-76	1425	7.9		ND					ND	ND		
08201500	11-15-76	1355	20										
08201500	01-24-77	1430	30		ND					ND	ND		
08201500	03-21-77	1335	22										
08201500	05-23-77	1335	70										
08201500	07-25-77	1325	8.0										
08201500	09-19-77	1415	3.0		ND						ND		
08201500	11-07-77	1400	3.1										
08201500	01-04-78	1105	7.4										
08201500	01-16-78	1430	4.3		ND					ND	ND		
08201500	03-20-78	1345	2.4										
08201500	05-30-78	1455	2.6										
08201500	07-05-78	1615	0.90										
08201500	09-08-78	1155	13		ND					ND	ND		
08201500	11-22-78	0943	14										
08201500	01-04-79	1105	7.4		ND					ND	ND		
08201500	03-28-79	1245	77										
08201500	05-03-79	1155	46										
08201500	06-14-79	1420	107										

Appendix D- Pesticide Values from Literature Search

Station Number	Date	Time	Dis-Charge, Inst. Cubic Feet Per Second	Metho-myl, Total (μg/l)	Methyl Para-thion, Total (μg/l)	Phorate Total (μg/l)	Prome-tryn, Total (μg/l)	Sevin, Total (μg/l)	Sima-zine, Total (μg/l)	Tox-aphene, Total (μg/l)	2,4-D, Total (μg/l)	Cis 1,3-Di-Chloro-propene, Total (μg/l)	Trans-1,3-Di-Chloro-propene, Total (μg/l)
08201500	01-08-80	1135	2.6		ND					ND	ND		
08201500	05-14-80	1155	3.6										
08201500	07-31-80	1327	0.29		ND					ND	ND		
08201500	01-22-81	1121	5.7		ND					ND	ND		
08201500	04-22-81	1048	33										
08201500	08-12-81	1532	21		ND					ND	ND		
08201500	01-19-82	0948	3.1		ND					ND	ND		
08201500	05-12-82	1032	6.1										
08201500	07-13-82	1017	3.7		<0.01					<1	<0.01		
08201500	01-18-83	1309	2.0		<0.01					<1	<0.01		
08201500	04-19-83	0951	3.8										
08201500	08-30-83	1008	1.8		<0.01					<1	<0.01		
08201500	01-25-84	1418	5.5		<0.01					<1	<0.01		
08201500	04-20-84	1540	1.3										
08201500	08-17-84	0952	0.29		<0.01					<1	<0.01		
08201500	01-09-85	1127	46		<0.01	<0.10				<1	<0.01		
08201500	01-23-85	1600	52	<2.0			<0.10	<2.0	<0.10				
08201500	04-30-85	1545	55										
08201500	08-23-85	1430	1.5		0.02					<1	<0.01		
08201500	02-12-86	1620	7.4		<0.01					<1	<0.01		
08201500	06-05-86	1320	22										
08201500	08-07-86	1500	5.5		<0.01	<0.01				<1	<0.01		
08201500	01-23-87	1200	39		<0.01					<1	<0.01		
08201500	05-07-87	1122	13										
08201500	09-01-87	1630	11		<0.01					<1	<0.01		
08201500	01-06-88	1500	5.3		<0.01					<1	<0.01		
08201500	05-10-88	1434	0.50										
08201500	08-30-88	1424	1.1		<0.01					<1	<0.01		
08201500	01-10-89	1423	0.50		<0.01					<1	<0.01		
08201500	05-10-89	1540	0.94										
08201500	02-07-90	1708	1.3		<0.01	<0.01				<1	<0.01		
08201500	05-24-90	1537	15										
08201500	08-30-90	1458	14		<0.01	<0.01				<1	<0.01		
08201500	02-14-91	0937	5.3		<0.01	<0.01				<1	<0.01		
08201500	05-28-91	1545	14										
08201500	08-15-91	1030	3.6		<0.01	<0.01				<1	<0.01		
08201500	01-30-92	0958	103		<0.01	<0.01				<1	<0.01		
08201500	05-14-92	1227	30										
08201500	09-01-92	1415	4.3		<0.01	<0.01				<1			

Appendix D- Pesticide Values from Literature Search

Station Number	Date	Time	Dis-Charge, Inst. Cubic Feet Per Second	Metho-myl, Total (µg/l)	Methyl Para-thion, Total (µg/l)	Phorate Total (µg/l)	Prome-tryn, Total (µg/l)	Sevin, Total (µg/l)	Sima-zine, Total (µg/l)	Tox-aphene, Total (µg/l)	2,4-D, Total (µg/l)	Cis 1,3-Di-Chloro-propene, Total (µg/l)	Trans-1,3-Di-Chloro-propene, Total (µg/l)
08201500	01-28-93	1130	13		<0.01	<0.01				<1	<0.01		
08201500	09-01-93	1215	1.2		<0.01	<0.01				<1	<0.01		
08201500	08-17-94	1245	3.6				<0.10		<0.10		<0.01	<0.2	<0.2
08201500	08-17-94	1300	3.6				<0.10		<0.10		<0.01	<0.2	<0.2
08201500	02-06-95	1205	4.9								<0.01		
8211520	28415	1350	2.0										
8211520	28457	1315	2.0										
8211520	28499	1250	1.9										
8211520	28544	1400	1.7		ND					ND	ND		
8211520	28583	1340	6.3										
8211520	28625	1315	1.4										
8211520	28663	1445	1.8										
8211520	28711	1630	2.2										
8211520	28751	1330	4.8										
8211520	28793	1415	14										
8211520	28835	1312	1.9		ND					ND	ND		
8211520	28880	1410	5.5										
8211520	28919	1135	2.0		ND					ND	0.01		
8211520	28961	1215	3.0										
8211520	28996	1550	2.4		ND					ND	ND		
8211520	29038	1510	2.7										
8211520	29081	0950	1.1		ND					ND	ND		
8211520	29123	1017	10										
8211520	29165	1350	2.8										
8211520	29206	1622	1.7										
8211520	29248	1535	3.3		ND					ND	0.02		
8211520	29290	1603	2.3										
8211520	29332	1622	1.7										
8211520	29374	1618	1.7										
8211520	29416	1815	2.0		ND					ND	ND		
8211520	29459	1119	3.5										
8211520	29511	1138	5.2										
8211520	29542	1545	2.1										
8211520	29592	1130	2.8										
8211520	29626	1530	9.0		0.05					<0.1	<0.01		
8211520	29661	1645	8.5										
8211520	29711	1310	333										

Appendix D- Pesticide Values from Literature Search

Station Number	Date	Time	Dis-Charge, Inst. Cubic Feet Per Second	Metho-myl, Total (µg/l)	Methyl Para-thion, Total (µg/l)	Phorate Total (µg/l)	Prome-tryn, Total (µg/l)	Sevin, Total (µg/l)	Sima-zine, Total (µg/l)	Tox-aphene, Total (µg/l)	2,4-D, Total (µg/l)	Cis 1,3-Di-Chloro-propene, Total (µg/l)	Trans-1,3-Di-Chloro-propene, Total (µg/l)
8211520	29763	0945	2.6										
8211520	29795	1058	3.0		ND					ND	0.02		
8211520	29844	1017	2.2										

08201500 Seco Creek @ Miller Ranch near Utopia, TX. (primarily rangeland)
08211520 Oso Creek at Corpus Christi, TX. (primarily cropland)
ND Not Detected by laboratory equipment at the time (initially reported as zero values)

Constituent	Common Brand Names (partial listing)	Pesticide Category	Detail
Ametryn	Evik 8W	Herbicide	
Atrazine	AAtrex, Atratol, Bicep, Lariet, etc.	Herbicide	Triazine Herbicide
Cyanazine	Bladex, Conquest, Extrazine	Herbicide	
Diazinon	Diazinon, Knox Out	Insecticide	
Disyston	DiSyston	Insecticide	
Endosulfan	Thiodan	Insecticide	
Ethion	Ethion 4	Insecticide	
Lindane	Lindane	Insecticide	
Malathion	Cythion, Malathion	Insecticide	
Methomyl	Lannate	Insecticide	
Methyl Parathion	Penncap	Insecticide	Organophosphorus Insecticide
Phorate	AAStar, Thimet	Insecticide	
Prometryn	Pramitol	Herbicide	
Carbaryl	Sevin	Insecticide	Carbamate Insecticide
Simazene	Aquazine, Pramitol, Princep	Herbicide	
Toxaphene	Toxaphene	Insecticide	Organochlorine Insecticide
2,4-D	Crossbow, Landmaster, Tordon, etc.	Herbicide	
1,3 Dichloropropene	Telone	Fungicide	

Appendix E- TNRCC Waste Permits

(ACQUIRED FEBRUARY 1995)

PERMIT NUMBER	CLIENT DOING BUSINESS AS NAME	STREAM SEGMENT I.D.	COUNTY	PERMIT CATEGORY	EXTENSION OUTFALL
WQ0011624-001	ARANSAS CO MUD 001	2473	Aransas	Public Domestic	OTFL 001
WQ0002691-000	ARANSAS CO MUD 001	2473	Aransas	Industrial	OTFL 001
WQ0011280-001	ARANSAS COUNTY AIRPORT	2472	Aransas	Public Domestic	OTFL 001
WQ0002077-000	DEGUSSA CORPORATION	2483	Aransas	Industrial	OTFL 001 (REPLACES 003)
WQ0002010-000	HERNDON MARINE PRODUCTS INC.	2483	Aransas	Industrial	OTFL 001
WQ0002010-000	HERNDON MARINE PRODUCTS INC.	2483	Aransas	Industrial	OTFL 002
WQ0010669-001	LAMAR WSC	2471	Aransas	Private Domestic	OTFL 001
WQ0002007-000	LIBERTY SEAFOOD INC.	2483	Aransas	Industrial	OTFL 001
WQ0010054-001	ROCKPORT CITY OF	2471	Aransas	Public Domestic	SOIL MON 301 ANN 18-30
WQ0010054-001	ROCKPORT CITY OF	2471	Aransas	Public Domestic	SOIL MON 201 ANN 6-18
WQ0010054-001	ROCKPORT CITY OF	2471	Aransas	Public Domestic	OTFL 001
WQ0010054-001	ROCKPORT CITY OF	2471	Aransas	Public Domestic	SOIL MON 101 ANN 0-6
WQ0010124-002	BEEVILLE CITY OF	2004	Bee	Public Domestic	OTFL 002 MOORE STREET PLANT
WQ0002788-000	INTERCONTINENTAL ENERGY CORP	2104	Bee	Industrial	OTFL 001 IEC PAWNEE MINE
WQ0010748-001	PETTUS MUD	2002	Bee	Public Domestic	OTFL 001
WQ0010084-001	UTILITY BOARD OF FALFURRIAS	2492	Brooks	Public Domestic	SOIL MON(101) ANNUAL
WQ0010084-001	UTILITY BOARD OF FALFURRIAS	2492	Brooks	Public Domestic	OTFL 001
WQ0002818-000	CHEVRON U.S.A. INC.	2492	Duval	Industrial	OTFL 001 PALANGANA URAN. OPER.
WQ0010067-001	DUVAL CO C&RD	2492	Duval	Public Domestic	OTFL 001 BENAVIDES
WQ0010270-001	DUVAL CO C&RD	2492	Duval	Public Domestic	OTFL 001 SAN DIEGO
WQ0010067-001	DUVAL CO C&RD	2492	Duval	Public Domestic	SOIL MON101 ANNUAL
WQ0010088-001	FREER WCID	2104	Duval	Public Domestic	OTFL 001
WQ0010536-002	ALICE CITY OF	2492	Jim Wells	Public Domestic	OTFL 002 SOUTHSIDE PLANT
WQ0010536-004	ALICE CITY OF	2492	Jim Wells	Public Domestic	OTFL 004 EASTSIDE PLANT
WQ0003552-000	COASTAL STATES CRUDE GATHERIN	2492	Jim Wells	Industrial	FALFURRIAS TERMINAL & STATION
WQ0003172-000	HENRY P KNOLLE FARMS	2102	Jim Wells	Agricultural	SOIL MON 201 ANN 6-18 INCH
WQ0003172-000	HENRY P KNOLLE FARMS	2102	Jim Wells	Agricultural	SOIL MON 301 ANN 18-30
WQ0003172-000	HENRY P KNOLLE FARMS	2102	Jim Wells	Agricultural	SOIL MON 101 ANN 0-6 INCH
WQ0003172-000	HENRY P KNOLLE FARMS	2102	Jim Wells	Agricultural	DAIRY FARM 900 KNOLLE FARMS
WQ0003330-000	HOWELL JESSE W	2492	Jim Wells	Agricultural	SOIL MON 101 ANN 0-6
WQ0003330-000	HOWELL JESSE W	2492	Jim Wells	Agricultural	SOIL MON 201 ANN 6-18
WQ0003330-000	HOWELL JESSE W	2492	Jim Wells	Agricultural	SOIL MON 301 ANN 18-30
WQ0003330-000	HOWELL JESSE W	2492	Jim Wells	Agricultural	CATTLE FEEDLOT 10000 HEAD
WQ0003009-000	KNOLLE CATTLE COMPANY	2102	Jim Wells	Agricultural	SOIL MONITORING(101)ANNUAL
WQ0003009-000	KNOLLE CATTLE COMPANY	2102	Jim Wells	Agricultural	DAIRY FARM 650
WQ0010592-001	ORANGE GROVE CITY OF	2204	Jim Wells	Public Domestic	CITY OF ORANGE GROVE - OTFL 001
WQ0010253-001	PREMONT CITY OF	2492	Jim Wells	Public Domestic	OTFL 001
WQ0010253-001	PREMONT CITY OF	2492	Jim Wells	Public Domestic	SOIL MONITORING INPT 101
WQ0003435-000	SANDIA AGRICULTURAL ENTP INC	2102	Jim Wells	Agricultural	SOIL MON 201 ANN 6-18 IN
WQ0003435-000	SANDIA AGRICULTURAL ENTP INC	2102	Jim Wells	Agricultural	SOIL MON 301 ANN 18-30 IN
WQ0003435-000	SANDIA AGRICULTURAL ENTP INC	2102	Jim Wells	Agricultural	DAIRY FARM 450 HEAD
WQ0003435-000	SANDIA AGRICULTURAL ENTP INC	2102	Jim Wells	Agricultural	SOIL MON 101 ANN 0-6 IN
WQ0003463-000	WOHLGEMUTH PAUL	2492	Jim Wells	Agricultural	SOIL MON 101 ANNUAL 0-6
WQ0003463-000	WOHLGEMUTH PAUL	2492	Jim Wells	Agricultural	OTFL 001/DAIRY FARM 500 HEAD

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PERMIT NUMBER	CLIENT DOING BUSINESS AS NAME	STREAM SEGMENT I.D.	COUNTY	PERMIT CATEGORY	EXTENSION OUTFALL
WQ0003463-000	WOHLGEMUTH PAUL	2492	Jim Wells	Agricultural	SOIL MON 301 ANN 12-24
WQ0003463-000	WOHLGEMUTH PAUL	2492	Jim Wells	Agricultural	SOIL MON 201 ANNUAL 6-12
WQ0013361-001	SARITA SEWER SERVICE AND WSC	2492	Kenedy	Private Domestic	OTFL 001 TOWN OF SARITA
WQ0001837-000	KING RANCH INC.	2492	Kleberg	Agricultural	CATTLE FEEDLOT 20000
WQ0010696-001	KINGSVILLE CITY OF	2492	Kleberg	Public Domestic	Soil Mon 101 ANN 0-6
WQ0010696-001	KINGSVILLE CITY OF	2492	Kleberg	Public Domestic	Soil Mon 301 ANN 18-30
WQ0010696-001	KINGSVILLE CITY OF	2492	Kleberg	Public Domestic	OTFL 001 PLANT 1
WQ0010696-002	KINGSVILLE CITY OF	2492	Kleberg	Public Domestic	Soil Mon 301 ANN 18-30
WQ0010696-002	KINGSVILLE CITY OF	2492	Kleberg	Public Domestic	CITY OF KINGSVILLE - OTFL 002 PLANT 2
WQ0010696-002	KINGSVILLE CITY OF	2492	Kleberg	Public Domestic	Soil Mon 101 ANN 0-6
WQ0010696-001	KINGSVILLE CITY OF	2492	Kleberg	Public Domestic	Soil Mon 201 ANN 6-18
WQ0010696-002	KINGSVILLE CITY OF	2492	Kleberg	Public Domestic	Soil Mon 201 ANN 6-18
WQ0013374-001	KLEBERG COUNTY	2492	Kleberg	Public Domestic	OTFL 001 - KLEBERG COUNTY
WQ0011515-001	RIVIERA ISD	2492	Kleberg	Public Domestic	SOIL MONITORING 101(ANNUAL)
WQ0011515-001	RIVIERA ISD	2492	Kleberg	Public Domestic	OTFL 001 SCHOOL
WQ0013344-001	U.S. Department of the Interi	2491	Kleberg	Public Domestic	OTFL 001 PADRE ISLAND NATL'
WQ0012035-001	US Dept. of The Navy	2492	Kleberg	Public Domestic	OTFL 001 Kingsville Naval Air Station Plant
WQ0001353-000	DIAMOND SHAMROCK REFINING AND	2106	Live Oak	Industrial	OTFL 001 PETROLEUM REFINERY
WQ0001353-000	DIAMOND SHAMROCK REFINING AND	2106	Live Oak	Industrial	OTFL 005 PETROLEUM REFINERY
WQ0001353-000	DIAMOND SHAMROCK REFINING AND	2106	Live Oak	Industrial	SOIL MON 101 ANN
WQ0001353-000	DIAMOND SHAMROCK REFINING AND	2106	Live Oak	Industrial	OTFL 004 PETROLEUM REFINERY
WQ0001353-000	DIAMOND SHAMROCK REFINING AND	2106	Live Oak	Industrial	OTFL 002 PETROLEUM REFINERY
WQ0001353-000	DIAMOND SHAMROCK REFINING AND	2106	Live Oak	Industrial	OTFL 003 PETROLEUM REFINERY
WQ0001353-000	DIAMOND SHAMROCK REFINING AND	2106	Live Oak	Industrial	OTFL 006 PETROLEUM REFINERY
WQ0002945-000	EVEREST EXPLORATION INC.	2103	Live Oak	Industrial	OTFL 001 MT. LUCAS PLANT(POST)
WQ0010455-001	GEORGE WEST CITY OF	2103	Live Oak	Public Domestic	SOIL MON ANN 101
WQ0010455-001	GEORGE WEST CITY OF	2103	Live Oak	Public Domestic	OTFL 001
WQ0010301-001	THREE RIVERS CITY OF	2106	Live Oak	Public Domestic	OTFL 001 City of Three Rivers
WQ0013461-001	US DEPT OF JUSTICE	2116	Live Oak	Public Domestic	SOIL MONITORING(3 RIVERS)ANNUL
WQ0013461-001	US DEPT OF JUSTICE	2116	Live Oak	Public Domestic	OTFL 001 THREE RIVERS FACILITY
WQ0013543-001	MCMULLEN CO WCID 001	2117	McMullen	Public Domestic	OTFL 001
WQ0013100-001	Texas Parks & Wildlife Dept	2116	McMullen	Public Domestic	OTFL 001 CHOKE CANYON/CALLIHAM
WQ0010140-001	Agua Dulce City of	2204	Nueces	Public Domestic	OTFL 001 City of Agua Dulce
WQ0002070-000	AMERADA HESS CORPORATION	2484	Nueces	Industrial	OTFL 001 Corpus Christi Terminal
WQ0000349-000	AMERICAN CHROME & CHEMICALS	2484	Nueces	Industrial	INPT 101 process
WQ0000349-000	AMERICAN CHROME & CHEMICALS	2484	Nueces	Industrial	INPT 201 chromic oxide
WQ0000349-000	AMERICAN CHROME & CHEMICALS	2484	Nueces	Industrial	OTFL 001 mixed wastewater
WQ0000656-000	AMERICAN PETROFINA PIPE LINE	2481	Nueces	Industrial	OTFL 003 HARBOR ISLAND TERM
WQ0000656-000	AMERICAN PETROFINA PIPE LINE	2481	Nueces	Industrial	OTFL 002 HARBOR ISLAND TERM
WQ0000656-000	AMERICAN PETROFINA PIPE LINE	2481	Nueces	Industrial	OTFL 004 HARBOR ISLAND TERM
WQ0002291-000	APPLIED INDUSTRIAL MATERIALS	2484	Nueces	Industrial	OTFL 001 - APPLIED INDUSTRIAL MATERIALS
WQ0010427-001	BISHOP CITY OF	2492	Nueces	Public Domestic	OTFL 001
WQ0011754-001	BISHOP CONSOLIDATED ISD	2204	Nueces	Public Domestic	OTFL 001
WQ0003318-000	CELANESE ENGINEERING RESINS	2484	Nueces	Industrial	OTFL 001
WQ0000579-000	CELANESE ENGINEERING RESINS	2492	Nueces	Industrial	OTFL 001 CHEMICAL MFG PLANT
WQ0000579-000	CELANESE ENGINEERING RESINS	2492	Nueces	Industrial	INPT 101 CHEMICAL MFG PLANT
WQ0000579-000	CELANESE ENGINEERING RESINS	2492	Nueces	Industrial	OTFL 002
WQ0003318-000	CELANESE ENGINEERING RESINS	2484	Nueces	Industrial	OTFL 002

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PERMIT NUMBER	CLIENT DOING BUSINESS AS NAME	STREAM SEGMENT I.D.	COUNTY	PERMIT CATEGORY	EXTENSION OUTFALL
WQ0000311-000	CENTEX CEMENT CORP	2482	Nueces	Industrial	OTFL 001 containment/ evaporation ponds
WQ0000311-000	CENTEX CEMENT CORP	2482	Nueces	Industrial	OUTFALL 101 PRECIPITATOR
WQ0001490-000	CENTRAL POWER & LIGHT COMPANY	2485	Nueces	Industrial	CP&L - OTFL 001 BARNEY M DAVIS SES
WQ0001490-000	CENTRAL POWER & LIGHT COMPANY	2485	Nueces	Industrial	CP&L - INPT 201 BARNEY M DAVIS SES
WQ0001244-000	CENTRAL POWER & LIGHT COMPANY	2482	Nueces	Industrial	OTFL 001 NUECES BAY SES
WQ0001255-000	CENTRAL POWER & LIGHT COMPANY	2101	Nueces	Industrial	OTFL 001 - CENTRAL POWER & LIGHT COMPANY
WQ0001244-000	CENTRAL POWER & LIGHT COMPANY	2482	Nueces	Industrial	INPT 101 NUECES BAY SES
WQ0001255-000	CENTRAL POWER & LIGHT COMPANY	2101	Nueces	Industrial	OTFL 002 - CENTRAL POWER & LIGHT COMPANY
WQ0001490-000	CENTRAL POWER & LIGHT COMPANY	2485	Nueces	Industrial	CP&L - INPT 101 BARNEY M DAVIS SES
WQ0001244-000	CENTRAL POWER & LIGHT COMPANY	2482	Nueces	Industrial	INPT 201 NUECES BAY PWR STA
WQ0000467-000	CHAMPLIN REFINING & CHEMICALS	2484	Nueces	Industrial	OTFL 001 CORPUS CHRISTI REFINERY
WQ0000467-000	CHAMPLIN REFINING & CHEMICALS	2484	Nueces	Industrial	OTFL 002 CORPUS CHRISTI REFINERY
WQ0000467-000	CHAMPLIN REFINING & CHEMICALS	2484	Nueces	Industrial	OTFL 003 CORPUS CHRISTI REFINERY
WQ0003562-000	CITGO REFINING & CHEMICALS IN	2484	Nueces	Industrial	OTFL 003 PORT AVENUE TERMINAL
WQ0003562-000	CITGO REFINING & CHEMICALS IN	2484	Nueces	Industrial	OTFL 002 PORT AVENUE TERMINAL
WQ0003562-000	CITGO REFINING & CHEMICALS IN	2484	Nueces	Industrial	OTFL 001 PORT AVENUE TERMINAL
WQ0002614-000	CITGO REFINING AND CHEMICALS	2484	Nueces	Industrial	OTFL 002 DEEP SEA TERMINAL
WQ0002614-000	CITGO REFINING AND CHEMICALS	2484	Nueces	Industrial	OTFL 001 DEEP SEA TERMINAL
WQ0011689-001	COASTAL BEND YOUTH CITY INC.	2204	Nueces	Private Domestic	OTFL 001
WQ0002540-000	COASTAL REFINING & MARKETING	2484	Nueces	Industrial	COASTAL REFINING & MARKETING - OTFL 001
WQ0000465-000	COASTAL REFINING & MARKETING	2484	Nueces	Industrial	OTFL 004 CORPUS CHRISTI REFINERY
WQ0000465-000	COASTAL REFINING & MARKETING	2484	Nueces	Industrial	OTFL 003 CORPUS CHRISTI REFINERY
WQ0000465-000	COASTAL REFINING & MARKETING	2484	Nueces	Industrial	OTFL 002 CORPUS CHRISTI REFINERY
WQ0000465-000	COASTAL REFINING & MARKETING	2484	Nueces	Industrial	OTFL 001 CORPUS CHRISTI REFINERY
WQ0003548-000	COASTAL STATES CRUDE GATHERIN	2484	Nueces	Industrial	OTFL 003 Treated tank bottom\Stormwater
WQ0003549-000	COASTAL STATES CRUDE GATHERIN	2484	Nueces	Industrial	OTFL 002 - COASTAL STATES CRUDE GATHERING CO.
WQ0003549-000	COASTAL STATES CRUDE GATHERIN	2484	Nueces	Industrial	OTFL 001 - COASTAL STATES CRUDE GATHERING CO.
WQ0003548-000	COASTAL STATES CRUDE GATHERIN	2484	Nueces	Industrial	OTFL 001 Stormwater
WQ0003062-000	COASTAL STATES CRUDE GATHERIN	2484	Nueces	Industrial	OTFL 001
WQ0003548-000	COASTAL STATES CRUDE GATHERIN	2484	Nueces	Industrial	OTFL 002 Stormwater
WQ0010401-006	CORPUS CHRISTI CITY OF	2101	Nueces	Public Domestic	OTFL 006 ALLISON PLANT
WQ0010401-009	CORPUS CHRISTI CITY OF	2491	Nueces	Public Domestic	OTFL 009 WHITE CAP PLANT
WQ0010401-008	CORPUS CHRISTI CITY OF	2491	Nueces	Public Domestic	CORPUS CHRISTI - 008 FLOUR BLUFF LAGUNA MADRE
WQ0010401-003	CORPUS CHRISTI CITY OF	2485	Nueces	Public Domestic	SOIL MON 303 ANN 18-30
WQ0010401-005	CORPUS CHRISTI CITY OF	2484	Nueces	Public Domestic	OTFL 005 BROADWAY PLANT
WQ0010401-004	CORPUS CHRISTI CITY OF	2485	Nueces	Public Domestic	OTFL 004 CORPUS CHRISTI/ OSO PLANT
WQ0010401-003	CORPUS CHRISTI CITY OF	2485	Nueces	Public Domestic	SOIL MON 103 ANN 0-6
WQ0010401-003	CORPUS CHRISTI CITY OF	2485	Nueces	Public Domestic	OTFL 003 WESTSIDE PLANT
WQ0010401-003	CORPUS CHRISTI CITY OF	2485	Nueces	Public Domestic	SOIL MON 203 ANN 6-18
WQ0002857-000	DIAMOND SHAMROCK REFINING AND	2484	Nueces	Industrial	OTFL 001
WQ0002857-000	DIAMOND SHAMROCK REFINING AND	2484	Nueces	Industrial	Otfl 003
WQ0002857-000	DIAMOND SHAMROCK REFINING AND	2484	Nueces	Industrial	Otfl 002
WQ0011541-001	DRISCOLL CITY OF	2204	Nueces	Public Domestic	OTFL 001
WQ0000314-000	ENCYCLE/TEXAS INC.	2484	Nueces	Industrial	OTFL 002 CORPUS CHRISTI PLANT
WQ0000314-000	ENCYCLE/TEXAS INC.	2484	Nueces	Industrial	OTFL 001 CORPUS CHRISTI PLANT
WQ0002506-000	FARRELL-COOPER MINING COMPANY	2484	Nueces	Industrial	OTFL 001
WQ0003450-000	HOECHST CELANESE CORPORATION	2485	Nueces	Industrial	OTFL 002
WQ0002083-000	HOECHST CELANESE CORPORATION	2492	Nueces	Industrial	OTFL 001

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PERMIT NUMBER	CLIENT DOING BUSINESS AS NAME	STREAM SEGMENT I.D.	COUNTY	PERMIT CATEGORY	EXTENSION OUTFALL
WQ0003450-000	HOECHST CELANESE CORPORATION	2485	Nueces	Industrial	OTFL 001
WQ0003137-000	JAVELINA COMPANY	2484	Nueces	Industrial	OTFL 001 JAVELINA COMPANY
WQ0003137-000	JAVELINA COMPANY	2484	Nueces	Industrial	INPT 101 JAVELINA COMPANY
WQ0003137-000	JAVELINA COMPANY	2484	Nueces	Industrial	INPT 201 JAVELINA COMPANY
WQ0002774-000	KOCH CARBON INC	2484	Nueces	Industrial	OTFL 001 CORPUS CHRISTI COKE S
WQ0002578-000	KOCH GATHERING SYSTEMS INC.	2484	Nueces	Industrial	OTFL 001 CORPUS CHRISTI TERM.
WQ0000531-000	KOCH REFINING COMPANY	2484	Nueces	Industrial	OTFL 005 WEST PLANT
WQ0000531-000	KOCH REFINING COMPANY	2484	Nueces	Industrial	OTFL 007
WQ0000531-000	KOCH REFINING COMPANY	2484	Nueces	Industrial	OTFL 008
WQ0000531-000	KOCH REFINING COMPANY	2484	Nueces	Industrial	OTFL 004
WQ0000531-000	KOCH REFINING COMPANY	2484	Nueces	Industrial	OTFL 001 1st of 4 phases
WQ0000531-000	KOCH REFINING COMPANY	2484	Nueces	Industrial	OTFL 002
WQ0000531-000	KOCH REFINING COMPANY	2484	Nueces	Industrial	OTFL 009
WQ0000531-000	KOCH REFINING COMPANY	2484	Nueces	Industrial	OTFL 003
WQ0000531-000	KOCH REFINING COMPANY	2484	Nueces	Industrial	OTFL 006 NORTH
WQ0012731-001	M-I DRILLING FLUIDS COMPANY	2501	Nueces	Private Domestic	OTFL 001 Harbor Island Plant
WQ0011712-001	MCDERMOTT INCORPORATED	2481	Nueces	Private Domestic	OTFL 001
WQ0010846-001	NUECES CO WCID 004	2481	Nueces	Public Domestic	OTFL 001 MUSTANG ISLAND NORTH
WQ0010846-002	NUECES CO WCID 004	2481	Nueces	Public Domestic	OTFL 002 Dist. Mustang Island South Plant
WQ0011583-001	NUECES CO WCID 005	2204	Nueces	Public Domestic	OTFL 001 BANQUETE PLANT
WQ0002075-000	Oxy Petrochemicals Inc	2485	Nueces	Industrial	OTFL 002
WQ0002075-000	Oxy Petrochemicals Inc	2485	Nueces	Industrial	OTFL 001
WQ0002075-000	Oxy Petrochemicals Inc	2485	Nueces	Industrial	INPT 201
WQ0002075-000	Oxy Petrochemicals Inc	2485	Nueces	Industrial	INPT 101
WQ0002075-000	Oxy Petrochemicals Inc	2485	Nueces	Industrial	OTFL 003
WQ0010261-001	ROBSTOWN CITY OF	2485	Nueces	Public Domestic	OTFL 001
WQ0011134-001	ROLOFF EVANGELISTIC ENTP INC	2485	Nueces	Public Domestic	OTFL 001 REBEKAH HOME FOR GIRLS
WQ0000457-000	SOUTHWESTERN REFINING CO. IN	2484	Nueces	Industrial	OTFL 004 (Terminal 3 area)
WQ0000457-000	SOUTHWESTERN REFINING CO. IN	2484	Nueces	Industrial	OTFL 003 (Terminal 2 area)
WQ0000457-000	SOUTHWESTERN REFINING CO. IN	2484	Nueces	Industrial	OTFL 006
WQ0000457-000	SOUTHWESTERN REFINING CO. IN	2484	Nueces	Industrial	OTFL 005
WQ0000457-000	SOUTHWESTERN REFINING CO. IN	2484	Nueces	Industrial	OTFL 002 (Termianl 1 area)
WQ0000457-000	SOUTHWESTERN REFINING CO. IN	2484	Nueces	Industrial	OTFL 007
WQ0000457-000	SOUTHWESTERN REFINING CO. IN	2484	Nueces	Industrial	OTFL 008
WQ0000457-000	SOUTHWESTERN REFINING CO. IN	2484	Nueces	Industrial	OTFL 001
WQ0011205-001	TENNESSEE PIPELINE CONSTRTN C	2485	Nueces	Private Domestic	OTFL 001 CUDDIHY AIRFIELD PLT.
WQ0011205-001	TENNESSEE PIPELINE CONSTRTN C	2485	Nueces	Private Domestic	SOIL MON 101 ANN 0-6 INCHES
WQ0011205-001	TENNESSEE PIPELINE CONSTRTN C	2485	Nueces	Private Domestic	SOIL MON 201 ANN 6-18 INCH
WQ0011205-001	TENNESSEE PIPELINE CONSTRTN C	2485	Nueces	Private Domestic	SOIL MON 301 ANN 18-30 INCH
WQ0011345-001	TEXAS A&M UNIVERSITY SYSTEM	2485	Nueces	Public Domestic	OTFL 001 RESEARCH & EXTENSION
WQ0003646-000	Texas A&M University	2491	Nueces	Industrial	OTFL 001
WQ0002888-000	Texs Ecologists Inc.	2492	Nueces	Industrial	OTFL 001
WQ0002888-000	Texs Ecologists Inc.	2492	Nueces	Industrial	OTFL 002
WQ0002888-000	Texs Ecologists Inc.	2492	Nueces	Industrial	OTFL 003
WQ0002720-000	TRIFINERY INC.	2484	Nueces	Industrial	OTFL 002 CORPUS CHRISTI
WQ0002720-000	TRIFINERY INC.	2484	Nueces	Industrial	OTFL 001 CORPUS CHRISTI
WQ0002317-000	US Dept. of The Navy	2481	Nueces	Industrial	OTFL 001 Corpus/Sanitary/SW
WQ0002317-000	US Dept. of The Navy	2481	Nueces	Industrial	OTFL 101 Corpus/treated process/sanitary/SW

PERMIT NUMBER	CLIENT DOING BUSINESS AS NAME	STREAM SEGMENT I.D.	COUNTY	PERMIT CATEGORY	EXTENSION OUTFALL
WQ0001909-000	VALERO REFINING CO	2484	Nueces	Industrial	OTFL 002 Corpus Plt/Stormwater
WQ0001207-000	KOCH GATHERING SYSTEMS INC	2481	San Patricio	Industrial	OTFL 004 INGLESIDE TERMINAL
WQ0001207-000	KOCH GATHERING SYSTEMS INC	2481	San Patricio	Industrial	OTFL 002 INGLESIDE TERMINAL
WQ0001207-000	KOCH GATHERING SYSTEMS INC	2481	San Patricio	Industrial	OTFL 003 INGLESIDE TERMINAL
WQ0001207-000	KOCH GATHERING SYSTEMS INC	2481	San Patricio	Industrial	OTFL 001 INGLESIDE TERMINAL
WQ0001497-000	LYKES BROS. INC. FEED YARD	2102	San Patricio	Agricultural	CATTLE FEEDLOT 10500
WQ0001651-000	E I DU PONT DE NEMOURS & CO.	2481	San Patricio	Industrial	OTFL 002 CHEMICAL MFG PLANT
WQ0001651-000	E I DU PONT DE NEMOURS & CO.	2481	San Patricio	Industrial	OTFL 001 CHEMICAL MFG PLANT
WQ0001909-000	VALERO REFINING CO	2484	Nueces	Industrial	OTFL 006 Corpus Plt/Stormwater
WQ0001909-000	VALERO REFINING CO	2484	Nueces	Industrial	OTFL 008 Corpus Plt/stormwater
WQ0001909-000	VALERO REFINING CO	2484	Nueces	Industrial	OTFL 005 Corpus Plt/Domestic
WQ0001909-000	VALERO REFINING CO	2484	Nueces	Industrial	OTFL 004 Corpus Plt/stormwater
WQ0001909-000	VALERO REFINING CO	2484	Nueces	Industrial	OTFL 001 Corpus Plt/Stormwater
WQ0001909-000	VALERO REFINING CO	2484	Nueces	Industrial	OTFL 007 Corpus Plt/Util/Stormwater
WQ0001909-000	VALERO REFINING CO	2484	Nueces	Industrial	OTFL 003 Corpus Plt/process/washdown/ballast/sw
WQ0002027-000	WRIGHT MATERIALS INC.	2102	Nueces	Industrial	OTFL 001 SAND & GRAVEL OP.
WQ0002085-000	TIPPERARY CORPORATION DBA	2483	San Patricio	Industrial	OTFL 001 CRUDE OIL PLANT
WQ0002142-000	NATIONAL OIL RECOVERY CORP	2481	San Patricio	Industrial	OTFL 001 CRUDE OIL REFINERY
WQ0002473-000	SAN PATRICIO MWD	2481	San Patricio	Industrial	OTFL 001 WATER TREATMENT PLANT
WQ0002535-000	REDFISH BAY TERMINAL INC.	2483	San Patricio	Industrial	OTFL 001
WQ0002717-000	INGLESIDE PROPERTIES INC.	2483	San Patricio	Industrial	OTFL 001
WQ0002717-000	INGLESIDE PROPERTIES INC.	2483	San Patricio	Industrial	OTFL 002
WQ0003012-000	Aker Gulf Marine	2483	San Patricio	Industrial	OTFL 001
WQ0003083-000	OCCIDENTAL CHEMICAL CORP	2481	San Patricio	Industrial	OTFL 001 CORPUS CHRISTI PLANT
WQ0003487-000	BAYSIDE TOWN OF	2472	Refugio	Industrial	OTFL 001
WQ0010015-001	MATHIS CITY OF	2103	San Patricio	Public Domestic	OTFL 001
WQ0010015-001	MATHIS CITY OF	2103	San Patricio	Public Domestic	Soil Mon 201 ANN 6-18
WQ0010015-001	MATHIS CITY OF	2103	San Patricio	Public Domestic	Soil Mon 301 ANN 18-30
WQ0010015-001	MATHIS CITY OF	2103	San Patricio	Public Domestic	Soil Mon 101 ANN 0-6
WQ0010055-001	SINTON CITY OF	2003	San Patricio	Public Domestic	OTFL 001
WQ0010092-001	GREGORY CITY OF	2481	San Patricio	Public Domestic	OTFL 001
WQ0010156-001	WOODSBORO CITY OF	2001	Refugio	Public Domestic	OTFL 001 City of Woodsboro
WQ0010237-001	ODEM CITY OF	2003	San Patricio	Public Domestic	OTFL 001
WQ0010255-001	REFUGIO TOWN OF	2002	Refugio	Public Domestic	OTFL 001
WQ0010256-001	REFUGIO CO WCID 001	2462	Refugio	Public Domestic	OTFL 001
WQ0010422-001	INGLESIDE CITY OF	2481	San Patricio	Public Domestic	OTFL 001
WQ0010478-001	PORTLAND CITY OF	2482	San Patricio	Public Domestic	OTFL 001 PLANT #1
WQ0010478-002	PORTLAND CITY OF	2481	San Patricio	Public Domestic	OTFL 002 NORTH SHORE WWTP
WQ0010521-002	ARANSAS PASS CITY OF	2483	San Patricio	Public Domestic	OTFL 002
WQ0010705-001	TAFT CITY OF	2472	San Patricio	Public Domestic	OTFL 001
WQ0011096-001	PORTLAND ENTERPRISES Inc.	2482	San Patricio	Private Domestic	OTFL 001 PORTLAND INN
WQ0011117-001	Austwell City of	2462	Refugio	Public Domestic	OTFL 001 City of Austwell Plant
WQ0011165-001	Texas Parks & Wildlife Dept	2103	San Patricio	Public Domestic	OTFL 001 LK CORPUS CHRISTI PK.
WQ0011334-001	THOMAS HUGHES C.	2003	San Patricio	Private Domestic	OTFL 001
WQ0011660-001	TEXAS DEPARTMENT OF TRANSPORT	2102	San Patricio	Public Domestic	OTFL 001 SAN PATRICIO RESTAREA
WQ0011660-002	TEXAS DEPARTMENT OF TRANSPORT	2102	San Patricio	Public Domestic	OTFL 002 SAN PATRICIO CO SOUTH
WQ0011660-002	TEXAS DEPARTMENT OF TRANSPORT	2102	San Patricio	Public Domestic	SOIL MONIT.102(ANNUAL)SANPAT/S
WQ0012013-001	TEXAS DEPARTMENT OF TRANSPORT	2002	Refugio	Public Domestic	SOIL MONITORING(101)ANNUAL

Appendix E- TNRCC Waste Permits

PERMIT NUMBER	CLIENT DOING BUSINESS AS NAME	STREAM SEGMENT I.D.	COUNTY	PERMIT CATEGORY	EXTENSION OUTFALL
WQ0012013-001	TEXAS DEPARTMENT OF TRANSPORT	2002	Refugio	Public Domestic	OTFL 001 REFUGIO CO REST AREA
WQ0012064-001	Aker Gulf Marine	2483	San Patricio	Private Domestic	OTFL 001
WQ0013412-001	TEXAS DEPARTMENT OF TRANSPORT	2003	San Patricio	Public Domestic	TX DEPT OF TRANS - OTFL 001 SINTON MAINT./CONST
WQ0013641-001	SINTON CITY OF	2003	San Patricio	Public Domestic	OTFL 001 ROB & BESSIE WELDER PARK
WQ0013644-001	SAN PATRICIO COUNTY MUD NO. 1	2101	San Patricio	Public Domestic	OTFL 001
WQ0013681-001	INTERNATIONAL BANK THE	2481	San Patricio	Private Domestic	OTFL 001

Oso Creek
Runoff Volume for 1989

Land use	Jan	Feb.	Mar	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Totals
Agriculture	0.0	0.0	0.0	61.8	0.0	157.1	0.0	0.0	0.0	0.0	5.8	2629.5	2854.1
Rangeland	0.0	0.0	0.0	12.2	0.0	37.9	0.0	0.0	0.0	0.0	0.0	610.1	660.2
Residential	1142.6	27.4	14.5	2044.0	51.3	2261.0	583.9	450.4	1563.3	416.9	1072.3	1149.7	10777.5
Commercial	793.5	21.9	11.6	1414.6	36.5	1555.9	404.9	318.9	1095.2	285.6	743.8	712.3	7394.7
Industrial	354.4	37.1	19.6	602.6	24.7	610.5	175.3	199.6	578.5	90.3	323.8	319.3	3335.6
Transportation	548.9	49.7	26.3	941.2	35.8	968.3	273.1	292.9	870.6	150.4	503.9	476.0	5137.0
Water	921.0	0.0	0.0	1615.0	38.0	1818.0	472.0	312.0	1143.0	359.0	850.0	732.0	8260.0
Total	3760	136	72	6691	186	7409	1909	1574	5251	1302	3500	6629	38419.1

all values in 1000 cubic meters
Runoff volume for water land use is direct precipitation on Oso Bay.

Loadings to Oso Bay
Total Nitrogen for 1989

Land use	Jan	Feb.	Mar	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Totals
Agriculture	0.0	0.0	0.0	271.9	0.0	691.1	0.0	0.0	0.0	0.0	25.3	11569.8	12558.2
Rangeland	0.0	0.0	0.0	8.5	0.0	26.5	0.0	0.0	0.0	0.0	0.0	427.0	462.1
Residential	2079.6	49.9	26.4	3720.1	93.5	4115.0	1062.7	819.7	2845.2	758.8	1951.6	2092.4	19615.0
Commercial	1063.3	29.4	15.5	1895.6	49.0	2084.9	542.6	427.3	1467.5	382.7	996.6	954.5	9909.0
Industrial	446.5	46.8	24.7	759.3	31.1	769.2	220.9	251.5	728.9	113.7	408.0	402.3	4202.9
Transportation	1020.9	92.4	48.9	1750.6	66.6	1801.1	508.0	544.8	1619.2	279.7	937.2	885.4	9554.8
Water	902.6	0.0	0.0	1582.7	37.2	1781.6	462.6	305.8	1120.1	351.8	833.0	717.4	8094.8
Total	5512.9	218.5	115.5	9988.6	277.4	11269.5	2796.7	2349.1	7781.0	1886.8	5151.8	17048.9	64396.7

all values in kilograms
Loadings for water land use is direct rainfall deposition on Oso Bay.

Loadings to Oso Bay

Total Phosphorus for 1989

Land use	Jan	Feb.	Mar	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Totals
Agriculture	0.0	0.0	0.0	80.3	0.0	204.2	0.0	0.0	0.0	0.0	7.5	3418.4	3710.4
Rangeland	0.0	0.0	0.0	0.1	0.0	0.4	0.0	0.0	0.0	0.0	0.0	6.1	6.6
Residential	651.3	15.6	8.3	1165.1	29.3	1288.8	332.8	256.7	891.1	237.6	611.2	655.3	6143.2
Commercial	253.9	7.0	3.7	452.7	11.7	497.9	129.6	102.0	350.4	91.4	238.0	227.9	2366.3
Industrial	78.0	8.2	4.3	132.6	5.4	134.3	38.6	43.9	127.3	19.9	71.2	70.2	733.8
Transportation	120.7	10.9	5.8	207.1	7.9	213.0	60.1	64.4	191.5	33.1	110.8	104.7	1130.1
Water	13.8	0.0	0.0	24.2	0.6	27.3	7.1	4.7	17.1	5.4	12.8	11.0	123.9
Total	1117.8	41.8	22.1	2062.1	54.8	2365.8	568.1	471.8	1577.5	387.4	1051.6	4493.7	14214.3

all values in kilograms

Loadings for water land use is direct rainfall deposition on Oso Bay.

Loadings to Oso Bay

Total Suspended Solids for 1989

Land use	Jan	Feb.	Mar	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Totals
Agriculture	0.0	0.0	0.0	6.6	0.0	16.8	0.0	0.0	0.0	0.0	0.6	281.4	305
Rangeland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1
Residential	46.8	1.1	0.6	83.8	2.1	92.7	23.9	18.5	64.1	17.1	44.0	47.1	442
Commercial	44.0	1.2	0.6	78.5	2.0	86.4	22.5	17.7	60.8	15.9	41.3	39.5	410
Industrial	21.4	2.2	1.2	36.5	1.5	36.9	10.6	12.1	35.0	5.5	19.6	19.3	202
Transportation	40.3	3.7	1.9	69.2	2.6	71.2	20.1	21.5	64.0	11.1	37.0	35.0	378
Total	153	8	4	275	8	304	77	70	224	49	142	423	1738

all values in metric tons

Oso Creek

Runoff Volume for 1990

Land use	Jan	Feb.	Mar	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Totals
Agriculture	0.0	1182.8	22953.1	69.1	12.6	0.0	0.0	0.0	0.0	6.3	0.0	0.0	24224.0
Rangeland	0.0	10.8	3852.3	0.3	3.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	3867.9
Residential	232.6	2169.1	3518.2	1760.2	881.8	253.6	756.2	29.3	1226.3	1144.2	534.8	146.9	12653.3
Commercial	161.4	1497.2	1851.3	1227.3	614.2	177.6	530.4	23.4	855.4	788.1	374.1	102.6	8203.0
Industrial	70.8	684.1	870.6	600.3	295.5	93.4	286.8	39.6	417.0	292.4	192.2	51.5	3894.2
Transportation	110.0	49.7	1190.6	914.6	451.5	140.6	430.0	53.1	636.0	469.8	290.5	78.2	4814.6
Water	188.0	1662.0	1643.0	1332.0	676.0	189.0	562.0	0.0	935.0	944.0	401.0	118.0	8650.0
Total	763	7256	35879	5904	2935	854	2565	145	4070	3646	1793	497	66307.0

all values in 1000 cubic meters

Runoff volume for water land use is direct precipitation on Oso Bay.

Loadings to Oso Bay
Total Nitrogen for 1990

Land use	Jan	Feb.	Mar	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Totals
Agriculture	0.0	5204.5	100993.9	304.1	55.3	0.0	0.0	0.0	0.0	27.6	0.0	0.0	106585.4
Rangeland	0.0	7.6	2696.6	0.2	2.1	0.0	0.0	0.0	0.0	1.1	0.0	0.0	2707.5
Residential	423.4	3947.7	6403.1	3203.6	1604.9	461.5	1376.2	53.3	2231.9	2082.4	973.4	267.4	23028.9
Commercial	216.3	2006.2	2480.7	1644.6	823.1	238.0	710.8	31.4	1146.2	1056.0	501.3	137.5	10992.1
Industrial	89.2	861.9	1097.0	756.4	372.3	117.7	361.3	49.9	525.5	368.5	242.1	64.9	4906.7
Transportation	204.7	92.4	2214.5	1701.2	839.8	261.6	799.8	98.8	1182.9	873.8	540.3	145.4	8955.1
Water	184.2	1628.8	1610.1	1305.4	662.5	185.2	550.8	0.0	916.3	925.1	393.0	115.6	8477.0
Total	1117.8	13749.1	117495.9	8915.6	4360.0	1264.0	3798.8	233.4	6002.8	5334.5	2650.1	730.9	165652.8

all values in kilograms
Loadings for water land use is direct rainfall deposition on Oso Bay.

Loadings to Oso Bay

Total Phosphorus for 1990

Land use	Jan	Feb.	Mar	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Totals
Agriculture	0.0	1537.7	29839.1	89.9	16.3	0.0	0.0	0.0	0.0	8.2	0.0	0.0	31491.1
Rangeland	0.0	0.1	38.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.7
Residential	132.6	1236.4	2005.4	1003.3	502.6	144.5	431.0	16.7	699.0	652.2	304.8	83.7	7212.4
Commercial	51.7	479.1	592.4	392.8	196.6	56.8	169.7	7.5	273.7	252.2	119.7	32.8	2625.0
Industrial	15.6	150.5	191.5	132.1	65.0	20.5	63.1	8.7	91.8	64.3	42.3	11.3	856.7
Transport.	24.2	10.9	261.9	201.2	99.3	30.9	94.6	11.7	139.9	103.3	63.9	17.2	1059.2
Water	2.8	24.9	24.6	20.0	10.1	2.8	8.4	0.0	14.0	14.2	6.0	1.8	129.8
Total	226.9	3439.6	32953.5	1839.2	890.0	255.7	766.9	44.6	1218.4	1094.4	536.8	146.9	43412.8

all values in kilograms
Loadings for water land use is direct rainfall deposition on Oso Bay.

Loadings to Oso Bay
Total Suspended Solids for 1990

Land use	Jan	Feb.	Mar	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Totals
Agriculture	0.0	126.6	2456.0	7.4	1.3	0.0	0.0	0.0	0.0	0.7	0.0	0.0	2592
Rangeland	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4
Residential	9.5	88.9	144.2	72.2	36.2	10.4	31.0	1.2	50.3	46.9	21.9	6.0	519
Commercial	9.0	83.1	102.7	68.1	34.1	9.9	29.4	1.3	47.5	43.7	20.8	5.7	455
Industrial	4.3	41.4	52.7	36.3	17.9	5.6	17.3	2.4	25.2	17.7	11.6	3.1	236
Transport.	8.1	3.7	87.5	67.2	33.2	10.3	31.6	3.9	46.7	34.5	21.4	5.7	354
Total	31	344	2847	251	123	36	109	9	170	144	76	21	4159

all values in metric tons

Oso Creek
Runoff Volume for 1991

Land use	Jan	Feb.	Mar	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Totals
Agriculture	6.3	225.7	0.0	4598.3	563.9	13837.7	2740.6	0.0	1709.6	0.0	25.1	43778.1	67485.2
Rangeland	0.0	3.9	0.0	631.5	132.0	3000.9	254.2	0.0	184.4	0.0	6.1	5489.5	9702.6
Residential	1367.5	1132.3	964.1	2393.5	4394.1	6260.1	864.2	897.6	4228.9	3338.7	135.4	4141.2	30117.5
Commercial	947.3	787.7	668.9	1559.5	3017.7	3896.6	550.6	629.9	2911.0	2295.8	94.9	1976.8	19336.9
Industrial	401.9	386.0	292.7	715.0	1204.1	1558.2	244.9	343.6	1373.5	809.9	59.1	1278.3	8667.4
Transport.	628.4	49.7	455.0	1074.3	1901.7	2371.4	364.0	514.5	2096.5	1315.5	86.6	1606.7	12464.4
Water	1100.0	864.0	756.0	1662.0	3489.0	4222.0	599.0	651.0	3192.0	2738.0	95.0	2413.0	21781.0
Total	4451	3449	3137	12634	14703	35147	5618	3037	15696	10498	502	60684	169554.9

all values in 1000 cubic meters
Runoff volume for water land use is direct precipitation on Oso Bay.

Loadings to Oso Bay

Total Nitrogen for 1991

Land use	Jan	Feb.	Mar	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Totals
Agriculture	27.6	993.0	0.0	20232.5	2481.2	60885.7	12058.5	0.0	7522.1	0.0	110.6	192623.7	296934.9
Rangeland	0.0	2.7	0.0	442.1	92.4	2100.6	178.0	0.0	129.1	0.0	4.2	3842.7	6791.8
Residential	2488.9	2060.7	1754.6	4356.2	7997.2	11393.5	1572.8	1633.6	7696.5	6076.5	246.4	7536.9	54813.8
Commercial	1269.3	1055.5	896.3	2089.8	4043.8	5221.4	737.8	844.1	3900.8	3076.4	127.2	2649.0	25911.4
Industrial	506.4	486.4	368.8	901.0	1517.2	1963.4	308.6	433.0	1730.7	1020.5	74.4	1610.7	10920.9
Transport.	1168.9	92.4	846.3	1998.2	3537.2	4410.9	677.1	957.0	3899.5	2446.8	161.0	2988.5	23183.7
Water	1078.0	846.7	740.9	1628.8	3419.2	4137.6	587.0	638.0	3128.2	2683.2	93.1	2364.7	21345.4
Total	6539.2	5537.5	4606.9	31648.5	23088.2	90113.0	16119.7	4505.7	28006.9	15303.4	816.9	213616.1	439902.0

all values in kilograms
Loadings for water land use is direct rainfall deposition on Oso Bay.

Loadings to Oso Bay

Total Phosphorus for 1991

Land use	Jan	Feb.	Mar	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Totals
Agriculture	8.2	293.4	0.0	5977.8	733.1	17989.0	3562.7	0.0	2222.4	0.0	32.7	56911.5	87730.8
Rangeland	0.0	0.0	0.0	6.3	1.3	30.0	2.5	0.0	1.8	0.0	0.1	54.9	97.0
Residential	779.5	645.4	549.5	1364.3	2504.6	3568.3	492.6	511.6	2410.5	1903.1	77.2	2360.5	17167.0
Commercial	303.1	252.1	214.0	499.1	965.7	1246.9	176.2	201.6	931.5	734.7	30.4	632.6	6187.8
Industrial	88.4	84.9	64.4	157.3	264.9	342.8	53.9	75.6	302.2	178.2	13.0	281.2	1906.8
Transport.	138.3	10.9	100.1	236.3	418.4	521.7	80.1	113.2	461.2	289.4	19.0	353.5	2742.2
Water	16.5	13.0	11.3	24.9	52.3	63.3	9.0	9.8	47.9	41.1	1.4	36.2	326.7
Total	1334.0	1299.7	939.4	8266.0	4940.3	23762.0	4377.0	911.8	6377.6	3146.4	173.7	60630.4	116158

all values in kilograms
Loadings for water land use is direct rainfall deposition on Oso Bay.

Oso Creek

Total Suspended Solids for 1991

Land use	Jan	Feb.	Mar	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Totals
Agriculture	0.7	24.1	0.0	492.0	60.3	1480.6	293.2	0.0	182.9	0.0	2.7	4684.3	7221
Rangeland	0.0	0.0	0.0	0.6	0.1	3.0	0.3	0.0	0.2	0.0	0.0	5.5	10
Residential	56.1	46.4	39.5	98.1	180.2	256.7	35.4	36.8	173.4	136.9	5.6	169.8	1235
Commercial	52.6	43.7	37.1	86.6	167.5	216.3	30.6	35.0	161.6	127.4	5.3	109.7	1073
Industrial	24.3	23.4	17.7	43.3	72.8	94.3	14.8	20.8	83.1	49.0	3.6	77.3	524
Transport.	46.2	3.7	33.4	79.0	139.8	174.3	26.8	37.8	154.1	96.7	6.4	118.1	916
Total	180	141	128	800	621	2225	401	130	755	410	23	5165	10979

all values in metric tons

Oso Creek

Runoff Volume for 1992

Land use	Jan	Feb.	Mar	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Totals
Agriculture	7992.3	17522.2	5869.1	48.2	29774.1	6993.8	0.0	0.0	34.6	0.0	6555.1	5.8	74795.1
Rangeland	0.0	3798.7	729.2	6.2	4819.4	984.2	0.0	0.0	0.1	0.0	28.4	0.0	10366.2
Residential	3430.9	3731.2	2049.4	2280.2	6124.3	2199.5	525.2	1677.3	1301.1	266.0	1531.7	552.1	25668.8
Commercial	2175.5	2044.6	1305.6	1580.5	3488.4	1359.8	362.5	1161.7	911.6	189.5	1024.9	384.6	15989.1
Industrial	990.9	911.1	656.9	687.4	1467.2	550.2	140.7	489.3	485.6	129.4	626.9	183.4	7319.0
Transport.	1478.5	49.7	961.6	1069.6	2111.1	825.6	223.9	766.2	729.6	187.7	890.8	280.7	9575.0
Water	2281.0	1903.0	1324.0	1804.0	3494.0	1473.0	425.0	1327.0	959.0	175.0	996.0	430.0	16591.0
Total	18349	29960	12896	7476	51279	14386	1677	5422	4422	947	11654	1837	160304.2

all values in 1000 cubic meters

Runoff volume for water land use is direct precipitation on Oso Bay.

Loadings to Oso Bay
Total Nitrogen for 1992

Land use	Jan	Feb.	Mar	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Totals
Agriculture	35166.0	77097.8	25824.0	212.0	131006.2	30772.6	0.0	0.0	152.1	0.0	28842.5	25.3	329098.5
Rangeland	0.0	2659.1	510.4	4.3	3373.6	689.0	0.0	0.0	0.1	0.0	19.9	0.0	7256.3
Residential	6244.3	6790.8	3729.9	4149.9	11146.3	4003.2	955.8	3052.7	2368.0	484.1	2787.7	1004.8	46717.2
Commercial	2915.2	2739.7	1749.5	2117.9	4674.5	1822.1	485.7	1556.7	1221.5	253.9	1373.4	515.3	21425.4
Industrial	1248.6	1148.0	827.7	866.2	1848.6	693.2	177.2	616.5	611.8	163.0	789.9	231.1	9221.9
Transport.	2750.0	92.4	1788.5	1989.5	3926.6	1535.7	416.4	1425.2	1357.1	349.0	1657.0	522.1	17809.6
Water	2235.4	1864.9	1297.5	1767.9	3424.1	1443.5	416.5	1300.5	939.8	171.5	976.1	421.4	16259.2
Total	50559.3	92392.7	35727.6	11107.7	159399.9	40959.3	2451.6	7951.5	6650.4	1421.5	36446.4	2720.1	447788.1

all values in kilograms
Loadings for water land use is direct rainfall deposition on Oso Bay.

Loadings to Oso Bay

Total Phosphorus for 1992

Land use	Jan	Feb.	Mar	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Totals
Agriculture	10389.9	22778.9	7629.8	62.6	38706.4	9091.9	0.0	0.0	44.9	0.0	8521.7	7.5	97233.7
Rangeland	0.0	38.0	7.3	0.1	48.2	9.8	0.0	0.0	0.0	0.0	0.3	0.0	103.7
Residential	1955.6	2126.8	1168.2	1299.7	3490.9	1253.7	299.3	956.1	741.6	151.6	873.1	314.7	14631.2
Commercial	696.2	654.3	417.8	505.8	1116.3	435.1	116.0	371.7	291.7	60.6	328.0	123.1	5116.5
Industrial	218.0	200.4	144.5	151.2	322.8	121.0	30.9	107.7	106.8	28.5	137.9	40.3	1610.2
Transport.	325.3	10.9	211.5	235.3	464.4	181.6	49.3	168.6	160.5	41.3	196.0	61.8	2106.5
Water	34.2	28.5	19.9	27.1	52.4	22.1	6.4	19.9	14.4	2.6	14.9	6.5	248.9
Total	13619.2	25837.9	9599.0	2281.8	44201.4	11115.4	501.9	1623.9	1360.0	284.6	10071.8	553.8	121051

all values in kilograms
Loadings for water land use is direct rainfall deposition on Oso Bay.

Oso Creek

Total Suspended Solids for 1992

Land use	Jan	Feb.	Mar	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Totals
Agriculture	855.2	1874.9	628.0	5.2	3185.8	748.3	0.0	0.0	3.7	0.0	701.4	0.6	8003
Rangeland	0.0	3.8	0.7	0.0	4.8	1.0	0.0	0.0	0.0	0.0	0.0	0.0	10
Residential	140.7	153.0	84.0	93.5	251.1	90.2	21.5	68.8	53.3	10.9	62.8	22.6	1052
Commercial	120.7	113.5	72.5	87.7	193.6	75.5	20.1	64.5	50.6	10.5	56.9	21.3	887
Industrial	60.0	55.1	39.7	41.6	88.8	33.3	8.5	29.6	29.4	7.8	37.9	11.1	443
Transport.	108.7	3.7	70.7	78.6	155.2	60.7	16.5	56.3	53.6	13.8	65.5	20.6	704
Total	1285	2204	896	307	3879	1009	67	219	191	43	925	76	11100

all values in metric tons

Oso Creek

Runoff Volume for 1993

Land use	Jan	Feb.	Mar	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Totals
Agriculture	0.0	1375.5	105.8	17.8	15564.5	42538.7	0.0	12.6	0.0	0.0	0.0	4109.7	63724.6
Rangeland	0.0	330.6	6.4	1.6	3005.0	5415.9	0.0	3.0	0.0	0.0	0.0	796.5	9559.0
Residential	136.5	2280.0	2143.2	1422.1	7299.7	7749.0	24.0	967.0	476.2	560.4	625.3	2817.0	26500.5
Commercial	96.8	1524.5	1487.2	988.9	4604.5	4471.3	19.2	664.2	336.3	393.9	430.9	1835.8	16853.5
Industrial	62.4	561.7	667.6	457.0	1879.5	2118.1	32.5	231.4	202.5	220.4	160.9	797.6	7391.6
Transport.	91.2	49.7	1032.4	703.3	2859.1	2991.8	43.6	376.8	298.8	328.7	258.2	1214.6	10248.2
Water	510.0	3646.0	2630.0	1100.0	3801.0	4038.0	0.0	576.0	496.0	968.0	472.0	1417.0	19654.0
Total	897	9768	8072	4691	39013	69323	119	2831	1810	2471	1947	12988	153931.3

all values in 1000 cubic meters

Runoff volume for water land use is direct precipitation on Oso Bay.

Loadings to Oso Bay

Total Nitrogen for 1993

Land use	Jan	Feb.	Mar	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Totals
Agriculture	0.0	6052.2	465.4	78.3	68484.0	187170.4	0.0	55.3	0.0	0.0	0.0	18082.9	280388.4
Rangeland	0.0	231.4	4.5	1.1	2103.5	3791.1	0.0	2.1	0.0	0.0	0.0	557.6	6691.3
Residential	248.4	4149.6	3900.5	2588.2	13285.5	14103.2	43.8	1760.0	866.7	1019.9	1138.1	5126.9	48230.8
Commercial	129.8	2042.8	1992.8	1325.1	6170.0	5991.5	25.8	890.1	450.6	527.8	577.4	2460.0	22583.7
Industrial	78.6	707.7	841.2	575.8	2368.2	2668.8	41.0	291.6	255.2	277.7	202.7	1004.9	9313.4
Transport.	169.7	92.4	1920.2	1308.2	5318.0	5564.7	81.1	700.9	555.8	611.3	480.2	2259.2	19061.6
Water	499.8	3573.1	2577.4	1078.0	3725.0	3957.2	0.0	564.5	486.1	948.6	462.6	1388.7	19260.9
Total	1126.3	16849.3	11702.0	6954.8	101454.1	223246.9	191.6	4264.3	2614.3	3385.3	2861.0	30880.1	405530.0

all values in kilograms

Loadings for water land use is direct rainfall deposition on Oso Bay.

Loadings to Oso Bay

Total Phosphorus for 1993

Land use	Jan	Feb.	Mar	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Totals
Agriculture	0.0	1788.1	137.5	23.1	20233.9	55300.3	0.0	16.3	0.0	0.0	0.0	5342.7	82842.0
Rangeland	0.0	3.3	0.1	0.0	30.1	54.2	0.0	0.0	0.0	0.0	0.0	8.0	95.6
Residential	77.8	1299.6	1221.6	810.6	4160.8	4416.9	13.7	551.2	271.4	319.4	356.4	1605.7	15105.3
Commercial	31.0	487.8	475.9	316.5	1473.4	1430.8	6.2	212.6	107.6	126.0	137.9	587.5	5393.1
Industrial	13.7	123.6	146.9	100.5	413.5	466.0	7.2	50.9	44.6	48.5	35.4	175.5	1626.1
Transport.	20.1	10.9	227.1	154.7	629.0	658.2	9.6	82.9	65.7	72.3	56.8	267.2	2254.6
Water	7.7	54.7	39.5	16.5	57.0	60.6	0.0	8.6	7.4	14.5	7.1	21.3	294.8
Total	150.2	3768.1	2248.5	1422.0	26997.7	62387.0	36.6	922.6	496.8	580.8	593.6	8007.7	107612

all values in kilograms

Loadings for water land use is direct rainfall deposition on Oso Bay.

Oso Creek
Total Suspended Solids for 1993

Land use	Jan	Feb.	Mar	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Totals
Agriculture	0.0	147.2	11.3	1.9	1665.4	4551.6	0.0	1.3	0.0	0.0	0.0	439.7	6819
Rangeland	0.0	0.3	0.0	0.0	3.0	5.4	0.0	0.0	0.0	0.0	0.0	0.8	10
Residential	5.6	93.5	87.9	58.3	299.3	317.7	1.0	39.6	19.5	23.0	25.6	115.5	1087
Commercial	5.4	84.6	82.5	54.9	255.5	248.2	1.1	36.9	18.7	21.9	23.9	101.9	935
Industrial	3.8	34.0	40.4	27.6	113.7	128.1	2.0	14.0	12.3	13.3	9.7	48.3	447
Transport.	6.7	3.7	75.9	51.7	210.1	219.9	3.2	27.7	22.0	24.2	19.0	89.3	753
Total	21	363	298	194	2547	5471	7	120	72	82	78	795	10050

all values in metric tons

Units Conversion Table

When You Know	Multiply By	To Find
acres	0.40469	hectares
acre-feet	0.12335	hectare-meters
cubic feet	0.02832	cubic meters
cubic meters	8.10832×10^{-4}	acre-feet
feet	0.30480	meters
gallons	3.78541	liters
inches	2.54000	centimeters
meters	3.28084	feet
miles	1.60934	kilometers
square kilometers	0.38610	square miles
square miles	2.58998	square kilometers

Appendix H - 1994 Texas Marina Facilities and Services Directory

Hollin, D., Abbreviated

Location	Address	FACILITIES				SERVICES							
		Wet Slips	Dry Storage	Ramps	Haul Out	Boat Repair	Boat Sales	Fuel Docks	Pump Out	Boat Rental	Charter	Bait Tackle	Food Services
ARANSAS BAY													
Aransas County Nav. Dist. Marina	Rockport Harbor Rockport, TX. 78382	150	0	1							•	•	
Aransas County Nav. Dist. Marina	Fulton Harbor Rockport, TX. 78382	100	0	1	•	•					•	•	
Key Allegro Isle Marina, Inc.	37 Mazatlan Rockport, TX. 78382	150	30	0			•	•				•	•
Sand Dollar Marina	HCR Box 38 Fulton, TX 78358	10	0	1				•			•	•	•
BAFFIN BAY													
Williamson Boat Works	Rt. 1, Box 81 Riveria, TX 78379	25	0	1	•	•	•	•					
CORPUS CHRISTI BAY													
Bahia Marina	Rt. 1, Box 278 Ingleside, TX 78362	51	0	1				•					•
Corpus Christi Municipal Marina	P.O. Box 9277 Corpus Christi, TX 78469	535	20	4	•	•		•	•		•	•	•
Corpus Christi Yacht Club - Private	98 Coopers Alley St. Corpus Christi, TX 78401-2899	87	89	0						•			•
Harbor Del Sol Marina	1400 Ocean Drive Corpus Christi, TX 78404	78	0	0									
Port Royale	15425 Fortuna Bay Dr. Corpus Christi, TX 78418	25	0	0									
Puenta Vista	14300 Aloha Corpus Christi, TX 78418	22	0	0									
CORPUS CHRISTI CHANNEL													
Deep Sea Headquarters	P.O. Box 388 Port Aransas, TX 78373	14	0	0				•			•	•	
Island Moorings Yacht Club & Marina	P.O. Box 1820 Port Aransas, TX 78373	285	0	0				•	•		•	•	•
University of Texas Boat Basin	P.O. Box 1267 Port Aransas, TX 78373	64	0	1									
Woody's Sport Center	P.O. Box 1438 Port Aransas, TX 78373	30	0	3				•			•	•	•

Appendix H - 1994 Texas Marina Facilities and Services Directory

		FACILITIES				SERVICES							
Location	Address	Wet Slips	Dry Storage	Ramps	Haul Out	Boat Repair	Boat Sales	Fuel Docks	Pump Out	Boat Rental	Charter	Bait Tackle	Food Services
CORPUS CHRISTI LAKE													
Fiesta Marina	HCR #1, Box 800 Sandia, TX 78383	30	0	1				•			•	•	•
GULF INTRACOASTAL WATERWAY													
Anchor Resort Condominiums	P.O. Box 8314 Corpus Christi, TX 78468-8602	41	0	0									
Mariner's Cay	14514 Cabana East Street Corpus Christi, TX 78418	22	0	0									
Marker 37 Marina	13317 South Padre Island Corpus Christi, TX 78418	35	0	2			•	•				•	•
Palm Harbor Marina	151 Port Avenue Rockport, TX 78382	50	0	1				•				•	•
Spinnaker	14434 Cabana East Street Corpus Christi, TX 78418	40	0	0									
LAGUNA MADRE													
Bluff Landing Marina	4242 Laguna Shores Road Corpus Christi, TX 78418	60	24	2		•		•			•	•	
Clem's Marina	13304 South Padre Island Drive Corpus Christi, TX 78418	23	0	2								•	•
The Coastway	13402 South Padre Island Drive Corpus Christi, TX 78418	15	0	2					•			•	
PORT ARANSAS HARBOR													
Port Aransas City Marina	P.O. Drawer 1 Port Aransas, TX 78373	179	0	8	•	•					•		
Teal Harbor Condominiums	P.O. Box F Port Aransas, TX 78373	31	0	0									
REDFISH BAY													
Fin & Feather	P.O. Box 458 Aransas Pass, TX 78336	13	50	2			•			•	•	•	•
San Patricio County Nav. District #1	P.O. Box 904 Aransas Pass, TX 78336	158	158	2				•			•	•	•

Appendix I - List of Acronyms and Abbreviations

Ag	Silver
AGNPS	Agricultural Nonpoint Source Pollution model
ARS	Agricultural Research Service
As	Arsenic
ASAE	American Society of Agricultural Engineers
Ba	Barium
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
CAFO	Confined Animal Feeding Operation
CBMS	Computer Based Mapping System
CCA	Chromated Copper Arsenate
CCBNEP	Corpus Christi Bay National Estuary Program
Cd	Cadmium
CERL	Construction Engineering Research Laboratory
cfs	Cubic Feet per Second
CFSA	Consolidated Farm Services Agency
cfu	Colony Forming Units
Cl	Chloride
cm	Centimeter
$CO(NH_2)_2$	Urea
COD	Chemical Oxygen Demand
CPL	Central Power and Light
Cr	Chromium
CREAMS	Chemicals, Runoff, and Erosion from Agricultural Management Systems model
CRP	Clean Rivers Program
CRWR	Center for Research in Water Resources
Cu	Copper
DCP	Dissolved Concentration Potential
DEM	Digital Elevation Model
DLG	Digital Line Graph
DO	Dissolved Oxygen
DR3M	Distributed Rainfall Runoff Model
EMC	Event Mean Concentration
ERS	Economic Research Service
FC	Fecal Coliform
FS	Fecal Streptococcus
ft	Feet
GBNEP	Galveston Bay National Estuary Program
GIS	Geographic Information System
GRASS	Graphical Resources Analysis Support System
GSI	Groundwater Services, Incorporated
ha	Hectare

Appendix I - List of Acronyms and Abbreviations

HEL	Highly Erodible Land
Hg	Mercury
HSPF	Hydrologic Simulation Program - FORTRAN
HUC	Hydrologic Unit Code
in	Inch
kg	Kilogram
km^2	Square Kilometer
m	Meter
m^3	Cubic Meter
μg/l	Micrograms per Liter
mg/l	Milligrams per Liter
mgd	Million Gallons per Day
MIADS	Map Information Assembly Display System
mi^2	Square Mile
mld	Million Liters per Day
N	Nitrogen
N_2	Nitrogen Gas
NA	Not Applicable
NADP	National Atmospheric Deposition Program
NASA	National Aeronautics and Space Administration
NAWQA	National Water Quality Assessment program
ND	Not Detected
NEP	National Estuary Program
NEXRAD	Next Generation Weather Radar
NHAP	National High Altitude Photography
NH_3	Ammonia Nitrogen
NH_4+	Ammonia Nitrogen (variant)
Ni	Nickel
NO_2	Nitrite
NO_3	Nitrate
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NRA	Nueces River Authority
NRCS	Natural Resources Conservation Service
NTN	National Trends Network
NURP	Nationwide Urban Runoff Program
O&G	Oil and Grease
OP	Orthophosphate
Pb	Lead
PO_4	Phosphate
ppb	Parts per Billion
ppm	Parts per Million
PRE	Particle Retention Efficiency

Appendix I - List of Acronyms and Abbreviations

RCWP	Rural Clean Water Program
ROTO	Routing Outputs To Outlets model
RU	Rice University
SO_4	Sulfate
SSURGO	Soil Survey Geographic Data Base
STATSGO	State Soil Geographic Data Base
SWAT	Soil and Water Assessment Tool
SWMM	Storm Water Management Model
SWRRB	Simulator for Water Resources in Rural Basins
TAES	Texas Agricultural Experiment Station
TAMU	Texas A&M University
TDS	Total Dissolved Solids
TDWR	Texas Department of Water Resources
TIGER	Topologically Integrated Geographic Encoding and Referencing System
TKN	Total Kjeldahl Nitrogen
TN	Total Nitrogen
TNRCC	Texas Natural Resources Conservation Commission
TP	Total Phosphorus
TSS	Total Suspended Solids
TSSWCB	Texas State Soil and Water Conservation Board
TSWQS	Texas State Water Quality Standards
TWC	Texas Water Commission
USDA	United States Department of Agriculture
USDI	United States Department of the Interior
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UT	University of Texas
Zn	Zinc

Table of Contents

Appendix I - List of Acronyms and Abbreviations