INVENTORY OF WASTE SOURCES IN THE COASTAL ZONE

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PREFACE

This report summarizes the available data which characterizes the quality of the environment of the Coastal Zone of Texas. The inventory of waste sources is based on existing data compiled by the various State agencies. The data were collected during the time period, August 15, 1970 through September 15, 1970 and therefore represent the accessible information on record at that time. The time limitation also made it almost impossible to include data which were on file but not available in a readily usable form. No attempt was made to actually collect samples in the field in order to supplement the available data.

The cooperation of the personnel of the various State agencies was essential to the completion of the inventory within the time frame work. The assistance of the personnel of the following agencies is acknowledged:

Texas Water Quality Board

Texas Water Development Board

Division of Planning Coordination, Office of the Governor

Texas Air Control Board

Texas State Department of Health

Texas Highway Department

The compilation and collection of the data would not have been possible without the assistance of Mr. Dennis J. Crowley. The assistance of Mr. Camilo Guaqueta in reducing the data for use in this report is also acknowledged. Mr. Crowley and Mr. Guaqueta are Research Engineers in the Environmental Health Engineering Laboratories at The University of Texas at Austin. The preparation of the final manuscript was completed by the secretarial staff of the Environmental Health Engineering Laboratories at The University of Texas at Austin. Typing of the final copy for printing was done by Marilyn Purdy.

I. INTRODUCTION

The use of the resources along the Texas Gulf Coast has resulted in changes in the air, water, and land environments. The extent and the type of environmental change depends on the type of activity. The effect of industrial utilization of natural resources is considerably different than the environmental changes caused by agricultural development. Large scale industrialization results in urbanization and the associated high population densities. The effects of this urbanization on the environment is different than the effects caused by small rural communities. *Man's activities have left their mark on the environment and this report is an attempt to evaluate the extent of environmental change caused by man's use and development of the natural resources in the Coastal Zone of Texas.*

Objectives

The primary objective of this report is to develop an inventory of the existing sources of waste materials discharged into the water and air and deposited onto the land in the Coastal Zone of Texas. These sources of potential pollution include *municipal and industrial wastewaters, solid wastes, and gases and particulate material discharged into the atmosphere.* A second objective is the evaluation of the inventory of waste discharges in an attempt to identify those areas where sufficient information is not available and to propose methods of obtaining the data. The final objective is recommendations of programs of action to improve the quality of the environment in the immediate future as well as for long-range planning purposes.

Scope

The inventory of waste sources and emissions includes the more obvious environmental insults caused by improper disposal of municipal and industrial solid wastes or inadequate treatment of municipal and industrial wastewaters as well as some of the more subtle potential pollution sources such as pesticides in the bay and estuaries as well as the emissions from motor vehicles. This inventory is developed *based on existing information from the records* of the Texas Water Quality Board, Texas Water Development Board, Texas Air Control Board, Texas State Department of Health, Texas Department of Public Safety, the U.S. Geological Survey and the Texas Parks and Wildlife Commission, and other published documents. In cases where similar data were available from more than one source, all attempts were made to reconcile any discrepancies which may have existed among the data.

Coastal Zone

The inventory of waste sources was limited to those counties which are considered to be in the Coastal Zone of Texas. The Coastal Zone includes 36 counties and covers an area ranging from Orange and Jefferson Counties along the Sabine River down to Hidalgo and Cameron Counties along the Rio Grande River.

The study area includes *33,451 square miles of land* plus approximately *6,300 square miles of submerged land* in the bays. The dry land area represents approximately 12 percent of the area of the State. The bays and estuaries along the Texas Gulf Coast provide the spawning and nursery areas on which much of the commercial fisheries industry is dependent. The population for the counties included in this study is *3,538,763 people* according to the initial 1970 Census data. This population represents 32.2 percent of the total estimated population of Texas for 1970.

The Coastal Zone provides a contrast. The highly industrialized and populated area between Beaumont and Houston is considerably different than the relatively undeveloped area between Freeport and Brownsville, with the exception of the Corpus Christi area. The extent and type of industrial activity as well as concentration of population can be related to the sources of waste as well as to the efforts and funds expended in attempts to satisfactorily treat and dispose of waste materials. The extent of agricultural development can be related in part to the quantity of herbicides and pesticides that may be found in the bay and estuary system.

The inventory of waste sources includes:

municipal and industrial wastewaters
salt water discharges
municipal refuse
refuse disposal practices
industrial emissions to the atmosphere
emissions from motor vehicles
animal wastes and pollution potential
pesticides in bays and estuaries

Other actual or potential waste sources which were not included in the inventory because of the limited time available for the completion of the study include releases of wastes associated with the transportation of materials by *pipelines and ships; dredging* for channel improvement or for utilization of mineral resources; and *litter and debris* from recreational activities associated with the beaches and waters of the Coastal Zone. Also, thermal discharges were not enumerated here since they are dwelt upon at length in a separate report on energy and power in the Coastal Zone.

II. INVENTORY OF WASTE SOURCES

The waste products of man's municipal and industrial activity which are discharged into surface water, onto the land, into the atmosphere or below ground have been identified where data was available. These data are summarized in this section of the report. This information includes:

(a) quantity and quality characteristics of municipal and industrial wastewater discharged into surface waters;

(b) quantity of industrial wastewaters disposed of by injection wells;

(c) salt water discharges and methods of salt water disposal;

(d) production of municipal solid wastes and current refuse disposal practices;

(e) particulate and gaseous emissions into the atmosphere from industrial sources;

(f) the number of registered motor vehicles and characteristics of automobile exhausts;

(g) animal production, feed lots and potential solid waste and water pollution problems;

(h) pesticides in the water and sediment of bays and estuaries;

(i) radioactive wastes

Wastewater Discharges

The wastewater generated from the use of water for municipal and industrial purposes contains *suspended and dissolved, organic and inorganic materials* which can effect the quality of the receiving waters. Many of the components of wastewaters are reactive and undergo *biological decomposition* or enter into chemical reactions in the aquatic system. The *setteable solids* will accumulate on the bottom of streams and the organic material in the sediments will decompose. The concentration of these materials will decrease with time and these substances are nonconservative. Some of these materials, however, are *nonreactive and persist in the aquatic* environment for long periods of time. These conservative or refractory materials are generally not affected by conventional water and wastewater treatment processes and *tend to accumulate in the water, in sediments, or in aquatic organisms.*

Other components of wastewaters are classified as *nutrients* since relatively low concentrations of these chemical elements are required by algae and have been associated with the occurrence of undesirable algal blooms in streams, lakes, estuaries and bays. These nutrients are also associated with accelerating *eutrophication* which is a natural process of aging occurring in bodies of water.

Some inorganic ions and some organic compounds are *toxic* to fish, other aquatic animals and algae. At high concentrations these materials can exert acute toxic effects resulting in dramatic results such as fish kills. Chronic exposure to sublethal concentrations of these materials can have more *subtle effects on the biota*. Algae tend to accumulate and concentrate some toxic substances. Predator fish feeding on these algae could ingest lethal doses of toxicants. Inorganic ions which have toxic effects include syanides, mercury, copper, cadmium, chromium, zinc, and nickel to name a few. Some other compounds and petrochemicals usually involved in reports of acute toxicity are acids, caustics, ammonia, chlorine, phenolic compounds, organic solvents, synthetic organic compounds, oil field brines, pesticides and detergents to list only a few.

Most pollutants are characterized by the *oxygen demand* on the receiving streams exerted by the wastewater discharges. Dissolved oxygen is required by fish and aquatic organisms. When there is no free dissolved oxygen in the water anaerobic conditions result in fish kills and are characterized by odors. The lack of dissolved oxygen generally upsets the "biodynamic" equilibrium which relates the interdependence of various aquatic species on each other and the effects of oxygen, nutrients and organic material on the organisms. *Biodynamic equilibrium* is characterized by numerous species of bacteria, algae, protozoa, crustacea and fish. Each species is present in limited numbers. The equilibrium is upset when the aquatic environment is changed resulting in the elimination of one type of organism and the predominance of another. Depletion of the dissolved oxygen resources changes the environment from aerobic to anaerobic and the biodynamic equilibrium which was established is upset.

The *dissolved oxygen balance in the receiving stream is important;* therefore, wastewaters must be classified in terms of their effects on the oxygen resources of the stream. Wastes are classified in terms of a Biochemical Oxygen Demand *(BOD)*, a Chemical Oxygen Demand *(COD)* or a Total Oxygen Demand *(TOD)*. Wastewaters are also characterized in terms of the Total Organic Carbon *(TOC)* content, which can be related to one of the oxygen demand parameters.

The Biochemical Oxygen Demand *(BOD)* is the quantity of oxygen utilized in the *microbial oxidation of biodegradable organic material* in the wastewater in a specific time (usually 5 days) and at a specific temperature (usually 68°F). The BOD usually indicates the oxygen required for the biological oxidation of biodegradable carbonaceous substances and in some cases for the degradation of nitrogenous materials.

The Chemical Oxygen Demand (COD) represents an estimate of the organic and inorganic materials which can be *oxidized by a chemical oxidizing agent.* The Total Oxygen Demand (TOD) is a relatively new parameter for which equipment has recently been developed and provides an estimate of the oxygen required to *satisfy all demands on the oxygen resources* in the stream. Equipment is also available for estimating the amount of organic and inorganic carbon in the wastewater. The TOC can be related to the BOD and/or COD.

The analytical procedures available for evaluating the parameters used to characterize the oxygen demand or carbon content of wastewaters have some limitations. A detailed discussion of all the procedures is beyond the scope of this report. *However, it is important to note that extreme caution is advisable in evaluating data relating to these parameters.*

The particulate and dissolved substances in wastewaters also effect the quality of the receiving stream. Deposition of organic and inorganic suspended material on the bottom of streams can cause sludge banks to form. The accumulation of dissolved solids in the water can limit the use of the water for some purposes. The solids in wastewaters are categorized below:

(a) setteable solids are the suspended matter in a waste which will settle by gravity under quiescent conditions in one hour.

(b) suspended solids are those materials which float on the surface or are in suspension in water and which are removed by laboratory filtering

(c) total solids are defined as the residue remaining after the water is evaporated from the sample and the residue dried to a constant weight

(d) dissolved solids are therefore the difference between the total solids and the suspended solids

(e) volatile solids are that fraction of the total suspended or dissolved solids which are lost upon ignition of the dried residue.

The characteristics of typical municipal wastewater are summarized in Table 1. The introduction of industrial wastewater into the collection system may markedly alter the composition of municipal wastewater. The amount of water used and the quantity of infiltration into the collection system also effects the characteristics of municipal wastewater.

The quantity of wastewater generated per person in Texas varies from less than 70 to 100 gallons per capita per day. The per capita wastewater flow increases with the population of the city. This increase may be attributed to the fact that larger quantities of water

TABLE 1

Characteristics of Typical Municipal Wastewater*

Characteristic	Maximum	Average	Minimum
pH Units	7.5	7.2	6.8
BOD (mg/l)**	276	147	75
COD (mg/l)	436	288	159
Settleable Solids (mg/l)	6.1	3.3	1.8
Total Solids (mg/l)	640	453	322
Suspended Solids (mg/l)	258	145	83

* Hunter, J. V., and H. Heukelekian
"The Composition of Domestic Sewage Fractions,"
Journal Water Pollution Control Federation, 37, 1142 (1965)

**mg/l = milligrams per liter = parts per million are used for public purposes in the communities. Therefore, when the wastewater from public facilities is assessed on a per capita basis, this value will increase. *The average municipal wastewater flow in Texas is 88.9 gallons per capita per day.* The average contribution of 5-day BOD and suspended solids for people in Texas respectively are *0.16 pounds and 0.21 pounds per capita per day.* These values are considerably lower than those reported for the national average values for these parameters which are 135 gallons of wastewater, 0.20 pounds of 5-day BOD, and 0.23 pounds of suspended solids per capita per day, respectively.

The characteristics of industrial wastewaters are as varied as the type of industry producing the wastes. The composition of wastewaters from different industries are presented for illustrative purposes in Tables 2 and 3.

Most municipal and industrial wastewaters have been treated to some extent to improve the effluent quality before discharge into the surface waters. The number of treatment plants in each county in the Coastal Zone are presented in Figure 1 and Table 4. The information was obtained from the data maintained in the form of an inventory of waste treatment facilities at the Texas Water Quality Board for all wastewater discharges for which permits have been granted. These permits are required under the State Water Pollution Control Act passed by the 57th Legislature of the State of Texas in 1961.

Current technology of wastewater treatment and renovation is such that the removal of almost all non-desirable constituents of wastewater is possible for some price. Treatment or renovation of wastewater is usually classified as *primary, secondard or tertiary. Primary treatment* includes numerous processes required for the removal and disposal of a portion of the suspended solids in the wastewater. *Secondary treatment* involves the removal of a portion of the dissolved organic material in the wastewater by means of microbiological oxidation. These processes are aerobic and vary in the way in which the bacteria are utilized. Waste stabilization ponds contain algae which provide the oxygen for use by bacteria in oxidizing the organic material. The effluent BOD is a function of the detention time and temperature. The effluent suspended solids concentration is between 50 and 100 mg/L. Trickling filters are treatment units in which bacteria which oxidize the organic matter grow in the form of slime attached to the surface of a rock or suitable support. These bacteria oxidize the organic matter with which they come in contact as the wastewater passes over the slime covered medium.

Activated sludge is the general name applied to a number of similar processes which involve the introduction of oxygen into a system containing a mixture of suspended bacterial growths (activated sludge) and the dissolved organic material in the wastewater.

TABLE 2

Industrial Wastewater Characteristics

Industry	Flow (gal)	BOD (lb)	SS (lb)	Other	
Brewery					
per barrel	370	1.9	1.03		
Cannery					
per case	75	0.7	0.8	Total Dissolved Solids	
Dairy					
per 100 lb					
Creamery butter	410-1350	0.34-1.68	---		
Cheese	1290-2310	0.45-3.0	---		
Condensed and evaporated milk	310- 420	0.37-0.62	---		
Ice Cream	620-1200	0	---		
Milk	200- 500	0.05-0.26	---		
Meat Packing per 100 live wt. killed					
old technology	2112	20.2	---		
typical technology	1294	14.4	---		
advanced technology	1116	11.3	---		
Poultry Processing per 1000 birds					
old technology	4000	31.7	---		
typical technology	10400	26.2	---		
new technology	7300	26.0	---		
Petrochemical Plants					
Petroleum Refining				Phenol	Sulfide
per barrel					
old technology	250	0.4	---	0.03	0.01
typical technology	100	0.1	---	0.01	0.003
newer technology	50	0.05	---	0.005	0.003

TABLE 2
(cont'd.)

Industry	Flow (gal)	BOD (lb)	SS (lb)	Other
Pulp & Paper				
per ton				
Bleached Kraft				
old technology	110,000	200	200	
prevalent technology	45,000	120	170	
new technology	25,000	90	90	
Bleached Sulfite				
old technology	95,000	500	120	
prevalent technology	55,000	330	100	
new technology	30,000	100	50	
Steel Mill				
per ingot ton				
old technology	9,860	---	103	Phenols, cyanides
prevalent technology	10,000	---	125	Fluorides, ammonia
new technology	13,750	---	184	oil, acids, emulsions, soluble metals
Tannery				
per 100 lb	660	6.2	13.0	
Textile				
per pound of cloth				
Wool	63	0.30	---	
Cotton	38	0.16	0.07	
Synthetic				
Rayon	3- 7	0.02-0.04	0.02-0.09	
Acetate	7-11	0.04-0.05	0.02-0.06	
Nylon	12-18	0.04-0.06	0.02-0.04	
Acrylic	21-29	0.10-0.15	0.03-0.15	
Polyester	8-16	0.12-0.25	0.03-0.16	

The Cost of Clean Water, Volume III, Industrial Waste Profiles, Federal Water Pollution Control Administration, U.S. Dept. of Interior, Washington, D. C. (1968).

No. 1 Blast Furnaces and Steel Mills
No. 3 Pulp and Paper
No. 4 Textile Products
No. 5 Petroleum Refineries
No. 6 Canneries
No. 7 Leather Tanning and Finishing
No. 8 Meat Products
No. 9 Dairies

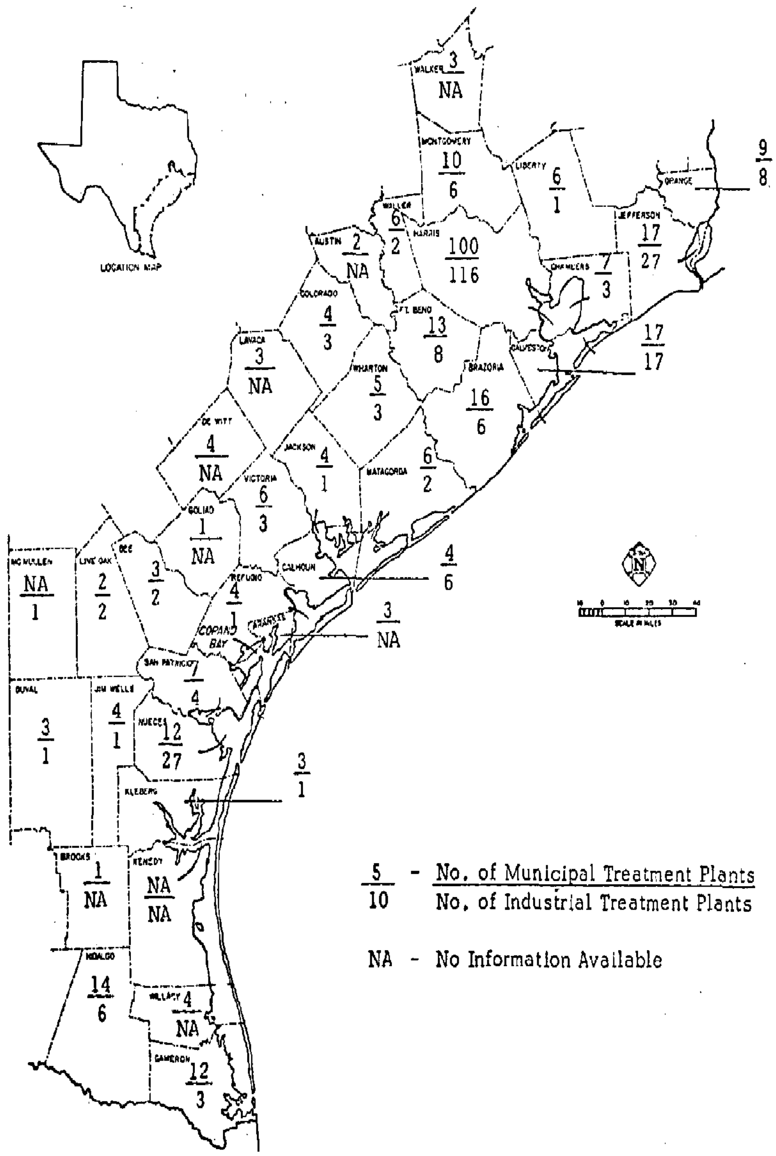
TABLE 3

Petro-Chemical Wastewater Characteristics

Chemical Product	Flow (gal/ton)	BOD (mg/l)	COD (mg/l)	Other Characteristics
Primary Petrochemicals:				
Ethylene	50-1,500	100-1,000	500-3,000	phenol, pH, oil
Propylene	100-2,000	100-1,000	500-3,000	phenol, pH
Primary Intermediates:				
Toluene	300-3,000	300-2,500	1,000-5,000	
Xylene	200-3,000	500-4,000	1,000-8,000	
Ammonia	300-3,000	25- 100	50- 250	oil,nitrogen, pH
Methanol	300-3,000	300-1,000	500-2,000	oil
Ethanol	300-4,000	300-3,000	1,000-4,000	oil, solids
Butanol	200-2,000	500-4,000	1,000-8,000	heavy metals
Ethyl Benzene	300-3,000	500-3,000	1,000-7,000	heavy metals
Chlorinated Hydrocarbons	50-1,000	50- 150	100- 500	pH, oil, solids
Secondary Intermediates:				
Phenol, Cumene	500-2,500	1,200-10,000	2,000-15,000	phenol, solids
Acetone	500-1,500	1,000-5,000	2,000-10,000	
Glycerin, Glycols	1,000-5,000	500-3,500	1,000-7,000	
Urea	100-2,000	50- 300	100- 500	
Acetic Anhydride	1,000-8,000	300-5,000	500-8,000	pH
Terephthalic Acid	1,000-3,000	1,000-3,000	2,000-4,000	heavy metals
Acrylates	1,000-3,000	500-5,000	2,000-15,000	solids, color, cyanide
Acrylonitrile	1,000-10,000	200- 700	500-1,500	color, cyanide, pH
Butadiene	100-2,000	25- 200	100- 400	oil, solids
Styrene	1,000-10,000	300-3,000	1,000-6,000	
Vinyl Chloride	10- 200	200-2,000	500-5,000	

TABLE 3
(cont'd.)

Chemical Product	Flow (gal/ton)	BOD (mg/l)	COD (mg/l)	Other Characteristics
Primary Polymers:				
Polyethylene	400-1,600		200-4,000	solids
Polypropylene	400-1,600		200-4,000	deashing solvents
Polystyrene	500-1,000		1,000-3,000	solids
Polyvinyl Chloride	1,500-3,000	50- 500	1,000-2,000	
Cellulose Acetate	10- 200	500-2,000	1,000-5,000	
Butyl Rubber	2,000-6,000	800-2,000	2,500-5,000	
Dyes and Pigments:	50,000-250,000	200- 400	500-2,000	heavy metals, color, solids, pH
Miscellaneous Organics:				
Isocyanate	5,000-10,000	1,000-2,500	4,000-8,000	nitrogen
Phenyl Glycine	5,000-10,000	1,000-2,500	4,000-8,000	phenol
Parathion	3,000-8,000	1,500-3,500	3,000-6,000	solids, pH
Tributyl Phosphate	1,000-4,000	500-2,000	1,000-3,000	phosphorus



WASTEWATER TREATMENT PLANTS

FIGURE 1

TABLE 4

WASTEWATER TREATMENT PLANTS

County	# Municipal Treatment Plants	Industrial Treatment Plants: # Based On Computer Print Out (1)	Industrial Treatment Plants: Total # Print Out & TWDB Info. (2)
Aransas	3	NA	NA
Austin	2	NA	NA
Bee	3	2	2
Brazoria	16	3	6
Brooks	1	NA	NA
Calhoun	4	2	6
Cameron	12	2	3
Chambers	7	3	3
Colorado	4	2	3
DeWitt	4	NA	NA
Duval	3	1	1
Fort Bend	13	5	8
Galveston	17	14	17
Goliad	1	NA	NA
Harris	100	88	116
Hidalgo	14	5	6
Jackson	4	0	1
Jefferson	17	18	27
Jim Wells	4	1	1
Kenedy	NA	NA	NA
Kleberg	3	1	1
Lavaca	3	NA	NA
Liberty	6	1	1
Live Oak	2	2	2
Matagorda	6	2	2
McMullen	NA	1	1
Montgomery	10	6	6
Nueces	12	19	27
Orange	9	8	8
Refugio	4	1	1
San Patricio	7	3	4
Victoria	6	1	3
Walker	3	NA	NA
Waller	6	2	2
Wharton	5	1	3
Willacy	4	NA	NA

* NA - No Information Available

The effluent of trickling filter and activated sludge plants contains between 15 and 25 mg/L of 5-day BOD and generally less than 20 mg/L of suspended solids.

The destruction of disease causing bacteria remaining after primary and/or secondary treatment is generally accomplished by adding *chlorine* to the plant effluent.

Tertiary treatment of water renovation systems include processes which will remove those substances which persist after primary and biological treatment. The persistent materials include:

(a) *suspended solids* which are removed by sand filtration or microstraining,

(b) *dissolved organic materials* which are removed by adsorption on activated carbon,

(c) *inorganic substances* measured as total dissolved solids (TDS) which may be removed by ion exchange, and

(d) *nutrients such as phosphorus* which may be removed by chemical precipitation and nitrogen which may be eliminated either biologically or by air stripping.

The solids removed or generated during the treatment of wastewaters also require treatment and disposal. The alternate systems for wastewater and sludge treatment and disposal include a myriad combination of various unit processes and, therefore, will not be attempted at this time. However, *improper handling and disposal of sludges can result in a source of water or air pollution.*

The wastewater discharge permit information maintained by the Texas Water Quality Board includes quantitative and qualitative data as well as the location of the treatment plant. This information is provided by the applicant for a permit. In addition to the permit data and return flow data which include actual wastewater flow and characteristics, data are also maintained for some of the permitted discharges. The quality information is based on grab samples of waste which do not represent the hourly and daily fluctuations. For the purpose of this inventory, the quantity of wastewater was expressed as a rate of flow in million gallons per day (MGD) and the quality of the wastewater was expressed in terms of those substances which exerted an oxygen demand expressed as a Biochemical Oxygen Demand (BOD) or the Chemical Oxygen Demand (COD) and as Suspended Solids (SS). Phosphate information is also included for municipal effluents where information is available. These quality parameters were selected because *this information is readily available for most discharges.* The data are summarized for each county in the Coastal Zone in Tables 5 and 6 and the flow data for the municipal and industrial wastewaters is presented in Figure 2. The Texas Water Development Board also provided some of the information regarding the total flow of wastewaters in the various counties. The wastewater flow information is based on the return flow data provided in the form of a computer printout.

TABLE 5

Municipal Wastewater Discharges*

County	Flow (MGD)	Quality: BOD Pounds/day	Suspended Solids Pounds/day	Phosphates Pounds/day
Aransas	1.39	564	867	71
Austin	0.53	347	245	83
Bee	1.30	314	240	366
Brazoria	9.89	2902	2970	977
Brooks	0.25	250	94	67
Calhoun	2.26	707	693	294
Cameron	15.18	8705	8243	1,703
Chambers	0.24	86	197	83
Colorado	1.52	1374	1368	134
DeWitt	2.81	432	455	216
Duval	0.50	200	218	15
Fort Bend	3.72	1293	1933	690
Galveston	14.95	16283	11257	1,788
Goliad	0.30	5	105	30
Harris	197.44	75443	128721	26,560
Hidalgo	18.25	8768	14752	2,504
Jackson	0.67	130	166	------
Jefferson	65.90	23258	12575	9,274
Jim Wells	2.60	990	814	1,002
Kenedy	------	-----	------	------
Kleberg	2.10	685	633	214
Lavaca	0.96	2838	1324	672
Liberty	0.96	267	329	35
Live Oak	0.55	102	274	59
Matagorda	2.72	1215	440	508
McMullen	------	-----	------	NA
Montgomery	2.05	774	878	371
Nueces	28.50	11825	5980	5,815
Orange	7.33	4345	1406	813
Refugio	0.86	476	664	199
San Patricio	3.34	1753	2373	915
Victoria	3.85	951	3078	2,461
Walker	2.35	510	589	650
Waller	0.32	170	150	47
Wharton	1.82	751	649	663
Willacy	1.03	76	54	61

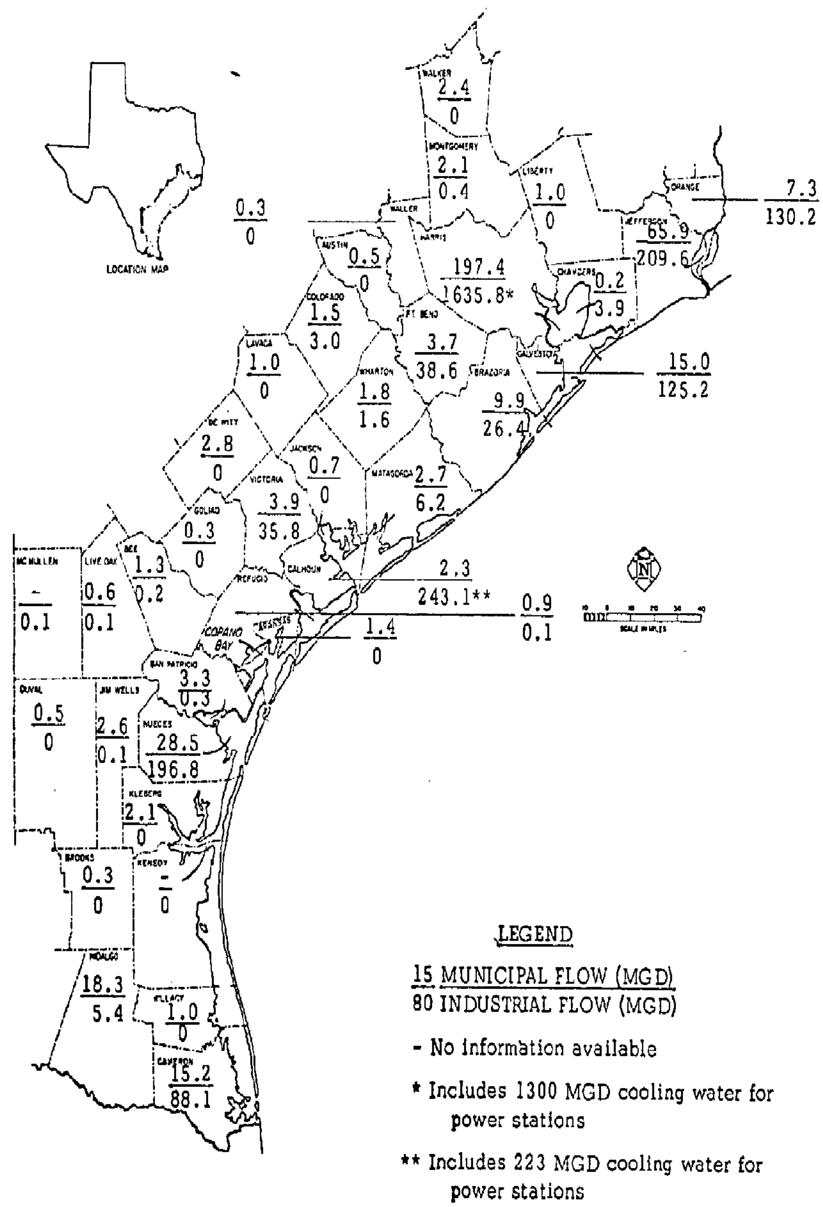
*Texas Water Quality Board (1970)
Texas Water Development Board (1970)

TABLE 6

Industrial Wastewater Discharges*

County	Flow (MGD)	Quality: BOD Pounds/day	COD Pounds/day	Suspended Solids Pounds/day
Aransas	-------	------	-------	------
Austin	-------	------	-------	------
Bee	0.2	350	1401	856
Brazoria	26.35	2327	80147	1112
Brooks	-------	------	--------	------
Calhoun	20.11	2152	85644	15823
Cameron	88.11	2636	2114	20678
Chambers	3.93	847	30765	462
Colorado	2.98	20	67	22
DeWitt	-------	------	-------	------
Duval	-------	------	-------	------
Fort Bend	38.60	7750	12593	30878
Galveston	125.19	112767	950862	300620
Goliad	-------	------	-------	------
Harris	335.76	554260	1422807	555831
Hidalgo	5.36	221	1660	2703
Jackson	------	------	-------	------
Jefferson	209.55	183174	643791	130801
Jim Wells	0.09	66	162	55
Kenedy	-------	------	-------	------
Kleberg	-------	------	-------	------
Lavaca	-------	------	-------	------
Liberty	-------	------	-------	------
Live Oak	0.12	2	-------	------
Matagorda	6.24	9846	11885	2812
McMullen	0.07	1	240	60
Montgomery	0.41	737	7982	271
Nueces	196.83	65106	934978	76935
Orange	130.21	151395	341480	91919
Refugio	0.04	1	5	4
San Patricio	0.3	24	495	35
Victoria	35.78	6755	10088	13010
Walker	------	------	-------	------
Waller	------	------	-------	------
Wharton	1.59	34	135	336
Willacy	------	------	-------	------

*Texas Water Quality Board (1970)
Texas Water Development Board (1970)



MUNICIPAL AND INDUSTRIAL WASTEWATER FLOWS (1970)

FIGURE 2

Much of the information relating to the wastewater quality for both the municipal and industrial discharges was not available in the return flow data. These data are collected by the staff of the Texas Water Quality Board and the lack of some data is a reflection of the under-staffing resulting from budget limitations.

The more recent data, namely that collected after February, 1970, would have to be obtained from the individual files and for each treatment plant which has a discharge permit. A system of self-reporting of the quality of the industrial wastewater influent has been initiated. However, as of this date, this system of reporting has been substantially less than 100 percent effective. As the self-reporting system develops and the difficulties eliminated, it would be possible to have monthly information regarding the effluent quality of each of the industrial discharges.

It should be pointed out at this time that the quality of the effluent from municipal and industrial wastewater treatment plants is affected to a large extent by the characteristics of the incoming wastewater, by the operation of the particular plant as well as the adequacy of the plant to handle the present day wastewater flows. The *infiltration of storm water or ground water* into the municipal wastewater collection systems in the Coastal Zone may also contribute to the total amount of flow which must be treated by municipal facilities. During periods of heavy rain it is possible that the infiltration of storm water into the collection system could result in overloading the treatment system thereby resulting in only partial treatment of the wastewater. The municipal wastewater flow presented in Table 5 and Figure 2 does *not* represent the contribution of infiltration into the collection systems in most cases. Therefore, these numbers are somewhat lower than the flow which would result during a period of high rainfall.

Infiltration will also affect the *quality* of the wastewater reaching the treatment plant. The amount of industrial wastewaters which are introduced into the municipal wastewater collection system will also affect the treatment efficiency of municipal plants. Therefore, these factors may account for some of the variations in the quantities of potential pollutants discharged by municipal plants in the different counties.

Many of the municipal wastewater treatment plants were not designed to treat the quantity of wastewater which now flows into the plant. Therefore, *they are overloaded and at best can only provide an effluent which is partially treated and of desired quality*. Many of the industrial wastewater treatment plants *require upgrading* in order to be able to effectively treat their particular wastewaters to a quality which meets water quality criteria.

It is interesting to note that the discharge of municipal wastewater in 30 of the 36 counties is less than 10,000,000 gallons per day (10 MGD) and of these 30 counties, 18 counties have municipal wastewater discharges of less than 3 MGD. Ten counties have a wastewater flow between 2 and 5 MGD while the wastewater flows in two counties is between 5 and 10 MGD. Three counties produce municipal wastewater flows between 10 and 20 MGD per day and the municipal wastewater flows in two counties is more than 20 MGD but less than 100 MGD. Almost 200 MGD of municipal wastewater is discharged in only one county.

These data are based on the information available on the wastewater discharge permits and the return flow data. In many of these counties, only a portion of the population is served by a wastewater collection system. The Texas Municipal League has reported the number of sewer connections in various cities; however, the population served is not directly correlatable to the number of connections. The remainder of the population in these counties are required to treat and dispose of the wastewaters in *individual septic tank systems*. The available information which deals with the number of septic tanks and used to treat wastewater in the Coastal Zone is sparse. The proximity of the ground water table to the ground surface in the Coastal Zone makes it possible for the discharge from the septic tank absorption field system to enter the shallow ground water and be carried directly into the surface waters with minimal additional treatment.

The information available on the number of people serviced by a municipal wastewater collection system is far from adequate. The results of an inventory compiled in 1968 by the Federal Water Pollution Control Administration indicate that *6,819,000 people in Texas were served by adequate municipal wastewater facilities, and the wastewater of 1,925,000 people had no treatment.* The percentage of the people in Texas who were served by less than adequate or no treatment facilities was *23.2 percent*. These numbers are based on the 1960 Bureau of Census population data. In some cases, an estimate of the population served in a particular county exceeds the preliminary census estimate of the 1970 population for that county. In other cases, the information available on the discharge permit application is not complete and an estimate of the population served is not readily available. Because of these discrepancies it is almost impossible to develop an accurate figure which relates the number of people in a particular county who have individual wastewater disposal systems, which consist of a septic tank and absorption field. In general, most of the municipal wastewater treatment plants in the counties in the Coastal Zone *require some upgrading* in order to discharge effluents which meet the water quality criteria established by the Texas Water Quality Board. The Federal Water Pollution Control Administration in their Cost of Clean Water series estimated the *projected cost to upgrade and construct municipal wastewater treatment facilities in Texas for fiscal years 1969-1973 to be $378,500,000.* The capital outlays needed total $323,600,000 and the operation and maintenance costs are estimated to be $72,200,000.

The industrial wastewater discharges summarized in Table 2 *do not include the wastewaters from feed lot operations but do include* *the return flows from power generation.** Of the 36 counties in the Coastal Zone, 14 counties have no industrial discharges. The quantity of wastewater discharged from industrial use is concentrated in Harris, Jefferson, Nueces, Orange, Galveston, Cameron, Victoria, Brazoria, Fort Bend, and Calhoun counties. These ten counties account for 99 percent of total industrial wastewater discharge in the Coastal Zone area. *The majority of this industrial wastewater flow is associated with the refining and petrochemical industries.* The quality of the industrial wastewater discharges is based on the information included on the permit application and in the return flow data which were made available by the Texas Water Quality Board in the form of a computer printout sheet. Where information relating the quality of the particular discharge to the flow was not available, these flow data were not included in calculating the total pollutional load generated in the various counties.

Some industrial wastewaters are difficult to treat and treatment to meet regulatory standards is considered to be economically unfeasible. These industrial wastewaters may be injected into subsurface porous strata. These wastes are merely stored below ground in strata which are sealed by impervious strata, thus isolated from usable underground water supplies or mineral resources.

Sedimentary rocks in the unfractured state generally can store large volumes of wastes. This group of rocks includes sandstones, limestones, and dolomites; unconsolidated sands are generally excellent disposal formations. Fractured strata should be avoided since vertical fissures may exist and the injected waste may travel vertically towards usable water supplies.

Disposal wells vary in depth from a few hundred feet to about 15,000 feet. The capacity of various wells ranges from less than 10 to more than 2000 gallons per minute. *Waste disposed of in injection wells includes streams containing acids, alkalies, chlorides, chromates, cyanides, high BOD wastes, nitrates, phosphates, radioactive wastes, and others which are difficult or more expensive to dispose of by other methods.*

The disposal system consists of a well and surface equipment such as pumps and pretreatment equipment which may be necessary to remove constituents of the waste which may interfere with subsurface disposal. Some of the details of the design of the injection tubing and the well are shown in Figure 3. A casing, generally of steel, is cemented in place to seal the disposal stratum from the other strata which were penetrated during the drilling of the well. An injection tube transports the waste from the surface to the disposal stratum. An oil or fresh water is used to fill the annular space between the injection stratum. By monitoring the pressure of fluid, leaks in the injection tube or damage to the casing can readily be detected.

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* *The report on Energy and Power includes a detailed discussion on the environmental effects of the alternate methods of power production.*

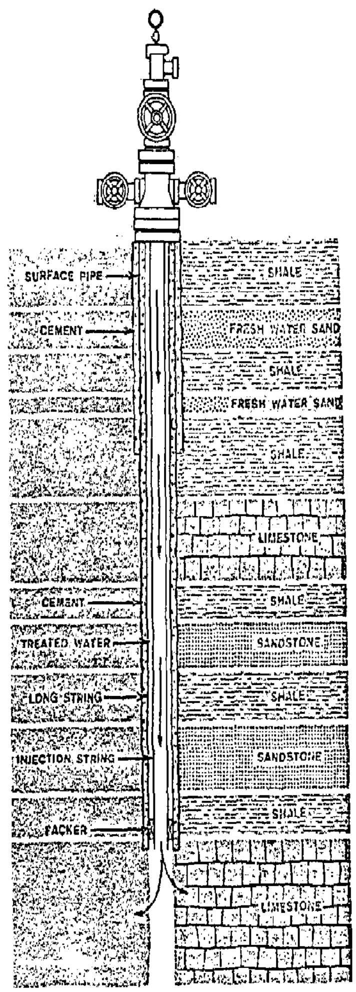


FIGURE 3

TYPICAL INJECTION WELL

The surface installation usually includes a storage pit or tank to level out variations in flow, equipment necessary for pretreatment of the waste and high pressure pumps. The degree of treatment required depends on the characteristics of the wastewater, the compatability of the formation water and the wastewater, and the characteristics of the receiving formation.

Injection wells are located in nine counties in the Coastal Zone. A total of *43 injection wells* which have been permitted are located in the Coastal Zone. Three of these permitted wells have not been installed. The number of wells and actual wastewater discharges are presented in Table 7 and Figure 4. The formations into which the industrial wastewaters are pumped are also listed in Table 7. The depth of the wells range from 3400 to 7650 feet below the ground surface. The permitted flow exceeds the actual flow being discharged into the injection well in some of the counties. This information regarding the total quantity of flow discharged into injection wells was obtained from the permit data available from the Texas Water Quality Board. No attempt was made to characterize the industrial wastewaters which were injected into the wells.

The total volume of industrial wastewaters disposed of in injection wells represents only a small fraction of the total quantity of industrial wastewater flow which is discharged into surface waters. Injection wells are located in those counties where the industrial activity is relatively high and where industrial wastewater flows far outshadow the amount of municipal wastewater flow which has been reported.

The discharge of *salt waters resulting from the exploration for natural gas and oil* into surface waters and ground waters can cause potential problems. The data presented in Table 8 and in Figure 5 indicate the quantity of salt water which must be disposed of in the various counties in the Coastal Zone. The method of salt water disposal is also shown in this table. These data were obtained from the Texas Water Development Board and are based on the result of a *1961* survey. Since this 1961 survey, *the Texas Railroad Commission has restricted the discharge of salt water into open pits and surface waters*. Therefore, based on this restriction, *no* salt water is presently discharged into surface water or into open unlined pits in the Coastal Zone. The results of a 1968 survey of salt water discharges were not available in a form that could be easily summarized in the limited time during which this inventory was compiled.

Solid Waste

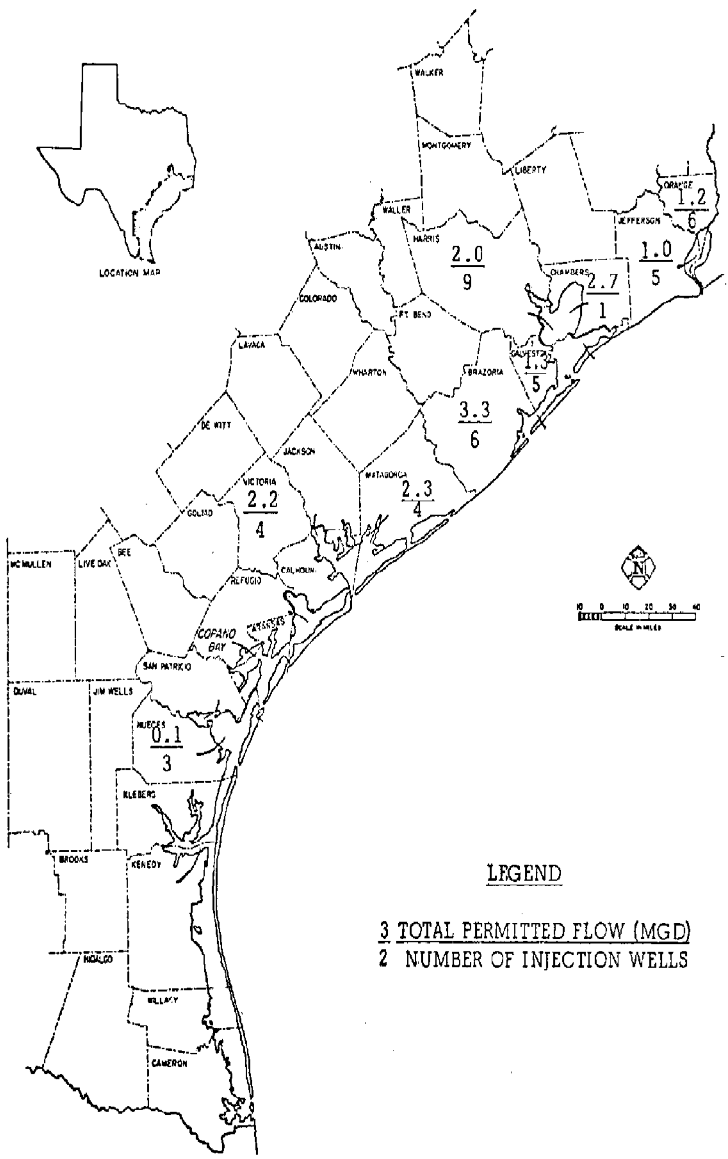
Solid wastes include a broad spectrum of materials which are no longer useful to man or for industrial purposes in their present form. A general classification of solid wastes which may be generated in a municipality is presented in Table 9. Most municipalities collect and dispose of *"ordinary refuse," "bulky waste,"* and in many cases, *"abandoned vehicles."* The extent to which municipal service is

TABLE 7

Wastewater Discharges into Injection Wells*

County	Number	Actual Flow (MGD)	Permitted Flow (MGD)
Brazoria	6	2.34	3.31
Chambers	1	-------	2.69
Galveston	5	1.065	1.281
Harris	9	1.983	1.983
Jefferson	5	0.955	0.955
Matagorda	4	2.325	2.325
Nueces	3	0.019	0.091
Orange	6	1.239	1.239
Victoria	4	2.18	2.18
Formation			
Miocene	22	5.84	7.19
Pliocene-Miocene	7	2.64	2.64
Salt Dome	3	------	2.694
Sands	3	0.552	0.552
Sandstone	4	2.18	2.18
Frio	4	1.151	1.151

*Texas Water Quality Board



WASTE DISPOSAL WELLS (1970)

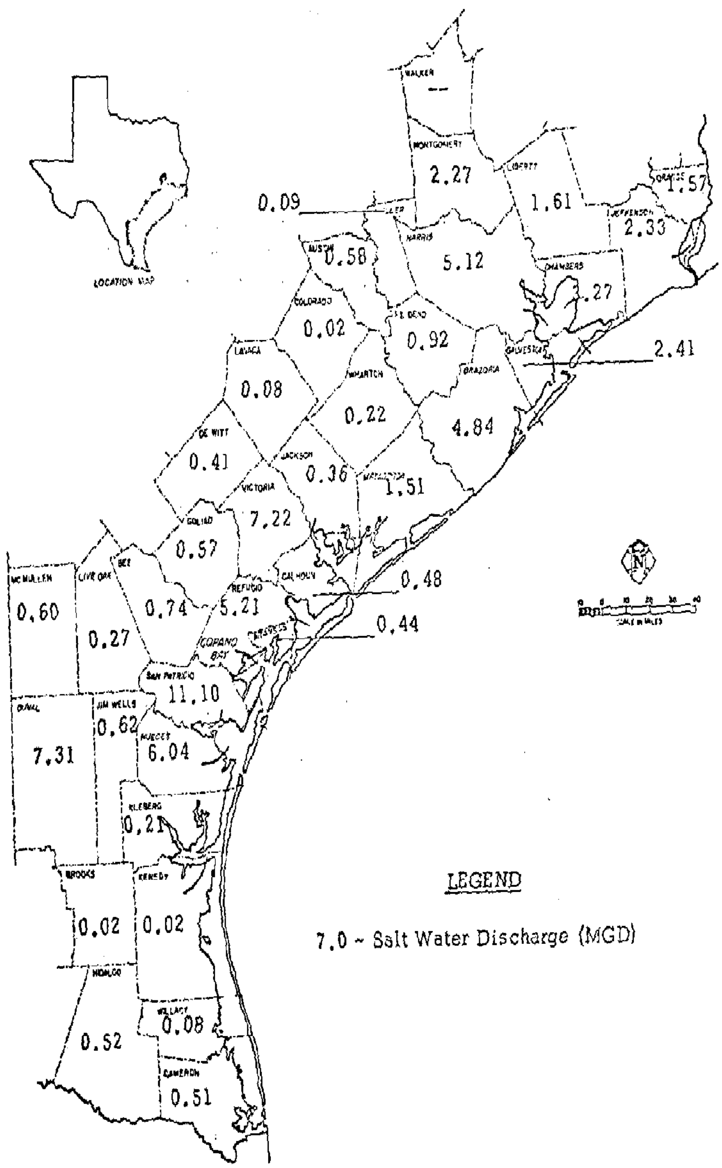
FIGURE 4

TABLE 8

Salt Water Discharges* (1961)
(Million Gallons Per Day)

County	Injection Wells	Open Pits	Surface Water	Other	Total
Aransas	--	0.20	0.24	--	0.44
Austin	0.56	0.02	--	--	0.58
Bee	0.43	0.31	--	<0.01	0.74
Brazoria	4.62	0.22	--	<0.01	4.84
Brooks	<0.01	0.01	--	<0.01	0.02
Calhoun	0.11	0.29	0.08	<0.01	0.48
Cameron	--	0.51	--	--	0.51
Chambers	1.82	0.24	1.19	0.02	3.27
Colorado	<0.01	<0.01	--	<0.01	0.02
De Witt	0.19	0.22	--	--	0.41
Duval	5.19	2.06	--	0.06	7.31
Fort Bend	0.77	0.14	0.01	--	0.92
Galveston	1.07	0.28	1.04	0.02	2.41
Goliad	0.43	0.14	--	--	0.57
Harris	2.08	0.70	2.33	0.01	5.12
Hidalgo	0.04	0.16	0.32	--	0.52
Jackson	0.26	0.04	0.06	<0.01	0.36
Jefferson	1.76	0.17	0.39	0.01	2.33
Jim Wells	0.30	0.32	--	<0.01	0.62
Kenedy	0.01	--	<0.01	--	0.02
Kleberg	--	0.19	0.02	<0.01	0.21
Lavaca	0.05	0.03	--	--	0.08
Liberty	1.35	0.20	0.06	<0.01	1.61
Live Oak	0.01	0.26	--	<0.01	0.27
Matagorda	1.37	0.14	--	<0.01	1.51
McMullen	--	0.60	--	--	0.60
Montgomery	1.97	0.09	--	0.21	2.27
Nueces	1.40	1.98	2.64	0.02	6.04
Orange	0.07	0.58	0.92	--	1.57
Refugio	2.68	1.54	0.99	--	5.21
San Patricio	0.88	2.93	7.27	0.02	11.10
Victoria	5.98	1.23	--	0.01	7.22
Walker	--	--	--	--	--
Waller	0.09	<0.01	--	--	0.09
Wharton	0.20	0.01	<0.01	<0.01	0.22
Willacy	0.01	0.06	--	<0.01	0.08

* Texas Water Development Board (1961)



SALT WATER DISCHARGE WELLS (1961)

FIGURE 5

TABLE 9

CLASSIFICATION OF SOLID WASTES

A. Ordinary Refuse

1. Garbage includes animal and vegetable residue resulting from the preparation, cooking and eating of food. This material is readily decomposed and is generally the cause of the foul odors associated with domestic solid wastes.

2. Rubbish or trash includes all other materials which are generally discarded by a homeowner, resident, small business, commercial establishment or restaurant. A portion of this material is burnable.

3. Yard trimmings include debris from cutting lawns, pruning etc., but excludes branches longer than 3 feet in length and tree stumps.

4. Small dead animals includes, dogs, cats, squirrels, etc. which are accidentally killed on public streets or roads.

5. Street refuse - litter from receptacles.

B. Bulky or Oversized Wastes

Discarded stoves, refrigerators or other large appliances and sofa, stuffed chairs or other large pieces of furniture, as well as, large branches, fallen trees, and tree stumps.

C. Abandoned Vehicles

D. Industrial Wastes

E. Demolition Wastes

F. Construction Wastes

G. Hospital Wastes

H. Hazardous Wastes

Include explosive toxic or radioactive liquids and solids

I. Water and Wastewater Treatment Plant Sludges provided to small businesses, restaurants, commercial establishments and industry is determined by the policy established by individual municipality or local government.

The composition of ordinary municipal refuse is presented in Table 10. It is interesting to note that *paper and paper products constitute about 40 percent of the weight of the refuse and that garbage constitutes only ten percent of the weight.* The use of household disposal units will reduce the quantity of garbage that enters the refuse collection system but will increase the load of suspended solids which must be handled at the municipal wastewater treatment plant. The relative percentage of glass, paper, metals, and plastics will depend on the packaging industry, although based on present trends an increase in the quantity of paper and paper products can be expected.

The solid waste production data for the Coastal Zone is presented in Table 11 and Figure 6. These data were obtained from the Texas State Department of Health and represent the results of a 1968 survey. The quantity of refuse collected by municipal and private vehicles and disposed of in municipal, county, and privately owned disposal sites are based on estimates provided by the municipal and county official and disposal site operators.

The amount of industrial solid wastes which are collected by private organizations are generally not included in these lists. Some of the private collectors can dispose of solid waste in municipal or county disposal facilities do not accept sludges, industrial solid wastes, or hazardous solid wastes.

The amount of refuse generated daily per person is also shown in Table 11. This number is based on the total estimated quantity of refuse collected annually divided by the estimated population served. Refuse collection vehicles are not routinely weighed in most areas; therefore, the weight of refuse collected is merely a guess. Since this per capita production rate is based on two estimated figures, *the specific value for each county varies considerably from the next.*

The per capita refuse production varies from *a minimum of 0.69 pounds* per *capita per day to a maximum of 13.3 pounds per capita per day*. The average production rate for the Coastal Zone based on the total estimated population served and the total estimated quantity of refuse collected is *5.12 pounds per capita per day.* This value compares well with the value of 5 pounds per capita per day which is normally accepted as a reasonable rate of refuse production. Adequate records of the actual weight of the refuse collected daily is required in each county if a reasonable estimate of the per capita production is to be available for future planning of a solid waste management program. Other solid wastes which are not included in the ordinary municipal refuse which require disposal are also listed in Table 11. Abandoned automobiles pose serious

TABLE 10

COMPOSITION OF ORDINARY MUNICIPAL REFUSE

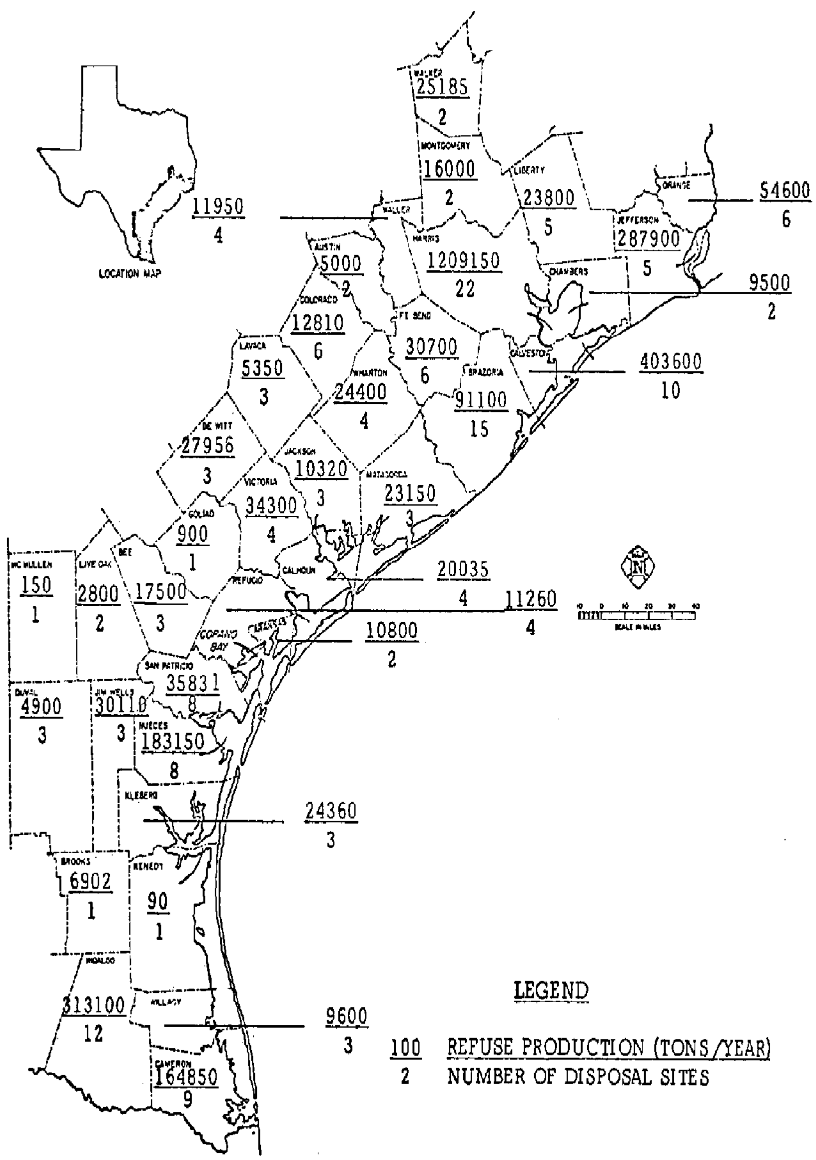
Component	Weight Percent
Paper	40
Garbage	10
Other Combustibles textile plastics fats, etc. grass tree limbs	25
Inerts glass ceramics stones metals ash	25

TABLE 11

Solid Waste Production*

County	Population Served	Tons/year	Quantity Pounds/capita/day
Aransas	9,600	10,800	6.2
Austin	14,300	5,000	1.9
Bee	23,500	17,500	4.1
Brazoria	106,000	91,100	4.7
Brooks	9,000	6,902	4.0
Calhoun	20,200	20,035	5.5
Cameron	134,900	164,850	6.7
Chambers	12,200	9,500	4.3
Colorado	18,500	12,810	3.8
De Witt	19,800	27,956	7.7
Duval	13,700	4,900	2.0
Fort Bend	51,300	30,700	3.3
Galveston	168,600	403,600	13.2
Goliad	5,000	900	1.0
Harris	1,597,800	1,209,150	4.1
Hidalgo	177,100	313,100	9.7
Jackson	14,100	10,320	4.0
Jefferson	247,600	287,900	6.4
Jim Wells	31,500	30,110	5.2
Kenedy	700	90	0.7
Kleberg	30,900	24,360	4.3
Lavaca	19,700	5,350	1.5
Liberty	32,500	23,800	3.7
Live Oak	7,200	2,800	2.1
Matagorda	31,700	23,150	4.0
McMullen	1,200	150	0.7
Montgomery	46,400	16,000	1.9
Nueces	232,500	183,150	4.3
Orange	72,900	54,600	4.1
Refugio	10,200	11,260	6.0
San Patricio	47,200	35,831	4.2
Victoria	56,800	34,300	3.3
Walker	28,500	25,185	4.9
Waller	14,700	11,950	4.4
Wharton	39,600	24,400	3.4
Willacy	14,600	9,600	3.6

*Texas State Department of Health (1968)



REFUSE PRODUCTION (1968)

FIGURE 6

problems to most municipalities. The results of a 1966 study of Solid Waste Production in Selected Texas Cities indicate that 1.6 passenger vehicles were abandoned for each 1,000 people. Therefore one could expect that about *5,7000 automobiles* will be abandoned in the Coastal Zone during 1970.

The sludge and residues resulting from the treatment of water for municipal supply and industrial use as well as from the treatment of municipal and industrial wastewaters also present a solid waste disposal problem. The quantity of sludge produce during treatment of water is affected by the quality of raw water supply, the chemicals added, the degree of treatment required to make the water suitable for municipal water supply, or for the specific industrial purpose. The water treatment sludges generally contain chemical precipitates and the sludges are difficult to concentrate but do not contain sufficient quantities of putrescible organic material; therefore, very little offensive odors are associated with these sludges. The characteristics of the wastewaters and the degree of treatment required will effect the quantity of sludge which is generated during the treatment of municipal and industrial wastewaters. These wastewater sludges generally contain putrescible organic material which readily decompose resulting in obnoxious odors. Therefore, these sludges require some type of treatment and disposal facilities at different treatment plants will vary. The residual solids may be buried or placed on the land as a soil conditioning agent. *Therefore the disposal of the solid residue and sludges from the treatment of wastewaters may result in pollution of ground and surface waters if improperly disposed of on land and air pollution if proper air cleaning is not furnished during incineration.*

The characteristics of industrial solid wastes are as varied as the industries located in the Coastal Zone. A very limited amount of information regarding the characteristics of the industrial solid waste is available. The staff of the Texas Water Quality Board is actively engaged in surveying the solid wastes generated at industrial facilities. The results of this survey, when completed, should provided qualitative and quantitative data for various types of industries.

Most industrial plant sites will store the sludges from water and wastewater treatment in lagoons on the plant site, if land is available. Otherwise these residues and other semi-solid residues are hauled off for disposal by private collectors. Most of the combustible residues in solid waste in industrial plant sites are incinerated at the plant site or collected by a private collection agency for disposal at some other site.

Disposal of municipal solid waste in the counties in the Coastal Zone is primarily on the land. The number of solid waste disposal sites reported in the Coastal Zone totals 175. This total includes four incinerator sites, three of which are in Harris County and one in Hidalgo County. One compost plant has also been reported in

Harris County. The remaining refuse disposal sites include sanitary landfills and open dumps. *Of the 175 number of land disposal sites, only 13 are considered to be sanitary landfills.* The remainder of the land disposal sites are considered to be *substandard landfills* generally characterized by uncontrolled burning of refuse, improper covering of the refuse at the end of the day, presence of rats and flies, drainage of runoff to surface water, blowing paper, and odors.

It should be pointed out that this information is based on a survey which was conducted by the Texas State Department of Health in 1968. Therefore, the number of disposal sites may have increased during this time and some of the dumps converted to sanitary landfills. The information available indicates that none of the incinerators plants for the disposal of refuse are presently in operation. The one operating compost plant which handled about 350 tons of refuse per day for the city of Houston in Harris County, has recently been shut down since *the market for reclaimed materials was a casualty of the economic slowdown.*

A sanitary landfill includes the placement of the refuse on the ground or in a prepared trench and compacted with a catepillar bulldozer or similar equipment. The compacted refuse is covered at the end of each operating day with about six inches of compacted soil. No burning of the refuse is permitted at the landfill site and proper drainage of the site is provided.

The pollution of ground water by refuse in sanitary landfills can take place only if the following conditions exist:

(a) the sanitary landfill is directly above or adjacent to an aquifer,

(b) the refuse in the sanitary landfill becomes supersaturated because of percolation of rainfall, pooling of surface water, or flow of ground water, and

(c) leached fluids are produced and the leachate enters the aquifer.

The geology, topography and ground water and surface water resources at the proposed sanitary landfill site should be carefully evaluated.* The site which provided the least potential for water pollution should be selected.

Refuse in sanitary landfill can absorb an extraordinary amount of water before supersaturated conditions develop and leachate is produced. Paper itself can absorb two to three times its weight in water. Leachate was produced only after 15 inches of water was

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* *The Bureau of Economic Geology has recently completed a study of the coastal region in which they identified potential landfill sites.*

continually applied at the rate of one inch per day to a fill in a ten-foot deep bin. The quantity of waste required to produce a leachate was about 25 gallons per cubic yard of fill or about 65 gallons per ton of refuse.

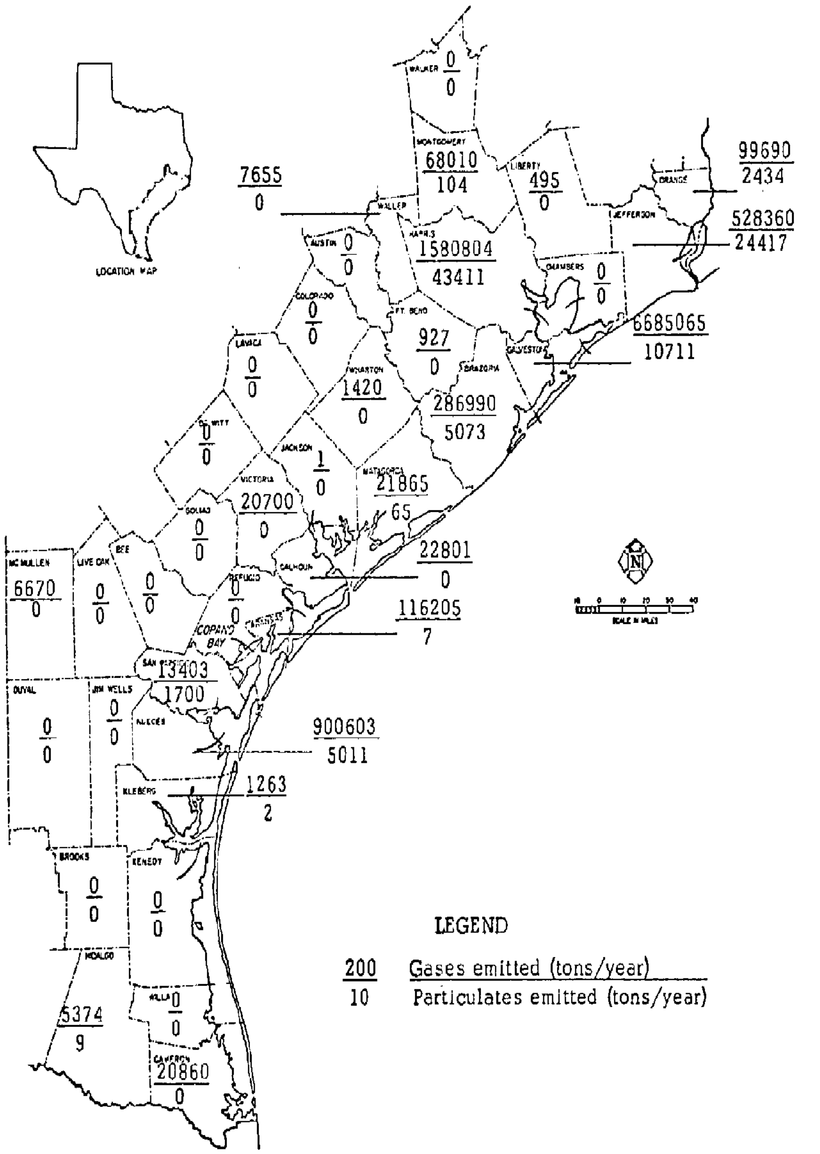
The overall picture of water pollution from a sanitary landfill is quite complex. The chances of water pollution can be minimized by locating the sanitary landfill away from ground water aquifers and surface water supplies. Proper draining of the site to avoid supersaturation of the refuse in the sanitary landfill is also necessary to eliminate production of leachate.

Open burning of refuse at dumps also *contributes to the particulate and gaseous emissions* to the atmosphere which constitute air pollution. The organic material in the refuse provides a good *breeding place for flies.* In the warm summer months, the time for flies to develop from the egg stage to adult is about 5 to 7 days. Although flies have not been directly incriminated with the transmission of diseases from refuse to humans, the flies are a nuisance. The garbage in the refuse also provides a *source of food for rats.* Therefore, an open dump is generally infested with rats which in turn can migrate from the dump to adjacent housing. Water that accumulates in discarded containers provides a *breeding place for mosquitoes* which in turn are vectors for the transmission of diseases such as encephalities, malaria, and yellow fever. Of these diseases, encephalitis is probably the most common and of most concern in the Coastal Zone.

Air Pollution

The gaseous and particulate emissions from industrial activities are presented in Table 12. *These emissions to the atmosphere do not include the particulate material and gases generated during the uncontrolled burning of refuse in open dumps, nor the emissions from motor vehicles.* The data in Table 12 were obtained for surveys conducted by the Texas Air Control Board and are expressed in terms of tons per year. The industrial gaseous emissions into the atmosphere include nitrogen oxides, sulfur oxides, hydrocarbons, carbon monoxide, hydrogen sulfide, sulfuric acid, flourides, and other compounds. Water vapor is also gaseous but is considered relatively harmless and not an air pollutant in the same sense as chemical compounds. The particulate and gaseous emissions into the atmosphere are also presented in Figure 7. There are not industrial emissions into the atmosphere in 14 of the counties in the Coastal Zone. Industrial gases are emitted in 21 counties, while particulate material and gases are reported to be emitted in only 12 counties.

The data presented in Table 12 indicate that the industrial counties account for the bulk of the atmospheric emissions. On a weight basis the industrial gaseous emission exceed the industrial particulate emission by a wide margin. More than *11,300,000 tons per year of industrial gaseous emissions* excluding water vapor and more than *93,000 tons per year of particulate emissions* have been reported



Industrial Emissions to the Atmosphere

Figure 7

TABLE 12

INDUSTRIAL AIR POLLUTION EMISSIONS*
(TONS/YEAR)

County	Gases	Particulates	Water Vapor
Aransas	116205	7	532000
Austin	0	0	0
Bee	0	0	0
Brazoria	286990	5073	35584194
Brooks	0	0	0
Calhoun	22801	0	3020000
Cameron	20860	0	523000
Chambers	0	0	3716
Colorado	0	0	0
DeWitt	0	0	0
Duval	0	0	0
Fort Bend	927	0	428008
Galveston	6685065	10711	13740000
Goliad	0	0	0
Harris	1580804	43441	296465702
Hidalgo	5374	9	439290
Jackson	1	0	0
Jefferson	528360	24417	19400000
Jim Wells	0	0	0
Kenedy	0	0	0
Kleberg	1263	2	13140
Lavaca	0	0	0
Liberty	495	0	50000
Live Oak	0	0	0
Matagorda	21865	65	3457650
McMullen	6670	0	0
Montgomery	68010	104	1892149
Nueces	900603	5011	21832105
Orange	99690	2434	14740482
Refugio	0	0	0
San Patricio	13403	1700	4124300
Victoria	20700	0	5000000
Walker	0	0	0
Waller	7655	0	4777936
Wharton	1420	0	122000
Willacy	0	0	0

*Texas Air Control Board (1970)

for the Coastal Zone. The relatively low amount of particulate material in the industrial emissions may be attributable to the fact that most industries burn natural gas which results in fewer particles than other fossil fuels. Enforcement of the Air Pollution Control legislation relating to particulate emissions may also be responsible for the relatively low quantity. Gaseous emissions are more difficult to remove and in most cases are not visible; therefore, the gases go by unnoticed except for any odors or colors associated with the gases.

Each industry has characteristic emissions which are unique to an industrial category or classification. Some typical emissions for industrial and agricultural activities are summarized in Table 13. The quantity and quality of gaseous and particulate emissions is related to the raw material used, the process applied and the effectiveness of the air pollution control equipment which is installed, if in fact any air cleaning devices are used.

The industrial emissions have the most direct effect on the environment immediately adjacent to the source of the emissions. In many cases the industrial emissions to the atmosphere are manifested by visible plumes at plant sites. This dramatic emission of colored plumes, particulate materials and chemical mists, etc., may travel some distance and affect the health and property of individuals at relatively remote locations. Odors may be the principle indicator of industrial emissions when no plume is obvious.

Motor vehicles also contribute to the emissions to the atmosphere. An inventory of the number of motor vehicles registered in the various counties in the Coastal Zone is presented in Table 14. The motor vehicles are classified in the following categories: passenger vehicles, trucks, buses, motorcycles, and a category including truck tractors, tractors, construction machinery, etc. The number of vehicles in the Coastal Zone which have exempt registration is not included. The distribution of passenger vehicles among the population in the Coastal Zone expressed as registered passenger vehicles per person is presented in Table 15 and Figure 8. The ratio does not vary significantly and covers a range of 0.28 to 0.49 registered passenger vehicles per person. The average for the Coastal Zone is 0.40 passenger vehicles per person. The population density is higher in the urban industrial counties and the total number of passenger vehicles is also high in these counties. Therefore the automobile emissions add to the industrial gaseous and particulate emissions.

The major components of automobile emissions are shown in Table 16 and include *carbon monoxide, hydrocarbons, oxides of nitrogen, oxides of sulfur, and particulate material.* The particulate material includes carbon particles, lead particles, and condensates which are discharged in the exhaust. The characteristics and quantity of automobile exhaust are a function of the speed of the vehicles and data in Table 16 are based on an average speed of 25 miles per hour.

TABLE 13

CLASSIFICATION OF INDUSTRIAL EMISSIONS

Type of Industry	Emissions
Chemical Industry	
Ammonia Plant	Ammonia fumes, carbon monoxide
Chlorine Plant	Chlorine, gas, liquid chlorine, mercury
Nitric Acid Plant	Nitric Oxide, nitrogen dioxide, acid mist
Paint and Varnish	Fumes, aldehydes, ketones
Manufacturing	Phenols, terpenes, particulates
Phosphoric Acid Plants	P_2O_5 Acid mist, nitrogen oxides
Phosphoric Acid	Gaseous fluorides
Fertilizer Plant	Silicon tetrafluoride, hydrogen fluoride
Sulfuric Acid Plant	Sulfur dioxide, acid mist
Food and Fiber Industry	
Cotton Ginning	Particulates, dust
Coffee Roasting	Particulates, smoke, odors
Feed and Grain Mills	Dust
Metallurgical Industry	
Aluminum Ore Reduction	Particulate alumina, carbon and fluorides, gaseous fluorine
Copper Smelters	Carbon monoxide, sulfur oxides, nitrogen oxides and fine particulate fume
Iron and Steel Mills	Particulates, fumes, smoke, particulate lead fumes
Lead Smelters	Lead fumes, sulfur dioxide
Zinc Smelters	Particulates, fumes, sulfur dioxide

TABLE 13
(con'd.)

Secondary Metals Industry	
Ferrous Metals	Particulates
Aluminum	Fine Particulates, gaseous chlorine and fluorine
Brass and Bronze Smelting	Particulates, zinc oxide fumes
Gray Iron foundary	Particulates
Lead Smelting	Particulates, sulfur compounds
Magnesium Melting	Particulates
Zinc Processes galvanizing, calcining smelting and sweating	Particulates
Mineral Products Industry	
Asphalt Roofing	Particulates, oil mist
Asphaltic Concrete Plant	Particulates
Calcium Carbide Plant	Acetylene, sulfur dioxide sulfur trioxide, particulates
Cement Plant	dust
Concrete Batch Plant	Particulates
Frit Manufacturing Plant	Particulates, condensed metallic fumes, fluorides
Glass Manufacturing Plant	Particulates, fluorides
Lime Manufacturing Plant	Particulates
Insulation Manufacturing Plants	Asbestos fiber, rock wool fibers
Petroleum Refinery	Hydrocarbons, particulates, nitrogen dioxide, carbon monoxide, aldehydes, ammonia
Plastics	Ethylene, methacrylate
Petrochemical Plants	Losses of intermediate and final product
Pulp and Paper Industry	Particulates, Hydrogen sulfide, methyl mercaptan, dimethyl sulfur
Dry Cleaning Plants	Chlorinated hydrocarbons, tetrachloroethylene, petroleum solvents, hydrocarbon vapors

TABLE 13
(con'd.)

Metal Scrap Yards	Smoke, soot
Rendering Plant	Organic vapors, odors
Agricultural Activities	
Crop spraying and dusting	Organic phosphates, chlorinated hydrocarbons, arsenic and lead
Field Burning	Smoke, flyash, soot
Refuse Incineration	Particulates, flyash
Open Dump Refuse Burning	Particulates, odors, hydrocarbons, smoke

TABLE 14

REGISTERED VEHICLES (1970)*

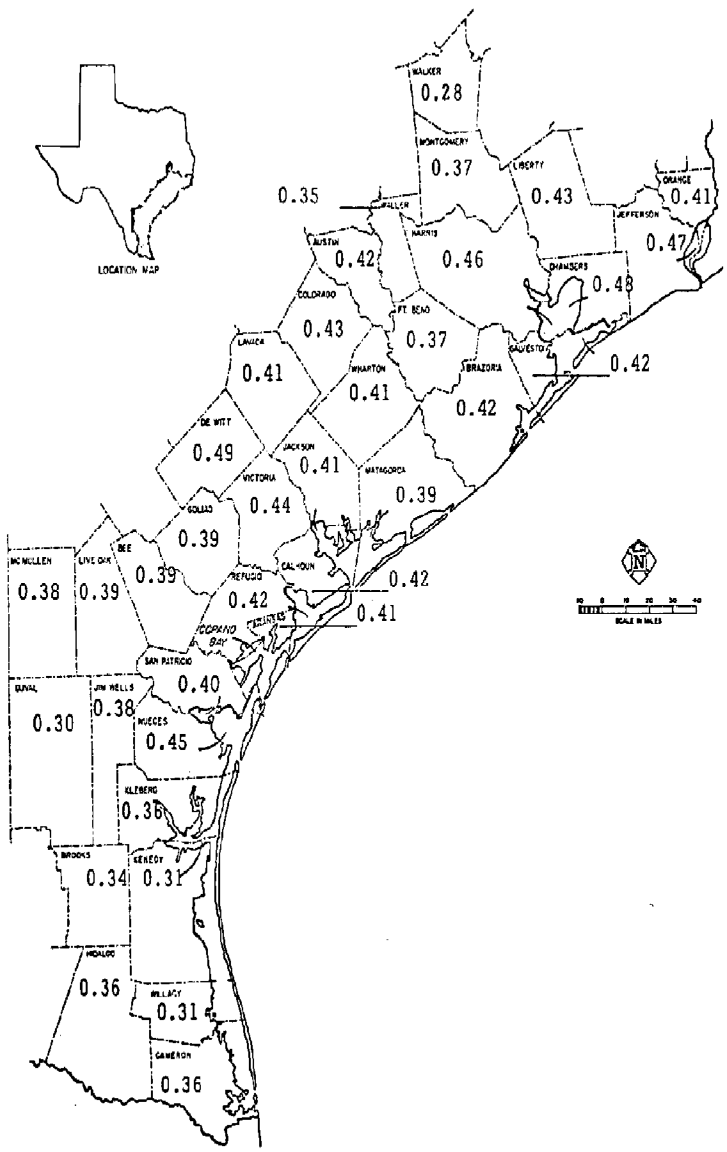
County	Passenger	Trucks	Buses	Motor Cycles	Others
Aransas	3432	1027	0	56	49
Austin	5573	2867	0	60	137
Bee	8620	2718	0	220	127
Brazoria	45085	14984	0	1105	456
Brooks	2643	378	0	25	48
Calhoun	7124	2315	0	165	78
Cameron	50099	12363	117	957	658
Chambers	5813	3936	0	53	476
Colorado	7387	3915	0	88	215
DeWitt	8705	3406	0	94	139
Duval	3403	1702	0	38	43
Fort Bend	18930	6544	0	251	289
Galveston	70214	15179	96	1514	549
Goliad	1778	881	0	19	18
Harris	796310	152919	472	16521	10547
Hidalgo	62817	19244	4	1029	959
Jackson	5168	2592	0	72	117
Jefferson	113815	23968	42	2227	1179
Jim Wells	12145	4324	2	183	264
Kenedy	204	102	0	1	2
Kleberg	11507	2671	0	419	364
Lavaca	7207	3160	0	417	94
Liberty	13192	6692	0	263	324
Live Oak	2435	1507	0	19	49
Matagorda	10909	4328	7	139	122
McMullen	398	320	0	8	17
Montgomery	17149	8213	0	497	250
Nueces	105038	20782	1	2034	1962
Orange	29012	8161	0	483	118
Refugio	3863	1562	0	59	68
San Patricio	17691	5664	0	232	247
Victoria	23502	6129	0	596	425
Walker	6910	2763	0	155	83
Waller	4942	2646	0	60	47
Wharton	14767	6009	0	178	264
Willacy	4855	2177	0	61	86

*Texas State Highway Department (1970)

TABLE 15

POPULATION AND PASSENGER VEHICLE DENSITIES (1970)

County	Population/Sq. Mi.	Vehicles/Person
Aransas	33.1	0.41
Austin	20.9	0.42
Bee	25.6	0.39
Brazoria	75.0	0.42
Brooks	8.2	0.34
Calhoun	33.8	0.42
Cameron	144.2	0.36
Chambers	15.4	0.48
Colorado	18.2	0.43
DeWitt	58.0	0.49
Duval	6.5	0.30
Fort Bend	58.4	0.37
Galveston	415.9	0.42
Goliad	5.3	0.39
Harris	1006.0	0.46
Hidalgo	107.9	0.36
Jackson	15.3	0.41
Jefferson	254.7	0.47
Jim Wells	36.9	0.38
Kenedy	0.5	0.31
Kleberg	38.6	0.36
Lavaca	19.3	0.41
Liberty	26.5	0.43
Live Oak	6.1	0.39
Matagorda	24.7	0.39
McMullen	0.9	0.38
Montgomery	43.3	0.37
Nueces	284.2	0.45
Orange	188.0	0.41
Refugio	11.6	0.42
San Patricio	59.3	0.40
Victoria	57.2	0.44
Walker	30.9	0.28
Waller	27.0	0.35
Wharton	33.8	0.41
Willacy	25.4	0.31



NUMBER OF MOTOR VEHICLES
REGISTERED PER PERSON (1970)

FIGURE 8

TABLE 16

Characteristics of Automobile Exhausts*

Emission	Quantity pounds per 1000 vehicle-miles 1966	1968**	1970**
Carbon Monoxide	165.0	15.0	10.4
Hydrocarbons	12.5	1.5	1.0
Oxides of Nitrogen	8.5	-----	----
Oxides of Sulfur	0.6	-----	----
Particulates	0.8	-----	----

*Duprey, R. L., Compilation of Air Pollutant Emission Factors, National Center for Air Pollution Control, Durham, North Carolina, 1968.

**Air/Water Pollution Report, January 29, 1968.

NOTE:

1966 - typical emissions of automobiles produced before 1966

1968 - typical emissions of 1968 model year automobiles with mandatory air pollution control devices installed

1970 - typical emissions of 1970 model year automobiles with air pollution control devices installed

The information shows typical emissions in the exhaust of automobiles produced before 1966 on which no air pollution control devices were installed as well as for passenger vehicles on which the mandatory air pollution control devices were installed. The air pollution control devices installed on the 1970 model year vehicles should reduce the quantities of carbon monoxide and hydrocarbons from *15.0 to 10.4* pounds per vehicle mile and from *1.5 to 1.0* pounds per vehicle mile, respectively.

The quantity of gaseous emissions from automobile exhausts in the Coastal Zone would be about *1,000,000 tons per year*. Comparatively speaking, industrial emissions in the Coastal Zone exceed 11,000,000 tons per year. This estimate is based on the fact that one-third of the vehicles in the Coastal Zone were equipped with air pollution control devices to meet the standards set during 1968 and 1970, and the fact that each of the passenger vehicles were driven for 10,000 miles during the year. As the number of older vehicles are replaced by those vehicles with effective air pollution control devices pollutant emissions to the atmosphere will be markedly reduced. However, the disposal of the abandoned vehicles could lead to a solid waste handling and disposal problem.

The gaseous and particulate emissions from those vehicles which use diesel fuel must also be included in the inventory. The characteristics of the emissions from vehicles burning diesel fuel is summarized in Table 17. The emissions to the atmosphere from aircraft also contribute to the total air pollution inventory. *Typical emissions for aircraft* are summarized in Table 18.

The cotton ginning operation is characterized by emissions of particulate material and gases into the atmosphere. Cotton gins are located in 18 counties in the Coastal Zone. The counties in which cotton gins are located and the quantity of cotton processed are presented in Table 19. The quantity of particulate emissions resulting from the ginning operation is also presented in this table. Approximately 11.7 pounds of particulates are generated from each bale of cotton processed. It should be noted, however, that the cotton ginning operation has been declining in the Coastal Zone. Therefore, cotton gins as sources of air pollution should also be on a decline.

Animal Waste

The production of animals such as beef cattle, milk cows, hogs, sheep and lambs, chickens, and turkeys present a solid waste management problem and can be the source of water pollution. The number of animals produced in the various counties in the Coastal Zone are summarized in Table 20. The source of this information is the U.S. Census of Agricultural, 1964.

A number of the counties in the Coastal Zone rank among the top ten counties in Texas in the production of particular animals. Five counties in the Coastal Zone are among the top ten counties in Texas

TABLE 17

Characteristics of Motor Vehicle Exhausts*

Emission	Quantity pounds per 1000 gallons of fuel: Automobiles (gasoline)	Diesel Engines
Carbon Monoxide	2300	60
Hydrocarbons	200	136
Oxides of Nitrogen	113	222
Oxides of Sulfur	9	40
Particulates	12	110

*Duprey, R. L., Compilation of Air Pollutant Emission Factors, National Center for Air Pollution Control, Durham, North Carolina, 1968.

TABLE 18

Characteristics of Aircraft

Exhaust Below 3500 Feet*
(pounds per flight**)

Emission	Jet Aircraft (per engine)		TurboProp		Piston Engine	
	Conventional	Fan Jet	2 Engine	4 Engine	2 Engine	4 Engine
Carbon Monoxide	8.75	5.15	2.0	9.0	134.0	326.0
Hydrocarbons	2.50	4.75	0.3	1.2	25.0	60.0
Oxides of Nitrogen	5.75	2.30	1.1	5.0	6.3	15.4
Particulates	8.5	1.85	0.6	2.5	0.6	1.4

*Duprey, R. L., Compilation of Air Pollutant Emission Factors, National Center for Air Pollution Control, Durham, North Carolina, 1968.

**Flight is defined as a combination of a landing and a take-off.

TABLE 19

COTTON GINNING*

County	Bales Ginned From 1966 Crop	Particulate Emissions pounds
Austin	6,971	81,561
Bee	4,485	52,475
Brazoria	4,504	52,697
Calhoun	5,562	65,075
Cameron	108,805	1,273,019
Colorado	5,934	69,428
Fort Bend	24,006	280,870
Hidalgo	98,867	1,156,744
Jackson	2,886	33,766
Jim Wells	8,113	94,922
Lavaca	7,692	89,996
Matagorda	4,304	50,357
Nueces	66,624	779,501
Refugio	9,586	112,156
San Patricio	59,161	692,184
Victoria	6,632	77,594
Wharton	30,723	359,459
Willacy	42,217	493,939

*U.S. Bureau of Census Reports

TABLE 20

ANIMAL PRODUCTION*

County	Cattle	Milk Cows	Hogs	Sheep Lambs	Chickens	Turkeys
Aransas	2,392	11	139	130	1,384	3
Austin	83,498	2,361	6,373	2,270	134,703	2,244
Bee	37,009	539	1,714	483	29,373	137
Brazoria	98,388	2,149	4,416	839	120,395	393
Brooks	39,768	1,389	134	72	44,384	40,049
Calhoun	13,208	76	115	468	6,314	163
Cameron	25,780	1,771	1,821	290	68,965	422
Chambers	46,879	51	408	330	16,312	111
Colorado	86,641	1,904	4,434	1,314	235,906	18,649
DeWitt	76,859	3,965	7,113	3,669	93,855	173,122
Duval	47,767	3,844	367	205	4,976	212
Fort Bend	74,451	1,038	5,047	730	104,001	4,837
Galveston	17,711	2,154	447	170	209,453	259
Goliad	44,670	224	5,978	1,902	17,118	2,389
Harris	95,829	13,190	4,964	1,259	344,948	575
Hidalgo	76,296	3,244	5,057	234	115,651	4,147
Jackson	59,176	355	1,569	739	25,223	627
Jefferson	45,813	533	376	280	15,052	213
Jim Wells	51,099	9,181	1,479	442	40,872	20,271
Kenedy	26,787	92	4	---	43	---
Kleberg	72,567	715	4,828	320	18,898	878
Lavaca	81,670	4,092	10,639	2,542	214,768	144,778
Liberty	47,502	1,241	1,165	113	50,667	208
Live Oak	40,290	501	3,726	198	25,277	179
Matagorda	75,706	214	1,283	974	13,771	836
McMullen	36,600	41	69	5	1,037	7
Montgomery	37,599	2,874	2,105	93	61,744	338
Nueces	21,516	161	2,583	576	60,791	2,732
Orange	9,154	105	1,114	122	12,730	35
Refugio	39,874	65	893	3,223	4,134	146
San Patricio	36,666	86	1,483	332	50,203	161
Victoria	69,256	620	2,924	2,406	49,598	11,775
Walker	37,987	1,272	4,558	112	46,694	521
Waller	46,864	1,397	2,059	589	34,072	1,161
Wharton	88,655	1,733	2,357	1,067	69,349	2,222
Willacy	18,533	802	1,255	173	86,107	176

*U.S. Census of Agriculture, 1964

in the production of particular animals. *Five counties in the Coastal Zone are among the top ten in beef cattle production.* These counties include Brazoria (1), Harris (3), Wharton (6), Colorado (7), Austin (8). *Harris County also ranks second in the State in the production of dairy cattle.* Lavaca County ranks seventh in the production of swine and tenth in the production of turkeys, while DeWitt County ranks seventh in the turkey production. The characteristics of animal waste are presented in Table 21. The information in this table show that for beef cattle, *each animal produces 60 pounds of manure per day and each animal produces wastes which have the same strength of the waste produced by 3.5 humans based on the total pounds of Biochemical Oxygen Demand (BOD) produced.* The potential for pollution of surface and ground waters as the result of runoff from rainfall from those areas where animals have grown in high concentration is quite evident.

Many of these animals are raised in *feed lots*. A total number of 147 feed lot sites have been reported to be located in 28 of the 36 counties which are included in the Coastal Zone. The operating feed lots number 40 and are located in 14 counties. The reported number of sites which have been permanently closed is 45. This inventory of feed lots was made available by the personnel of the Texas Water Quality Board. Data for the Coastal Zone are summarized in Table 22 and Figure 9.

The State of Texas ranks second in the United States in the number of cattle marketed from feed lots. In 1968, 1594 cattle feed lots marketed 1,970,000 cattle. However, 1,858,000 cattle were marketed from 294 feed lots which had a capacity of over 1000 head of cattle.

The effective handling, treatment and disposal of these concentrated wastes must be included in any animal waste management program. The disposal methods represent additional costs, therefore, a wide variety of systems are employed. *The degree of treatment ranges from almost no treatment to extensive waste processing.*

Pesticides

Pesticides for the control of insects which damage crops and undesirable weeds enter the surface water during periods of runoff of storm water and from agricultural lands. The pesticides are transported by the streams and rivers to the bays and estuaries in the Coastal Zone. *Many of these organic compounds are not readily assimilated in the aquatic system and persist for long periods of time.* The results of a survey conducted by the Texas Water Development Board and the U.S. Geological Survey are presented in Tables 23 and 24. The data in these tables indicate that the pesticides which are commonly found in water samples include DDD, DDE, and DDT. The pesticides were found in the waters of four of the estuaries in which the survey was conducted. *It is interesting to note that in some of the sediment samples these insecticides were detected although no pesticides were present in the overlying water at the*

TABLE 21

CHARACTERISTICS OF ANIMAL WASTES*

	Beef Cattle	Dairy Cattle	Poultry	Swine	Sheep
Animal Weight (lb)	950	1400	5	200	100
Manure Produced (lb/day)	60.0	80.6	0.4	17.4	7.2
Dry Solids (lb/day)	10.0	10.0	0.1	0.9	1.7
BOD (lb/animal/day)	1.0	1.0	0.02	0.3	-----
Total Nitrogen (lb/animal/day)	0.3	0.4	0.003	0.05	-----
Population Equivalent**	3.5	------	-----	0.90	0.31

*Livestock Industries in Texas as Related to Water Quality, Preliminary Report, Texas Water Quality Board, June, 1970.

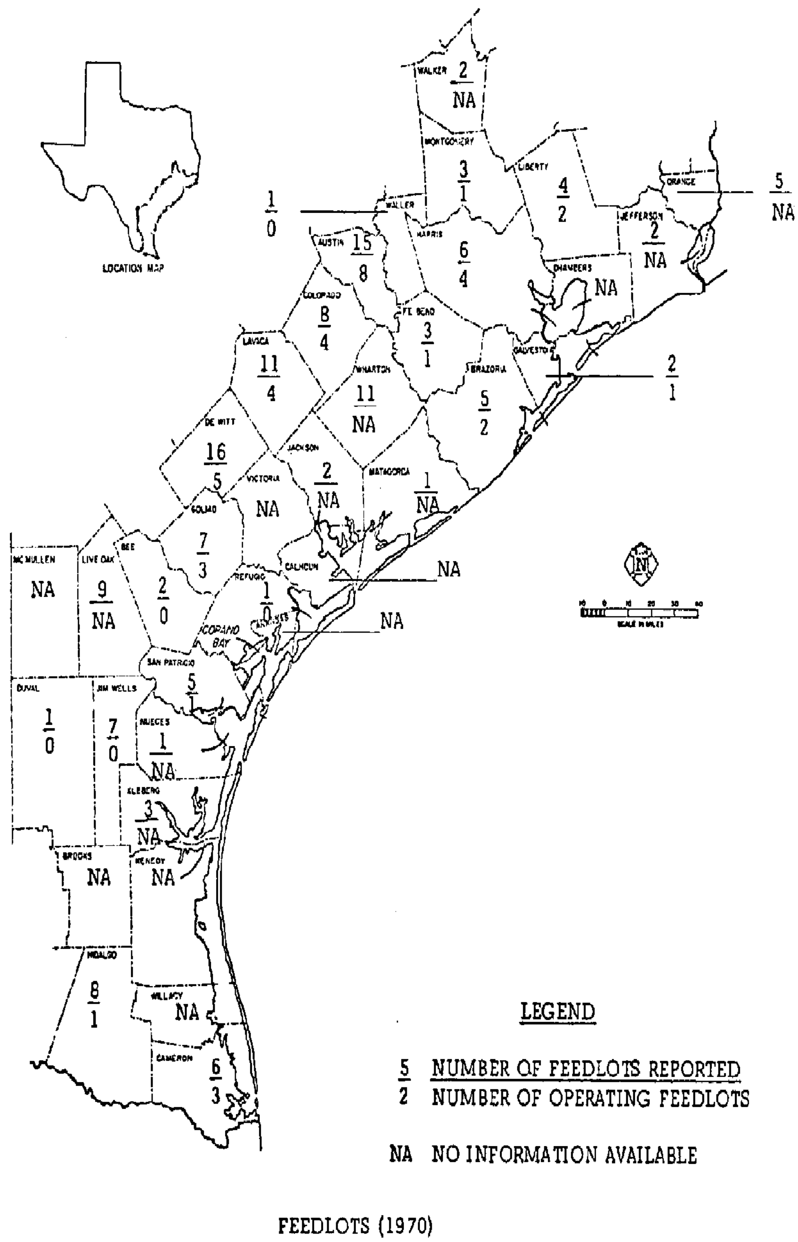
**Population Equivalent is the number of humans required to produce the same amount of BOD produced by one animal. These numbers are based on the contribution to the BOD of municipal wastewater attirbutable to the organic material in human excrement.

TABLE 22

FEEDLOTS*

	No. of Reported Sites	No. of Operating Sites	No. of Closed Sites	No Information
Aransas		No information available		
Austin	15	8	6	1
Bee	2	NA	2	NA
Brazoria	5	2	2	1
Brooks		No information available		
Calhoun		No information available		
Cameron	6	3	3	NA
Chambers		No information available		
Colorado	8	4	NA	4
DeWitt	16	5	NA	11
Duval	1	NA	1	NA
Fort Bend	3	1	2	NA
Galveston	2	1	1	NA
Goliad	7	3	NA	4
Harris	6	4	2	NA
Hidalgo	8	1	4	3
Jackson	2	NA	NA	2
Jefferson	2	NA	NA	2
Jim Wells	7	NA	7	NA
Kenedy		No information available		
Kleberg	3	NA	1	2
Lavaca	11	4	NA	7
Liberty	4	2	2	NA
Live Oak	9	NA	7	2
Matagorda	1	NA	NA	1
McMullen		No information available		
Montgomery	3	1	2	NA
Nueces	1	NA	NA	1
Orange	5	NA	NA	5
Refugio	1	NA	1	NA
San Patricio	5	1	1	3
Victoria		No information available		
Walker	2	NA	NA	2
Waller	1	NA	1	NA
Wharton	11	NA	NA	11
Willacy		No information available		

*Texas Water Quality Board (1970)
NA - No Information Available



FEEDLOTS (1970)

FIGURE 9

TABLE 23

Pesticides*

<u>Insecticides</u>
A-DDD
B-DDE
C-DDT
D-Dieldrin

	Insecticide**									
	Water				Total	Sediment				Total
Estuary	A	B	C	D	(PPB)	A	B	C	D	(PPB)
Arroyo Colorado	x	x	-	-	0.05	N	N	N	N	
Arroyo Colorado Cutoff	-	-	-	-	----	x	x	-	x	3.21
Arroyo Colorado (Laguna Madre)	-	-	-	-	----	-	-	-	-	-----
Lavaca-Tres Palacios	-	-	x	-	0.01	x	x	x	-	22.80
Lavaca-Tres Palacios (Tres Palacios Bay)	-	-	-	-	----	x	x	-	x	3.17
Lavaca-Tres Palacios (Texas Intercoastal Waterway)	x	x	x	-	0.69	N	N	N	N	
Lavaca-Tres Palacios (Palacios Bay)	-	x	-	-	0.01	x	x	x	x	100.20
Lavaca-Tres Palacios (Lavaca Bay)	x	x	x	-	1.02	N	N	N	N	
Lavaca-Tress Palacios (Lavaca River)	-	-	-	-	----	x	x	x	x	8.16

*Texas Water Development Board (1970)

**(x) indicates compound is present in the sample

(-) indicates compound is not present in the sample

(N) indicates no sample available

TABLE 23 - Con'd.

Estuary	Water A	Water B	Water C	Water D	Insecticide** Total (PPB)	Sediment A	Sediment B	Sediment C	Sediment D	Total (PPB)
Guadalupe (San Antonio Bay)	-	-	x	-	0.02	x	x	x	x	3.64
Guadalupe (Guadalupe Bay)	-	-	x	-	0.61	x	x	x	x	9.14
Guadalupe (Guadalupe Estuary)	-	-	x	-	0.01	x	x	-	-	4.30
Guadalupe Guadalupe River	-	-	x	-	0.02	x	x	-	-	4.00
Colorado River	-	-	-	-	----	x	x	x	-	24.70
East Matagorda (Matagorda Bay)	-	-	-	-	----	x	x	x	-	2.83
Sabine-Neches	-	-	-	-	----	x	x	-	-	1.40
Laguna Madre (Baffin Bay)	-	-	x	-	0.01	x	x	-	-	2.50
Nueces Bay	-	-	-	-	----	N	N	N	N	
Nueces Estuary	-	-	-	-	----	N	N	N	N	
Mission-Aransas	-	-	-	-	----	N	N	N	N	

*Texas Water Development Board (1970)
**(x) indicates compound is present in the sample
(-) indicates compound is not present in the sample
(N) indicates no sample available

TABLE 24

Pesticides*

Herbicides: A-2,4-D; B-Silvex; C-2,4,5,-T

Herbicides**

Estuary	Water A	Water B	Water C	Total (PPB)	Sediment A	Sediment B	Sediment C	Total (PPB)
Arroyo Colorado	-	-	-	----	N	N	N	
Arroyo Colorado Cutoff	-	-	-	----	-	-	-	----
Arroyo Colorado (Laguna Madre)	-	-	x	0.01	N	N	N	
Lavaca-Tres Palacios	x	-	x	0.04	N	N	N	
Lavaca-Tres Palacios (Tres Palacios Bay)	x	-	x	0.22	N	N	N	
Lavaca-Tres Palacios (Texas Intercoastal Waterway)	-	-	-	----	N	N	N	
Lavaca-Tres Palacios (Palacios Bay)	x	-	x	0.27	N	N	N	
Lavaca-Tres Palacios (Lavaca Bay)	x	-	x	0.18	N	N	N	
Lavaca-Tres Palacios (Lavaca River)	-	-	-	----	N	N	N	

*Texas Water Development Board (1970)
**(x) indicates compound is present in the sample
(-) indicates compound is not present in the sample
(N) indicates no sample available

TABLE 24 - Con'd.

Estuary	Herbicide** Water A	B	C	Total (PPB)	Sediment A	B	C	Total (PPB)
Guadalupe (San Antonio Bay)	x	-	x	0.17	N	N	N	
Guadalupe (Guadalupe Bay)	x	-	x	0.27	N	N	N	
Guadalupe (Guadalupe Estuary)	-	-	-	----	N	N	N	
Guadalupe (Guadalupe River)	-	-	-	----	N	N	N	
Colorado River	x	-	x	0.07	N	N	N	
East Matagorda (Matagorda Bay)	x	-	x	0.08	N	N	N	
Sabine-Neches	-	-	x	0.02	N	N	N	
Laguna Madre (Baffin Bay)	-	-	x	0.02	N	N	N	
Nueces Bay	-	-	-	----	N	N	N	
Nueces Estuary	N	N	N		N	N	N	
Mission-Aransas	-	-	x	0.13	N	N	N	

*Texas Water Development Board (1970)
**(x) indicates compound is present in the sample
(-) indicates compound is not present in the sample
(N) indicates no sample available

time of sampling. A typical example is the Arroyo-Colorado Estuary at the Cutoff. The insecticides detected in the sediments included DDD, DDE, and Dieldrin. These data also indicate that insecticides *can be concentrated in the sediments of an estuary and bay*. This fact is pointed out by comparing the concentrations of the insecticides in the overlying water with that detected in the sediment. The concentration of insecticides in the water in the estuaries range between 0.01 and 1.02 parts per billion (ppb); however, the concentration of insecticides detected in the sediments range from 1.40 to 100.2 ppb. In fact, the lowest concentration of insecticides in the water was detected in the water sample taken at the location in Palacious Bay in which the sediment concentration was in excess of 100 ppb. This concentration of insecticides by the sediments *can be attributed in part* to the clay particles on which the insecticide is adsorbed which are flushed into the bays. Plankton which concentrate the insecticides upon dying will fall to the bottom of the bay or may be consumed by predators which in turn concentrate the compound. Insecticides are also removed from the water and become concentrated in the food chain. Relatively high concentrations have been reported in plankton and fish harvested from the bays in the Coastal Zone.

Samples of water from the various bays and estuaries were also analyzed for herbicides. The herbicides detected in the water samples included 2, 4-D, and 2, 4, 5, -T. The herbicides concentration ranged from 0.01 ppb to a maximum of 0.27 ppb. Only one sample of sediment was analyzed for herbicides; therefore, no information is available which would indicate the ability of the herbicides to persist in the environment for sufficiently long periods of time and become concentrated in the sediments.

Radioactive Substances

The release of radioactive materials into the environment can be another source of environmental pollution. There are 376 licensees for use of radioactive materials in the Coastal Zone. This number represents 33 percent of the licensees in the State of Texas. The licensees in the Coastal Zone are found in 17 counties. The location of the licensees for use of radioactive materials is presented in Table 25. This information was made available by the Occupational Health Division of the Texas Department of Health who monitor all possible sources of radiation pollution and regulate the use of radiation.

The majority of the radioactive material in the Coastal Zone is used in hospitals or in the offices of doctors and radiologists, and by well loggers. The radioactive material is used in such a way that there is little or no chance of release of this material to the environment. The only radioactive regulator located in the Coastal Zone is in the N. S. Savanah when this vessel is in port. The N. S. Savanah does not discharge any radioactive waste into the bays in the Coastal Zone. There are no radioactive dumps reported in the Coastal Zone. This data indicates that there are no present problems with releases of radiation into the environment.

TABLE 25

RADIOACTIVE SOURCES*

County	Number of Licenses For Radioactive Material
Aransas	1
Austin	3
Brazoria	10
Calhoun	2
Cameron	7
Colorado	1
DeWitt	7
Fort Bend	1
Galveston	24
Harris	223
Hidalgo	10
Jefferson	38
Matagorda	4
Nueces	28
Orange	8
Victoria	6
Walker	3

*Texas State Department of Health (1970)

LIMITATIONS OF INVENTORY

This inventory of waste sources is useful in *pointing to sources* of potential pollution; however, it *does not in itself provide any information regarding the collective effects of these discharges and emissions on the environment of the Coastal Zone.* The available data in many instances is incomplete and additional information is necessary in order to complete the inventory of waste sources in the Coastal Zone and to be able to evaluate the effects of these waste discharges on the environment.

Coordination of data collection, storage and management is essential. The result of this study indicates that a number of State agencies collect and store similar data to be used for different purposes. Many of the agencies *do not* upgrade their inventory of data as frequently as other agencies; therefore, different conclusions are drawn after reviewing what many people consider is the same information. Much of the available information is several years old and *does not* reflect any improvement in operation of the treatment or disposal facility which may have been completed since the data were collected.

Data which are necessary to complete the overall inventory of water carried pollutants include monthly information regarding the quality and flow of all municipal and industrial discharges. The *self-reporting system* of obtaining effluent quality and quantity information could provide the necessary information to maintain an accurate and current inventory of wastewater discharges. However, *the self-reporting system will be only of limited value if the municipal and industrial personnel can be convinced that they are not in jeopardy of retroactive penalties for not complying with the effluent standards.* This does not mean that the penalty for non-compliance would be eliminated. However, *some statute of limitation* should be established during which time the municipality or industry is subject to the penalty for non-compliance.

The quality of the receiving streams is necessary in order to effectively evaluate the effects of municipal and industrial discharges on the water quality. A system of data collection to provide this information would be extremely costly.

Presently water quality data are collected by the staff of the *Texas Water Quality Board* and of the *Texas Water Development Board* in cooperation with the personnel of the *United States Geological Survey*. *The inventory of water quality is not complete.* Continuous monitoring will be necessary to evaluate any improvement in water quality resulting from more effective wastewater treatment.

The cost of collecting this water quality information could be *markedly reduced* if the data were gathered by the industrial and municipal personnel who monitor the quality of their respective effluents. In other words, by tying the water quality information with the effluent quality data on a self-report system the cost of collecting the water quality information can be markedly reduced.

The quality of the surface water in the Coastal Zone was not a part of this inventory due to time and information-availability constraints; however, this information is essential to any water pollution control and water quality management programs. The effect of discharges from power stations which would increase the temperature of the receiving stream must also be included in these programs. Information of the quantity of water returned to the surface waters and the temperature of these returned flows are being collected by another task group and is not in this particular inventory.

The concentration of *heavy metals* in industrial and municipal discharges is also not routinely determined. The concentration of *coliform organisms* or other fecal organisms or viruses in municipal wastewaters and any sanitary waste from industrial plants should also be available. This information will provide a means of evaluating the treatment efficiency of the plant when considered in connection with the other effluent quality data.

Information relating to the *number of septic tanks* and absorption fields in the Coastal Zone is very sparse. The proximity of the ground water table to the surface of the ground on the Coastal Zone makes it imperative that the number of septic tanks be determined and that the quality of the ground water in the vicinity of the septic tank system be evaluated in order to determine the effect of the septic tank discharges on the water quality. It is especially important that those areas in the Coastal Zone which have high population densities and where septic tanks are used be identified and steps taken to eliminate septic tanks in those areas.

The *infiltration of storm water* during periods of heavy rainfall can markedly increase the quantity of wastewater which must be treated at the municipal treatment plant. The quantity of infiltration into the municipal collection system should be determined and proper steps be taken to *minimize infiltration* by proper water proofing of the joints in the collection system.

The *quality characteristics of storm waters* which flush a wide assortment of materials from rooftops, streets, industrial plant sites, agricultural lands, lawns and other surfaces must be determined in order to completely develop an effective inventory of pollution sources.

The effects of *drainage from open refuse dumps* which can contribute to the pollution load of streams should be evaluated. The extent of this pollution is dependent on the quantity and quality of flow in the stream as well as in the quantity of runoff from the dump. The effect of leachate for dumps on the quality of water in the ground water table in the Coastal Zone should also be evaluated.

Data which relate to the *direct contribution made by the runoff or percolation from feedlots* to the pollution of surface and ground water in the Coastal Zone are not complete at this time. The method of waste disposal and the quality of effluents from the operating feed lots should be determined. The staff of the Texas Water Quality Board are attempting to compile information regarding the operating feed lots and their effect on water sources and land.

The solid waste information available for the Coastal Zone is incomplete. The rate of refuse production for the counties in the Coastal Zone are estimates based on an estimate of the refuse collected and disposed of in municipal, private, and county facilities since very few municipalities actually weigh the collected refuse. Therefore, in order to determine the actual amount of refuse produced on a per capita basis it is essential that the weights of refuse collected be recorded and reliable estimates of the population served be developed. In many of the counties covered in this study, the population served within a county exceeded the population estimated by the 1970 Census. The quantity of refuse generated by those people who are not serviced by a municipal or private collection system must also be determined.

The number of *abandoned vehicles* and quantity of bulk wastes must be determined for the various counties in the Coastal Zone. Information relating to the quantity of *water treatment and waste treatment plant sludges* produced in the Coastal Zone as well as the method of disposal of these sludges must be included in any inventory of solid wastes.

There is almost no information available which relates to the characteristics and quantity of *industrial solid waste* generated in the Coastal Zone. The characteristics of the industrial solid waste are as varied as there are industries since each particular type of industry generates a specific type of industrial solid waste. Sludges and other residue formed by industrial activity must also be included in this inventory of industrial solid wastes. The staff of the Texas Water Quality Board has embarked on a program to develop quantitative and qualitative data for industrial solid wastes.

The information dealing with the solid waste disposal practices in the Coastal Zone is based on the 1968 survey. More current surveys must be completed in order to determine what effect the curtailment of open burning by legislation has on converting the open dumps to sanitary landfills. In many areas the "Rest Areas" provided along the highways by the Texas Highway Department have become the *dumping grounds for household refuse.* It is essential that all open dumps be converted to sanitary landfills, in order to reduce potential water and air pollution which are generally associated with open dumps. Conversion of the open dumps to sanitary landfills will also improve the overall health of the community and environment by eliminating breeding places for rats, flies, and mosquitoes. The quantity of manure generated at feedlots and methods of manure disposal must also be considered in any overall inventory of solid wastes.

The sources of *industrial air pollution* and the Coastal Zone have been compiled and the characteristics of the emissions summarized by the Texas Air Pollution Control Board. Very little information is available which indicate the effects of these atmospheric discharges on the overall quality of the air and Coastal Zone. The surveillance of the individual discharges of industrial air pollutants must be monitored in order to maintain a current inventory of quantity and quality of emissions into the atmosphere. The characteristics of the industrial emissions as well as the quality of the ambient air can be reported on a regular basis. A self-reporting system similar to that proposed for monitoring wastewater discharges should be developed for air quality monitoring.

The contribution to the emissions to the atmosphere by *automobiles* also contribute to the overall quality of the air in the Coastal Zone. Federal legislation which requires air pollution control devices on all new cars will significantly reduce the quantity of these emissions. The contribution to the overall air pollution in the Coastal Zone caused by open burning of refuse at open dumps must also be included. However, as the open dumps are converted to sanitary landfills this source of air pollution will be eliminated. An inventory of emissions into the atmosphere from other activities such as cotton ginning, grain, drying and storage must also be included in the inventory of air pollution.

An overall inventory of the quantity of *organic pesticides and heavy metals* which enter the surface waters in the Coastal Zone should be completed. The heavy metals and pesticides accumulate in the aquatic food chain. There is considerable evidence, based upon Parks and Wildlife data, that these materials build up in the sediments, and become concentrated there. Therefore, a routine program is needed to determine the concentration of these materials in both the tissues of the organisms forming the food chain and in the underlying sediments. This information could then be used to assess the impact of these materials on the entire aquatic community.

APPLICATIONS OF INVENTORY

A complete inventory of waste sources in the Coastal Zone of Texas is essential to the development and planning of a complete program of environmental quality management. *The interaction among the air, land, and water environments make it necessary that all liquid, solid, and gaseous emissions into the environment must be included in any plan.* The completed inventory can be used for a multitude of planning programs.

On a local level, the officials can have a realistic assessment of the emissions into the environment and the overall effects of these discharges on the environment. In many cases, the resources of a particular municipality or county may not be sufficient to cope with the control of pollution. However, if the county was incorporated into some type of regional planning program or into some area council of governments, financial resources and technical competence can be made available to even the smallest community or the least densely populated county. There are five area councils in the Coastal Zone at the present time. The counties which make up the individual planning groups are shown in Figure 10. These groups include all but six of the counties. A complete inventory of waste sources for the counties in a particular planning council would also assist these groups in developing an effective plan of action for managing the quality of the environment. This information can be used to inform the public of the overall environmental quality. In this way, the public can decide on the steps that must be taken to remedy the situation and improve the environmental quality. This information can also be used as a basis on which to *decide what degree of industrial development might be permitted to take place in a given area.* On the other hand, industry can also take advantage of such an inventory in evaluating the resources of a particular county in the Coastal Zone as well as the quantity of emissions and discharges already present near the proposed plan site.

State agencies which have specific responsibilities for various aspects of environmental quality maintenance can also benefit from a complete inventory of waste sources. Those agencies which are responsible primarily for the enforcement of pollution control legislation and maintenance of environmental quality can use the inventory to quantitatively identify those areas which the effluents must be cleaned up to a greater extent in order to maintain or improve the quality of the air and water resources. By continuous updating of the inventory, these agencies can also have available the changes in environmental quality resulting from enforcement of pollution control legislation. Those agencies responsible for the planning of the resources of the Coastal Zone can also benefit from a waste inventory. This inventory would immediately provide an indication of the pollutional effects or load on the environment resulting from

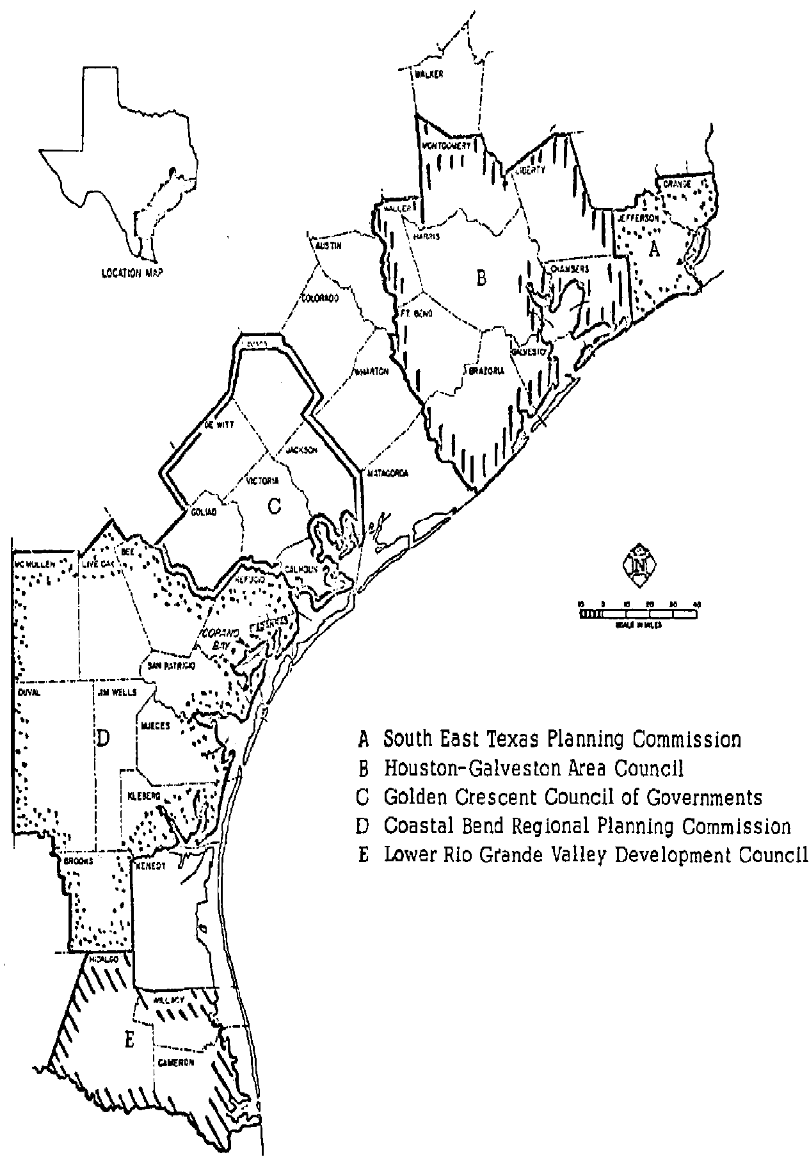


FIGURE 10.
AREAL PLANNING COUNCILS

development of the resources of the region. *The consequences of developing other resources in the Coastal Zone can also be projected on the basis of environmental effects of past development.*

An inventory of all of the pollution sources should be developed not only for the Coastal Zone, *but for the entire state. This statewide inventory is especially important when it comes to developing a water resources management program.* All of the major Texas rivers flow from the inland portion of the state through the Coastal Zone and into the Coastal bays. Therefore, persistant organic and inorganic constituents of wastewaters can be transported great distances in our streams and dumped into the estuary and bay streams. The accumulation of toxic materials in the food chain of the aquatic organisms of the bays and Gulf waters can reduce the value of the commercial fisheries in the Coastal Zone. The quality of the water in the bays and estuaries of the Coastal Zone can be markedly affected, not only by the industrial and municipal discharges of wastewater, but also by the regulations of the flow of fresh water carried by the rivers which flow from the inland portion of the state into the Coastal area. As more stringent effluent standards are required for industrial and municipal wastewater discharges, the *complete reuse of water* by industries and municipalities would further reduce the quantity of fresh water which is returned to the estuary and bay system.

The influence of the *reduced freshwater flows* caused by impoundment of streams *coupled with increased reuse of water* must be considered in any overall water resources management plan.

Atmospheric emissions effect the immediate area into which they are released. However, these materials may be carried by the wind for great distances and may in fact have a detrimental effect on the quality of the air in counties in which no industrial emissions are located. Therefore it is essential that an inventory of the atmospheric emissions for each area of the state be available and that a current inventory of the quality of the air in various counties also be maintained.

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