

CHAPTER XX
POLLUTION OF WATER

ASPECTS OF WATER POLLUTION IN THE COASTAL AREA OF THE GULF OF MEXICO ¹

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Principal natural resources of the Gulf that appear susceptible to damages from water pollution are sport and commercial fin fisheries, shellfisheries, wildlife, and recreational areas that are utilized by local people or attract tourists.

Through the Mississippi River alone, the Gulf receives drainage from 1,244,000 square miles, or 41 percent of the land area of the United States. Water comes from points as far distant as Bozeman, Montana, and Jamestown, New York, and from land fronting on the Gulf itself. Damaging pollution occurs locally at many upstream points of this and other long river systems. Because of natural purification and great distances of flow to the Gulf such pollution need not be considered here. With the exception of sediment loads, which may be carried great distances with little change in character, significant sources of pollution are those located near the Gulf.

The data upon which this report is based relate principally to sources of pollution lying within 50 miles of the Gulf. Pollution sources lying outside this zone are considered only if they are particularly significant by virtue of their specific quality or quantity. The land area so defined includes parts of Florida, Alabama, Mississippi, Louisiana, and Texas. Except with respect to shellfish sanitation, very few water pollution studies have been published. As a result, most information on this subject is found unpublished in the files of State health departments and water pollution control agencies. The most intensive investigations have been conducted by private organizations and were initiated by allegations of damages to oyster resources by petroleum industry wastes. Pending litigation and threatened litigation have kept reports of most of the findings from publication. A number of studies conducted

by various agencies have been published (Gunter 1942; Anonymous 1949; Specht 1950; Phelps and Barry 1950; Anonymous 1952; Galtsoff et al., 1935; Galtsoff 1936).

The accuracy of data on water pollution is necessarily short-lived, principally because progress is continually being made as more municipalities and industries take action to abate pollution. This chapter is based on information available in 1953. Up-to-date information for specific areas may always be obtained from appropriate State agencies.

NATURE OF POLLUTION AFFECTING THE GULF WATERS

Wastes of various kinds enter the Gulf waters by direct discharge from coastal municipalities and industries or through tributary streams that serve as transmission media for wastes from considerable areas. Included are raw and partially treated municipal sewage, industrial wastes characteristic of a great variety of manufacturing processes, and sediment loads from soil erosion.

Municipal sewage is a complex mixture of the liquid-carried wastes that result from modern human existence. Although it is about 99.9 percent water, the solids making up the remaining 0.1 percent are the cause of the problems of sewage pollution. The discharge of untreated sewage to watercourses is objectionable mainly because of three of its characteristics: (1) actual or potential presence of pathogenic bacteria that threaten the health of persons using the water and cause economic losses to the shellfish industry by making the product unsafe for human consumption, (2) organic constituents that have a biochemical demand upon oxygen resources of the water so that aerobic organisms suffocate, and disagreeable odors and appearance from putrefaction become a nuisance, and (3) a solids content that makes the

¹ Assistance was given by State water pollution control agencies and shellfish sanitation agencies in the preparation of this report.

water unsightly and blankets the bottom and its population of organisms with layers of putrescible particles.

Industrial wastes vary in character with the nature of the industrial process in which they originate. Organic wastes, such as those from food processing, sugar refining, or pulp and paper making, are similar to sewage in their ability to diminish oxygen resources. In most cases, however, the oxygen demand per unit volume is greater than that of sewage and the pollution effects more drastic. Various chemical plants, metal industries, and oil field operations have wastes with high inorganic content. Discharges of such wastes cause damaging pollution if they make aquatic environments uninhabitable for desirable organisms, or if the receiving water becomes less suitable for any human usage. Once in the water, some wastes of this kind are dissipated appreciably only by dilution.

Sediment loads, which have their origin principally in soil losses from the land, enter the Gulf, its estuaries, lagoons, and contiguous lakes in some degree through every tributary stream. Data on sediment loads are available only for the principal contributors. The annual load of the Mississippi River alone is some five hundred million tons (Matthes 1951), and the load from all sources may bring the total to a billion tons or more. Aside from the losses of valuable soil resources, deposition of sediment loads along the coastal zone has raised serious problems in development and maintenance of navigation channels and harbor installations and has destroyed valuable shellfish growing areas.

WATER POLLUTION CONTROL AGENCIES, PROGRAMS, AND LAWS

Under provisions of the Water Pollution Control Act (Public Law No. 845, 80th Congress), the Division of Water Pollution Control of the Public Health Service participates, along with the States, in water pollution control activities; however, the primary rights and responsibilities in controlling water pollution rest with the States.

For the purposes set forth in the act, the country has been divided into major river drainage basins, and 9 field offices have been established to permit close, effective cooperation with State water pollution control agencies. Three such

drainage basins have frontage on the Gulf of Mexico. A river basin office in Atlanta, Georgia, is concerned with water pollution activities in Florida, Alabama, and Mississippi. Another in Little Rock, Arkansas, has corresponding functions in Louisiana and Texas.

The ultimate aim of the cooperative activities is to abate and prevent water pollution in the United States. One step toward accomplishing this is the development of comprehensive programs for eliminating or reducing pollution. Basic in such development is recognition that a number of interests such as public health, wildlife and conservation, industry, municipalities, and agriculture have a stake in formulation of the program, its execution, and its cost. Each program will apply to an entire watercourse, or significant part as a unit, and will set down the pattern of remedial and preventive measures that will permit full utilization of the water resources for all present and potential water uses.

Evaluation of the present problem in each major drainage basin on the basis of presently available information has been completed. Reports on three of these areas contain data of significance with respect to the Gulf.²

The Water Pollution Control Act authorized the appropriation of funds for grants-in-aid to official State water-pollution control agencies to be expended by them in the conduct of investigations, research, surveys, and studies related to the prevention and control of water pollution caused by industrial wastes. Each of the Gulf States now has an active program along these lines. Encouragement of cooperative activities by the States and in the enactment of uniform State laws relating to water pollution, the collection and dissemination of information on the subject, provision of technical assistance with specific problems, and participation in the formulation of water-quality objectives are other phases of the overall program.

Pollution control activities of the individual Gulf States are related to and largely dictated by provisions, powers, and duties set forth in their existing legislation. Pertinent facts for each State follow.

² Summary Reports on Water Pollution: (1) Western Gulf Drainage Basin, (2) Southwest-Lower Mississippi Drainage Basin, and (3) Southeast Drainage Basin 1951.

FLORIDA

Authorization to control water pollution is vested in the State Board of Health by legislative act (Ch. 381.43 and 387.08, Florida Statutes, 1941) and is implied by the enabling act authorizing the creation of a Sanitary Code by the State Board of Health (Ch. 381.50, Florida Statutes, 1941). Two other State agencies have limited authority in this field. The Commission of Game and Fresh-water Fish has the power and authority to enforce the prohibition against the placing of certain deleterious substances or forces into fresh waters whereby fish are or may be injured. The State Board of Conservation is given authority to promulgate regulations to prevent action in one watershed area or location which will adversely affect the surface or underground water supply in another area.

ALABAMA

Responsibility for water pollution control activities in Alabama is vested largely in the Water Improvement Commission with comprehensive powers of enforcement, including the issuance of permits for the discharge of waste into the waters of the State. The State Department of Health has general authority with respect to enforcement of laws relating to public health and specific authority with respect to protection of drinking water. The State Department of Health also has responsibility for cooperating with the Water Improvement Commission in conducting investigations, inspections, and related activities.

MISSISSIPPI

Water pollution control is administered in Mississippi by two State agencies. The State Board of Health has authority to control water pollution through its general public health powers. The Game and Fish Commission has pollution control powers which specifically include the authority to hold hearings, issue regulations and final orders, and provide for judicial review of such orders, and is enabled to control pollution for the protection of game, fish, and wildlife.

LOUISIANA

Authority in Louisiana relating to water pollution control is vested in the Stream Control Commission, State Board of Health, and Louisiana Department of Wildlife and Fisheries. The

Stream Control Commission has the general power and duty of administering all pollution control laws of the State that are broad and comprehensive. It may adopt standards, make investigations, hold hearings, and has enforcement powers. The State Board of Health has pollution control authority relating to public health. The Department of Wildlife and Fisheries enforces the Commission's orders, rules and regulations relative to pollution.

TEXAS

Water-pollution-control authority is vested in the State Board of Health and the Game and Fish Commission. The Office of the Attorney General acts as legal counsel to the enforcement agencies. The General Land Office, in cooperation with the Game and Fish Commission, establishes rules and regulations to prevent pollution on State-owned lands including tidelands. The State Board of Health has general pollution-abatement functions with specific emphasis on public-health aspects. The State Board of Health may set standards for drinking water, may review plans and specifications, make investigations, and hold hearings. Enforcement is by writ of injunction under civil statute and fines under penal code as issued by court. The Game and Fish Commission deals with matters protecting fish and oysters. A Water Pollution Advisory Council serves as a consultative and advisory body to other agencies, affected groups and industries.

FEDERAL-STATE SHELLFISH CONTROL PROGRAM

The sea-food products most affected by pollution of tidal waters, particularly from the public-health point of view, are the edible bivalve mollusks, oysters, clams, and mussels. During feeding these mollusks may retain from the overlying waters any pathogenic organisms which may be present along with their normal food materials. Since the commercially valuable edible mollusks are fixed by biological factors to those waters along the coast which are more or less diluted by fresh-water runoff from adjacent land bodies, it is obvious that some pollution of these shellfish-growing beds is unavoidable.

Adequate administrative controls over shellfish production must exist if outbreaks of typhoid fever and other enteric diseases carried by shell-

fish are to be avoided. This was pointedly brought out during the winter of 1924-25 when a series of typhoid outbreaks was traced to contaminated oysters which had been shipped from one packer to several large cities in the United States (Lumsden et al. 1925). Following this, basic control patterns were drawn up between the shellfish industry, the State health departments, and the United States Public Health Service. The Bureau of Chemistry of the United States Department of Agriculture (now the Food and Drug Administration of the Federal Security Agency) and the Bureau of Fisheries of the United States Department of Commerce (now the Fish and Wildlife Service of the United States Department of the Interior) were involved in this early planning.

Under this arrangement, the Public Health Service develops recommended standards and manuals of operating practice (Anonymous 1946) which are applied by the shellfish industry under the supervision of the State shellfish-control agencies. The Public Health Service evaluates these control procedures of the State agencies on a continuing basis. When satisfied that proper controls are exerted by the States, the Public Health Service publishes routine lists of shellfish shippers who are certified by the individual State shellfish-control authority, usually the State department of health. These lists are distributed widely throughout the United States to health officials and others who may be concerned with the problem of market quality of raw shellfish. In practice, a shellfish shipper finds it necessary to be properly certified in order to be able to market his products in most parts of the United States.

As in the case of most of the shellfish-producing States, the States bordering on the Gulf of Mexico divide the controls over shellfish operation between two State agencies. The purely sanitary aspects of the control program, including surveillance over the sanitary quality of shellfish-growing beds and operation of packing houses, rest with the individual State health department. Actual control of shellfish-growing areas which are closed to commercial fishing, on the other hand, is handled by some other State agency. In the case of Florida, the State Board of Conservation bears this responsibility, while in Alabama the State Conservation Department is involved.

The Mississippi Seafood Commission patrols growing areas closed because of pollution in that State. In Louisiana, the Division of Oysters and Water Bottoms of the Department of Wildlife and Fisheries assists the State Department of Health in patrolling the closed areas. The Texas Game and Fish Commission cooperates with the Texas State Department of Health on patrol work in that State.

In the following pages areas closed to commercial harvesting of shellfish are described specifically on the basis of information resulting from sanitary and bacteriological surveys conducted by the several State departments of health. In most instances the results of such surveys are contained in reports cited in an annotated bibliography (Anonymous 1952).

SUMMARY OF WATER POLLUTION DATA

The summary set forth below is based entirely upon readily available information from various sources, and no investigations have been made specifically for the purpose of this report. The data therefore are admittedly incomplete. This is particularly true of industries and pollution caused by their wastes. Gaps in the data are nonetheless significant and point the direction of necessary future work.

Because of tremendous quantities of available dilution water, it is unlikely that pollutional wastes originating in the coastal area have appreciable effects upon either water or resources in the open waters of the Gulf. Reports of such effects have not been forthcoming, and no intensive investigations appear to have been made. On the basis of information now available, however, there are at least 369 separate sources of pollution that may have localized effects upon coastal waters of the Gulf or the lower reaches of tributary streams. One hundred ninety-seven of these are municipalities, sewer districts and institutions that utilize tributary watercourses, sloughs, lagoons, estuaries, and bays to dispose of their wastes. The sewer systems concerned serve a total of about 3 million persons. Industrial wastes of unknown character and quantity are also discharged to these sewer systems. Sewage from 35 municipalities with a total of 755,000 sewerers reaches surface waters without treatment of any kind. Numerical data on treatment loads or plant efficiencies are not

available for the 162 municipalities that provide treatment so that the actual total discharge for all municipalities is not known.

Because summary data on industrial wastes are not available for Texas and are less complete than municipal data for other Gulf States the extent of the industrial waste pollution problem is not fully shown. On the basis of present knowledge, 173 industrial plants of various kinds discharge treated or untreated waste directly to surface waters. These plants include production of pulp and paper, sugar, petroleum and its products, processed food, chemicals, and metals. Their wastes are of many different kinds. One hundred fifteen plants produce organic wastes, but the quantity can be estimated with confidence for only five, which discharge a total of 76,000 population equivalent.³ Inorganic wastes are produced by 67 plants, and the type of wastes from five plants is not known. A number of plants have process wastes with appreciable quantities of both organic and inorganic components. Considerable additional information is needed before an estimate of the total quantity of waste from all sources can be made.

Although 82 percent of the municipalities along the Gulf coast that have sewer systems also have sewage treatment facilities, at least 25 percent of

the total sewered population is not served by such facilities. In addition, recent phenomenal population growth and obsolescence of equipment have made 60 of the 162 existing sewage treatment facilities physically inadequate to satisfactorily treat the waste they receive.

Definite information on provision of pollution prevention measures or practices by industries is available for only about one-third of the plants. Less than one-third of these have treatment facilities of which two have insufficient capacity and three have unsatisfactory operation.

An increase of approximately 14 percent in the number of municipal treatment facilities will be necessary to help bring about an adequate pollution abatement program for the receiving waters. These new facilities, which are 22 in number, would serve about 130,000 people. In addition, 37 percent of the existing facilities need either to be replaced by new plants or enlarged and remodeled to handle existing loads in an adequate manner. These plants now serve about 272,000 persons.

Information on necessary remedial measures is available for only 14 percent of the industries. The facilities for 13 industries are known to be satisfactory, 9 new facilities are needed, and 3 need enlargements or additions.

Distribution by States of basic data on water pollution is shown in tables 1 through 4 and maps, figures 1 and 2. These are self-explanatory.

TABLE 1.—Municipal sources of pollution in the coastal area of the Gulf of Mexico ¹

1 State	2 Number of municipalities ²	3 Total sewered population	4 Municipalities with sewage treatment	5 Population served	6 Municipalities without treatment	7 Sewered population
Florida.....	61	470,050	48	432,850	13	37,200
Alabama.....	12	161,500	10	159,400	2	2,100
Mississippi.....	8	65,500	7	55,500	1	10,000
Louisiana.....	30	821,300	22	205,850	8	615,450
Texas.....	86	1,491,450	75	1,401,200	11	90,250
Total.....	197	3,009,800	162	2,254,800	35	755,000

¹ Sources lying within 50 miles of the Gulf plus several significant sources lying just outside the 50 mile zone.

² Cities, towns, villages, sewer districts, and institutions.

³ Sewered population equivalent of industrial waste is based on 0.167 pounds of 5-day, 20° C. biochemical oxygen demand per capita per day in municipal sewage.

TABLE 2.—Industrial sources of pollution in the coastal area of the Gulf of Mexico ¹

1 State	2 Number of plants	3 Treating wastes	4 Not treating wastes	5 Existing treatment facilities undetermined	6 Producing organic wastes	7 Producing inorganic wastes	8 Undetermined type of waste
Florida.....	47	9	1	37	31	17	1
Alabama.....	10	0	6	4	8	1	1
Mississippi.....	12	0	7	5	9	1	2
Louisiana.....	104	10	30	64	67	48	1
Texas.....							
Total.....	173	19	44	110	115	67	5

¹ Sources lying within 50 miles of the Gulf plus several significant sources lying just outside the 50-mile zone.

² Total adjusted for duplication shown in ¹.
³ Fourteen of these plants produce inorganic wastes also.

TABLE 3.—Needs for abatement of water pollution in the coastal area of the Gulf of Mexico ¹

1 State	2 Source	3 New plants	4 Sewered population	5 Replace existing plants	6 Sewered population	7 Additions or enlargements	8 Sewered population	9 None	10 Sewered population	11 Undetermined	12 Sewered population
Florida.....	Municipal.....	10	31,800	24	116,050	4	41,200	17	271,500	6	9,500
	Industrial.....									46	
Alabama.....	Municipal.....	2	2,100	3	3,700	2	4,300	5	151,400	0	
	Industrial.....	6								4	
Mississippi.....	Municipal.....	1	10,000	0	0	0	0	7	55,500	0	0
	Industrial.....									12	
Louisiana.....	Municipal.....	0		3	15,800	3	15,100	23	789,950	1	450
	Industrial.....	3				3		11		85	
Texas.....	Municipal.....	9	85,350	7	10,700	15	66,200	53	1,328,900	2	300
	Industrial.....										
	Municipal total.....	22	129,250	36	145,250	24	126,800	104	2,592,450	11	16,050
	Industrial total.....	9				3		13		147	
	Total.....	31	129,250	36	145,250	27	126,800	117	2,592,450	158	16,050

¹ Sources lying within 50 miles of the Gulf plus several significant sources lying just outside the 50-mile zone.

TABLE 4.—Existing industrial waste treatment facilities in the coastal area of the Gulf of Mexico ¹

1 Type of industry	2 State	3 Number of plants	4 With treatment facilities	5 Without treatment facilities	6 Undetermined
Paper and allied products.....	Florida.....	3	1	1	1
	Alabama.....	5	0	5	0
	Mississippi.....	1	0	1	1
	Louisiana.....	2	1		
	Texas.....				
Area total.....		11	2	7	2
Food and kindred products.....	Florida.....	23			23
	Alabama.....	3			3
	Mississippi.....	1			1
	Louisiana.....	49		24	25
	Texas.....				
Area total.....		76		24	52
Leather and leather products.....	Florida.....	3			3
	Alabama.....				
	Mississippi.....				
	Louisiana.....				
	Texas.....				
Area total.....		3			3
Chemical and allied products.....	Florida.....	17	8		9
	Alabama.....				
	Mississippi.....	8		5	3
	Louisiana.....	9	3	2	4
	Texas.....				
Area total.....		34	11	7	16

TABLE 4.—Existing industrial waste treatment facilities in the coastal area of the Gulf of Mexico ¹—Continued

1 Type of industry	2 State	3 Number of plants	4 With treatment facilities	5 Without treatment facilities	6 Undetermined
Primary metal industries.....	Florida.....				
	Alabama.....	1			1
	Mississippi.....				
	Louisiana.....	1			1
	Texas.....				
Area total.....		2			2
Oil production industries.....	Florida.....				
	Alabama.....				
	Mississippi.....				
	Louisiana.....	37	6	3	28
	Texas.....				
Area total.....		37	6	3	28
Products of petroleum.....	Florida.....				
	Alabama.....				
	Mississippi.....				
	Louisiana.....	3		1	2
	Texas.....				
Area total.....		3		1	2
Miscellaneous.....	Florida.....	1			1
	Alabama.....	1	0	1	0
	Mississippi.....	2		1	1
	Louisiana.....	3			3
	Texas.....				
Area total.....		7		2	5
Total.....		173	19	44	110

¹ Sources lying within 50 miles of the Gulf plus several significant sources lying just outside the 50-mile zone.

DAMAGES TO RESOURCES CAUSED BY POLLUTION

Coastal waters of the Gulf are subjected to pollution directly by discharges from waterfront cities and industries and indirectly through polluted river systems. With this the case, the effects of pollution are not spread uniformly along the coast; they are restricted to localized areas where population and industries are concentrated, where rapid waste dilution is limited by physiographic features, and where exploitable resources occur. It is obvious from this that the susceptible resources include the fin fishes, shrimp, crabs, and oysters that depend upon estuarine existence for at least a part of their life; and near centers of population—the sport fishing and boating waters, bathing beaches and recreational areas, and waterfront property that depreciates as pollution increases.

Available data on sources and kinds of pollution imply notable potentialities for causing damages to resources in restricted areas. In spite of this, observed effects upon the resources have not been of sufficient magnitude to stimulate the required studies aimed at actually evaluating the extent of damage. Surveys and closure of shellfish produc-

ing areas because of bacterial contamination give only a fair suggestion of one source of economic loss. Lack of sufficient data makes it impossible to evaluate the full damages from pollution along the Gulf coast.

For purposes of this report the Gulf Coast from Key West to the Rio Grande has been divided into 23 separate drainage areas.⁴ Localized pollution damages of some kind or other occur in most of these areas. Almost one-half of them, representing waters of each of the Gulf States, have shellfish areas that are closed to commercial fishing because of pollution. A number of otherwise popular bathing beaches located in at least seven different areas have been made unfit for use. Outright destruction of fish and impairment of sport fishing waters have occurred locally at many points along the coast. Nuisance conditions, losses in property values, effects of sediment deposition, and other more subtle changes that accompany pollution contribute to the total damages.

These impairments of water quality and deleterious effects upon specific resources of the Gulf represent both tangible and intangible values.

⁴ See figs. 73 and 74, pp. 562 and 563.

Map No. 1

Sources of Pollution and Existing Treatment Facilities



FIGURE 73.—Sources of pollution and existing treatment facilities.

Map No.2
Municipal and Industrial Pollution Abatement Needs



FIGURE 74.—Municipal and industrial pollution abatement needs.

It is not possible to place a monetary value upon some of the effects of pollution, particularly those related to public health and welfare. Losses to the fishery, in tourist and resort trade, expenditures for maintaining silted navigation facilities, and perhaps other effects could be expressed in terms of dollars. No estimates of this kind have been made for the entire Gulf, but the total losses undoubtedly would extend into millions of dollars.

The water-pollution picture in each drainage area is summarized in the following pages. Limits of the areas and their numerical designations are shown on figures 73 and 74.

LOWER FLORIDA AREA (1)

In the Lower Florida Area, which extends northward from Key West to include the Caloosahatchee River drainage, the economy depends largely on attracting tourists. Water and climate are chief factors in the attraction. Water resources are used for recreation, agriculture, sport and commercial fishing, and shellfishing. Population is sparse, urban, and has high seasonal fluctuation.

There are four sewerage municipalities. Key West has a new sewerage system under construction which will serve about 40,000 people. Inadequately treated sewage is discharged from La Belle with 400 sewerage inhabitants.

The following have no treatment facilities:

Municipality:	Sewered population
Everglades.....	300
Fort Myers.....	11,000

Industry is limited in extent and unimportant to the water-pollution problem.

The tidal estuary of the Caloosahatchee River is adversely affected by pollution from Fort Myers to the mouth. All of the Caloosahatchee River from the west end of the Seaboard Airline Railroad Bridge on the east to a line drawn east across the river on the west from Redfish Point is closed to the taking of shellfish because of pollution.

PEACE RIVER AREA (2)

The Peace River Area includes the west Florida coastal zone from the middle of Pine Island northward to Osprey. Population is predominantly urban. Chief occupations relate to phosphate rock mining, agriculture, and processing crops.

Charlotte Harbor is economically important for sport and commercial fishing, shellfishing, and attraction of a voluminous tourist trade. Upstream the Peace River is used by one small city for domestic water supply.

Raw and poorly treated municipal sewage from five small municipalities, wastes from citrus processing, and finely dispersed clay and matrix materials from phosphate mining activities (Phelps and Barry, 1950) cause pollution of the lower river. There are 4 municipalities with sewer systems serving a total of 8,250 persons. Arcadia, with a sewerage population of 3,850, has no sewage treatment facilities. The facilities at the following are inadequate:

Municipality:	Sewered population
Wauchula.....	2,700
Punta Gorda.....	1,500
Zolfo Springs.....	300
Fort Meade.....	2,700

No shellfish areas are closed because of pollution, but the quality of bathing water at Charlotte Harbor beach is affected by sanitary sewage from Punta Gorda. Overall effects of pollution from all sources upon fishery and other resources are not known. The phosphate waste problem has been studied (Specht 1950), and the effects of these wastes, as well as all other wastes entering the stream, are now being studied in a 4-year survey by the Florida State Board of Health in cooperation with the phosphate companies.

TAMPA BAY AREA (3)

The Tampa Bay Area includes the Florida coastal zone from Treasure Island northward to Crystal Bay. The bulk of the population is concentrated in the larger cities of Tampa, St. Petersburg, Sarasota, Clearwater, and Bradenton. Resort trade and widespread recreational use of water for bathing, boating, and fishing are economically important. Water from streams is also used for public water supplies and agricultural purposes. Other notable industries include commercial fishing, phosphate mining, and production of chemicals.

Pollution of the Tampa Bay drainage is caused by municipal discharges serving more than 300,000 persons and by industrial waste from 6 upstream phosphate mines, several citrus canneries, and miscellaneous plants. The larger cities in the resort area either do not have treatment facilities or have inadequate ones.

The following 8 municipalities, with a total sewered population of 29,950, either have no sewage treatment facilities or have inadequate septic tanks:

Municipality:	Sewered population
Palmetto.....	4,000
Pass-a-Grille Beach.....	900
Palma Cia Park.....	4,600
Bradenton.....	12,000
New Port Richie.....	1,000
Largo.....	1,000
Virginia Park.....	3,800
Maryland Manor.....	2,650

Existing treatment facilities at the following 3 municipalities that serve about 3,000 persons are inadequate:

Municipality:	Sewered population
Brooksville.....	1,000
Crystal River.....	500
Mulberry.....	1,600

The following cities have installed, or are installing, adequate sewage treatment plants:

Municipality:	Sewered population
Tampa.....	140,000
Tarpon Springs.....	5,000
Sarasota.....	18,000
Plant City.....	9,000
Dunedin.....	4,800
Clearwater.....	10,000
Treasure Island.....	3,000
Brewster.....	800
St. Petersburg.....	61,000
Madeira Beach.....	5,420
McDill Air Base.....	6,000

Tampa Bay is grossly polluted, and bathing waters in Clearwater Harbor and St. Joseph Sound have been affected adversely. Several large shellfish producing areas are closed to the taking of shellfish because of pollution. The descriptions of these areas are as follows:

1. Sarasota Bay from Stickney Point Bridge on the south to a line from South Shore of Cow Point to shore of Long Boat Pass.
2. The Manatee River from its mouth to east bank of Braden River; Braden River to a point 1 mile from its mouth.
3. McKay Bay and tributaries, Hillsborough Bay and tributaries, north of a line drawn from the interbay peninsula east to the south bank of the Alafia River.
4. Smacks Bayou; Coffee Pot Bayou; Big Bayou; Little Bayou and waters of Tampa Bay in vicinity of St. Petersburg.

5. All of Clearwater Harbor. That part of St. Joseph Sound south of a line extended west from the center of Ozona.

6. Anclote River and Kramers and Whitcomb Bayous.

7. Both Homosassa and Little Homosassa Rivers and tributaries, Salt River, St. Martins River, excluding Greenleaf Bay, the northern half of Game Creek Bay, and the portion of salt River south of Crystal River to Ozello.

WITHLACOOCHEE RIVER AREA (4)

The Withlacoochee River Area covers the Florida coastal zone from Crystal Bay northward to the middle of Waccasassa Bay. Population is sparse and largely rural. Income is derived chiefly from growing and processing citrus fruits and byproducts. Off the coast, commercial fishing and shellfishing are carried on. The river is used for limited production of hydroelectric power and irrigation.

Because of small populations and large supplies of dilution water damages from municipal and industrial waste pollution are not great. There are only 7 small municipalities with sewerage systems that serve a total of 5,200 persons. Dunellon, with a sewered population of 1,150, has no treatment facilities and Cedar Key, with a sewered population of 400, has inadequate facilities.

Although there are objectionable localized points of pollution in the area, there are no closed shellfish areas. Other resources of the Gulf do not now appear affected.

SUWANNEE RIVER AREA (5)

This area includes the 50-mile coastal zone of the Suwannee River drainage basin fronting on the Gulf between Waccasassa Bay and Horseshoe Cove. This is one of the largest rivers in Florida and is used for sport fishing, public water supplies, waterfowl hunting, and, near the Gulf, for commercial fishing and shellfishing. Population is predominantly rural. Products of the area include corn, tobacco, peanuts, pecans, tung oil, lumber, and raw material for naval stores extraction. There are no noteworthy industrial operations.

Three small unsewered municipalities will need adequate treatment facilities of some kind whenever sewerage systems are developed.

Damages to either fresh water or marine resources are not defined but appear unlikely, or of little consequence.

OCHLOCKONEE RIVER AREA (6)

The Ochlockonee River Area extends along the Gulf coast from Horseshoe Cove to East Bay near Apalachicola. The coastal towns are tourist, resort, and fishing camp centers. St. Marks, Carrabelle, and Panacea are ports of some importance. The bulk of the population is employed in agriculture and logging, and industry is of minor importance.

Sport and commercial fishing and shellfishing, recreation, and shipping are the principal water uses.

Of 9 municipalities, with almost 33,000 sewered inhabitants, only Tallahassee and Foley do not need improvements in sewage disposal. Four small municipalities have no effective treatment facilities:

Municipality:	Sewered population
Quincy.....	3,300
Perry.....	1,200
Havana.....	200
Monticello.....	1,500

Two others, with a total sewered population of 1,500, have inadequate treatment:

Municipality:	Sewered population
Dale Mabry.....	1,000
Carrabelle.....	500

The bay area adjacent to Carrabelle is polluted to some degree apparently by shipping in the port of Carrabelle and perhaps also by drainage through New and Crooked Rivers. All of the Spring Creek area north of a line extended across the mouth of the creek in southeast to northwest direction is closed to taking shellfish because of pollution.

APALACHICOLA RIVER AREA (7)

The Apalachicola River Area fronts on the Gulf from East Bay westward to Beacon Hill. Population is sparse and mainly rural. Economic activity includes significant agriculture such as production of peanuts, cotton, corn, tobacco, hogs, and cattle, and cutting of timber near the coast. A sulphate paper mill is located at Port St. Joe.

Waters of the area are popular for game fishing, bathing, boating, and other recreation. Commercial fishing and shellfishing are very important

sources of income. Catches of shrimp in Apalachicola Bay and the coastal waters from Cape St. George to St. Joseph's Point make Apalachicola a principal production center.

The area has 2 sewered municipalities with a connected population of 3,500 persons. Port St. Joe has treatment facilities of adequate capacity, but these need improved operation; the facilities at Apalachicola are inadequate.

Near the mouth of the Apalachicola River the waters are among the most productive of shellfish in the entire Gulf. Because of sewage pollution part of these waters have been closed to commercial shellfishing. They are described as follows (Wakefield 1948): Bounded on the west by a line from the mainland to the eastern tip of St. Vincent Island, this line being sighted from the white beacon "f" through the eastern tip of St. Vincent Island; thence easterly to beacon "2"; thence easterly to beacon "52"; thence north through the western tip of Cat Point; to the mainland; and all of the area bounded by the mouths of the Apalachicola, Little St. Marks, St. Marks, and East Rivers.

Pollution in St. Joseph's Bay is caused by a poorly operated municipal treatment plant at Port St. Joe and from the paper mill at the same location.

CHOCTAWHATCHEE RIVER AREA (8)

The Choctawhatchee River Area extends along the Gulf coast from St. Joseph's Point westward to Mary Esther. Within 50 miles of the coast uncleared timber land is used for cattle grazing. Commercial fishing and shellfishing are important along the coast. Beyond 50 miles, agriculture predominates. Tourist trade, sport fishing, and related recreational activities are important sources of income related to water resources.

Six municipalities, four of which have a total sewered population of 19,000, have adequate sewage treatment facilities.⁵ DeFuniak Springs discharges raw sewage from 1,000 persons, and Lynnhaven has inadequate facilities.

Only minor pollution problems occur over most of the area, but discharges of municipal sewage from the Panama City-Lynn Haven area have limited the utility of recreational waters in St. Andrew's Bay adjacent to Panama City, the

⁵ The remaining two municipalities are military establishments for which data on populations served by sewers are not available.

south shore of North Bay near Lynn Haven, and in East Bay. The following areas are also closed to commercial shellfishing:

North Bay: (Fanning Bayou) that part north of the mouth of each of the three prongs. (Upper East) all of that part south of a line extending west from Deer Point through Mill Point to the south point of Newmans Bayou and bounded on the west by a line extending south to Little Oyster Bar Point. (Lower South) all of that part south of a line extending east from Shell Point to the south shore of Coose Bayou.

St. Andrew Bay: All of the bay from Hathaway Bridge on the west to DuPont Bridge on the east excepting that part on the Gulfside of a line extending from Bear Point to Redfish Point.

Wastes from a sulphate pulp and paper mill near Panama City caused local conditions inimical to aquatic life as recently as 1950 (Anonymous 1950), but remedial action has since been taken by the industry.

PERDIDO-ESCAMBIA AREA (9)

Perdido-Escambia Area extends westward from Mary Esther, Florida, to the vicinity of Bon Secour, Alabama. Pensacola is the chief population and industrial center and an important seaport which also harbors commercial fishing fleets. Production of livestock and timber are principal nonurban activities. Water resources of the coastal area relate to sport and commercial fisheries, oyster production, bathing, and recreation.

Pensacola, which discharges partially treated sewage from a population of 35,000 persons into Pensacola Bay, is the chief source of sewage pollution. Discharges from 2 other inadequate municipal treatment plants that serve about 3,700 persons reach waters of the area also:

Municipality:	<i>Sewered population</i>
Moreno Court.....	3,000
Robertsdale, Alabama.....	700

Flomaton, with 1,000 sewered inhabitants, has no treatment facilities.

Because of sewage pollution large areas have been closed to the production of shellfish. They are described as follows:

1. All of Pensacola Bay west of a line drawn due south from Gulf Point to the south shore of the bay-Bayou Texar and Bayou Chico.

2. That portion of Escambia Bay north of the Louisville and Nashville Railroad Bridge.

3. All of Blackwater Bay north of a line drawn west through Escribasso Point.

The quality of bathing waters also has been affected. This is particularly true in certain parts of Pensacola Bay, in Bayou Grande, Bayou Chico, and Bayou Texar.

Industrial wastes from breweries, dairies, rendering plants, a large naval stores plant, and a paper mill have caused objectionable pollution conditions.

Paper mill wastes have made Elevenmile Creek unfit for fish despite remedial action by the industry (Anonymous 1950). Conditions in the bay prevent growing shellfish that would have a great potential annual value (Phelps and Barry 1950).

MOBILE BAY AREA (10)

The Mobile Bay Area includes Bon Secour Bay and extends westward to Isle Aux Herbes. Population is concentrated at Mobile which forms the center of an industrial area at the head of Mobile Bay. Ship building and repair, pulp and paper making, and lumbering are prominent. In addition to serving as a navigation waterway, Mobile Bay is used extensively for commercial fishing, oyster production, recreation, and a wintering area of waterfowl. Hunting is a popular sport there. It is also one of the principal shrimp fishing grounds of Alabama.

Adequate facilities for disposal of municipal sewage now serve 30 percent of the sewered population. The City of Mobile has purchased a site and plans are under preparation for a sewage treatment plant which will serve approximately 85,000 people. The Eslava Treatment Plant for the City of Mobile is being enlarged to three times its present capacity and will provide treatment for approximately 42,000. Pritchard has a new treatment plant under construction which will serve 10,000 people. Improvements have been made at the Chickasaw Plant which is now satisfactorily treating the sewage from 10,300 people. Industrial wastes including both organic and inorganic wastes of unknown quantities are discharged into the Bay.

Pollution has affected bathing and other recreational waters in various parts of the bay. A number of areas have been closed to commercial

shellfishing because of pollution. These are described as follows:

1. All of Bon Secour River lying upstream from a line extending due north from the east bank at the inlet to Oyster Bay from said Bon Secour River.

2. Bayou Labatre and the coastline area immediately adjacent to its mouth.

3. Bayou Coden and the coastline area immediately adjacent to its mouth.

4. Areas affected by pollution from Mobile River including Upper Mobile Bay near the mouth of the river. Dog River, the shoreline in the vicinity of Fairhope and Fish Rivers do not involve shellfish producing areas because no oyster reefs exist in the immediate vicinity.

Protection of the water resources from the damaging effects of pollution can be accomplished by providing sewage treatment facilities for 3 municipalities serving approximately 100,000 persons. Information is not conclusive in regard to the effects of industrial wastes on shellfish production.

PASCAGOULA RIVER AREA (11)

The Pascagoula River Area covers the coastal zone from Isle Aux Herbes in Alabama westward to Bay St. Louis, Mississippi. Principal cities are Pascagoula, Ocean Springs, Biloxi, Gulfport, Long Beach, and Pass Christian. In addition to a thriving winter tourist patronage along the coast, economy of the area depends upon processing natural resources. These include lumber, naval stores, paper, and sea food. Recreational uses of watercourses, such as fishing, hunting, and boating, are of major importance. Coastal waters yield fish, shrimp, crabs, and oysters. Biloxi is the principal shrimp and oyster landing port of Mississippi.

A total sewerred population of approximately 54,000 is distributed among seven municipalities or institutions. Gulfport, which has a sewerage system serving only a small part of the City, has extended its sewers to include most of the town. The City has acquired and is now using the existing facilities of Gulfport Field for the treatment of sewage. Although most cities have sewage treatment plants, sewage pollution is sufficiently serious in some areas to prohibit commercial shellfishing. Closed areas are described as follows:

1. The area included in Pascagoula River from a point 1 mile above Pascagoula River toll bridge

to a point 2 miles outward from the mouth of the river and within the east and west boundaries of the Pascagoula River channel.

2. The Back Bay of Biloxi north and west of Highway 90 bridge extending from Biloxi, Mississippi, to Ocean Springs, Mississippi.

3. That portion of Biloxi Bay included between the U. S. Highway No. 90 bridge across Biloxi Bay and a straight line across the Bay determined at its northeast extremity by the water tower in Ocean Springs and its southwest extremity by Flashing Light No. 31 off the eastern tip of the Biloxi Peninsula, which line shall then proceed in a westerly direction to the northwestern end of Deer Island, and including the area fronting the city of Biloxi from the Biloxi USO Building to the most easterly point of Biloxi Peninsula at the U. S. Coast Guard Base, and lying between the main shore line and the line from Flashing Light No. 31 to the northwestern end of Deer Island. Also included is the area commonly referred to as the "Ocean Spring Small Craft Harbor" from the Biloxi Bay shoreline inward to the upper extremity of this harbor.

4. The area bounded on the north by that portion of the Gulfport shore line of Mississippi Sound between its intersection with the extension of 42d Avenue South in Gulfport, and the east boundary of the United States Veterans Hospital property; on the west by a line running south 2 miles from 42d Avenue extended; on the east by a line running south two miles from the east boundary of the United States Veterans Hospital property; and on the south by a line running parallel to the shoreline and 2 miles therefrom connecting with the outer ends of the east and west boundary lines.

Industrial wastes of various kinds are discharged to the area's waters in sufficient quantities to cause local problems. Bayou Bernard, which empties into Back Bay near Biloxi, has had periodic killings of fish from industrial waste pollution (Anonymous 1950).⁶ A sports fishery has been damaged in tributary waters adjacent to Back Bay at Gulfport. Bathing waters have been affected at Back Bay and Biloxi Bay near Biloxi and at the beach at Pascagoula.

⁶ From a summary report on the Pascagoula River Basin prepared by Mississippi State Board of Health. Unpublished.

PEARL RIVER AREA (12)

The Pearl River Area includes drainage from parts of Mississippi and Louisiana and fronts on the Gulf between Bay St. Louis and a point 5 miles west of the Louisville and Nashville Railroad Bridge crossing the Rigolets. Population is sparse. Principal population and industrial centers are Bogalusa and Franklinton, Louisiana, which are located inland. Industrial operations include production of naval stores and other chemical products, pulp and paper, primary metals and processed foods. A number of oil and gas fields are located in the lower part of the drainage basin.

Waters of Mississippi Sound and Lake Borgne are used extensively for sport fishing, bathing, boating, and other recreation. They are also fished commercially for fin fish, shrimp, and oysters.

There are no sewerred municipalities on the Gulf coast in this area. Bogalusa, with a sewerred population of 10,000, discharges untreated sewage to the Pearl River about 50 miles above the mouth. Industrial wastes of various kinds are discharged at Bogalusa, Franklinton, and Picayune. Although pollution occurs upstream in the watercourses, no shellfish areas downstream are closed to commercial fishing. Effects upon other resources of the Gulf are unknown.

LOWER MISSISSIPPI RIVER AREA (13)

The Lower Mississippi River Area includes the section south of Baton Rouge that is bounded on the east by the Pearl River Basin and on the west by the East Atchafalaya Basin Protection Levee southward to Morgan City and from this point southward to Atchafalaya Bay. Because of levees no appreciable surface drainage reaches the Mississippi River. Drainage east of the Mississippi River and north of New Orleans drains to the Gulf through Lake Pontchartrain. Drainage west of the Mississippi is away from the river and southerly to the Gulf.

The water of the Mississippi entering the area already has passed through cycles of pollution and recovery from distant sources of pollution. The effects of such pollution upon the Gulf are not significant. Drainage from erodible lands through which the river flows already have given it, at this point, an annual sediment load of one-half billion tons.

New Orleans is the chief population, industrial and marketing center and also an important port. Land use is principally agricultural. Petroleum production and refining, chemical manufacture, and processing of sugar, foods, seafood, menhaden, cottonseed, and wood are principal industrial activities. Fresh water resources are important for public and industrial water supplies. The coastal waters are used for sport fishing and other recreation and are a rich source of sea food. Chandeleur and Breton Sounds and Barataria Bay are fished extensively for shrimp. Much of the coastal area along the delta and westward is swampland cut by complicated sluggish watercourses. Large areas are set aside as wildfowl refuges, but the swamplands also serve as rich muskrat trapping grounds.

Of 15 sewerred municipalities in the area, 5 discharge sewage without treatment. The largest is New Orleans, with a sewerred population of 582,000, which pumps the sewage to the Mississippi River. The others are the following:

Municipality:	<i>Sewered population</i>
Plaquemine.....	5, 740
St. Bernard Sewage District.....	
Donaldsonville.....	4, 500
Gretna.....	11, 000

Three other municipalities have sewage treatment facilities that are inadequate:

Municipality:	<i>Sewered population</i>
Houma.....	10, 000
Covington.....	3, 500
Slidell.....	2, 000

At least 22 industrial plants discharge untreated wastes. Among them are at least 19 sugar plants distributed in the area. Pollution prevention measures are in operation at an oil refinery upstream at Baton Rouge and at Norco (Anonymous 1951b).

Because of large quantities of dilution water serious effects of pollution are principally localized near concentrations of industry. No shellfish areas are closed to commercial fishing because of pollution.

ATCHAFALAYA RIVER AREA (14)

The Atchafalaya River Area includes the drainage southward from Lafayette and fronts on the Gulf from Caillou Bay to Grand Chenier. The lower parts of the Morganza and related floodway systems drain through the area. Agriculture is a

major activity with rice, cotton, and sugarcane as principal crops. Oil fields and sugar processing plants are scattered outside the floodway area. Principal cities are Crowley, Lafayette, and New Iberia. Water resources are used for irrigating rice, for navigation, and sport and commercial fishing. Caillou, Atchafalaya, and Vermillion Bays are fished extensively for shrimp. Coastal swamps are used for hunting, muskrat trapping, and wildfowl refuges.

Twelve municipalities have sewerage systems that serve almost 80,000 persons. Nine have adequate sewage disposal facilities, Jennings with 7,300 persons has none, and the facilities at the following are either inadequate or poorly operated:

Municipality:	Sewered population
Abbeville.....	9, 000
Jeanerette.....	4, 000

Industrial waste pollution is caused principally by sugar plant wastes and oil field brines. Large quantities of organic matter are discharged during the harvest season from 22 cane sugar mills that have a combined daily capacity of 31,000 tons of sugar. More than 11,000 barrels of brine wastes per day result from oil field operations. Although 65 to 70 percent of the salt brines are disposed of adequately by reinjection, appreciable quantities still enter surface waters.

No shellfish areas are closed to commercial fishing because of sewage pollution. During the sugar season local nuisances result from sugar mill wastes. In the past, brine wastes have interfered with the use of rice irrigation water, but at the present time, orders issued by the Stream Control Commission forbid deposition of brines into irrigation waters during certain times of the year.

CALCASIEU RIVER AREA (15)

The Calcasieu River Area includes the lower 50 miles of the narrow Calcasieu Basin. It fronts on the Gulf between Grand Chenier and Johnson's Bayou. The area is important for production of rice and a number of minor crops, has about 20 oil fields, and industrial activities that include petroleum processing, ginning cotton, production of pulp and paper, and food processing. Lake Charles is the principal city. Uses of fresh water include rice irrigation, industrial use by oil refineries and paper mills, and navigation below Lake Charles. Muskrat trapping and

farming are important in marshes south of Lake Charles. Shrimp and fish are taken from the offshore waters.

Lake Charles, with a sewer population of 54,000, and Maplewood with 2,500, have municipal sewage treatment facilities. One small community that is located some distance inland has inadequate facilities, and Oakdale, also inland, discharges untreated municipal sewage. The Lower Calcasieu River is also subject to considerable pollution from ship traffic and from periodic flooding of land areas at the small communities of Cameron and Hackberry where pit privies are common. Principal industrial wastes come from oil fields, two oil refineries, two chemical plants, and a fish meal company.

Because of sewage pollution, the entire Calcasieu River and its tributaries are closed to commercial shellfishing. During periods of low flow, wastes from oil refineries and other industries have caused oxygen depletion in parts of the Calcasieu River.

SABINE RIVER AREA (16)

The area includes parts of Louisiana and Texas in the Sabine River drainage basin, the eastern half of Sabine Lake and its pass to the Gulf. The largest city is Orange, Texas. Cattle and rice are principal agricultural products. Oil wells are numerous. Industrial processing includes petroleum, chemicals, and food. Fresh water is used extensively for rice irrigation, industrial water supplies, and navigation. Fish and shrimp are taken from the offshore waters.

Sewered municipalities are Orange, Newton, and Kirbyville, Texas. Their sewer systems serve 25,000 persons. The existing facilities at these municipalities have adequate capacity. Considerable pollution comes from oil-well brines and sediment loads from erosion.

The Sabine and Neches Rivers together carry an annual silt load of about 7 million tons into Sabine Lake. During the past 75 years, ocean-going shipping on the lake has become restricted to the confined channel of the Intercoastal Waterway which is maintained by dredging. Oyster reefs in Sabine Lake were destroyed long ago by siltation.

NECHES RIVER AREA (17)

The Neches River Area includes the drainage from Silsbee downstream and extends along the

Gulf from the middle of Sabine Lake to High Island. Beaumont and Port Arthur are largest of the 9 cities with more than 80 percent of the urban population. Petroleum, gas, cotton, and other farm products are the basic materials for industry which is concentrated near these cities. Water use by industry is heavy and important; tremendous quantities are used for rice irrigation also. Coastal waters are used for sport fishing and other recreation. Fish and shrimp are taken commercially offshore.

Total organic pollution load from all sources in the area is estimated at 750,000 population equivalent. There are 9 municipalities that have sewer systems serving a total of 173,000 persons. The following municipalities are without sewage treatment facilities:

Municipality:	Sewered population
Groves.....	2,470
Port Neches.....	5,450
Lakeview.....	3,080
Griffing Park.....	2,100
Port Arthur.....	57,400

There are also wastes from industries of various kinds and salt brines from oil fields. Soil erosion over the drainage area has resulted in damaging silt deposits in both the Neches River and Sabine Lake. (See Sabine River Area.) The river had a natural 60-foot deep channel upstream to Beaumont in 1876 but now requires continuous dredging to maintain a 25-foot channel.

At times fishing has been damaged by effects of organic waste pollution. Although salt brines have occasional effects upon irrigation water, effects upon resources of the Gulf are not known.

TRINITY RIVER AREA (18)

The Trinity River Area includes drainage from Livingston downstream on the Trinity River, from Humble downstream on the San Jacinto, and drainage from the area surrounding Galveston Bay. The area fronts on the Gulf between High Island and the southern tip of West Bay. The drainage basin is predominantly agricultural except for the Houston-Galveston area where a growing variety of manufacturing industries has been developed. About 65 percent of the population of the Texas Gulf area is concentrated about this industrial development. Petroleum and chemical industries are prominent.

Watercourses are used for public and industrial water supplies; Galveston Bay for navigation and

for fishing to a limited degree. In the vicinity of Galveston, Gulf waters are popular for sport fishing, bathing, boating, and other recreation. Galveston is an important shrimp landing port.

All but one of the sewerred municipalities, with systems serving about 1 million persons, have sewage treatment facilities. Most of these are adequate. Although Galveston now has no treatment facilities for a connected population of 70,000, a plant is under construction. Because of pollution from municipal wastes, that area of Galveston Bay lying between a line extending from Texas City along the dike to the point of the ferry landing on Bolivar Peninsula as a northern boundary and the Galveston causeway as a western boundary is closed to the taking of shellfish. However, it is believed very few, if any, shellfish are actually to be found in this area. Industrial wastes also contribute to the pollution problem, although there is little specific information on wastes from the various industries or oil fields. Galveston Bay receives an annual silt load of 8.1 million tons from the Trinity River and 1.2 million tons from the San Jacinto.

There has been a spectacular decline in Galveston Bay fishery resources during the past 60 years. Since 1890 the catch dropped from more than a million pounds to only 336 pounds in 1948. Pollution is considered an important contributory factor. At the present time an extensive pollution survey is being made of Galveston County waters by the Texas State Department of Health in cooperation with Galveston County. Fishing has been seriously damaged in Buffalo Bayou by sewage from Houston.

BRAZOS RIVER AREA (19)

The Brazos River Area includes drainage of the Brazos and San Bernard Rivers from Rosenberg toward the Gulf. At the coast, the area extends between West Bay and Matagorda Bay. Population is fairly low. Rosenberg, Bay City, and Freeport are the principal cities. Industry of the area has developed around petroleum and agricultural products. Irrigation of rice and industrial and municipal water supplies are the principal uses of fresh water. Coastal waters are used for fishing and recreation. Freeport is an important shrimp landing port.

Most of the municipalities now have sewage treatment facilities, but West Columbia, Velasco,

and Freeport do not. This results in the discharge of raw sewage from 10,000 persons. The following municipalities have inadequate sewage treatment facilities:

Municipality:	Sewered population
Richmond.....	2, 000
Brazoria.....	1, 000

Pollution also is caused by brine wastes and wastes from a number of industrial plants. Large sulfur workings and a plant for recovering chemicals from salt water are located at Freeport.

The Brazos River once entered an estuary much larger than Galveston Bay but now flows directly to the Gulf after having filled the estuary with silt. The river carries an estimated annual silt load of 35.3 million tons despite the small drainage area.

Water pollution damages to resources of the area are not well defined. No shellfish areas are closed because of pollution, but periodic fish losses near Freeport are believed caused by discharges of caustic wastes from an industry located there.

COLORADO RIVER AREA (20)

The Colorado River Area includes the lowermost drainage of the Colorado River and the part of Matagorda Bay lying northeastward from Tres Palacios Bay. Matagorda at tidewater and Wharton 47 miles upstream are the only sewered municipalities. Economic activity is based upon petroleum and agriculture, but industrial development is limited, and the few existing factories are scattered. Fresh water is used for domestic and industrial water supplies and for irrigation. Matagorda Bay is used for sport fishing, waterfowl hunting, boating, and other recreation. Fish and shrimp are taken commercially here and off shore.

Untreated sewage from 4,500 persons at Wharton is the only municipal source of pollution. Silt is the major cause of pollution. Because of upstream impoundments, the river now carries to the Gulf a silt load acquired mainly in the lower 245 miles of its course. Annual load prior to 1941 was estimated at 8.9 million tons. Silt is reported to have all but destroyed some six or seven thousand acres of oyster reefs near Matagorda. None of the remaining shellfish areas are closed because of pollution. Like the Brazos River the Colorado has formed a delta to the

Gulf and overflows to Matagorda Bay only at flood flows.

GUADALUPE RIVER AREA (21)

The area includes drainage of the Navidad, Lavaca, Guadalupe, and San Antonio Rivers, and the bay areas and coastal waters from Tres Palacios Bay to Hines Bay. Victoria, El Campo, and Port Lavaca are the principal cities. Cotton farming and production of oil and gas, especially in the coastal area, are chief economic activities. A large aluminum reduction plant is located at Port Lavaca. Water uses include municipal and industrial water supplies, irrigation, and recreation. Oyster reefs of commercial importance are located in Espiritu Bay and Tres Palacios Bay near O'Connor. Bay areas are important for sport fishing and hunting of waterfowl. Fish and shrimp are taken commercially in the bays and offshore waters. Palacios and Port Lavaca are important shrimp landing ports.

There are 11 municipalities with sewer systems that serve a total of 40,000 persons. All of these municipalities have sewage treatment facilities, but facilities of the following are inadequate:

Municipality:	Sewered population
Ganado.....	1, 350
Edna.....	3, 600
Goliad.....	800

No shellfish areas are closed to commercial fishing because of pollution. Except for oil-field brines, industrial wastes are not a serious problem. Corrective action instigated by the pollution control agencies is proving quite effective in reducing the effects of brine pollution.

Lavaca Bay receives the silt loads of the Lavaca and Navidad Rivers and shorter Karon-Lavaca and Tres Palacios Creeks. The Lavaca, alone, carries an average annual silt load of more than 200,000 tons. Guadalupe and San Antonio Rivers discharge silt into San Antonio Bay: the Guadalupe at an average annual rate of 600,000 tons and the San Antonio at least 700,000 tons.

Effects of pollution upon resources of the adjacent area of the Gulf are not known.

NUECES RIVER AREA (22)

The Nueces River Area includes drainage of Mission, Aransas, and Nueces Rivers. It fronts on the Gulf between Hines Bay and Corpus Christi Pass. Principal cities are Corpus Christi,

Beeville, and Robstown. With exception of the vicinity of Corpus Christi, the area is sparsely populated, with farming and cattle ranching the chief activities. Sulfur and rock asphalt are produced and processed, and oil production is increasing. A large corn products refinery and a synthetic fabrics plant are located in the Corpus Christi area. Fresh water resources are used extensively for municipal and industrial water supplies, stock-watering, and irrigation. Oyster reefs are located in Nueces, Copano, Aransas, and Mesquite Bays. The area is popular for sport fishing, waterfowl hunting, and boating. Aransas Pass and Rockport are important shrimp landing ports.

There are 12 sewerred municipalities with a total sewerred population of 137,500 of which 100,000 are in metropolitan Corpus Christi. Although all sewerred municipalities provide sewage treatment, the facilities at the following three are inadequate:

Municipality:	Sewered population
Refugio.....	3,700
Odem.....	1,200
Ingleside.....	150

Nueces Bay was closed to commercial oystering about 20 years ago because of raw sewage discharges at Corpus Christi. Improved facilities for sewage treatment now in operation and elimination of waterfront privies have permitted resumption of oyster marketing. There are now no areas closed to commercial fishing.

Large quantities of oil-field brines are evaporated in ponds or injected underground. Some not so treated have caused pollution of Mission Creek and Copano Bay. Wastes from a synthetic fabrics plant at Kingsville were suspected of causing a fish kill. Caustic soda from a chemical plant has, on occasion, affected waters in a turning basin near Corpus Christi. This problem is receiving attention by the industry. The extent of damage from these conditions is not known.

LOWER RIO GRANDE AREA (23)

The Lower Rio Grande Area is the coastal zone from Corpus Christi Pass to the International Boundary. It includes drainage of a number of creeks, Arroyo Colorado, and the Rio Grande River. The northern portion is dry, sparsely populated, and utilized for cattle ranching; the southern part is in the "Magic Valley" with its

widespread irrigation, semitropical climate, and tremendous agricultural development. Processing of citrus fruits and vegetables is a major industry along with fish and shellfish processing. Brownsville, Harlingen, Alice, and McAllen are principal cities. Tourist trade is a major factor in the area's economy during the winter months. Fresh water resources are used extensively for irrigation. The Arroyo Colorado serves as a wasteway for surplus Rio Grande water, an irrigation drain, and as a waste disposal canal to Laguna Madre. About 200 fishing boats operate from the mouth of the river. There are oyster reefs in South Bay. Coastal waters are also used for sport fishing and recreation.

The 27 sewerred municipalities have a total connected population of 146,300, and all have treatment facilities. The facilities of 9 municipalities serving 15,300 persons are inadequate:

Municipality:	Sewered population
San Diego.....	1,800
Orange Grove.....	550
Aqua Dulce.....	100
Bishop.....	2,000
Mercedes.....	500
La Feria.....	1,470
Edecouch.....	500
Rio Hondo.....	400
San Benito.....	8,000

Only two municipalities discharge treatment plant effluents to the Rio Grande, most others to Arroyo Colorado. Industrial wastes come from numerous fruit, vegetable, and sea food canneries and quick-freeze plants, oil refineries, a chemical plant, a large candy and gum factory, and castor and cottonseed processing plants.

The Arroyo Colorado, at times, is heavily overloaded with sewage and industrial wastes. Effects upon resources of Laguna Madre or the Gulf are not known. The oyster beds in South Bay are 50 miles distant from the mouth of Arroyo Colorado and well protected by distance from the discharged wastes.

THE GULF COAST OF THE REPUBLIC OF MEXICO

In general, the area draining to the Gulf is sparsely populated. Land is used largely for grazing, lumbering, and agriculture. The oil industry is the only one of significance with respect to water pollution. Fishing for fin fish, shrimp, and oysters are important local industries along the coast. The oyster producing capacity of

Mexican waters has not been developed thoroughly because of lack of markets. Local beaches are used extensively for bathing and, even near the cities, the Gulf waters are clear and inviting.

Except for Tampico, Veracruz, Villa Hermosa, and Coatzacoalcos, domestic sewage is disposed of on an individual basis. The effects of such disposal upon the Gulf and its estuaries is negligible. At Tampico untreated municipal sewage is discharged to the Panuco River which provides adequate dilution to prevent nuisances. Because of a peculiar combination of tides and currents this sewage has contaminated parts of Laguna Vieja beyond acceptable limits for oyster harvesting. At Veracruz a primary sewage treatment plant was constructed and placed in operation in 1950. A few sewer outlets are not as yet connected to the treatment plant.

Loading of crude oil into ships at Tampico, Tuxpan, and Coatzacoalcos, on occasion, has resulted in accidental spills that have fouled beaches near these points. The offending parties have been cooperative in preventing recurrences. This is the only known industrial waste problem on the Gulf, and there are no records of injury to fish or other aquatic life.

Silt deposition is the greatest pollution problem on the Mexican Gulf Coast. Silt and sand carried by the Panuco and Grijalva Rivers clog the harbors at Tampico and Alvaro Obregon, respectively, and necessitate dredging to permit navigation. From north to south the silt carrying rivers of Mexico discharging along the Gulf coast are: Soto la Marina, Barbarena, Panuco, Tuxpan, Cazonas, Nautla, Tecolatia, Actopan, Misantla, Boca del Rio, Papaloapan, Coatzacoalcos, Tonalá, Nuevo San Filipe, Santana, Cuxcucha, Grijalva, and San Pedro. Many of these streams discharge to brackish estuaries which contain oyster reefs. Undoubtedly the deposition of silt will destroy the oyster reefs which are a valuable natural resource.

Because of the near nonexistence of sewage and industrial waste pollution in the Gulf coast area there is no antipollution campaign in Mexico. Federal law regarding pollution is very brief and consists of a paragraph or two in the Sanitary Code which forbids the discharge into waters of materials harmful to health and navigation. Under the Sanitary Code detailed regulations could be drawn up for controlling pollution, but

this has not been necessary as yet. The Federal Health Department (Salubridad) and Federal Harbor Police (Marina) are the agencies charged with pollution control; their activities along this line are largely concerned with handling complaints. Principal complaints concern the oil pollution previously mentioned. There is no routine determination of water quality or the amounts of pollution except in the Tampico area where the health department has an interest in the bacterial quality of oyster-producing waters. The several Mexican States could, if so inclined, promulgate and enforce water pollution control laws.

For the past several years Mexico has discussed soil conservation, and some beginnings of a working program have developed which in time will reduce the amount of silt carried to the Gulf.

From the standpoint of organic pollution of Gulf waters the program carried out in Mexico is adequate to handle present conditions, although from a conservation and public health view some soil conservation and general sanitation practices could be improved. It can be safely said that when Mexico has a real need for an antipollution campaign it will be forthcoming.

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