BACKGROUND PAPER:
LAND-BASED SOURCES (LBS)
OF POLLUTION
AS THE DOMINANT MARINE POLLUTION PROBLEM
IN THE WIDER CARIBBEAN REGION

prepared by

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EXECUTIVE SUMMARY

Land-based Sources of Marine Pollution (LBS) of concern in the Wider Caribbean involve both the point and non-point source categories, and include:

- o Agricultural Sources,
- o Industrial Sources,
- o Sewage Sources,
- o Solid Waste Sources.

The lack of adequate marine water quality survey and monitoring data in the region delayed the recognition for some time of the magnitude of the total contribution to regional marine pollution problems from LBS of all types. The growing accumulation of site-by-site surveys on a country-by-country basis of identifiable LBS sources and the observable relationship of these sources to nearby marine environmental damage and wider regional implications has caused a general consensus to emerge among experts that as much as 90% or more of the region's marine pollution problems are attributable to LBS of all kinds.

LBS threaten the capacity of the near-coastal ocean waters to support life and to recycle or neutralize natural and anthropogenic products and emissions. For the coastal and island environments, nutrient over-enrichment, toxic substances and pesticides contamination contribute to habitat degradation, water supply contamination and public health problems. The coral reefs, seagrass and mangrove systems are especially suffering from LBS effects. The depletion of oxygen caused by increased biological oxygen demand (BOD) of waste disposal has caused mass mortalities of fauna due to asphyxiation. Suspended sediment has reduced light penetration, causing major shifts in biotic communities, as well as degradation of corals.

Pesticides that have bio-accumulated and untreated sewage pathogens affect marine biota and can be transmitted through fishery resources to humans. Many types of LBS also pose serious health and ecological hazards through contamination of fresh water supplies used for drinking, washing and agriculture, and through early entry into the food chain via crops, dairy products, poultry and meat products, even before entering the marine environment.

While most of the LBS environmental effects of greatest concern involve impacts on the near coastal waters and lands, the entry of pollutants into the large scale regional ocean circulation system is what makes the overall problem inherently a regional one, and the Caribbean Sea and Gulf of Mexico a common "regional sea" for marine environmental matters. The major flow patterns of the ocean currents in the region are from southeast to northwest, carrying marine pollution along the northeastern coast of South America, the east coast of Central America and the Caribbean Islands, and then into the Gulf of Mexico and around Florida to the Atlantic coast of the U.S. The dominant regional meteorological patterns contribute additional physical linkages to the integrated regional character of the problem.

Important technical studies and reports that have contributed to the present state of understanding concerning the LBS problem in the Wider Caribbean include:

- A 1984 UNEP Eastern Caribbean Community (CARICOM) study,
- A 1984 Pan American Health Organization (PAHO) inventory of pollutants and their sources, by individual country in the Wider Caribbean,
- A two volume study prepared for PAHO in 1988 of sewage problems in the Eastern Caribbean,
- The U.S. National Report on environmental priorities in the Caribbean prepared by EPA and NOAA in 1989,
- An EPA funded study on LBS problems in 34 Caribbean countries prepared in 1989,
- A Regional Seas Program environmental assessment document for the Wider Caribbean prepared by UNEP and Greenpeace in 1990,
- A U.S. Dept. of State, Man and the Biosphere Program (MAB), report on an August 1989 conference on LBS in the Wider Caribbean sponsored by MAB,
- A major survey of the state of knowledge on the regional oceanography of the region by G. Wust in 1964,
- An analysis of the pollution and living resources implications of the regional oceanography by D. K. Atwood in 1977.

Land-Based Sources of Pollution As the Dominant Marine Pollution Problem in the Wider Caribbean

1.0 Land-Based Sources of Marine Pollution (LBS) in the Wider Caribbean

Land-based sources of marine pollution (LBS) are defined as the disposal or release of polluting substances from land-based activities into coastal and marine waters. Discharges from a wide range of activities contribute to pollution of the near-coastal environment and also enter the main oceanic circulation systems, contributing to adverse environmental effects across broad areas impacted by those circulation systems. Run-off from agricultural lands and urban areas contribute significant quantities of nutrients, pesticides, and other harmful substances. These more diffuse sources are accompanied by the more obvious industrial outfalls that discharge directly into the coastal ocean waters, estuaries and inland rivers that ultimately transport sediment and contaminants to estuarine and coastal waters.

Also included is the direct and indirect deposition of airborne pollutants in the marine environment. The overwhelming proportion of airborne sources are land-based. Indirect deposition involves transport of airborne pollutants into the marine environment through deposition first onto the land and eventually transport to the marine environment via run-off, river systems and ground waters.

Generally excluded from this definition are pollutants resulting from deep sea disposal, maritime transportation and sea-bed activities. While petroleum spills at sea are not included, petroleum spills from land storage facilities, coastal oil rigs on land, pipelines and other land transportation systems are all categorized as LBS, whenever the pollution from these sources is apt to reach the marine environment by any of the pathways already enumerated.

Within the scope of this definition, there are four major categories of LBS (Betz, 1990):

- Agricultural Sources; including fertilizers and pesticides which mainly enter the environment through run-off of rain and irrigation water, improper cultivation practices causing soil erosion into streams, estuaries and coastal waters,

- Industrial Sources; both organic and inorganic pollutants (pretreated or otherwise) including toxic chemicals produced in conjunction with industrial processes and mining activities which are directly

discharged into streams, estuaries and coastal waters, meteorologically eroded into the same avenues or leached out of buried disposal sites through the medium of the ground waters; petroleum spills on land are also included in this category,

- o Sewage Sources; these include both treated and untreated human and animal organic waste emanating from privy pits, septic tanks, packaged treatment plants, sewage system outfalls and disposal ponds transported through marine outfall pipes or leached into aquifers, and then to the marine environment,

- o Solid Waste Sources; cover a wide variety of hazardous and non-hazardous detritus and discarded material produced by construction, transportation and packaging, communications and other activities of civilized societies that become general litter, are disposed of in landfills and other sites[2], or partially incinerated, and that produce pollution through a complex chain of degradation and decomposition processes entering all of the water transport media described above.

Based on the limited data that has been available, marine pollution experts have made a number of estimates of the relative contributions from the major known source categories to pollutants of all kinds in the global marine environment due to human activities (GESAMP, 1990; Johnson, 1976; Goldberg, 1982; MPS, 1991). These estimates of the global averages, and corresponding regional estimates, generally indicate that the overall LBS contribution is 80 +/- 10 %, i.e., the range is from 70 to 90 percent. Of the 80%, it is estimated that for the global average situation, 40% (of the 80%) comes from direct deposition into the oceans of airborne pollutants originating from LBS. Therefore, the global estimate is that about one third of all the pollution in the marine environment originates from airborne pollutants originating on land (LBS) and another 47% or so derives from all other LBS entering the marine environment by other routes.

At the time that the Cartagena Convention (The Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region) and associated protocol (A Protocol Concerning Co-operation in Combatting Oil Spills in the Wider Caribbean Region) were negotiated, concerns focused on oil spills (no distinction between pure marine sources and LBS oil spills was made within the protocol), pollution from ships, and ocean dumping. These vessel related sources of marine pollution

[2] In some instances in the Caribbean, these wastes fill wetlands or are deposited directly into the sea.

gradually were recognized to represent a comparatively minor part of the problem. While serious marine pollution problems had been recognized as existing in the Wider Caribbean for some time, the lack of extensive blue water surveys and water quality monitoring networks made it difficult to assign the problem to specific source categories on any quantifiable basis.

Now, LBS are believed to be the major contributors of marine pollution in the Caribbean and the Gulf of Mexico environment (scientific experts generally agree that perhaps upwards of 90 percent or more of marine pollution in the Wider-Caribbean Region is accounted for by LBS (MAB, 1990)[3]). However, it has also been recognized that addressing the spectrum of land-based sources is the most costly and complicated pollution problem to negotiate technically and politically, and to actually implement remedial actions for, once general agreements have been negotiated.

It is recognized that there is now an urgency in confronting the LBS problem and a need to establish a basis for solution (ACOPS, 1988). The emerging recognition of the magnitude of the LBS problem has largely resulted from an accumulation of site-by-site surveys conducted on a country-by-country basis across the Wider Caribbean. These surveys identified relevant sources and were often able to tie these sources to identifiable damage to the nearby marine environment, as well as indications relating effects in the wider region. Specific studies are cited in Section 5.0 below.

Pollution from ships and dumping of wastes at sea are now subject to international controls under the London Dumping Convention and other agreements. However, land-based sources of pollution, in particular fertilizer/pesticide runoff, industrial and transportation sector wastes, and airborne deposition, are the most serious threat to the health of the oceans and are <u>not</u> subject to international regulation.

2.0 <u>Point and Non-Point LBS</u>

Many of the land-based sources of pollution degrading the environment are easily recognizable, particularly the direct point sources that discharge directly to coastal waters, such as sewage effluent, industrial discharges and municipal stormwater outfalls. In the U.S. coastal waters within the Gulf of Mexico, 68 percent of the total volume of industrial waste water discharged into the region from point sources is from chemical and allied product manufacturing facilities; while all of this

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[3] MAB (1990) states that "Scientists believe that over 85% of the marine pollution in the Wider Caribbean Region is the result of land-based sources." However, some major survey results that have become available since August 1989 have caused experts to unofficially voice even higher estimates at subsequent meetings and workshops.

discharged waste water is treated, it often contains high levels of heavy metals and other potentially toxic contaminants (MAB, 1990). There is also a major problem in the Caribbean region with sewage effluent. Most countries in the Caribbean Region dispose of sewage directly or indirectly into coastal waters with little or no treatment (Archer; 1984, 1988).

Airborne deposition originating from LBS are also known to be a problem in the Wider Caribbean. Any major point source of airborne pollutants on a relatively small island is likely to deposit a substantial portion of its burden directly into the marine environment in short order.

In some islands, non-point sources pose a greater problem than point sources. Non-point sources of pollution are less easily identifiable, but their effects are equally as abusive. Over-sedimentation, nutrient over-enrichment, and toxic contamination of the marine environment, most often transported via storm runoff, are major threats to the integrity of the marine ecosystem.

Topsoil containing pesticides and fertilizers erode with no set pattern into the coastal waters, while poorly engineered and located solid waste disposal sites leach additional toxic burden threatening sea grasses, coral reefs, fisheries, and at the end of the food chain, local populations (MAB, 1990). In some instances, disposal is taking place direct to the sea, or resulting in de facto filling of wetland areas. Massive erosion is causing siltation and turbidity in both inland and coastal waters, depleting fresh water and damaging mangrove forests, savannahs and other fragile coastal environments. This results not only from erosion of farmlands and beaches, but from the progressive destruction of tropical forests in much of the region (Davidson, 1990)

3.0 The Physical Basis for LBS (and Other Marine Pollution) as a Wider Caribbean Regional Problem

Anyone whose only experience of the Caribbean is skin-diving as a tourist in the crystal clear waters off the Cayman Islands and similar sites would find it hard to believe that there is any LBS problem in the Caribbean, or any other marine pollution problem in the region, unless they were to compare the quality of coral reef systems over the time-span of a decade. Similarly, it is not likely to be obvious to non-oceanographers/meteorologists that marine pollution originating in the north eastern coastal areas of South America might have significant impacts on the marine pollution levels of the Gulf of Mexico. The truth of the matter is that the Caribbean island areas do have significant marine pollution problems, only some of which are of their own making, and pollution sources as far away

as South America are significantly impacting the coasts of Florida and the entire Gulf of Mexico.

The key to understanding this is the nature of the prevailing meteorological patterns, and more importantly, the nature of the ocean circulation in the region, both of which intimately link the countries of the Wider Caribbean in matters regarding the marine environment. The major flow of surface water (and marine pollutants) is from the southeast to the northwest. The surface flow patterns are dominated by the major surface current systems, which move large volumes of water very quickly through the region. The ocean "boundary currents" flowing from the mid-Atlantic, enter the southeast portion of the Wider Caribbean through the lesser Antilles and past the north coast of South America, flowing through the major basin of the Caribbean (Wust, 1964). The 1991 oil spill in international waters near St. Kitts illustrated the dominant northwestern flow pattern, as most of the islands to the west of St. Kitts as far as Puerto Rico were affected.

The flow then splits into two main streams. One stream flows into the Gulf of Mexico, and provides the so-called eddy or loop current during those seasons when flow remains as an intact boundary current. Seasonal loop currents also form in the Gulf of Panama, bringing strong flow along the coast of Central America. The second main stream of the boundary current system forms the Gulf Stream, which dominates the coastal flow along the U.S. eastern coast.

Strong, adverse wind patterns, such as the major hurricane systems, dominate the region on a seasonal basis. These wind systems can carry large volumes of airborne contaminants across several national boundaries in a matter of hours, while strong marine currents can carry large volumes of marine pollutants through the region in a matter of days (MAB, 1990). Another characteristic of the deep ocean areas of the Wider Caribbean is the lack of renewal or flushing (Atwood, 1977). Large masses of deep ocean water tend to concentrate pollutants for long periods of time, causing damage to resident ecosystems. These concentrated pollutants also pose the threat of eventually reaching the surface in large amounts during storm seasons, for example (Archer, 1988a,b). Another example of the role played by large scale wind fields is offered by the Trade Winds which carry dust from the Sahara Desert as far as the Caribbean in sufficient quantities to affect the background levels of particulates once or twice a year.

4.0 LBS Effects in the Wider Caribbean

LBS threaten the capacity of the oceans to support life and to recycle or neutralize natural and anthropogenic products and

emissions. For example, the oceans are believed to have absorbed up to one half of the total carbon dioxide emissions of about 200 years of the industrial revolution.

For the coastal and island environments, nutrient over-enrichment, toxic substances and pesticides contamination contribute to habitat degradation, water supply contamination and public health problems. The coral reef, seagrass and mangrove systems are especially vulnerable to LBS pollution. Coral reefs exist in delicately balanced physical/chemical systems. The depletion of oxygen caused by increased biological oxygen demand (BOD), associated with selected categories of LBS, has caused mass mortalities due to asphyxiation of fauna. Moreover, suspended sediment reduces light penetration, in turn causing major shifts in biotic communities or the degradation of coral communities.

Pesticides, used properly, have benefits in the non-marine environment. However, pesticides that have bio-accumulated and untreated sewage containing pathogens may both affect marine biota or be transmitted through fishery resources to humans. Many types of LBS (e.g., pesticides and toxic waste) also pose serious human health and ecological hazards. The problem is engendered even before entry into the marine environment, through contamination of fresh water supplies used for drinking, washing and agriculture and through early entry into the land-based component of the food chain via crops, dairy products and meat products.

In a technical paper delivered at a regional coastal zone management workshop, Chow (1985) reports that sewage and other pollutants are causing stress on the fringing reefs around Barbados and that heavy algal growth on coral reefs and dense solid waste litter on the nearby ocean floor are appearing in areas of the ocean exposed to similar conditions around Jamaica. Oceanographic experts have expressed concerns that this outflow of untreated sewage from land-areas into the marine environment, then cascading down into the deeper waters surrounding island nations in the Caribbean is causing oxygen depleted waters to develop at various depths. A serious concern is that these deeper oxygen depleted oceanic layers (which can involve substantial masses of water) have the potential of re-emerging at the surface from storm effects, upwellings and changing seasonal meteorology, with resulting environmental impacts on tourism, public health, fisheries and beaches (Archer, 1988a; Davidson, 1990).

These problems would be compounded by any general rise in global sea levels resulting from global warming due the greenhouse effect. Contaminated waters would intrude further inland, threaten aquifers and add stress on mangroves, corals, beaches, compound storm effects and accelerate erosion.

5.0 Technical Studies and Reports

The literature that exists on the general subject of LBS problems in the Wider Caribbean for the most part is not to be found in formal scientific journals or other readily available sources. Rather, it is mostly contained in special governmental, multilateral and non-governmental publications of organizations such as UNEP, AID, CARICOM, PAHO, MAB, EPA and Greenpeace. These publications record the results of surveys and studies undertaken and/or funded by these organizations or workshops and meetings of experts sponsored by them.

A UNEP/CARICOM (Caribbean Community) study (UNEP, 1984) was undertaken in 1984 "because of the overabundant evidence of pollution in the Caribbean Sea (mainly from land-based sources); and because of detrimental effects of the numerous pollution sources on coastal ecosystems (particularly fisheries and coral reefs), which form a protective barrier to coastlines and coastal property, and on the amenities providing marine recreational activity for tourist industries" vital to financial viability of most of the Caribbean islands. An inventory of pollutants and their sources, by individual country throughout the Wider Caribbean, was prepared under Pan American Health Organization (PAHO) sponsorship, which identified adverse impacts to ecosystems and public health (Archer,1984). An additional report by Archer prepared for PAHO is in two volumes (Archer 1988a, 1988b), and focuses upon sewage problems in the Eastern Caribbean, based on surveys there in 1987 and 1988.

In 1989, countries prepared national reports on environmental priorities in the Caribbean for UNEP. EPA, with input from the National Oceanic and Atmospheric Administration (NOAA), prepared the US national report contribution to this UNEP effort (EPA, 1989), entitled "U.S. National Report on Environmental Priorities in the Caribbean." Additionally, the EPA Office of International Activities (OIA) funded a study in 1989 on land-based sources of marine pollution in the Caribbean, which surveyed 34 nations. The study report (Betz, 1990), evaluates the political, economic, social and legal infrastructure in the region to support LBS protocol development. An additional report, in draft (UNEP, 1989), was prepared by an non-governmental organization (NGO) for UNEP, entitled "Inventory of Types and Sources of Marine Pollution in the Wider Caribbean Region, Including Factors Affecting Marine Environmental Quality." UNEP also published a Regional Seas document in 1990, Report 121, prepared with Greenpeace and titled "Environmental Assessment of the Wider Caribbean Region" (Davidson, 1990).

The U.S. Department of State published a report (MAB, 1990) entitled "Land-Based Sources of Marine Pollution in the Wider Caribbean Region" as a result of the technical meeting hosted by

Man and the Biosphere (MAB) in August 1989. EPA was represented at this meeting through the Director of the Gulf of Mexico Program and the Director of the EPA CAribbean Field Office. Four key sections of this report, prepared by regional experts, cover the following topics: 1) Inventory of Land-Based Sources of Marine Pollution, 2) Impact of Land-Based Sources of Marine Pollution, 3) Development of Tropical Water Quality and Effluent Standards, 4) Marine Pollution Control Strategy.

6.0 Technical Data

As late as August, 1989, it was reported at the MAB Workshop in San Juan, Puerto Rico (MAB, 1990) that there is "virtually no information on the physical and chemical characteristics of the streams and coastal waters in the Region, except for data obtained in the most developed countries." The physical data sets that are lacking include such basic quantities as water depths, stream flow velocities, seasonal sediment loads, marine currents velocities, coastal wave data, tidal ranges, sea level changes and littoral drift. The situation for microbiological data is similar. This makes it very difficult to conduct comprehensive analyses, and explains why the recognition of the importance of the LBS problem came rather recently (since about 1983 and the signing of the Cartagena Convention). It should be noted however, that the both effects of LBS in the marine environment and the sources of the pollution are both evident and documented, as is discussed below.

Some efforts have been made recently, with UNEP, EPA and NOAA involvement, to move toward regional monitoring of both the water medium and major known LBS sites. However, progress is slow. Most of the effort through 1992 will be at the experts meeting and workshop level. Actual monitoring programs for many ambient physical, chemical and biological parameters are still some ways off.

The recognition of the LBS problem in the Caribbean is largely a result of country-by-country studies conducted in the 1980's. The information from these surveys served to piece together a picture of the extent of the source problem as well as the range of the related impacts. The study conducted by Archer (1984) provided estimates of specific source pollution discharges and related these to clearly observable environmental effects. Specific examples of coastal and marine ecosystems vital to coastal fisheries that have sustained damage largely attributable to identified sources of uncontrolled disposal of industrial waste and sewage follow[4]:

[4]All of the quoted examples are from Archer (1984).

- "The discharge of oil waste into the mangrove system at McKinnon's Salt Pond and ultimately into the adjacent coral reef structure off St. Johns in Northwest Antigua,"

- "Cane sugar production waste and sewage effluents that have destroyed the mangroves at Fitches Creek northeast of Antiqua, and coral reef structures off Basseterre Harbour, St. Kitts,.... suspected damage to coral reefs and shoal 2 km offshore from Fitches Creek,"

- "The oil waste pollution from oil refining industry into the Gulf of Paria on the west of Trinidad, mixed with toxic industrial waste and sewage effluents from the Caroni Swamps, has damaged fisheries and poses public health problems in adjacent coastal waters and beaches,"

- "Untreated sewage and excreta disposal in coastal shallows off some islands of the Bahamas (e.g., off north Andros), have all but destroyed the sponge industry as well as some mangrove systems,"

- "The discharge of numerous marine outfalls from septic tank and package sewage treatment plants are causing damage to coral reefs off the south, southwest, and west coasts of Barbados with diminishing effects on reef-fish propagation, and erosion of some reefs that form barriers to the destructive effect of wave action on beaches and sea-front property."

- "In countries such as St. Kitts-Nevis with serious soil erosion problems with their friable loose volcanic soils, heavy loads of soils laden with pesticides and other agricultural chemicals used in crop production are swept into the sea and on to the reefs and marine benthic systems,"

- "In the Windward Islands in the South Caribbean Antillean chain, fungicides, nematocides, and other pest controlling agents used in the production of bananas reach the coastal and marine environment via rivers and streams,"

- "Some urban centers have old collection systems that are now inadequate to cope with population growth and industrial development. These systems generally have no treatment capability; they discharge crude sewage into harbors and coastal areas.... Examples of such systems can be found in Castries, Saint Lucia, St. Georges, and Grenada."

- "In several of the countries studied (e.g., Barbados, Bahamas, Belize, Montserrat and parts of Trinidad and Tobago), the subsurface disposal of sewage poses threats to potable ground water supplies and public health."

The accumulating evidence from detailed country-by-country surveys, such as the PAHO study cited above (Archer, 1984), have caused the regional experts to conclude that the total range of LBS problems contributes to upwards of 90% of the marine and coastal pollution problems in the Caribbean. As detailed inventories are constructed and more environmental observations are made, this picture will be further refined and quantified.

It should be noted that even in Puerto Rico, which is U.S. territory and where more data of all kinds are generally available, only 60% of the population is served by a sanitation sewage system. The situation for Puerto Rico is summarized in the table on "Goals and Progress of State-wide Water Quality Planning for Puerto Rico - Fiscal Year 1988-1989" provided in the Appendix.

The major findings of the 1990 UNEP Regional Seas study, Report 121, cited in the previous section are:

- Major flow of ocean surface water is from southeast to northwest, into the Gulf of Mexico from the Caribbean Sea,
- The Worldwatch population estimate for 1988 is two hundred million, and an additional transient population of ten million tourists annually, with less than 10% of this population in the Caribbean Basin being served by any form of sewage treatment (from a NOAA study),
- Run-off of agricultural chemicals is estimated at more than one billion pounds per year,
- Coastal ecosystems near industrialized areas have substantial concentrations of heavy metal contamination (based on a 1987 UNEP finding),
- Petroleum pollution (estimated as mainly from land-based sources), as floating tar and dissolved or dispersed petroleum hydrocarbons, is severe and endangers sea turtles and fish from causally related declines in reproduction (from a Caripol 1980 study).

7.0 Approaches for Addressing The Problem

The countries of the Wider Caribbean represent a very wide range of economic development and application of environmental

protective measures. The United States as the most industrially advanced and populous country in the region has had to confront the problem of LBS and other pollution sources sooner than most of the other countries. However, its early industrialization and traditional sensitivity to public health issues has also generally caused it to undertake early development of a basic public health infrastructure consisting of sewage systems, water treatment and trash disposal approaches that have avoided or minimized some of the problems now widespread among many of the other countries of the region.

Nevertheless, the LBS related problems in the Gulf of Mexico remain serious, as they do for Puerto Rico and the U.S. Virgin Islands. Moreover, as noted in UNEP Report 121, cited in the previous section, the common ocean currents systems of the Wider Caribbean (mainly the Loop Current) tend to circulate pollutants from the north coast of South America, the Caribbean coast of Latin America, past the Island countries and Puerto Rico, and into the Gulf of Mexico and around Florida.

As a result, U.S. Gulf Coast states are directly in the path of this common pollution stream. For example, Texas has been making a major effort to address their local Gulf coastal pollution problems, but has found these local efforts are being limited by the imported pollution levels (particularly in the form of marine debris) from the Caribbean. The Gulf of Mexico Program (GOMP) and individual U.S. Gulf Coast states, such as Texas, are actively urging the Department of State to assist in addressing the problem on a multinational basis.

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APPENDIX

Goals and Progress of State-Wide Water Quality Planning for Puerto Rico

Fiscal Year 1988-1989

GOALS AND PROGRESS OF STATEWIDE WATER QUALITY PLANNING FOR PUERTO RICO - FISCAL YEAR 1988-89

		DESIGNATED USES SUPPORT		ATTAINMENT OF CWA GOALS				
	Bodies of Water	Designated Use Support		Fishable Goal		Swimmable Goal		
		(Miles)	(Percent)	(Miles)	(Percent)	(Miles)	(Percent)	
I.	RIVERS:							
	Size Fully Supporting	2,077.70	38.0	2,756.90	51.3	2,738.40	50.9	Size Meeting
	Size Threatened	567.70	11.0	2,048.20	38.1	1,736.80	32.4	Size Partially Meeting
	Size Partialy Support	1,207.20	23.0	565.80	10.5	482.80	8.9	Size Not Meeting
	Size Not Supporting	1,520.60	28.0	2.30	0.1	415.20	7.8	Size Not Attainable
	Total Rivers	5,373.20	100.0	5,373.20	100.0	5,373.20	100.0	Total Rivers
II.	ESTUARIES:							
	Size Fully Supporting	14.70	8.3	95.1	53.9	64.2	36.4	Size Meeting
	Size Threatened	14.40	8.2	61.1	34.7	49.2	27.9	Size Partially Meeting
	Size Partially Support	99.50	56.4	20.1	11.4	34.1	19.4	Size Not Meeting
	Size Not Supporting	47.70	27.1	-	-	28.8	16.3	Size Not Attainable
	Total Estuaries	176.30	100.0	176.30	100.0	176.30	100.0	Total Estuaries
III.	COASTS:							
	Size Fully Supporting	252.10	58.0	318.70	73.4	238.00	54.8	Size Meeting
	Size Threatened	38.40	9.0	88.50	20.4	60.40	13.9	Size Partially Meeting
	Size Partially Support	74.40	17.0	23.20	5.4	40.70	9.4	Size Not Meeting
	Size Not Supporting	69.10	16.0	3.60	0.8	94.90	21.9	Size Not Attainable
	Total Coasts	434.00	100.00	434.0	100.0	430.00	100.0	Total Coasts
IV.	LAKES/LAGOONS:	(Acres)	(Percent)	(Acres)	(Percent)	(Acres)	(Percent)	
	Size Fully Supporting	3,033.00	31.0	7,627.00	68.0	6,791.0	61.0	Size Meeting
	Size Threatened	112.00	1.0	1,124.00	10.0	1,960.0	17.0	Size Partially Meeting
	Size Partially Support	3,538.00	32.1	2,395.00	22.0	2,395.0	22.0	Size Not Meeting
	Size Not Supporting	4,033.00	35.9	-	-	-	-	Size Not Attainable
	Total Lakes/Lagoon	11,146.00	100.0	11,146.00	100.0	11,146.00	100.0	Total Lakes/Lagoons