A GENERATION OF PROGRESS IN SANITARY ENGINEERING FACILITIES AND SERVICES FOR LATIN AMERICAN AND CARIBBEAN COUNTRIES[1]

Abel Wolman, M.D.;[2] Mark D. Hollis, M.D.;[3] and Charles S. Pineo, B.S.[4]

Latin American and Caribbean countries have made tremendous strides in sanitary engineering over the past 25 years. Yet a review of this progress shows that much of it has been absorbed by rapid population growth. Thus, strong efforts now in process must continue (or grow even stronger) if an increasingly large share of the people is to be served.

Relative to the age of man, 25 years is but a moment. In human history, however, a quarter of a century is a reasonable unit of measure for calibrating progress or change. The Twelfth Congress of the Inter-American Association of Sanitary Engineering in Caracas, Venezuela, held from 23 to 29 August 1970, offered a reasonable opportunity for retrospective appraisal of progress in this part of the world. Since community water supply and sewerage have priority in any general sanitation program, these systems have been used as the main parameters. Workers in public health in general, and in sanitary engineering in particular, have long been aware that proper construction and operation of these systems dramatically reduce the incidence and frequency of disease and also contribute significantly, if indirectly, to economic and social development. It is still true that "... armies have fought over water, people have died from it, civilizations have dwindled after losing it, health workers have blessed it, and monarchs and priests have worshipped it."[5]

Therefore, this review is devoted to: reasonably detailed assessment of the present status of these sanitary facilities in certain parts of the Western Hemisphere; diagnosis of the striking causes for progress in some regions and failure in others; and prognosis of the deficiencies yet to be met, the financial requirements in prospect, and the opportunities for expanding engineering endeavors in emerging environmental fields.

Contributing Factors

A number of circumstances, both internal and external, have contributed to the unprecedented expansion of sanitary engineering activities in certain regions during the past quarter of a century. Among these influences were the following:

1) In 1902 the International Sanitary Bureau was established. It was renamed the Pan American Sanitary Bureau (PASB) in 1924 and expanded to the Pan American Health Organization (PAHO) in 1947. It was then designated the Regional Office of the World Health Organization for the Americas, to provide advisory services to the Governments in three broad areas: (a) eradication and control of communicable diseases; (b) strengthening of health services; and (c) education and training activities.

2) Starting in 1913, the Rockefeller Foundation began cooperating actively with various Governments in developing stable organizations (within the governmental structures) dedicated to promotion of health and prevention of disease.

3) Events of World War II led to organization of the Institute of Inter-American

---

[1]Updated version of the article published in Spanish in *Boletín de la Oficina Sanitaria Panamericana*, Vol. LXXI, No. 3 (September 1971), pp. 194-214.

[2]Professor Emeritus of Sanitary Engineering and Water Resources, Johns Hopkins University, Baltimore, Md., U.S.A.

[3]Chief, Department of Engineering and Environmental Sciences, PAHO/WHO.

[4]Sanitary Engineering Consultant to PAHO/WHO.

[5]Presentation by Dr. Abel Wolman at the XVII World Health Assembly of the World Health Organization; Geneva, Switzerland; March 1964.

Affairs (IIAA) by the United States of America and to emergence of cooperative units known as *servicios*, which placed emphasis on public health, environmental sanitation, and sanitary engineering (as well as on agriculture, education, and transportation).

4) The Inter-American Association of Sanitary Engineering (AIDIS) was organized in 1946; this agency holds biannual congresses, produces its own technical journal, maintains sections in each country of the Region, and boasts a membership of more than 2,000 sanitary engineers.

5) Well-organized courses in civil engineering and other fields basic to the preparation of sanitary engineers have been made available by Latin American universities.

6) Scholarships for graduate education in sanitary engineering and other fields have been generously provided by the Rockefeller Foundation, the IIAA and its successor agencies, the Pan American Health Organization, and other organizations.

7) Courses for education in sanitary engineering in Latin America have been expanded at both undergraduate and graduate levels. A notable feature of this expansion was development of the Regional Graduate School of Sanitary Engineering for Central America.

8) Special courses were instituted outside of Latin America that were organized specifically to meet the needs of sanitary engineers in the developing countries.

9) Short courses were organized in a network of universities throughout the Western Hemisphere, to provide continuing education in the rapidly changing sanitary engineering field.

10) Sanitary engineering consulting firms were gradually incorporated in most Latin American and Caribbean countries; some were working only within the borders of their own country, while others provided consultation throughout the Region and even worldwide.

11) National and international agencies employed sanitary engineers on both long- and short-term assignments to take advantage of their training and extend the scope of their experience.

12) The Advisory Committee on Environmental Sanitation, established by the Director of the Pan American Sanitary Bureau in 1958, reached unanimous agreement that the best method for reducing disease and accelerating the rhythm of economic development was by concentrating on extension and improvement of water supply systems, with second priority assigned to provision of sewage disposal facilities.

13) In signing the Charter of Punta del Este in 1961, the Governments of Latin America set themselves specific and ambitious goals for water supply and sewage disposal during the decade of 1961-1971.

14) In 1961, the Inter-American Development Bank added the Social Progress Trust Fund to its Ordinary Capital Fund and the Fund for Special Operations. The Trust Fund, established through agreement with the United States of America, was set up to finance social development projects in four specific fields, including community sanitation and water supply. Actually, the first loan made by the IDB from its Ordinary Capital (approved in February 1961) was for expansion and improvement of the water supply and sewerage systems of Arequipa, Peru.

15) Sanitary engineering interests grew logically from responsibility for design and construction of environmental sanitation projects to participation in organization and management of these facilities as community or regional systems.

16) There was recognition of the need for efficient utilization of existing water resources, and for planning the development of river basins on a multinational basis when necessary.

17) There was active participation in planning and carrying out programs for water quality control.

18) Industrial cooperation assisted in local development of materials and equipment essential to the construction, maintenance, and operation of water and sewarage facilities.

Population Patterns

The latest estimates of the demographers give tropical America the dubious distinction of having the fastest-growing populations in the world. The annual rate of growth for the region south of the United States of America, between 1930 and 1965, was close to 2.5 per cent. At this rate, a population doubles in less than 29 years. Continuation of the present pace of growth would give the region a rate in excess of 3.5 per cent, which would double the population in 20 years and triple it in only 31 years. Especially significant from a public health point of view is that the area's urban population is increasing at an even higher rate, probably more than 5 per cent per year.

Against this background, let us consider

Top: Child drinking from pump in a rural village.
Bottom left: Laying pipe for a water supply system.
Bottom right: Excavation of ditches for sewerage.

what the public health and environmental sanitation situation was in 1937. In that year the population of the Latin American and Caribbean countries was estimated at 122 million. This was divided between 46 million urban inhabitants (38 per cent) and 76 million rural dwellers (62 per cent)–considering communities with fewer than 2,000 people as rural. There were four cities with over one million people.

In 1965, the area's total population was 248 million. Nevertheless, in this period diseases ordinarily associated with unsanitary environmental conditions–diarrheal diseases, gastritis, and enteritis, particularly in children under four years of age–were principal causes of death in practically all of these countries.

In 1940 the Pan American Health Organization had three sanitary engineers working throughout the region. The Director, in his report to the XI Pan American Sanitary Conference in September 1942, devoted the following paragraph to water supplies:

> One of the most pleasing aspects of public health development in recent years has been the increasing attention devoted to water supplies. The Bureau itself has found the services of its sanitary engineers increasingly called upon in connection with the extension and improvement of these essential facilities, and also with those of sewage disposal. In reference to this matter, mention may be made of a recent happening of potentially great defense importance, namely, the adoption (in Costa Rica) of a law placing all water supplies under the control of the National Department of Health. In these days when every point of the Hemisphere is of importance from the military point of view, however undeveloped commercially, the authority to bring national support and direction to the improvement of such essential services in even the smallest towns becomes a matter of primary concern.[6]

A number of the public health agencies had environmental sanitation departments, and several had sanitary engineers on their staffs. The Rockefeller Foundation, working with public health agencies, had begun to stimulate interest in the further development of such departments and in the role of the sanitary engineer. By 1940, the Foundation had already provided scholarships for graduate study to 30 sanitary engineers from Latin America.

The Foundation's work had an important influence on establishment, in 1940, of the first formal agency of the Government of the United States of America for overseas technical assistance. This was the Office of Inter-American Affairs, later to be named The Institute of Inter-American Affairs (IIAA). Mr. Nelson Rockefeller was the first coordinator.

At the same time, International lending agencies showed growing interest in making loans for water supply construction in Latin America. At the request of the Export-Import Bank in 1940, arrangements were made for a United States Public Health Service sanitary engineer to work with a sanitary engineer from PAHO on a complete study of the Guayaquil and Quito water supply systems. Full reports, with recommendations and estimates for each of the projects, were submitted in 1941, and loans of $5.3 and $4.0 million, respectively, were made in April 1942.

Some of the universities in the area were already stressing sanitary engineering subjects as part of their courses in civil engineering, and others were studying the possibility of setting up special courses in sanitary engineering. In 1941, one PAHO sanitary engineer prepared an outline for a sanitary engineering course at the request of the Engineering School of Peru.

Thus, by the early 1940's the stage was set for the sanitary engineering activities which have contributed so much to Latin America's economic and social development during the past quarter of a century. The need for improving environmental sanitation conditions was apparent and understood throughout the region. A nucleus of sanitary engineers had been trained. The basic methods for international and bilateral cooperative programs, introduced by the Rockefeller Foundation, were modified and adapted to changing needs. The initial administrative procedures and regulations of PAHO and IIAA (including the latter's successor agencies) had been laid down, and international financing was starting to become available.

[6] XI Pan American Sanitary Conference, 1942.

Since then, however, the population has grown at a rate unforeseen in 1940, or even 1960, producing the prediction gap shown:

	Population (in millions) Urban	Rural	Total
1971 population estimated in 1961	149.0	130.8	279.8
1971 population estimated in 1967	158.3	128.1	286.4
Population in 1961	101.6	107.0	208.6
Population in 1971	164	127	291

The population predictions made in 1961 for 1971 were substantially exceeded. This necessitated considerable modification of plans to meet needs for water supplies, sewerage services, and other facilities.

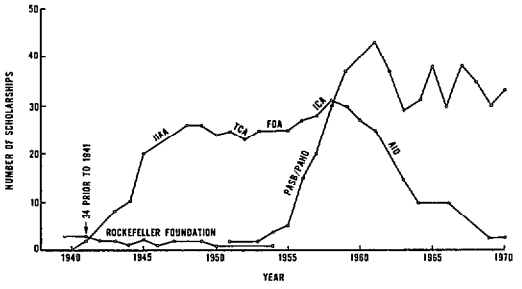
Education and Training

Fortunately, it was realized many years ago that provision of sufficient health services to meet upward-spiralling needs would require expansion of both facilities and manpower resources. The education and training of this manpower was given early and continuing emphasis by the countries and the technical assistance agencies cooperating with them.

Over 40 years ago, the Rockefeller Foundation determined that a program of sanitary engineering fellowships would make a most valuable contribution to improving environmental sanitation. By 1954, when the Foundation program had been phased out, it had provided scholarships for 54 academic courses in sanitary engineering to engineers from 14 Latin American countries.

The emphasis has been continued by PAHO/WHO and the Agency for International Development (AID)—the latter continuing the work of IIAA. It is conservatively estimated that AID and IIAA sponsored graduate education for more than 500 sanitary engineers from Latin America, and that PAHO/WHO has sponsored nearly the same number. IIAA's scholarship program for sanitary engineers started in 1942, reached a peak in 1955-1960, and tapered off as the agency's emphasis shifted from technical assistance to economic development. On the other hand, PAHO began to provide a number of fellowships soon after it started to increase its sanitary engineering services in 1953. These fellowships have built up to an annual average of between 30 and 40, which is still maintained. (Figure 1 depicts the academic scholarships provided by international agencies for sanitary engineers in Latin America.)

FIGURE 1—Academic scholarships in sanitary engineering.



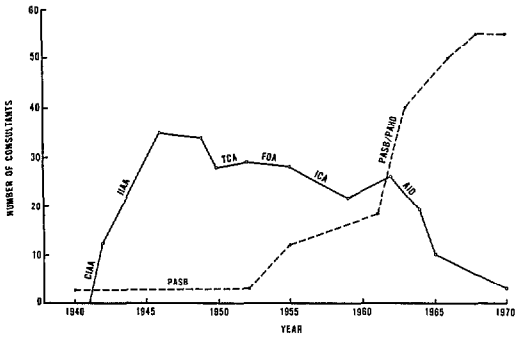
This total of over 1,000 scholarships, supplemented by others from national agencies and other organizations, has helped create the large corps of well-trained sanitary engineers that has contributed so much to the growth of sanitary engineering projects and education in the Region.

International Consultants

A major contribution of the international and bilateral agencies' technical assistance programs has been providing these scholarships, assisting in selection of candidates, and preparing accepted candidates for graduate study—usually outside their own countries and frequently outside the Region. Responsibility for this process has been one of the many duties of the sanitary engineering consultants assigned by these agencies to the various countries.

Figure 2 shows the number of sanitary engineering consultants assigned by PAHO/WHO and IIAA-AID from 1940 to the present time. As AID policy has changed and

FIGURE 2–International sanitary engineering consultants assigned in Latin America.



the use of sanitary engineering consultants has decreased, PAHO has increased the number of its consultants. Whereas IIAA-AID had at least one sanitary engineering consultant, and sometimes more, assigned in most of the countries in Latin America from about 1943 to 1963, PAHO had only a few for the whole Region. The situation now has been reversed; PAHO has one or more sanitary engineering consultants in each of the countries and AID has practically none. Some of the AID engineers are still working in the Region, but as engineers on economic development projects who are not specifically assigned, as formerly, to sanitary engineering programs.

The Inter-American Association of Sanitary Engineering

The Inter-American Association of Sanitary Engineering grew out of a small meeting of sanitary engineers called by the Pan American Health Organization and the Institute of Inter-American Affairs in 1942. The participants agreed there was need for and much interest in a Pan American organization for promoting sanitary engineering activities, including education, in the Region. That October they presented a recommendation that such a unit be created. Enough interest and support were obtained so that in June 1946 the first conference was held in Rio de Janeiro; it was attended by 203 persons from Argentina, Bolivia, Brazil, Chile, Paraguay, Peru, the United States of America, and Venezuela. Three committees were set up to develop objectives and establish organizational and administrative procedures. In September 1946 a second conference was held in Caracas, Venezuela, with 200 delegates from Colombia, Costa Rica, Cuba, the Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Mexico, Nicaragua, Panama, the United States of America, and Venezuela.

By 1948, when the First Congress was held in Santiago, Chile, the Association had 1,186 active members, including both sanitary engineers and members of allied professions. Twelve countries had organized national chapters. The Second Congress of the Association, held in Mexico City in 1950, was attended by 241 delegates and two observers.

Institute of Inter-American Affairs

Establishment of the IIAA by the United States of America in 1942 was one of the important milestones in the development of sanitary engineering in Latin America. Water supply and other environmental sanitation activities were an important part of the agency's health programs. Agreements establishing these cooperative health programs were formulated during a meeting of the 21 Ministers of Foreign Affairs at Rio de Janeiro in January 1942. Shortly afterward, health and sanitation field parties were set up in a number of the countries at the latters' invitation; cooperative health activities were underway in most countries of the Region within a year.

The basic field party usually consisted of a public health doctor assisted by a sanitary engineer, public health nurse, business manager, and often a health educator and sanitarian. Field operations were conducted through a cooperative unit, generally called the *servicio*, in the Ministry of Public Health. While the *servicio* was a part of the Ministry, it had considerable autonomy. It usually had an IIAA director (the public health doctor or the sanitary engineer) and a national co-director. It employed its own personnel (nationals of the country), set its own salary scales, and was financed through a joint fund provided by IIAA

and the cooperating Government. As domestic counterparts acquired sufficient skill and experience, United States IIAA personnel gave them executive responsibility and thereafter served only as consultants to the program.

Many recipients of IIAA scholarships were *servicio* employees who received on-the-job training in the *servicio*, got their graduate training through the scholarship program, and returned to positions in the *servicio*. Ex-*servicio* employees currently hold responsible positions both in and outside their Governments. Many are working with international organizations, particularly the World Health Organization and the Inter-American Development Bank.

Through the cooperative efforts of the *servicios*, many water supply and sewerage systems, public markets, small slaughterhouses, health centers, and other health facilities have been built. Wells have been dug or drilled; thousands of sanitary privies have been built and installed; training programs have been expanded. (Although reference is only made here to the *servicio's* sanitary engineering and environmental sanitation activities, extensive work was carried out in all areas of public health.)

The *servicios* were characterized by flexibility and a minimum of paperwork. As a device for getting things done in a critical period and under adverse conditions, they were most effective. However, times and conditions change, and none of the *servicios* exist today in their original form. Most have been absorbed by the national health ministries, where they retain varying degrees of autonomy.

In addition to cooperating with the Latin American countries inside their borders, through the *servicios* and more recently through AID missions, AID has also provided a number of programs organized in the United States of America for all developing countries. A number of these have been arranged specifically to meet the needs of sanitary engineers. They include:

a) The ground water development course conducted in cooperation with the School of Public Health of the University of Minnesota every year since 1959. This course has been attended by over 300 students from 55 countries. The program consists of classroom work and lectures supplemented by field work to develop a knowledge of the basic techniques necessary for planning and supervising well-drilling and ground water development operations.

b) A special course, developed at the University of Akron, Ohio, for engineering management of water supplies, initiated in 1961. It has been attended by over 100 participants from 36 countries. The course objective is to train engineers and officials in operation and maintenance of water supply systems.

c) The International Program in Sanitary Engineering Design, originated at the University of North Carolina in 1962 to provide both academic and practical opportunities for sanitary engineers in the developing countries. It is a unique educational venture which is staffed, equipped, and planned to meet the participants' specific needs. In addition to intensive academic work, the program provides each student with practical on-the-job experience in first-rate municipal and consulting engineering organizations, under continuing university supervision. This direct exposure to engineering organizations and procedures is perhaps as important to the participant as his engineering training. Nearly 75 participants from 24 different countries have attended this course.

Each of these courses has been "exported" to Latin American countries, as well as to other parts of the world. The first and second have been adopted in Colombia and the third has gone to Peru.

AID's Regional Office for Central America and Panama (ROCAP) and the University of North Carolina have assisted in development of the Regional Graduate School of Sanitary Engineering at the University of San Carlos in Guatemala; the Pan American Health Organization, the World Health Organization, and other agencies have provided scholarships. The school, established in 1965, was specifically designed to meet the Region's needs in preparing sanitary engineers. Over 50 students have participated in this course since its inception in 1965.

The Pan American Sanitary Bureau

As Figure 2 shows, the Pan American Sanitary Bureau maintained two or three sanitary engineers on its staff until about 1953, when it gradually began expanding its sanitary engineering activities at the request of national governments. By 1961, when the Charter of Punta del Este stimulated community water supply and sewerage programs, it had nearly as many sanitary engineering consultants working in Latin America as did AID. Over the past decade, mounting numbers of assistance requests were prompted by increased emphasis on water supply and sewage disposal activities, and by growing interest and concern about more complex problems of water quality control, development of multi-purpose use of water resources, and environmental sanitation. In an effort to keep up with these requests, the Organization has expanded its sanitary engineering staff to more than 50 members. Table 1 shows the variety of consultations provided by PAHO during 1971. The staff members' activities have been supplemented by the services of short-term consultants, called in to assist with problems not usually handled by the regular staff. Recently, this work by short-term consultants has grown to between 70 and 80 man-months per year; individual assignments range from a week to three months in length.

In recent years, two major PAHO contributions to sanitary engineering activities have been development of: (a) group consultation for helping to improve the administration and management of water supply and sewage disposal facilities, and (b) short courses operating through a network of universities to provide continuing adult education in the expanding sanitary engineering field.

The use of group advisory services was started in 1965 in Honduras. There it became evident, as the responsibilities of the Water Authority expanded, that assistance was required in modernizing the agency's administrative and management practices. Because of the number of departments and activities involved, the Organization responded to an assistance request by developing a team approach: consultation was provided by a group of experts, each one working with a Honduran agency counterpart in his specialty. This form of in-depth consultation proved so successful that it has been provided to numerous national agencies and has been requested by many more. Further proof of the efficacy of this type of assistance is the willingness of national agencies to finance it themselves, either from their own budgets or from a loan for an expansion program.

These group advisory services have been aimed at reorganization and rationalization of public water supply and sewerage services. Economic and management criteria, and the policies, procedures, and practices necessary to facilitate attainment of institutional goals are all applied. The teams' activities are aimed at both operational and higher management levels; their goal is to analyze the existing situation, and to work out policies and procedures with personnel at these levels which the latter will put into effect. The teams' consultants are recruited almost exclusively from Latin America or the Caribbean, where they hold responsible positions in efficient, well-run utilities.

The entirely new concept of short courses for continuing adult education in the sanitary engineering field was introduced in 1963. Since then the number of short courses given has increased from four to between 65 and 70 per year. The courses, covering a variety of subjects and conducted by a network of 36 universities in 21 countries, serve about 1,800 participants each year. They include both refresher training and introduction to new skills or subjects, such as multi-purpose utilization of water resources and use of computers in solving sanitary engineering problems. The courses are supported by the universities themselves, by PAHO, and by several other agencies–including the Organization of American States and the Inter-American Development Bank.

The Inter-American Development Bank

Since 1961, the Inter-American Development Bank has provided 60 per cent of the

TABLE 1–Collaboration provided by PAHO in community water supply and other environmental activities (staff short-term consultants), 1971.

Type of services	Zone I							Zone II				Zone III							Zone IV				Zone V	Zone VI			
	Barbados	Guyana	Jamaica	Surinam	Trinidad and Tobago	West Indies	Venezuela	Cuba	Dominican Republic	Haiti	Mexico	British Honduras	Costa Rica	El Salvador	Guatemala	Honduras	Nicaragua	Panama	Bolivia	Colombia	Ecuador	Peru	Brasil	Argentina	Chile	Paraguay	Uruguay
COMMUNITY WATER SUPPLY																											
Water authorities—Organization or improvement	X	X		X	X	X	X		X	X			X			X	X	X	X	X	X	X	X	X	X	X	
Other agencies—Organization or improvement		X		X		X			X	X	X		X	X		X				X	X	X	X	X	X		
Water supply system—Design				X					X					X	X			X	X	X				X		X	
Organization and management	X	X		X	X	X			X	X	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X
Problems		X		X	X	X			X	X	X			X		X		X		X	X		X			X	X
Planning—National or regional			X	X	X	X			X	X				X				X	X	X	X	X	X	X	X	X	X
Water rates—Establishment or improvement				X	X	X			X		X							X		X		X	X	X		X	
Public relations				X		X			X		X		X									X				X	
Rural community water supply		X	X	X		X			X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Groundwater exploration, drilling				X					X	X			X	X		X	X	X	X	X						X	X
Community development, self-help									X	X				X		X	X	X		X			X	X		X	
Water quality control	X	X	X	X	X	X			X		X			X		X	X	X	X	X		X	X	X	X	X	
Water resources study			X	X		X			X	X								X		X	X				X		
Revolving fund mechanism									X	X				X					X				X	X		X	
Fluoridation	X		X	X	X	X					X		X	X			X	X	X	X		X	X		X		
Laboratories—Installation, operation		X		X		X			X	X	X			X			X		X	X		X	X		X	X	
Design standards, criteria—Development			X	X		X			X				X					X		X		X		X	X		
UNICEF projects				X		X	X							X		X	X		X	X	X	X	X		X	X	X
Financing—Method or loan request preparation				X	X				X		X			X	X	X				X					X	X	
OTHER ENVIRONMENTAL SANITATION																											
Ministry of health—Assistance	X	X	X	X		X	X		X	X	X		X	X	X	X	X	X	X	X	X	X	X		X	X	X
Sanitary engineering department—Assistance	X	X	X	X		X	X		X	X				X	X	X	X	X	X	X	X	X	X		X	X	
Environmental sanitation (miscellaneous)	X	X	X	X		X			X	X			X	X	X	X	X	X	X	X	X	X	X		X	X	X
Pollution control, sewage treatment, industrial waste	X		X	X		X					X			X		X		X		X	X	X	X		X	X	X
Privy program				X		X			X	X		X	X	X	X	X	X	X	X		X	X				X	
Oxidation ponds—Design and use											X			X		X		X	X	X	X		X	X	X	X	X
Solid waste, sanitary landfill	X	X	X	X		X								X		X		X	X	X	X	X	X		X		
Air pollution control			X				X				X		X	X	X			X	X	X	X	X	X	X			X
Industrial hygiene and radiation	X	X	X			X	X		X				X			X		X	X	X	X	X	X	X			X
Studies or surveys	X	X	X			X			X	X	X							X					X	X	X	X	
UNDP projects—Supervision or development		X		X			X		X		X					X	X			X		X	X		X		X
Sanitary engineering programs—Universities		X		X			X			X	X			X	X	X	X	X	X	X	X		X	X	X	X	X
Short courses—Organization or presentation	X		X		X	X	X		X		X		X	X	X	X	X	X	X		X	X	X	X	X	X	X
Courses—Sanitary inspectors		X	X						X			X		X	X			X	X	X	X			X	X	X	
Seminars, symposia		X			X						X		X		X			X	X	X	X		X	X	X	X	
Centers or institutes											X												X		X		
Manuals—Preparation			X		X		X		X		X			X		X		X	X	X	X		X	X	X	X	X

international financing for design and construction of community water supply and sewage disposal systems. The remaining 40 per cent has come from the Agency for International Development, The International Bank for Reconstruction and Development (World Bank), and the Export-Import Bank. The amounts of money made available by international lending agencies and recipient nations from 1961 through 1971 are summarized in Table 2.

TABLE 2–Summary data on the community water supply program in Latin America for the alliance decade, 1961-1971.*
(in millions of U.S. dollars)

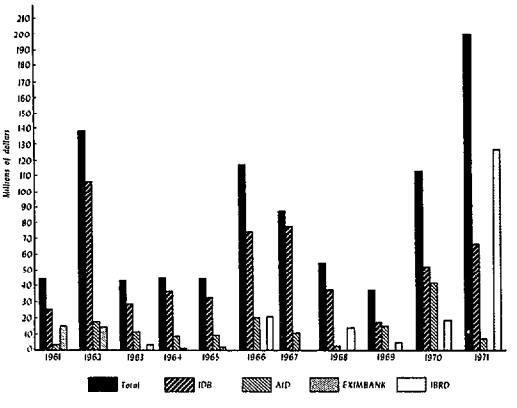
International loans from:	
Inter-American Development Bank (IDB)	553.45
Agency for International Development (AID)	147.36
International Development Association (IBRD)	188.80
Export-Import Bank (EXIMBANK)	30.51
Total international loans	920.12
National funds, including counterpart funds to support international loans	1,688.55
Total	2,608.67

*Includes both approved and signed loans.

These agencies' loans, which have totalled US$920 million since 1961, coupled with an unprecedented US$1,688 million assigned by the national Governments for water supply and sewerage systems, have provided the life blood for these programs. The funds allocated to each country by the international lending agencies are shown in Table 3, along with estimated national matching funds and additional national funds allocated for water supply and sewerage programs during the period. Further details are given in Figure 3.

The policies developed by the lending organizations in granting loans for water supply and sewerage systems have affected agencies requesting those loans. From the lending organizations' point of view an important consideration is that sufficient administrative, technical, and financial capacity must exist to assure that the project will be carried out properly and the systems operated efficiently. Sometimes this has meant that the agency responsible for carrying out the project or operating the systems has had to reorganize itself or improve its procedures. In many cases, the agencies concerned have taken advantage of the advisory services provided by PAHO's teams of consultants.

FIGURE 3–International loans for urban and rural water supply and sewerage systems in Latin America, 1961-1971.
(Millions of U.S. dollars)



Another important consideration for lending institutions involves water rates. These rates must at least cover the system's regular operating costs–including administration, maintenance, interest payments, and (as far as possible) depreciation.

In addition, all proposed projects must form part of the country's economic and social development plan; and any loan request must have the approval of the national planning agency or the Central Government. Every project should also form part of a master plan which takes account of future population growth.

The greatest cause of past delay in studying and granting loan requests was lack of well-formulated projects and suitable studies. Therefore, a guide for submission of loan requests was prepared by each of the lending insti-

TABLE 3–Funds allocated for construction of water supply and sewerage systems in Latin America.

(January 1961-December 1971)
(Amounts in thousands of U.S. dollars)

Country	International loans								Estimated national matching funds
	IDB		IBRD		AID		EXIMBANK		
	Water	Sewerage	Water	Sewerage	Water	Sewerage	Water	Sewerage	
Argentina	45,730	2,270	—	—	1,400	—	—	—	56,030
Barbados	—	150	—	—	—	—	—	—	70
Bolivia	10,600	4,800	—	—	1,145	—	—	—	9,397
Brazil	141,060	16,650	22,000	15,000	30,695	33,900	—	—	411,164
Chile	27,945	1,700	—	—	2,000	840	188	—	23,654
Colombia	36,751	7,233	120,000	2,500	3,800	9,600	1,261	—	114,400
Costa Rica	3,900	3,940	—	—	5,900	500	4,000	—	8,024
Dominican Republic	9,060	1,090	—	—	3,000	—	—	—	5,925
Ecuador	17,200	11,168	—	—	—	—	—	—	13,423
El Salvador	7,680	1,520	—	—	75	—	—	—	4,540
Guatemala	24,318	2,000	—	—	1,369	—	—	—	14,625
Guyana	—	—	—	—	2,650	—	—	—	1,200
Haiti	7,510	88	—	—	—	—	—	—	1,600
Honduras	3,300	400	—	—	1,050	—	—	—	1,470
Jamaica	—	—	5,000	—	3,700	—	—	—	5,900
Mexico	27,974	2,550	—	—	—	—	36	—	20,296
Nicaragua	2,000	4,885	3,000	—	143	—	—	—	8,128
Panama	5,842	370	—	—	26,140	10,851	—	—	15,647
Paraguay	3,895	4,670	—	—	—	—	—	—	3,550
Peru	25,024	10,836	—	—	5,700	2,900	5,123	1,500	13,079
Trinidad and Tobago	7,900	—	—	—	—	—	—	9,000	15,013
Uruguay	12,943	3,300	—	—	—	—	1,900	—	23,768
Venezuela	46,000	7,200	21,300	—	—	—	7,500	—	121,131
Total	466,632	86,820	171,300	17,500	88,767	58,591	20,008	10,500	922,034

International loans		$ 920,118
Water	$746,707	
Sewerage	173,411	
National matching funds		922,034
Other national funds		766,520
Total funds		2,608,672

tutions. As a result, applicants now have better understanding of the institutions' requirements, and the presentation of loan requests has improved greatly.

The fiscal responsibility exercised by recipients in handling these loans for sanitary facilities was well-demonstrated by Brazil in 1970. In that year Brazil's national bank established a revolving fund of a billion dollars for local agencies to borrow from on a repayable basis. This procedure, the result of years of negotiation with the Central Government, will undoubtedly be used as a model elsewhere. Variations on the method are already practiced in other Latin American Countries.

Charter of Punta del Este

One of many factors having a profound influence on sanitary engineering progress was the signing of the Charter of Punta del Este in 1961. Yet the emphasis placed by the Charter on water supply and sewage disposal was foreshadowed by the conclusions of an Advisory Committee on Environmental Sanitation established by the Director of the Pan American Sanitary Bureau in 1958. The Committee's unanimous conclusion contained the following statement: ". . . that the concentration of forces to extend and improve existing water supply systems and to construct new systems–to furnish water of good quality and abundant quantity through house connections–is the best method of reducing disease, accelerating the rhythm of economic development, increasing tourism, and serving as an incentive for the construction of new housing. The Committee agreed that water

supply should have first priority, with the provision of sewage disposal being assigned second priority."

As a direct result of the lively Member Government interest aroused by the Committee's action, specific and challenging water supply and sewerage goals were established in the Charter of Punta del Este. These specified that by the end of the 1960's water supply and sewage disposal was to be afforded no less than 70 per cent of the urban population and 50 per cent of rural dwellers.

The magnitude of the task was stressed by PAHO in a report prepared in 1963 for the Task Force on Health at the Ministerial Level; the report pointed out that attainment of the Charter's water supply goals alone would cost at least 5.25 billion dollars. This estimate covered only the cost of providing additional water supply services, without improving existing services; the cost of sewage disposal facilities needed to meet the Charter goals was not quantified.

While the task seemed beyond reach, the goals of the Charter focused attention on the need, gave visibility to the problem, and provided a yard-stick against which progress could be measured. The results achieved serve as one of several measures of progress in sanitary engineering during the past quarter-century.

Progress Since Punta del Este

PAHO has recently published a definitive work on the background, progress, and projections relating to the Charter goals, under the title *Community Water Supply and Sewage Disposal Programs in Latin America and Caribbean Countries: Status and Trends–Projections, 1968-1971.* This document discusses the steps leading to the goals established in the Charter, the situation in 1961, progress made from 1961 through 1968, and projections for 1971. Basic data on these matters are provided in Figure 4 and Table 4. Nearly all countries have reached or surpassed the Charter's 70 per cent goal for water service to urban areas (through house connections or public hydrants); and five countries have reached or surpassed the 50 per cent goal for rural communities.

Significant as these tabulations are, they reflect only a portion of the progress attained. This is because, in addition to the increased *number* of people served in 1971, several million were receiving *better* service. Significant progress has been made during the past quarter of a century in other aspects of sanitary engineering as well. Old phobias are being dispelled. More people, in both urban and rural areas, accept the fact that water supply and sewerage services must be paid for like electricity and other services. Officials, engineers, and economists now realize that there are ways of obtaining necessary funds, which they once felt to be unobtainable. All Member Countries have passed legislation assigning specific responsibilities for these activities; organizational structures have been set up, and management has been improved.

Progress in Education

Another indicator of progress is found in education and research. In 1942, an engineer had to leave the area to get his sanitary engineering degree. Some sanitary engineering subjects, such as water supply design, were taught as part of civil engineering courses.

A survey made by PAHO in 1960 revealed that there were 86 departments or schools in 83 institutions of higher learning in Latin America which offered instruction in sanitary engineering to civil or sanitary engineers. Of these departments or schools, 81 were concerned only with preparation for the first (professional) degree in engineering; three offered postgraduate instruction as well; and two confined themselves exclusively to postgraduate education. For students working toward their first engineering degree, one institution offered a program of sanitary engineering instruction parallel to that for civil engineering.

Further strides have been made since then, particularly in Latin American graduate education for sanitary engineers. Complete undergraduate specialization in sanitary engineering is

TABLE 4—Status of water supply and sewerage system services in Latin America at the end of 1971.

(Population in thousands)[a]

Country or other political unit	Date of data	Water supply															Sewage disposal			
		Total					Urban						Rural				Urban	Rural	Total	%
		Population	Population served				Population	Population served					Population	Population served						
			House connections	Easy access	Total	%		House connections	%	Easy access	Total	%		House connections	Easy access	Total	%	Connected			
Argentina	Nov. 71	24,210	12,742	1,200	13,942	58	18,400	12,000	65	1,000	13,000	71	5,810	742	200	942	16	6,300	—	6,300	26
Barbados	Oct. 71	241	135	106	241	100	110	105	95	5	110	100	131	30	101	131	100	—	—	—	
Bolivia	Nov. 71	5,062	659	505	1,164	23	1,127	563	50	478	1,041	92	3,935	96	27	123	3	365	—	365	7
Brazil	Dec. 70	96,775	35,621	14,109	49,730	51	50,300	26,047	52	12,109	38,156	76	46,475	9,574	2,000	11,574	25	13,440	—	13,440	14
British Honduras	Nov. 71	121	34	25	59	49	66	30	45	25	55	83	55	4	—	4	7	2	—	2	2
Chile	Nov. 71	9,450	4,630	1,930	6,560	69	6,500	4,500	69	1,800	6,300	97	2,950	130	130	260	9	2,530	185	2,715	29
Colombia	Dec. 71	21,500	8,800	3,200	12,000	56	12,600	6,800	54	2,600	9,400	75	8,900	2,000	600	2,600	29	7,700	2,750	10,450	49
Costa Rica	Oct. 71	1,792	1,188	206	1,394	78	878	817	93	61	878	100	914	371	145	516	56	211	—	211	12
Cuba	June 66	7,950	5,610	650	6,260	79	5,020	3,840	76	650	4,490	89	2,930	1,770	—	1,770	60	1,700	—	1,700	21
Dominican Republic	Nov. 71	4,188	1,172	518	1,690	40	1,818	1,017	56	322	1,339	74	2,370	155	196	351	15	307	—	307	7
Ecuador	Nov. 71	6,380	1,680	470	2,150	34	2,480	1,500	60	350	1,850	75	3,900	180	120	300	8	1,500	40	1,540	24
El Salvador	July 71	3,706	801	738	1,539	40	1,691	700	41	123	823	49	2,015	101	615	716	36	507	—	507	14
Guatemala	Dec. 71	5,309	795	1,290	2,085	39	1,836	739	40	897	1,636	89	3,473	56	393	449	13	769	—	769	14
Guyana	Dec. 71	735	374	40	414	56	225	206	92	15	221	98	510	168	25	193	38	67	—	67	9
Haiti	Jan. 71	5,073	201	337	538	11	948	155	16	257	412	43	4,125	46	80	126	3	75	—	75	2
Honduras	Dec. 71	2,716	621	330	951	35	813	498	61	257	755	93	1,903	123	73	196	10	404	2	406	15
Jamaica	Mar. 71	1,889	780	423	1,203	64	520	500	96	8	508	98	1,369	280	415	695	51	139	14	153	8
Mexico	Dec. 71	54,569	25,720	4,000	29,720	54	31,013	19,940	64	4,000	23,940	77	23,556	5,780	—	5,780	25	12,700	—	12,700	23
Nicaragua	Oct. 71	1,951	781	252	1,033	53	942	663	70	192	855	91	1,009	118	60	178	18	398	—	398	20
Panama	July 71	1,475	700	370	1,070	73	714	645	90	68	713	99	761	55	302	357	47	482	4	486	33
Paraguay	June 71	2,448	170	220	390	16	904	170	19	130	300	33	1,544	—	90	90	6	127	—	127	5
Peru	Sept. 71	13,586	3,300	2,100	5,400	40	6,164	3,200	52	1,300	4,500	73	7,422	100	800	900	12	4,000	12	4,012	30
Surinam	Nov. 71	414	153	124	277	67	215	139	65	76	215	100	199	14	48	62	31	85	—	85	21
Trinidad and Tobago	Dec. 70	1,060	562	460	1,022	96	358	297	83	59	356	99	702	265	401	666	95	181	2	183	17
Uruguay	Nov. 71	2,860	2,057	193	2,250	79	2,120	1,988	94	132	2,120	100	740	69	61	130	18	1,215	—	1,215	42
Venezuela	Dec. 71	10,700	6,893	1,963	8,856	83	7,300	5,570	76	1,370	7,300	100	3,400	1,323	233	1,556	46	3,400	121	3,521	33
Eastern Caribbean countries and territories	Dec. 70	504	131	232	363	72	168	74	44	55	129	77	336	57	177	234	70	14	—	14	3
Total		286,664	116,311	35,991	152,302	53	155,230	92,703	60	28,699	121,402	78	131,434	23,607	7,292	30,899	24	58,618	3,130	61,748	22

[a] Current estimates of population and population served as received from countries by the Department of Engineering and Environmental Sciences, PASB.

offered at two universities: by the Faculty of Sanitary Engineering of the National Engineering University in Lima, Peru; and by the University of Valle in Cali, Colombia. Graduate programs in Sanitary Engineering are offered at nine Latin American universities. A total of 173 students were enrolled in these programs in 1967.

It appears that the trend toward graduate-level training in the area is now firmly established. Probably the oldest and best-recognized graduate sanitary engineering programs are those offered by the University of São Paulo's School of Public Health and the Engineering Faculty of the University of Buenos Aires. These two programs have the advantage of good laboratories and excellent libraries. Other programs, of more recent origin, are developing rapidly.

One of the more recent developments in graduate education has been organization of the Regional Graduate School of Sanitary Engineering at the University of San Carlos, Guatemala. Its program, started in 1965, has been authorized for the region of Central America and Panama by the Superior Council of Central American Universities (CSUCA). It has been developed to meet the needs of that region, from where most of its students come. The program has excellent laboratory facilities at its disposal; in fact, the Municipality of Guatemala City and the Ministry of Public Works have transferred their laboratory equipment and personnel there. The Regional School now provides laboratory services to these and other agencies, performing both teaching and research functions.

To sum up, Latin American students may now do graduate work in their own area, in their native language, with emphasis on problems they will encounter when practicing their profession.

It is also encouraging to see that Latin American universities are undertaking substantially more applied research in sanitary engineering and related fields than they did even a few years ago. A 1968 survey indicated that 25 institutions were carrying out 118 research projects. A number of the research projects now in progress are sponsored by PAHO, which is assisting universities in carrying out such activities in parallel with adult education projects. In addition, a significant number of investigations are being financed by interested agencies within the countries.

The Pan American Center for Sanitary Engineering and Environmental Science became operational in Lima, Peru, in 1969. It is designed to render expert technical and scientific assistance to Member Governments. Increasing emphasis will be placed on environmental problems arising from technological developments, and from urban and industrial growth. The Center should serve as a selective international reference and information source, and should in time stimulate training and research activites. The professional staff at the Center covers the fields of water supply, water pollution, air pollution, industrial hygiene, urbanization, housing, and rural community development. Advisory services have already been provided to 14 Member Governments.

Prospective Issues

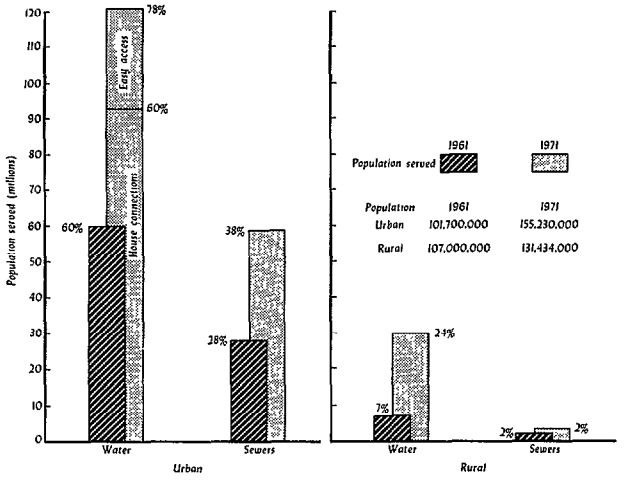
With the exception of the industrially developed western world, the greatest progress in the installation of sanitary facilities is found in Latin America. Worldwide, Latin American countries account for well over 80 per cent of all international loans for these facilities. The remainder of the loans have been widely scattered.

In spite of this gratifying progress, wide disparities still exist among and within countries. Averages conceal these variations, both in urban and rural areas.

Rural service can only be described as almost universally meager, with the exception of a few Caribbean islands. Elsewhere, the number with water service ranges from 1 to 60 per cent, with the average being only 24 per cent. This realistic picture of unfinished business is clearly shown in Figure 4.

The sewage disposal situation, of course, is far worse. In urban areas, a reported total of 62 million people live in houses with sewer connections, but 43 million of these are concen-

FIGURE 4–Population served with water supply and sewerage systems in Latin America (1961 and 1971).



trated in only four countries. In rural areas, sewer connections serve only 3.1 million people. At present prices, the cost of providing sewer connections for the next 10 years will exceed six billion dollars. This means that these facilities will continue to merit top priority action for many years to come.

Since the world does not stand still, new environmental determinants of health, disease, and welfare have emerged. These impose even more difficult tasks upon the engineer, chemist, economist, financier, and social scientist. Some of these tasks have already been assumed; the need to fulfill others is now sufficiently visible to warrant their assessment and gradual fulfillment as national resources become available.

Water Resource Development and Water Pollution Control

Joint river-basin planning and development are becoming more important as competition for water resources increases. Countries in the River Plate basin, fully aware of the changing character of environmental problems, have established an inter-country commission to provide a comprehensive approach to basin problems. PAHO/WHO is contributing consultants for this task and is sponsoring seminars and training courses for professional and technical personnel.

The Santa Lucía sub-basin of the River Plate has been the subject of a special joint study by the Organization of American States, PAHO, and the Government of Uruguay. This study is designed both to serve as a model and to provide a specific plan for maximun use of the basin's water resources. Member Governments have requested similar types of assistance from PAHO for other river basins such as the Guayas in Ecuador, the Lerma in Mexico, the Bogotá in Colombia, the Huallaga in Peru, and two major drainage areas in Brazil affecting Rio de Janeiro and São Paulo.

The upward surge in the Region's economic development is significantly altering water and land uses and values. Water resource development and water pollution control are becoming major problem areas, and water quality management is being made increasingly complex by economic development.

Solid Wastes

The collection and disposal of solid wastes is a major economic problem for all metropolitan areas; Latin American cities spend up to 40 per cent of the municipal budget for this service.

The PAHO/WHO program of assistance began in the 1960's. During the decade, requests for technical assistance exceeded resources. Preliminary studies and evaluations

have been made of existing conditions, and short courses and seminars on the subject are being held at universities in a number of countries. Technical assistance has been given to more than 30 cities in Argentina, Brazil, Chile, Curaçao, the Dominican Republic, Bermuda, Barbados, Jamaica, Honduras, Nicaragua, Panama, Peru, Mexico, Venezuela, and a number of United States border cities. Some eight short courses or seminars have been held on subjects related to solid waste management in Argentina, Brazil, Chile, Mexico, Panama, Peru, and Venezuela. Most of the Organization's effort has been directed to providing assistance for improving managerial and operational methods and procedures.

Insect Vectors

Health-related problems involving insect vectors are obviously important in many areas of Latin America. Chagas' disease is widespread, requiring specialized control efforts; PAHO staff members working on rural and urban housing assist with this problem. Schistosomiasis is widespread and is becoming more significant with the development of river basins and the expansion of irrigation systems. A program for malaria eradication is being carried out by PAHO/WHO in close collaboration with the global malaria eradication effort. *Aedes aegypti* control efforts have been renewed, in the form of a Region-wide eradication program.

The Environment

Fortunately, the basic epidemiology of familiar environmental forces is fairly well delineated in the areas of water supply, sewerage, solid wastes, food protection, and occupational health. Refinements and deeper assessments are still required with respect to radioactivity, trace elements, inorganic chemicals, and viruses.

As responsibilities are broadened–to encompass control of air and water pollution, improved hygiene and housing utilization, and supervision of users and producers of ionizing radiation–problem solving becomes more difficult. Similarly, the epidemiology becomes less clear, except where microbiological contaminants predominate. The consequences of complex organic emissions, substandard housing, and long-term exposure to low doses of radiation still require further observation and evaluation.

Man-environment relationships should certainly become more evident as efforts toward manipulation, correction, and prevention of environmental stresses multiply. Given a strong input of scientific understanding, wisdom and logic should both characterize and validate future performance.

One always hopes that, as the rate of change increases with respect to the character and magnitude of environmental stresses, pollution potentials will be more effectively predictable. In the meantime, we must rely on general indicators such as data on population, per capita wealth, energy consumption, and industrial production. Predictions about the extent of future environmental degradation, particularly in developing regions, must be made with caution. Fortunately, our tools for predicting future trends, such as systems analysis, operations research, and other tools arising out of technologic change, are more numerous and more easily manipulated than in the past. They should increase the options available in making both private and public policy, and hence reduce the hazards of prophecy.

In discussing the agenda for a seminar on environmental health, Dr. Abraham Horwitz, Director of the Pan American Sanitary Bureau, succinctly described the philosophical reasons why an environmental approach will be required in coping with future problems:

> The agenda harmonizes the traditional with the modern, the transition from the rural community to urban culture . . . . We all want to improve community environmental conditions, so as to reduce risk of illness and death for today's inhabitants and those of the future, while always respecting their style of life. Differentiation of the determinants of health and illness in the environment (between living biological determinants; inanimate physical or chemical determinants; and psychological, social, or behavioral determinants) corresponds

to the need to establish practical classifications; but these divisions do not precisely reflect the situation in the real world; for there is in fact no break in continuity between human beings and all that is external to them, whatever its nature, which by convention we term "the environment."[7]

Summary

This review provides a fairly detailed assessment of the sanitary engineering situation in Latin America and the Caribbean, with emphasis on the key role of international organizations since World War II. In general, this period has seen unprecedented sanitary engineering achievements that have made significant contributions to the area's developing economies. Especially noteworthy progress has been made over the past decade in supplying public water systems and services, and in laying a solid base for sanitary engineering training and research. The countries of the area face major challenges in the years ahead, particularly from rapid population growth. But their firm base of competence and past achievement, combined with new financing methods, positive attitudes, and vision to conceive joint regional projects, places them in a position to cope effectively with these problems.

[7]Address at the opening of the Seminar on Environmental Health in Urban Planning held in Mexico City, 7 November 1966. *Boletín de la Oficina Sanitaria Panamericana* LXII (1):62-63, 1967.