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PROCEEDINGS OF THE  
18TH CARIBBEAN WATER ENGINEERS' CONFERENCE  
WATER AND SANITATION IN THE CARIBBEAN BEYOND 1990

Volume II

Basseterre, St. Kitts, West Indies  
1-3 November 1989

ENVIRONMENTAL HEALTH PROGRAM

WASHINGTON, D.C.

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18TH CARIBBEAN WATER ENGINEERS' CONFERENCE

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Presentations

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## LIST OF ABBREVIATIONS

CBWMP	Caribbean Basin Water Management Project
CDB	Caribbean Development Bank
CEHI	Caribbean Environmental Health Institute
CIMH	Caribbean Institute for Meteorology and Hydrology
HRD	Human Resources Development
PAHO/WHO	Pan American Health Organization/World Health Organization
UN	United Nations
UNDP	United Nations Development Program
UNICEF	United Nations Children's Fund
UNDTCD	United Nations Department of Technical Cooperation for Development

## ACKNOWLEDGEMENT

The Conference is part of a global effort, the primary objective of which is for the developing countries to design effective water supply and sanitation strategies for the 1990's. The Conference gratefully acknowledges all those whose support has led to its successful realization, in particular the Collaborative Council of External Support Agencies of which WHO is the Secretariat for its guidance and financial support. The Conference also acknowledges the contribution of the Caribbean Development Bank for sponsoring the participants from the Eastern Caribbean countries and the Pan American Health Organization/World Health Organization (PAHO/WHO) for organizing and managing the Conference. Special acknowledgement is given to the Government of St. Christopher/Nevis for hosting the Conference and for the courtesies extended to all the participants.

## PREFACE

Volume II is an integral part of the Proceedings of the 18th Caribbean Water Engineers' Conference on Water and Sanitation, which was held in Basseterre, St. Kitts, West Indies from 1-3 November 1989. It begins with the opening address of Mr. Royden Benjamin, Assistant to the Honorable Minister of Communications, Works and Public Utilities, St. Kitts, West Indies, and includes technical papers presented by PAHO/WHO temporary advisors, UN agencies, regional institutions (CDB and CEHI), external support agencies, as well as statements by representatives from private companies and manufacturers with their head office abroad and/or from water offices in the Region. In addition, Volume II includes statements which provide up-to-date information on the water supply and sanitation sector in the countries of the Region.

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A. Opening Address



OPENING ADDRESS

18th Caribbean Water Engineers' Conference  
Fort Thomas Hotel, Basettere, St. Kitts  
Wednesday, 1 November 1989

Royden Benjamin  
Assistant to the Honorable Minister  
of Communication, Works and Public Utilities

"Mr. Chairman, Mr. Athill Rawlins, Water Engineer/St. Kitts Water Services, Mr. O. K. Yhap, CDB Representative, Mr. Alexander Rotival, Chairman of the Collaborative Council and UNDP Coordinator for the Water Decade, Mr. Raymond Reid, PAHO/WHO Representative.

I am deputising for the Honorable Minister, who is away on official business. He sends his best regards and extends wishes for a successful Conference.

It gives me great pleasure to welcome all of you to our Land of Beauty and trust that you are already experiencing Kittitian hospitality. Please enjoy your time here with us, and I do hope you will take back pleasant memories of your visit.

I am sure that this 18th Caribbean Water Engineers' Conference will be very informative and challenging. It is a very good idea for you to come together as Water Engineers - get away from the field work and the everyday hustle and bustle and enjoy a time of discussion and sharing of ideas; to learn from one another and to hear reports of what is happening in the various territories; to get insights into the rapid development in technology and management skills.

We must never underestimate the importance of these sessions, for it is through them we learn and grow and gain the knowledge which will be useful for us.

There is a saying which goes "You never miss the water until the well goes dry." This truth was brought home to us during the recent passing of Hurricane Hugo.

Water is a vital and important part of our existence and we all need it for daily living.

Thanks to Mr. Athill Rawlins and staff for a tremendous job well done in restoring water supply to our island in quick time. We are grateful for their efforts.

### Development in Small Caribbean States

As the Chairman said in his opening remarks, the Government of St. Kitts-Nevis is committed to the development of Water Services in the Federation. We have embarked upon a program of land distribution to provide housing lots for our citizens. There is also a project to build 500 low-income houses throughout the island. Construction is on the increase as many homeowners are also renovating or expanding their homes.

With all of this building and construction taking place, there is a demand for water. However, we need to ensure that we provide clean, safe water especially as we are thinking of Health for all by the Year 2000.

There is going to be added pressure on our Water Engineers to improve the water supply and sanitation in the Caribbean in the 1990's. We have come a long way, but there is much more to be done.

### Economic Consideration

In order for us to meet the demands which the development of our countries have brought, there is going to be the need for training and, hence, the need for funding for these training programs.

Funding for equipment and testing is also very important. If we are going to reach out to the housing developments and resort areas, there must be improvement to our distribution systems and there are costs which must be met.

I note that there are representatives from CDB, CIDA, PAHO, UNDP and other agencies at this Conference; as the needs surface, I trust they will give considerations to the Caribbean States.

### Human Considerations

During this time, it is easy for you to get concern with all of the technical and economic aspects of water services. We all need to be reminded that in all of our efforts and endeavors, we are here to help to bring a better life to all of our citizens. The end result of our coming together should be better services, stronger countries and happier people.

Let us never forget the human care and concern. This is of utmost importance and should always be at the center of our planning.

With this in mind, I extend best wishes for a fruitful and rewarding Conference. May you be inspired and challenged during your time here and go back to your territories with a new commitment.

It gives me great pleasure to declare this 18th Water Engineers' Conference open."

B. Technical Papers by the Pan American Health Organization/  
World Health Organization (PAHO/WHO) Staff and Temporary Advisors

Principal Areas for Future Attention

Guillermo H. Davila  
Coordinator, Environmental Health Program  
Pan American Health Organization (PAHO)

Organization of the Sector

- National water supply and sanitation systems should be established that will mobilize all the elements involved in facilitating the delivery of services by this sector.
- Particular attention should be given to the financial system.
- The policies of decentralization and municipalization have made it urgent to establish national systems, and planning for action will be especially important.
- Urban coverage will have precedence and will demand the greatest investments. Particular attention should be given to the low-income population on the outskirts of the cities.
- Permanent programs should be established for the development of human resources at all levels. Such programs should have continuity and, thus, regular and permanent funding.

Optimization and Recovery of Installed Capacity

Here it is well to emphasize the concept of "efficient water use," which involves such facets as:

- Reduction of current high levels of consumption, streamlining of services delivery (including the review of design standards), and "humanization" of engineering through a social approach.
- Reduction of waste and inappropriate uses of water, consciousness-raising in general about the value of water and sanitation services, and creation of a spirit of "conservation." It will be necessary to bring about a decided change in users' habits, mainly through education campaigns.
- Use of water-saving plumbing fixtures (toilets, etc.). Regulations should be drafted requiring that they be used.
- Establishment and application of appropriate pricing policies. It will be necessary to eliminate "political control" of rates.

### Development and Use of Appropriate Low-Cost Technologies

It will be necessary to establish an attitude in planning and in engineering design, whereby, low-cost technologies are adopted as normal practice. In this regard, it will be important to modify existing traditional programs in sanitary engineering education so that they will foster a mentality that is more in line with present realities.

- Attention should be given to innovation and adaptation based on applied research in order to contribute to knowledge and to encourage development of the new technologies that concern us.
- Community participation should be optimized so that there will be a commitment to technological changes that favor less costly services, an area that is so critical for the sector, and also promote and reinforce the concept of paying for the use of the water. We ask: Shouldn't water service be considered an important element in the list of household costs for calculating minimum wages in order to meet the basic needs of families?
- Increased productivity of the services through programs for controlling physical and commercial losses should be the basis for operation and maintenance of the services as well as the key to administrative and institutional development.

### Water Quality - Pollution

- It is important to recognize that water resources are finite and are already being overused.
- The quality of water resources for human use should be given high priority. Biological contamination and the growing risk of chemical contamination are cause for concern; actions should address both surface and groundwater. It is essential to launch vigorous programs to protect water sources, giving attention to all the factors that cause pollution, including solid waste disposal, industrial efflux, contamination of agricultural origin, etc.
- It is necessary to plan effectively for the utilization of water resources wherever sanitary uses are important.
- The quality of drinking water should be zealously controlled and monitored, with full attention to the health risks posed by pollution.
- Since we live in a world in which there is close contact with human excreta (in the case of large cities), health care demands that this be given urgent attention and that the topic be assigned high priority.

- Water and sanitation companies should rank health concepts according to their importance and should endeavor to improve their services on this basis.
- It should be recognized that wastewater has economic value and should not be discarded; efforts should be made to encourage its reuse in for agriculture and other purposes.

#### Concept of Universal Coverage

Although it may seem that we are raising an issue which is a "lost cause," since there have been repeated references to the impossibility of addressing the high cost of such an ambitious goal, I would say that, even given the restrictions, today more than never, we should attempt to regain our optimism with regard to this task. It is desirable, and I believe productive, for us to look toward a future in which every person in the Americas has the benefit of minimum water supply and excreta disposal services, in the interest of his or her health and well-being, thus, permitting access to a better quality of life than we have in 1989.

The availability of financial resources by itself is not the answer to our problems. What will count will be the adoption and implementation of the concepts mentioned above, together with those resulting from the present meeting.

The 1990's will bring more urgent demands than we had in the 1980's, and we should be very seriously concerned lest the year 2000 finds us at the same sanitary level as we have in 1990--or worse. I believe that sanitary engineers and other professionals in Latin America and the Caribbean have the experience and the conditions to exercise an influence, through their actions, at both the community and the government level to mobilize future action that is consistent with the concerns and development efforts of our countries.

Overview of the International Drinking Water Supply  
and Sanitation Decade (IDWSSD)

Raymond Reid  
Regional Advisor, Environmental Health Program  
Pan American Health Organization (PAHO)

The declaration of the ten-year period 1981-1990 as the IDWSSD stems from two United Nations Conference.

1. The United Nations Conference on Human Settlements held in Vancouver, Canada, in 1976, which recognized the need to accelerate program of water supply for the sanitary disposal of excreta and wastewater in urban and rural areas.
2. The United Nations Water Conference held in Mar del Plata, Argentina, in 1977, which recommended that the Decade of the 1980 be designated as IDWSSD.

This lead to the Proclamation of November 1980, by the General Assembly of the United Nations of the period 1981-1990 as the IDWSSD.

Health Impact

This global effort was in response to a growing recognition that lack of clear and adequate sanitation has a profound impact on the health and welfare of people in developing countries.

The following are some of the most notable quotes regarding the effect of water sanitation on the life of poor people in the developing world:

- . "Two billion potentially productive men, women, and children -- half the world's population -- are denied the clean water and adequate sanitation necessary to begin to fulfill their aspirations for a fuller, more productive life," according to United Nations Development Program Administrator, Bradford Morse."
- . "The yearly incidence of water-and excreta-related diseases among children is estimated at 3 to 5 billion, and about 15 million children below the age of 5 die in developing countries every year," reports United Nations Children's Fund Executive-Director, James P. Grant. He adds that, "The absence of safe water and sanitation plays an important role in those deaths, which could be cut by 50 percent if everyone had access to water supply and sanitation."

- "About 80 percent of all disease in the developing world is related to unsafe water supplies and inadequate sanitation," according to World Health Organization former Director-General, Halfdan T. Mahler."

In Latin America and the Caribbean, it was estimated at the beginning of the Decade that diarrheal diseases accounted for 200,000 death each year not taking into account other water sanitation related disease. In the Caribbean, we still have a high incidence of diarrheal diseases; in some places, transmission of typhoid and waterborne diseases continue.

Even the urban explosion did not originate with the Decade, the 1980's witnessed the full force of this phenomenon as increase in population as high as 5 percent was recorded in certain region in the urban sector created by large rural and urban migration.

In 1980, WHO has estimated that 25 million people, excluding the Peoples Republic of China, had to be provided with appropriate sanitation service every year in the urban sector to only maintain existing levels of services.

In the case of Latin America and the Caribbean, additionally 7 million and 6.4 million respectively per year would have to be provided with water supply and sanitation to maintain 1980 level of coverage to account for population increase.

#### Water Supply and Sanitation Coverage

	<u>Global</u>		<u>Latin America and Caribbean</u>	
	<u>Population</u> <u>(Millions)</u>	<u>Percent</u> <u>Coverage</u>	<u>Population</u> <u>(Millions)</u>	<u>Percent</u> <u>Coverage</u>
Urban Water	730	75	236	84
Rural water	1,510	30	124	41
Urban Sanitation		58		74
Rural Sanitation		14		11

Notwithstanding the economic difficulties, the size and complexity of the task, the Decade provided the hope to million of poor people and a process for improvement of water and sanitation sector and service coverage. New concepts and important strategies were suggested to reach the goals.



## DECADE CONCEPTS

### Complementary of Water Supply, Sanitation and Health Education

The Decade advocated that unless water supplies programs were followed by adequate means of sanitation, and an understanding of the need for proper hygiene, it will not be possible to achieve the potential benefits. This has been clearly demonstrated in several communities throughout the world and also in Latin America.

Decade programs must take HEALTH IMPROVEMENT as the prime objective, and that means accompanying investments in pumps and pipes with parallel programs for latrines and health education.

### Water Quality and Health

Providing "safe" water is one of the IDWSSD objectives. Maintaining a safe supply, by preventing contamination and continuously monitoring quality is another. WHO has published new guidelines on water quality, from which countries can set national standards which best suit their local needs. The goal of improving water quality is more elusive, because the provision of water takes precedent and community means are sometimes limited for proper surveillance. In rural areas particularly, appropriate skills and experience are in short supply, and technology choices must take account of water quality protection with minimal resources.

Implementation of excreta and wastewater disposal can also assist in preventing contamination of drinking water sources. Another element is the increasing importance of toxic chemicals in the protection of drinking water sources.

### Community Participation

The IDWSSD also strongly advocated Community Participation as being essential if development projects are to have any chance of achieving their aims.

The experience of the Decade has contributed to change the concept of community participation from a restricted sense to the supply of free labor, local material to one in which the community is looked at as a real partner in the planning, execution and operation of the services.

Primary Health Care experience has shown very clearly that successful projects originate in the community. The cooperation between health and water and sanitation institutions provides a means of mutually strengthening their effort and obtain more efficient results particularly in rural areas.

### Appropriate Technology

From the beginning of the Decade, it was understood that the high cost of traditional technology would make it impossible to achieve Decade goals. One of the strategies was to adopt strategies that can not only reduce cost, but simple enough that communities would be able to operate the system.

Modification in sewage collection technology was also seen as the only way to close the gap between people served with water and sewage collection in developing countries. A wide spectrum of technology has been tested, evaluated, and promoted during the Decade. Some resulting from effort by international agencies or from national effort to solve specific problems.

### Participation of Women

The IDWSSD also advocated full participation of women in the water sector. Women was seen as the primary consumer of water supplies and must have an important role, including the selection of technology that affects them.

In recognition of the important role of women, a task force was established by the Steering Committee for Cooperative Action for the IDWSSD in 1982 to develop strategies for enhancement of the role of women in the IDWSSD. Women groups became more active in the field of water and sanitation and were responsible for developing several community projects.

### Water Resources Management

The competition for scarce water resources between various users, including agriculture, fisheries, and others; the protection of water quality and demands in a way which takes account of future needs, as well as present priorities; and make it imperative that a good water resources management plan be considered to take into account present and future needs and set priorities accordingly.

The scarcity of Water Resources give rise to increase in wastewater reuse, which is becoming a more frequent alternative, thus, increasing the risks to health.

### Planning and Financing

The regional strategies recommended the development of stronger political commitment, express the need for governments and political leaders to assign higher priority to water supply and sanitation services, and to incorporate these services in National Development Plans for Financing.

Each country was required to identify specific target for the Decade and develop national sector (Decade) plan to address these targets. Technical assistance was provided to some countries in the preparation of such plans. Other countries proceeded on their own to develop the plans. Others did not prepare Decade plans, but continued with Water Improvement programs.

Among mechanism that were considered appropriate was the formation of coordinating mechanism as Decade Coordination Committee, which functioned at the earlier stage of the Decade, but these committees lost momentum as the years went by.

Notwithstanding all the above concept, financing the Decade was the most important factor that will make it a reality. The increase in financing was supposed to come from increased allocations in the national budgets and increase in donors' contributions to the sector.

Preliminary information collected by WHO seems to indicate that funding water supply and sanitation programs from national budget has increased to almost 50 percent between 1981 and 1986. "External annual funding seem to have increased by around 55 percent between the beginning and later year of the Decade."

However, the funding fell short from the total amount estimated at the beginning of the Decade. A recent study by WHO estimated current annual spending from all donors to be about three billion a year.

Associated with the financing is the notion of cost recovery, which was given an added significance during the Decade. Beneficiaries are expected to pay part or all system cost.

#### Evaluation

As we approach the end of the Decade, we are considering Decade evaluation. The purpose of the evaluation will be to assess the situation of the water supply and sanitation in line with the strategies proposed as the basis for updating national and sanitation programs. Evaluation will be carried out at several levels: national, regional and global levels.

The national evaluation is primarily the responsibility of the government.

Guidelines for national evaluation have been prepared. They are being circulated to the countries for their consideration.

A regional evaluation will also be carried out in a Regional Symposium, it will involve assessment of the situation and progress achieved during the Decade through the interaction of various agencies involved in the sector and preparation of all Decade assessment reports preceeding the AIDIS Congress in September 1990, and in addition, the compilation of country experience and assessment to give a regional picture.

The evaluation process will encourage sector institutions to use progress achieved during the Decade: to adjust their strategies and programs, strengthen their institutions and human resources, and to renew political commitment for the sector.

Several themes and unfulfilled needs should be carefully analyzed. Among them is the need for a more efficient use of water. Water losses, unaccounted for or inefficient use constitute a waste of resources. The problems of equity in the distribution of resources must be addressed.

Any future activities in the water sector should take conservation measures very seriously.

The goals of good operations and maintenance meaning continuous operation of the supplies and those of water quality remains elusive. In addition, problem of sewage collection and disposal remains critical if fresh and coastal water pollution is to be avoided.

Several groups and meetings have already recommended that Decade approaches in relation to water preservation, community participation, appropriate technologies, and others should continue to be emphasized. In the Caribbean, we would like to focus on problems and issues that are specific to the islands.

The end of the Decade should be seen an opportunity for reassessment and to take a look in the future to promote better health through a better environment.

Survey of Water Systems in the Eastern Caribbean:  
Needs and Improvement

Emile Warner  
Temporary Advisor, PAHO/WHO

Antigua Water Supply System

The Antigua Public Utilities Authority (APUA) has responsibility for management and operation of the telephone, electricity and water supply systems. As far as the last-named is concerned, APUA provides water service throughout the island of Antigua to an estimated population of 85,000 persons, and of this number about 50,000 are served through individual metered service connections.

Between 1984 and 1987, a firm of consultants, as part of a USAID Project, prepared a Master Plan on a five-stage improvement program for APUA and this represents a blueprint for development of the Antigua Water Supply System. Indeed, the five stages of the Master Plan indicate the source of supply, treatment, transmission and distribution storage capability required to satisfy projected water demands through the year 2020.

Principal Achievements (1981-1989)

1. Development of Water System Master Plan.
2. Improvements to Delaps and other Water Treatment Plants comprise the following:
  - a) new chemical feed systems;
  - b) improved flocculation;
  - c) improved flow patterns and hydraulic capacity of settling basins;
  - d) new filter media and filter flow control systems;
  - e) improved filter backwash equipment;
  - f) laboratory facilities; and
  - g) sludge lagoon improvements.

(The Delaps Water Treatment Plant constructed in 1975 to be operated in conjunction with the Potworks impounding reservoir and Pumping Station was originally rated at 2.1 mgd. Its treatment capacity is now conservatively estimated at 2.4 mgd. and can be operated at 3.6 mgd.).

3. Installation of new Crabbs Peninsula Desalination Plant (2.0 mgd. capacity).
4. Construction (now underway) of a 16"/12" transmission pipeline from the Crabbs Desalination Plant to the Cassada Pumping Station.

#### Stages I and II of Master Plan

It is not proposed to reproduce the details of the improvements listed in the Master Plan except to draw attention to the capital investment involved in the first two of five stages:

Stage I (through 1990)	US\$10,950,000
Stage II (1991-1995)	US\$11,040,000

#### Present Situation

Present water production is approximately 4 mgd. and is made up as follows:

- a) 1 mgd. - desalinated
- b) 1 mgd. - groundwater from wells
- c) 2 mgd. - surface water (impoundments)

According to the consultants, in 1990 the average daily demand is estimated at 3.20 mgd. and the maximum daily demand at 4.80 mgd. In addition, the Manager of the Water Division has pointed out that wells in the southwestern part of the island are pumped directly into the system so that any interruption in the electricity supply or break occurring on a pipeline gives rise to immediate disruption in the water service. Besides, there are water quality implications especially in relation to turbidity, color and bacterial wholesomeness.

#### Tourist Industry

Special mention is being made of the tourist sector as it is a major contributor to the country's economy.

According to the Department of Tourism, arrivals totalled 139,726 in 1985 and there were 1,835 hotel rooms. By 1990, the Ministry of Economic Development has projected that there would be 234,223 tourist arrivals and 3,260 hotel rooms. (The water demand mentioned above takes these figures into account).

Since tourists come principally from developed countries, it is necessary for water quality standards that are adopted to conform to those observed say, in Europe and North America. To this end, the consultants have suggested the adoption of water quality goals that are either health-related or aesthetics-related.

### Finances

The revenues of the APUA cover its operating expenses.

As far as capital works are concerned, the Authority has recently utilized financing provided by an Italian contractor for construction of the 16/12" transmission pipeline now being carried out. However, according to the law, prior approval of the Minister responsible for finance was necessary and the Authority would service the debt.

With respect to the conduct of Studies, assistance has been received from USAID.

### Constraints

From discussions with the Management of the Authority, it appears that the major constraint is the difficulty in obtaining funds for development projects. This difficulty is further compounded by the fact that replacement of major elements of the existing system (e.g., transmission pipelines) needs to be undertaken and, although desirable, will not result in expansion of the service.

With respect to human resources, there is a shortage of skills at the subprofessional level, but solutions for this problem might well reside in a review of the national education system.

### Improvement of Service Quality in the 1990's

1. Continuation of groundwater exploration.
2. Construction of 8" diameter treated water transmission main from Bristol Springs to St. Philips Reservoir in the Southeast.
3. Construction of a water treatment plant, clear water reservoir and highlift pumping station, as well as a service reservoir to provide storage for 48 hours supply in the southwestern section of Antigua.
4. Enhancement of water quality surveillance.

### Dominica Water Supply System

With effect from 1 June 1989, responsibility for management, operation and development of the Dominica Water Supply System has been vested in the Dominica Water and Sewerage Company Ltd., a company incorporated under the Companies Act of the Commonwealth of Dominica. At present, all the share capital is held by the government and technical assistance is being provided by the Canadian International Development Agency (CIDA).

In this case, technical assistance includes the engagement and placement of a Chief Executive (General Manager) and two other line managers; namely, Manager, Finance and Manager, Operations and Maintenance. A local trainee has been recruited for each position.

CIDA is utilizing the services of a Canadian Executing Agency that consists of a consortium of two firms of Canadian Consulting Engineers, namely Groupe Conseil Saguenay Dessau International, Inc., and Hamilton Engineering International Ltd.

It appears that this experiment marks the first attempt at privatization of a water utility in the English-speaking Caribbean, and its performance should be followed with great interest.

This Water Company is the successor organization to the National Water Services Division (NWS) of the Ministry of Communications, Works and Housing.

Almost all the employees of the NWS, including senior staff personnel who elected to make their services available to the company have been retained. These total approximately 110, of whom about 50 are part-time caretakers of small water intakes, etc.

#### Present Situation

There are some 45 surface-water systems being operated and the total daily water production has not yet been determined. However, Roseau and environs are supplied with 4.1 mgd., the main contribution coming from the Antrim system.

Of a total population of 80,000 persons, it is estimated that some 30,000 live in Roseau and environs receive pipeborne water. Another 42,000 persons are provided with piped water and therefore, a total of 72,000 persons enjoy a pipeborne water supply 24 hours daily. At the other end of the scale, some 10,000 persons have no access to piped water.

All public water supplies are disinfected with chlorine using gaseous chlorine (Roseau) or calcium hypochlorite in granular or tablet form. The disinfection process aims at maintaining chlorine residuals of 0.2 mg/l at the ends of the distribution systems.

Samples are collected on a routine basis from several points of the distribution systems for determination of chlorine residual and bacteriological examination. All this is undertaken by inhouse technicians.

As far as water quality is concerned, the Company is striving to satisfy the guidelines prepared by the World Health Organization (WHO) with particular reference to bacteriological quality.



All commercial and industrial customers are metered, but less than 10 percent of residential premises are metered. However, all new services are metered and the Company has set as one of its goals that, as far as it is beneficial, all services should be metered.

#### Financing of Projects

CIDA has provided Cdn.\$4.69 million (EC\$10.3 million) for technical services, equipment and the training of NWSB personnel. Some of the specifics of this program of assistance include the following:

- a) institution rebuilding and strengthening (including a significant training component);
- b) rehabilitation of many of the existing water systems;
- c) acquisition of equipment, e.g., vehicles, compressors and tools;
- d) establishment of a water resources inventory system;
- e) demonstration of rainwater roof-catchment systems;
- f) implementation of improved leak detection program; and
- g) review of long-term requirements for new work in overall system.

The Government of Dominica is also committed to provide counterpart funding, but this is expected to be relatively small.

At present, the Company's revenues of EC\$2.5 million are insufficient to cover its operating expenses of EC\$3.5 million. The deficit of EC\$1 million is funded by the Government of Dominica. It is, however, expected that there should be a revision of water tariffs so that by 1991, the Company should be in a position to break even and, thereafter, to generate funds for development and expansion of the system.

In addition to the above, the Government of Dominica is providing EC\$2 million for certain capital works to be carried out in 1989-1990. These include extensions to systems, provision of storage, increase in supply lines - all intended to bring on stream increased quantities of water.

#### Sector Support Programs

The Environmental Health Unit of the Ministry of Health is very concerned about its role within the sector and is gearing itself to carry out effective surveillance of water supplied through the public system.

Equipment has been procured with the assistance of the Caribbean Environmental Health Institute (CEHI) for the bacteriological examination of water samples, as well as the training of personnel to perform the tests.

It appears that the Company enjoys attention from the highest political level in the island and is, therefore, operating in a favorable governmental environment within both Dominica and Canada.

### Constraints

The present tariffs are too low, and result in the Company being in a deficit position.

### Improvement of Service Quality in the 1990's

- a) Revision of water tariffs.
- b) The provision of 95 percent of the population with piped water.
- c) The conduct of feasibility studies and detailed engineering designs for improvement and expansion of the water supply system.
- d) Protection of watersheds from the intrusion of agricultural activities.
- e) Development of the Company into a viable and self-sufficient organization.
- f) Strengthening of liaison between the Water Company and the Ministry of Health.
- g) Development of capability within the Ministry of Health to provide effective surveillance with particular reference to drinking water quality.
- h) Monitoring of pesticide and weedicide levels in the public water system.

### Grenada Water Supply System

The Central Water Commission has responsibility for the provision of public water supply services in Grenada and it is expected that legislation would soon be enacted to expand its statutory responsibilities to include the provision of sewerage services.

### Present Situation

It is estimated that of a total population of 92,000 persons, some 80 percent or 73,600 have access to pipeborne water while about 20 percent or about 18,400 persons have no access to piped water.

The Commission operates about 36 water supply systems in various parts of the island. During the wet season, the total daily water production varies between 6.8 mgd. and 7.2 mgd. while in the dry season it varies between 4.9 mgd. and 6 mgd.

It has been estimated that in the Greater St. Georges area (which includes the industrial area and Point Salines International Airport), there is a shortfall of 1 mgd. between the supply of 2.5 mgd. and the demand of 3.5 mgd. during the dry season. Besides, there are perennial problems in some areas due to a number of factors, including inadequacy at source, insufficient carrying-capacity of the pipe system, and the need to replace old and leaking pipelines.

All industrial and commercial premises are metered, but flat rate charges are applied to residential properties depending on the Annual Rateable Value. There are 14,062 service connections and of these, 1,207 are metered, that is, less than 10 percent of all water services are metered.

There is a high level of unaccounted for water which has been assessed at 40 to 50 percent in St. Georges (based on the results of reservoir drop tests at night time) and there is reason to believe that this figure is applicable to the entire water system in Grenada. Consequently, there appears to be pressing need for a leak detection and waste control program to be implemented.

As far as water quality is concerned, some 64 samples are collected each week and tested for faecal coliforms and faecal streptococci. In addition, chemical determinations for pH, chloride, total conductivity and total hardness are carried out.

Monitoring of marine and coastal pollution of the Inner Harbor, Grand Anse Beach area and beaches on the North Shore of the Island is undertaken with the assistance of the Caribbean Environmental Health Institute (CEHI).

#### Financing of Projects

During the period 1983-1988, water supply projects totalling EC\$4.1 million were funded by the British Development Division (BDD), Caribbean Development Bank (CDB), USAID and the Central Water Commission. These projects were wide ranging in nature and included the equipping of a vehicle maintenance workshop, procurement and installation of deepwell pumps, resanding of slow sand filters, construction of pipelines, and the expansion of treatment plant capacity.

At present, the European Development Fund is providing finance for replacement of some 13-1/2 miles of pipelines between St. Georges and St. David and between Grenville and Sauteurs. The estimated cost of this project is EC\$3.4 million.

CIDA has also provided Cdn\$250,000 for the purchase of pumps and associated equipment for wells.

With respect to the Commission's finances, its recurrent budget is approximately EC\$6.25 million and revenues point to a surplus of EC\$1.7 million. However, the latter is not always realized in terms of cash collections, since a substantial portion of it represents government's payment to the Commission for providing water service to users of public standpipes.

#### Constraints

1. Negative political fallout.
2. Need for training of technician-level staff (including accounting personnel assigned to the Parishes).

#### Improvement of Service Quality in the 1990's

1. Implementation of an effective leak detection and waste control program.
2. Expansion of the present groundwater development program to extract an additional quantity of 1 mgd.
3. Rehabilitation and upgrading (where necessary) of slow sand filter systems.
4. Training of waterworks operators.
5. The completion of project documentation to the level that it could be used for approaches to international lending agencies.
6. Monitoring of pesticide and weedicide levels in the public water supply.
7. Intensification of efforts at water quality assurance.
8. Review and formulation of measures to minimize the ill-effects of algal bloom in reservoirs.

#### Montserrat Water Supply System

The Montserrat Water Authority (MWA) was established in 1972, "to promote the conservation and proper use of the water resources of the colony and to provide and maintain an adequate supply of pure and wholesome water for public and private purposes in the colony."

The MWA is, therefore, charged with the responsibility of provide water service to the entire population of some 12,000/13,000 persons. (The population level is somewhat static on account of a very high level of emigration).

During the 1970's, the entire public water supply system was redeveloped with the assistance of the Canadian International Development Agency (CIDA). These works included the construction of wells, pipelines and pumping stations, as well as the installation of chlorination equipment and cathodic protection systems. Then in 1983, a Master Plan was prepared by the MWA with assistance from the United Nations Development Program (UNDP).

#### Present Situation

Present production is approximately 1 mgd. The entire supply is groundwater made up as follows:

- 85 percent - spring water
- 15 percent - well water

The MWA has 5,000 customers who are served through metered service connections.

All residents have access to pipeborne water provided through public standpipes, serviced premises with yard taps or internal plumbing systems.

Water is disinfected using chlorine tables, but the control of application rates might be somewhat deficient. Steps are being taken to change to HTH (calcium hypochlorite with 85 percent available chlorine), but the need for control of dosage rates would be no less critical.

#### Focus of 1983 Master Plan

1. Spring sources to be developed.
2. Transmission mains to be replaced.
3. Increase of storage capacity with the construction of additional reservoirs.
4. Improvement or provision of access roads to the reservoirs and spring sources.

#### Financing of Water Projects

Funds are provided by the British Development Division (BDD), CIDA and the European Development Fund (EDF). Indeed, development works are not constrained by the lack of funds.

With regard to operating expenses, these are covered by the Authority's revenues.

### Sector Support Programs

MWA has access to the colony's training program. Besides, it conducts its own in-house training sessions and sponsors employees for six-week training courses in the Operation of Water Supply Systems at the College of Arts, Science and Technology (CAST), Jamaica.

The practice of rotating employees in different sections of the Authority should enable MWA to keep the organization slim in terms of employee numbers. (Total employees number 61).

### Improvement of Service Quality in the 1990's

1. Construction of five new service reservoirs ranging in capacity from 40,000 to 100,000 imperial gallons at various locations identified in the 1983 Master Plan.
2. Improvement of disinfection facilities.
3. Enhancement of water quality surveillance.

### Saint Lucia Water Supply System

The Water and Sewerage Authority (WASA) of Saint Lucia, the successor organization to the Central Water Authority, is a statutory body responsible for the provision of all public water and sewerage services. The Authority reports to the Minister of Health, who has Cabinet responsibility for WASA, Saint Lucia.

The Central Water Authority (CWA) was twinned with the Wessex Water Authority of Bristol, England, in 1980-1983 and during the period 1980-1982, Wessex provided management services. That arrangement ended in 1983 but there has been a continuing relationship between the two Authorities to the benefit of CWA/WASA.

Although no National Committee was established to draw up plans to meet the goals set by the International Drinking Water Supply and Sanitation Decade (IDWSSD), national goals were designed for Saint Lucia, and these included the provision of potable water for all communities of not less than 10 households.

### Present Situation

There are some 33 surface-water supply systems operated by the Authority with a total daily water production estimated at 6 to 6.5 mgd. Two of the most important systems are the Sarot Water Treatment Plant with a capacity of 2.4 mgd. and Hill Twenty which produces about 0.8 to 1.0 mgd. These two systems serve Castries and sections of Northern Saint Lucia.

It has been estimated that of a total population of 150,000 persons, 85 to 95 percent have access to piped water. There are 23,000 accounts, so that some 100,000 persons are provided with water within their premises. Another 40,000 persons draw water from public standpipes and about 10,000 have no access to pipeborne water.

There is no conscious attempt to distinguish between urban and rural levels of service, but there are variations depending on the availability and quality of water.

With respect to water quality, samples are collected from strategic points of the distribution systems and examined at the Authority's Central Laboratory. Between 2,000 and 2,300 samples are tested each month so that there is comprehensive coverage of the water supply system to provide quality assurance.

#### Achievements (1981-1989)

1. Authority twinned with the Wessex Water Authority of the United Kingdom. Benefits include:
  - a) provision of management services and institution strengthening; and
  - b) continuing relationship as desired by WASA, Saint Lucia.
2. Construction of raw water pumping stations, pipelines and service reservoirs and the acquisition of standby generating plant - all resulting in the provision of an improved, expanded and more reliable water service.
3. Increase from approximately 55 to 85/95 percent of the population having access to pipeborne water.

#### Financing of Projects

Funds have been provided by British Development Division (BDD), Caribbean Development Bank (CDB), USAID and the Government of Saint Lucia.

The Roseau Water Supply Project which involves construction of a dam across the Roseau River near to Millet and associated works is designed to meet the water demands of Castries and Northern Saint Lucia up to the year 2025. The first phase of the project is estimated to yield 4.8 mgd. and the final phase, 7 mgd. The project cost is estimated at EC\$104 million and funding is being provided by CIDA, CDB, World Bank, Organization of Petroleum Exporting Countries (OPEC) and the Government of Saint Lucia. Implementation of the project has already begun and completion of the first phase is scheduled for 1993.

As far as the Authority's finances are concerned, it has moved from a position in which it generated surpluses in 1985 and 1986, sustained a loss in 1987, broke even in 1988 and estimates a loss of EC\$100,000 in 1989. Its present operating expenses are of the order of EC\$8.5 million.

An approach to the Public Utilities Commission for revision of the water tariffs is being contemplated. If successful, it is confidently predicted that the Authority would be able to cover its operating expenses and provide funds for capital works.

### Constraints

It has been advanced that the present water tariffs are too low and need to be increased.

### Improvement of Service Quality in the 1990's

1. Revision of water tariffs.
2. Completion of the Roseau Water Supply Project.
3. Strengthening and improvement of systems to make it feasible for water of consistently safe quality to be supplied to the population at large.
4. Development of capability within the Ministry of Health to exercise effective surveillance over the quality of water delivered to the public by WASA.
5. Monitoring of pesticide and weedicide levels in the public water supply.

### St. Vincent and the Grenadines Water Supply System

The Central Water and Sewerage Authority of St. Vincent and the Grenadines, established in 1978, has responsibility for providing water service to the entire population of some 120,000 persons.

Between 1981 and 1989, the total daily water production was increased by about 25 percent, mainly through partial completion of two water supply projects in the northeastern section of St. Vincent at Georgetown and Sandy Bay. These systems have not yet been fully completed but beneficial use is being made of them and the average production rate is 0.5 mgd. and 0.2 mgd. respectively.

### Present Situation

At present, total water production varies between 3.5 mgd. in the dry season and 6.5 mgd. in the wet season. (Dry season is generally January to May; wet season - June to December).



To date, all the public water sources are surface-water and the systems are all gravity-fed.

Existing treatment facilities provide only for settling of large particles and simple chlorination, so that during the dry season water delivered to the distribution system is of excellent quality, but during the wet season when turbidity levels rise sharply, there is severe impairment of water quality.

It is estimated that about 90 percent of the population have access to piped water either through service connections or public standpipes.

There are 13,000 domestic service connections so that using a figure of five persons per household, some 65,000 persons are served through connections from the distribution system. There are 4,000 metered domestic customers and all industrial, commercial and government buildings are provided with metered services.

Water demand figures have not yet been developed, but operating experience indicated that while there is excess water say, in the North Leeward section of the island served by the Cumberland system, shortages exist elsewhere. However, the nation's capital, Kingstown, is generally adequately supplied.

#### Financing of Water Projects

The Sandy Bay Water Supply Project is being financed by a grant from the Baptist Church, the Georgetown project is being funded by the Taiwanese Government, and assistance is provided by USAID for construction of pipelines and storage facilities at the Diamond Industrial Estate.

Some assistance has been received from CIDA, and loan facilities are expected to be forthcoming from the Caribbean Development (CDB). Discussions have also been held with representatives of the French Government.

The Authority's revenues cover its operating expenses. Indeed, the surplus generated is considered to be sufficiently sizeable to service loans for capital works.

#### Sector Support Programs

The Authority has been pursuing a vigorous program of human resources development at professional, technical and craft levels. For example, employees have been sponsored for training in engineering, land surveying, accountancy, construction, business administration and waterworks operation at the University of the West Indies, technical colleges in Canada and Jamaica (CAST) and at workshops organized by the Caribbean Basin Water Management.

In addition, an experienced accountant was recruited from India through the Commonwealth Fund for Technical Cooperation (CFTC) to assist in improving the accounting systems and to train counterpart staff.

As far as the metering program is concerned, its success in encouraging customers to reduce waste has helped the Authority to improve its services to customers in areas where the supply used to be deficient. Consequently, there appears to be positive political fallout and, therefore, active political support is readily identified with the policies of the Authority.

### Constraints

No constraints have been identified. Indeed, the Authority seems poised to become a very viable and vibrant public utility in the 1990's.

### Improvement of Service Quality in the 1990's

1. Provision of treatment facilities for flocculation, coagulation, sedimentation and filtration at the Dalaway, Montreal and Majorca Waterworks.
2. Improvement of disinfection facilities at all waterworks.
3. Improvement in the pipe systems.
4. Groundwater exploration.
5. Monitoring of pesticide levels in the drinking water.
6. Exploring further development of surface-water sources.

Waste Water Collection, Treatment and Disposal in the Caribbean:  
Status and Strategy

Arthur B. Archer  
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A. STATUS

1. History - Water Supply Development: Uses and Wastes

1.1 It is now generally well known and understood in water and wastewater professional disciplines and operating agencies that sewage, or wastewater as it is now appropriately termed, is not largely the wastes from the human body - excreta and urine - but the product of the variety of undertakings and uses requiring the use of water, e.g., cooking, laundering, wastes from industry et. al. In fact, it is becoming fully understood that wastewater consists of approximately 99 percent aqueous matter or water, with the remaining 1 percent or less being particles of solids transported by the water, but being the major component for biodegradation of the total substance, and also containing the microbial life (e.g., bacteria) capable of transmitting diseases, such as typhoid fever, gastroenteritis, cholera and leptospirosis, and precipitating degradative environmental conditions.

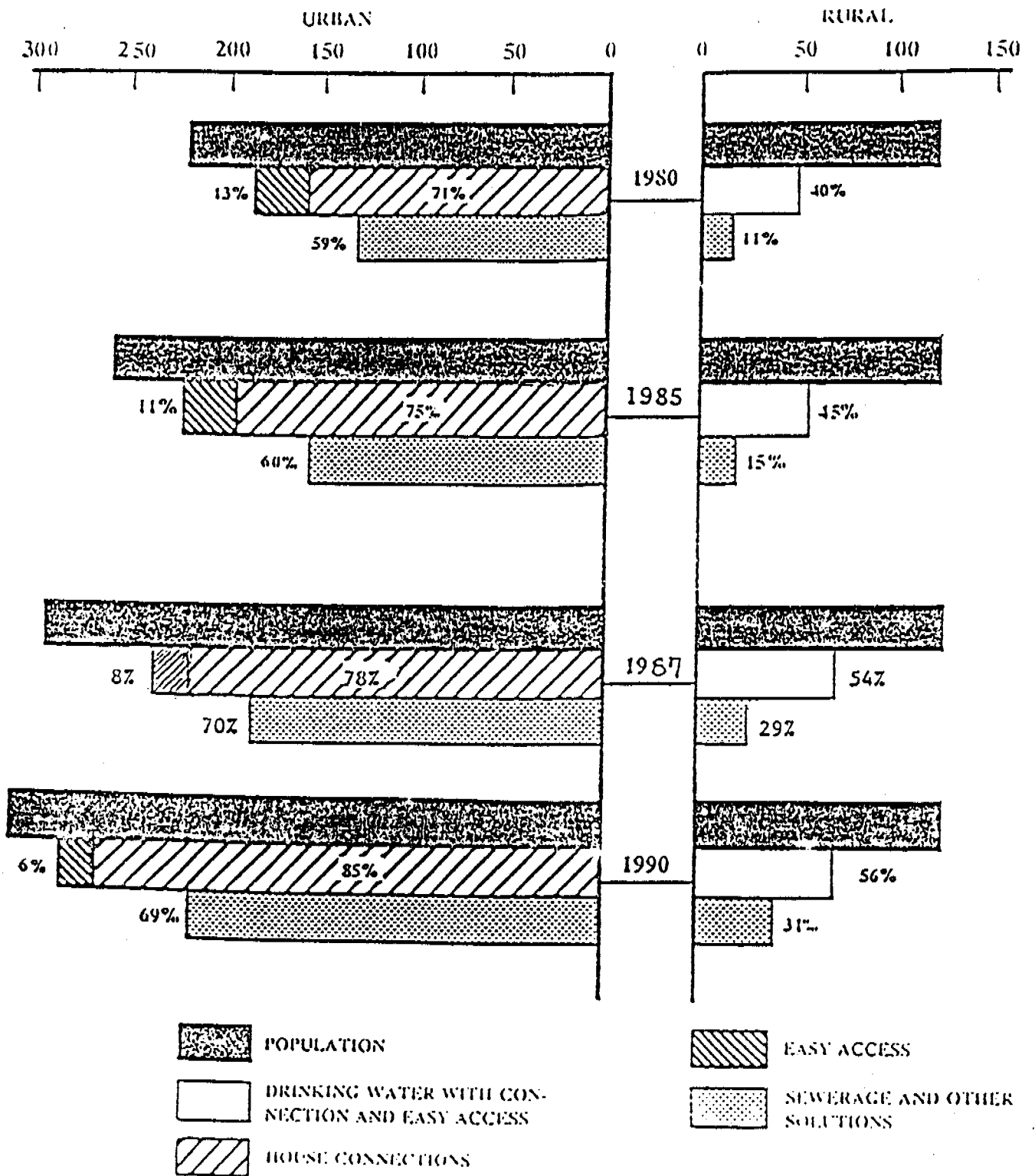
1.2 The post - 1939-1945 war years have seen rapid advancement in chemical technology, and with the use of chemical agents for washing and cleaning (e.g., detergents) and others in industrial processes (e.g., cyanide from metal dyeing) there is the inclusion of more toxic substances in municipal sewerage systems and more specifically in sanitary wastewater (sewage). With this new industrial revolution has come the quest for social change with improvement in the standard of living in the Caribbean, and unmistakably, there has been no greater catalytic factor to improvement in standards of living than the comparatively rapid provision of running water to homes, commercial places and industry. We have seen with the introduction of running water to homes, and, where physical or economic conditions remain an obstacle to providing supplies to individual homes, running water is supplied within easy reach of homes, e.g., at standpipes.

1.3 Incentives to Water Supply and Wastewater Disposal

There is little doubt that the World Health Organization initiated International Drinking Water Supply and Sanitation Decade (1980-1990) has done much to further stimulate the efforts of Caribbean and other countries worldwide to provide running water to communities previously deprived of this resource. The graphical chart, Figure 1, gives the picture of water supply, and sewerage and other wastewater disposal, in Latin America and the Caribbean during the Drinking Water Supply and Sanitation period, 1980-1987, with projections to 1990. The number of urban house connections with running water increased by 7 percent to 1987, while a total increase to 1990 is projected to 14 percent, while the increase of supplies of running water to homes and within easy access in rural areas was 14 percent by 1987 and is projected to 16 percent by year 1990. A similar percentage increase is projected for sewerage

Urban and Rural Population With Drinking Water and Sewerage Service in Latin America and the Caribbean 1980, 1985 and 1987 and target for 1990

FIGURE 1



Changes in urban and rural sewerage and sanitation percentages are due to revision of coverage figures submitted by Brazil

and other wastewater disposal improvements, but unlike water supply within an 85 percent of populations served by running water, sewerage and other disposal systems will only increase from 11 to 31 percent of regional populations served. Figure 2 shows the picture of water supply in Caribbean (CARICOM) countries. There is yet much to be done in the Eastern Caribbean subregion.

## 2. Wastewater Neglected - Need for Change

2.1 With the increase in supplies of running water, there appears to have been little thought given to the ways and means of disposing of the water wasted in domestic, commercial and industrial activities. For example, it is a well established estimate of 70 to 80 percent of water supplied to homes for domestic uses is wastewater; in industry, say the sugar industry between 3m<sup>3</sup> to 8m<sup>3</sup> of effluent per ton of sugar produced, and in the food processing and manufacturing industry an average of 60m<sup>3</sup> effluent per second is produced during working time. Figure 3 shows the status of sewage and excreta disposal in CARICOM Caribbean countries (1985) and demonstrates the fact that the wastewater disposal area of water supply has been neglected or generally misunderstood, with the resultant deteriorating environmental conditions due to the random disposal of untreated or only partially treated wastewater.

Table 1 gives the CAREC Epidemiological statistics for the period 1978 to 1982. These statistics show a high incidence of sewage pollution related diseases in nine (9) of the eleven (11) countries studied in the 1981-1982 "UNEP/CARICOM/PAHO Project for the Protection of the Coastal and Marine Environment of Caribbean Countries," with gastroenteritis having the highest incidence, and sewage and excreta polluted water being virtually confirmed as the main mode of transmission of the disease. The highest occurrence of typhoid fever was in areas without sewerage systems and where streams and rivers are used for the disposal of untreated sewage and excreta.

## 2.2 Methods of Wastewater Treatment and Disposal

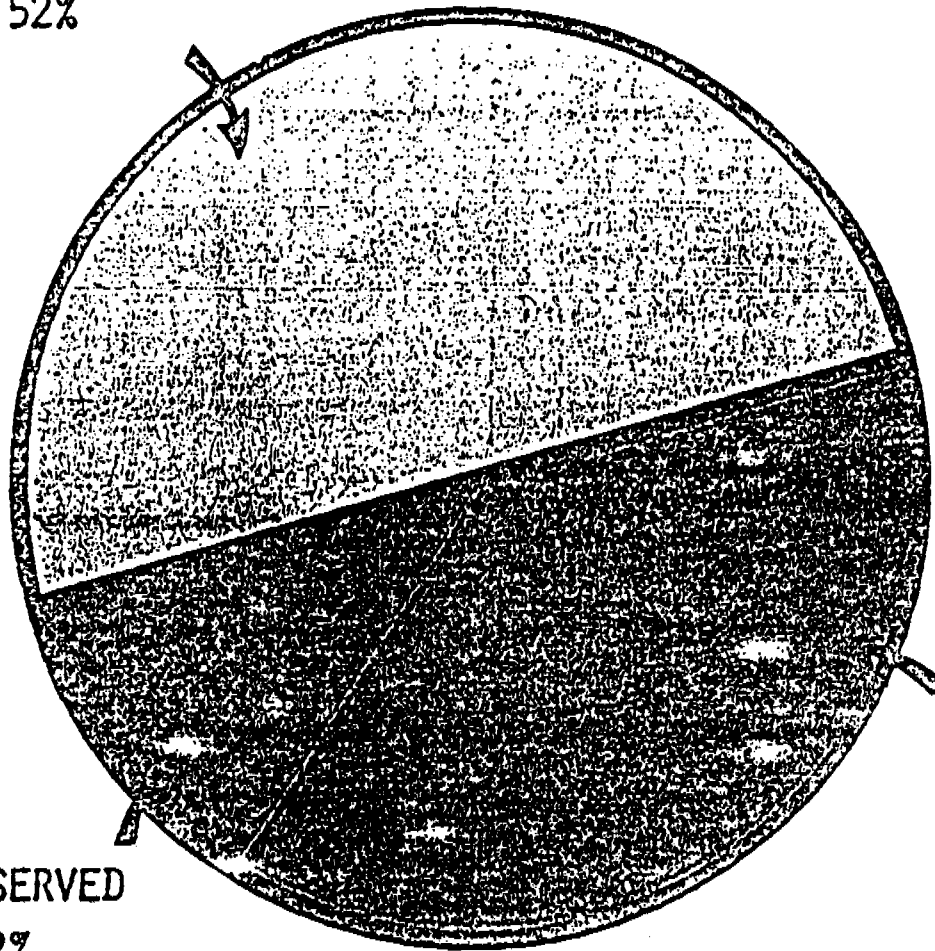
The method of treatment and disposal of waterborne wastes in the Caribbean, particularly in the Eastern Caribbean are few and somewhat basic with the septic tank being the preferred and most used method of treatment before disposal of effluent into wells, soakaways, tile fields, rivers, streams or the sea. The efficiency and public health protective quality of disposal of this wastewater depend almost entirely on the characteristics and absorptive capacity of the soil in the use of soakaways, wells and tile fields as disposal media. It is well known that in hard volcanic soils, such as in many parts of the Windward Islands, in the plastic almost impervious clays of St. John's, Antigua, there is minimal absorptive capacity, while in low-lying sandy densely developed coastal areas, such as in the Bahamas Islands, Barbados and Saint Lucia, the soils' efficiency to absorb septic tank and indeed other wastewater effluents is limited by volume, and the level of groundwater in the area, which is almost invariably high. The resulting failure of soil absorption in these mainly coastal/urban areas is the ponding of wastewater and effluents with their threats to public health and damage to the aesthetics and environmental quality of the areas.

# WATER SUPPLIES

FIGURE 2

HOUSE CONNECTION

52%



EASY ACCESS

35%

NOT SERVED

12%

COVERAGE OF WATER SUPPLIES

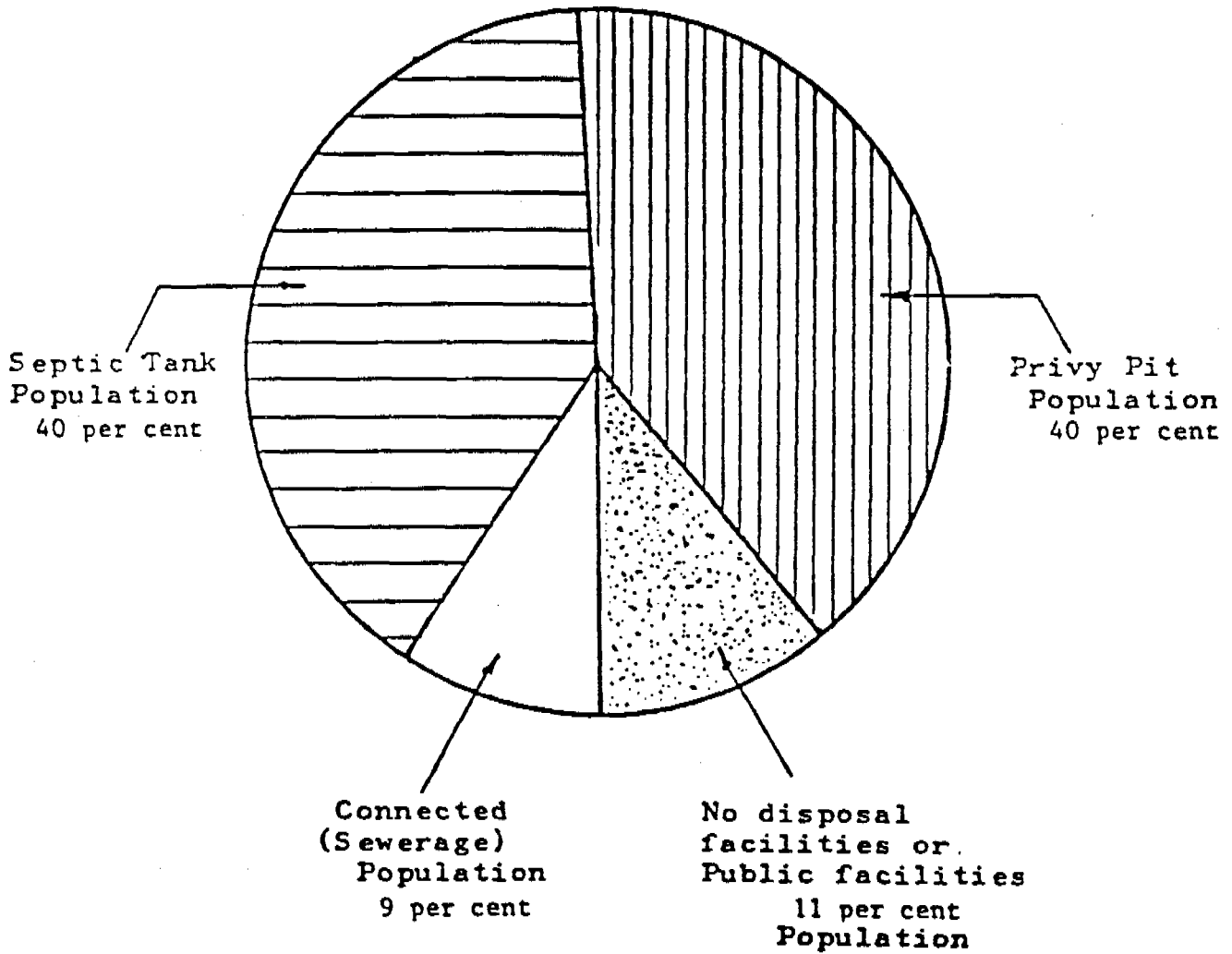
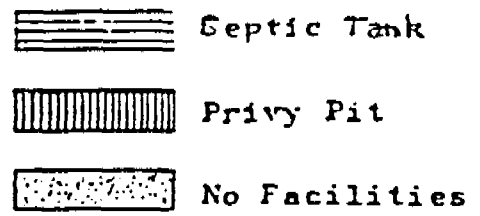
Table 1  
Occurrence of Waste Disposal, Water Pollution, and Related Diseases in the Caribbean  
Country

Year	Antigua	Bahamas	Barbados	Dominica	Grenada	Montserrat	St.Kitts-Nevis	St. Lucia	St. Vincent
<u>TYPHOID FEVER</u>									
1978	0	0	2	40	4	-	0	10	0
1979	0	2	4	18	1	-	0	4	0
1980	1	3	1	16	1	-	0	7	0
1981	1	-	1	65	2	-	0	14	4
1982	-	2	3	-	-	-	-	10	-
<u>GASTRO ENTERITIS (children under 5 years old)</u>									
1978	310	2,100	104	350	1,610	35	450	1,430	440
1979	270	2,000	370	339	885	90	780	900	986
1980	1,678	1,146	164	82	1,041	6	601	876	1,015
1981	423	-	141	67	335	-	665	377	1,366
1982	98	1,934	187	-	-	-	302	604	-
<u>DYSENTERY</u>									
1980	-	-	-	-	-	-	-	153	-
1981	-	-	-	-	-	-	-	103	-
1982	-	-	-	-	-	-	-	19	-

Notes:

- = Data not available or disease not notifiable

Data source: CAREC Review of Communicable Diseases in the Caribbean.



**Figure 3**  
**Regional Composite Percentages of Domestic Waste Treatment and Disposal Facilities**



### 2.2.1 Destruction of Coastal and Near-Shore Ecosystems

In many of the Caribbean Island countries, untreated and partially treated sewage is contributing to the rapid destruction of coastal and marine ecosystems, such as mangroves, sea-grasses and coral reefs via point source (e.g., through pipelines) and nonpoint sources (drains carrying grey water, industrial wastes, and over land).

In the case of coral reefs, which are naturally cemented masses of minute marine fauna (corals), they provide:

- a) a natural barrier which dissipates the force of waves and perform a protective function to coastal property, and beaches which they replenish by the natural process of bioerosion of calcium carbonate sand;
- b) large areas of symbiotic existence of coral reefs and reef fisheries; and
- c) a scenic submarine attraction to visitors from temperate areas of the world.

Marine and coastal studies carried out in several countries in the Region have established coastal wastewater disposal by point, nonpoint sources and by subsurface infiltration as major contributors to the deterioration of marine water quality with its consequential effects on public health, the environment and the economy of many Caribbean countries. Knowledge of the results of these studies appear to be having some impact on governments' raising their priority on wastewater collection, treatment and disposal.

### 2.2.2 Tourism: Its Impact

Tourism, as the industry has been developing in the Caribbean over the past 1-1/2 decades, and perhaps in consonance with the International Drinking Water Supply and Sanitation Decade, has probably exerted the most positive influence in addressing the need to adequately dispose of our wastewater, particularly in coastal and urban-coastal areas. There is a greater awareness of the need to improve environmental conditions in order to attract and maintain tourist industries.

The efforts in the use of septic tanks and subsurface or marine disposal have proved and are still proving inadequate for the large urban and coastal wastewater flows from hotels, apartment buildings and some government buildings. The resort to package sewage treatment plants, particularly at coastal hotels, with marine outfalls have been far from satisfactory as the majority of them are poorly operated and maintained, often with long term breakdowns due to unavailability of spares and of trained maintenance and repair personnel. Failure of package plants, and septic tanks with their adverse impacts are threats to tourism on which many Caribbean countries depend for infrastructural development through foreign exchange earnings.

2.2.3 Sewerage systems are, thus, seen as the most suitable infrastructural system to effectively collect, treat and dispose of wastewater. It is, however, also acknowledged that sewerage systems are very costly, and in the Region's current economic crisis, where governments generally are incapable of singularly generating the funds to construct sewerage systems, most sewerage projects will need to be executed with financial assistance from International and Regional Donor agencies.

### 3. Sewerage Systems - Water and Sewerage Authorities

Sewerage systems are not new in the Caribbean. The City of Port-of-Spain, Trinidad, had its first sewer system constructed in 1861. Subsequently, major systems were installed in Trinidad in 1902, 1935-1937, with the largest single sewerage project constructed during years 1962 to 1965. Jamaica has also had a sewerage system constructed in Kingston in the early years of this century, while Grenada, Saint Lucia, and the Windward Islands of Dominica had sewer systems constructed during the 1940's, with Barbados and St. Vincent having systems constructed during the 1970's and in 1982 respectively.

#### 3.1 Water Authorities

It is now the usual institutional practice for water authorities to be established to manage the water resources and distribution system of countries' water supply. Water authorities are now being appropriately given the responsibility to manage, operate and maintain sewerage systems. Almost invariably, the sewerage sector is heavily subsidized by the water sector. This subsidization is largely resultant of:

- a) property connections not made mandatory;
- b) connections being mandatory, but the statutory powers and requirements (ordinances and bylaws) not being enforced; and
- c) sewer rates not being collected, as operation costs and plant depreciation increase.

With the sewerage sector now being treated as a high priority infrastructural, public health and economic necessity, it becomes necessary for action to be taken at the highest level of government - the policy making level - to dispel the common notion that services, such as sewerage is a social and welfare service, and to positively establish the fact that sewerage systems are services which require considerable study, planning and its execution for the public good.

The Trinidad and Tobago Water and Sewerage Authority, perhaps the most advanced in the Eastern Caribbean has established a well structured and staffed wastewater section with the authority and expertise to pursue the country's plans for extending sewerage systems to the densely developed areas of Port of Spain and San Fernando. The Bahamas also has a comparatively long-standing

Water and Sewerage Authority, while Barbados established its Water Authority (1980) with the responsibility for sewerage. Saint Lucia and St. Vincent established authorities within the last five years, while Grenada is in the process of establishing its Water and Sewerage Authority to take over the functions of water supply from the Central Water Authority, and sewerage from the Ministry of Health.

This is obviously an encouraging turn of governmental events, and one of early signs to donor agencies that sewerage is really a priority in the improvement of environmental and health conditions and wise planning for future development.

B. STRATEGY

1. External Financial Assistance

With the almost inevitable need to seek external financing to plan, design and construct sewerage systems in the Caribbean, governments need to make the policy, institutional, and preparatory counterpart arrangements to attract serious consideration by donor agencies for external financing.

1.1 Preparatory Measures

Steps to be taken towards making application for assistance in the preparation and construction of sewerage systems include:

- a) establishing and demonstrating the high priority of the construction, operation and maintenance of the sewerage system for a specific area;
- b) countries need to have the following established or be in the course of being established or actuated:
  - i) an appropriate institution for managing, operating and maintaining the system. The establishment of water and sewerage authorities is a positive step in the Region;
  - ii) the preparation of tariff structure which should at least meet the financial requirements for management, operation and maintenance of the system, and depreciation of plant;
  - iii) the availability of experienced and competent technical personnel, and the provision of specific training to selected personnel in the operation and maintenance of the system; and
  - v) the early preparation of appropriate, strong legislation to, inter alia, achieve total or the maximum connections to the system, and to ensure timely collection of tariff revenue.

- c) and seeking technical assistance from a donor agency in the preparations for seeking financial assistance, once the national priority for the sewerage project is truly established.

## 1.2 A Regional Cooperative Approach to Sewerage

With the daunting economic conditions in several Caribbean countries, there is some reluctance to seek bilateral and multilateral (Donor Agency) assistance. Consideration may be given to seeking financial and technical assistance on a Regional or subregional basis. This will require considerable negotiation and resolute action at the political level, but is attainable. In such a pursuit, note and advice may be taken of the Mediterranean experience where 16 sovereign countries joined in the "Barcelona Treaty" to obtain financial and technical assistance from several international donor agencies to clean up the Mediterranean Sea and the coastal areas of the participating countries of untreated and partially treated wastewater and industrial effluents, which were taking that water body and adjoining territories to ecological, environmental and economic disaster.

## 1.3 Appropriate Technology

While in the Caribbean, the highest density populations are in urban-coastal and coastal areas, there are other areas of comparatively high population in small towns, villages and rural housing settlements.

With the high cost of conventional sewerage systems, consideration may be given to the use of methods termed "appropriate technology" to collect, treat and dispose of wastewater at lower costs as the scope of sewerage in such areas are unlikely to attract or justify external financing. In this context, some study may be given to the use of "small bore sewer systems."

1.3.1 In small bore sewer systems, the sewer pipelines only receive the liquid portion of household wastewater for off-site treatment and disposal. Grit, grease and other solids are separated from the wastewater flow in interceptor tanks installed on each property, upstream of the connection to the sewer. The solids which accumulate in the interceptor tanks are removed periodically for disposal.

The advantages of this system are:

- a) reduced wastewater flows in pipelines as solids are removed and larger quantities are not required for transport of solids;
- b) reduced excavation costs as less gradients are required in pipelines for transporting wastewater without the solids;
- c) reduced material costs as pipelines are of smaller sizes, manholes are reduced in number, and there is less need for lift stations with their power costs and need for maintenance; and

- d) less structural and mechanical facilities for screening, sedimentation et al., since much of this is done in the interceptor tanks.

The disadvantages or serious constraints in the small bore sewer systems are:

- a) the need for periodic excavation and disposal of solids from the interceptor tank;
- b) the maintenance and monitoring of interceptor tanks need to be done by an operating agency, and not the property owner, hence efficient management is a priority;
- c) an established method of treating the wastewater from the system needs to be promulgated; and
- d) experience with the system is limited and mixed.

C. Technical Papers by United Nations (UN) Agencies

Water Resources Management in Small Caribbean States

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(Presented by K. Suthakar, Civil Engineer)

(The views expressed in the following presentation are the author's and do not necessarily represent those of the United Nations or the countries referred to either individually or collectively).

General Background

Water supply and demand differ widely in each of the small Caribbean islands and strategies adopted for water resource development and management are equally diverse. Regional water resources are unevenly distributed: in many of the islands, there is significant unsatisfied demand for water, while in a few, there is a surfeit that cannot easily be made available for the common good of the Region.

The following observations are based on in-depth experience gained in several, but not all, small Caribbean islands, and therefore, might not have universal application. However, whereas factors affecting the availability of water are unique to each island, issues involving policy, institutional structure, and organization have been found to be common and may, therefore, more appropriately be addressed on a regional basis.

Acute problems are faced on account of many interrelated factors. Notable among these are: small area, limited rainfall, common drought, high runoff, high evaporation, complex geology and low groundwater storage volume, vulnerability to saline intrusion and pollution, limited financial and human resources, and lack of broad water policies. Virtually, all the islands of the Eastern Caribbean rely heavily on the tourist industry to support their economies, and the need to satisfy high seasonal demands associated with this industry imposes a heavy burden of capital investment and operational cost which, unless recovered by correspondingly high tariffs levied directly on the industry, must be born by a public which can barely afford to meet its own share.

In most cases, the problem of supplying water for basic needs can be solved without recourse to costly nonconventional sources, such as barging, desalination, etc. Once all the most easily developed water resources are tapped, the development of groundwater and use of impervious catchments are the most promising methods of correcting the present imbalance between demand and supply. In a number of countries of the Region, it has been noted during project preparation that low-cost and simple water development methods have been overlooked, sometimes in favor of sophisticated and costly systems that have no relevance to small island needs. Those islands within the Region which are of volcanic origin are, on account of their topography and geological structure, favored with perennial springs and surface waters, which when juxtaposed with groundwater permit a highly effective regime of conjunctive use to overcome seasonal shortfalls.

In many countries water legislation, whether enforced or not, often results in unfair water distribution among the demand sectors. Increasing the availability of water will in the short term, offset this imbalance, but reform of some of the legislation and its associated administrative framework is needed.

No long range management strategy can be effective unless accompanied by official, comprehensive government policy supported by appropriate legislation. This have been notably lacking in water resource management throughout the Region, and the thrust of future strategy must be strongly policy oriented with emphasis on the strengthening of regional institutions so as to provide guidance on these policies.

UNDP Project RLA 82/023

UNDP has been active in the provision of technical assistance and coordination of water sector inputs in Eastern Caribbean Region, since the beginning of the present decade, principally through its Regional Project entitled, "Water Resources Assessment, Development, and Management in the Small Caribbean Islands." As well as pursuing the primary goals of water resources exploitation, assessment and planning in these islands, this project, since its inception in 1980, broadened its scope to assume a wide sectorial role. Currently, the main coordination of inputs within the water supply sector, the coordination of inputs within the water supply sector, the provision of technical guidance in the preparation of individual island projects and liaison with international and bilateral agencies. Assistance to governments in making application for the funding of waterworks by local and external agencies has also been a major activity, and the elaboration of long-term development plans has proved to be an excellent guide for funding agencies to allocate their investment resources. The project is also active in the training of national technical staff by the provision of fellowships and shorter term courses.

Employing a team of UN Associate Experts and Volunteers, dispersed throughout the Region, and managed and coordinated by UNDTCD staff out of Barbados, the project operates in the majority of the small English-speaking islands, with intermittent involvement in the Netherlands Antilles. A number of UNDP funded individual national projects with their own particular goals have also been supervised by the Regional Project.

The impact of the technical assistance provided in this way is reflected in the fact that the project has assisted in the preparation of projects involving over US\$435 million of follow-up capital investment much of which has been generated from donor agencies. Contributory funding for the running of the project has amounted to little over US\$4.0 million. Manpower development and the strengthening of sector institutions has been achieved cost-effectively through the provision of technical personnel working side by side with local staff.



### Water Resources Development Plans

The manner in which water resources on the various islands may best be developed to meet demand will depend primarily on economic factors although reliability and accessibility will also be major considerations.

Natural water resources, such as surface water, groundwater and rainwater catchments should received primary consideration, but as more readily available resources are being tapped, new sources become increasingly expensive. When costs of natural resources become inflated or alternatively, when they become exhausted, the use of nonconventional resources must be considered as an alternative. Methods commonly considered have included desalination in all its forms, as well as barging from islands with an excess of water. There is some reluctance to accept desalination in view of its high cost and complexity of operation and maintenance, while barging is viewed favorably only as an option in times of crisis. The purchaser of barged water is hesitant to enter into agreements which require guaranteed acceptance of a fixed quantity over a long period. Without this assured income, capital investment by the supplier is unattractive. Other stated objections to barging have been problems of sovereignty, force majeure, and risk. Barging between islands of the same States does not involve these problems and becomes a viable option when water resources are unevenly distributed.

One of the principal output of the project has been the preparation of development plans for five islands, setting viable goals for water service levels, and presenting an optimum investment program to achieve these goals. All viable alternative sources of supply were examined and least cost solutions determined. These plans have been helpful to the various funding agencies to determine the optimum manner in which to provide financial assistance.

Some of the innovations recommended and adopted have been:

1. the implementation of communal piped salt water systems for toilet flushing, thus, permitting the exclusive use of scarce fresh water for potable water needs (Turks and Caicos);
2. the renting of prefabricated roofwater catchment tanks to low-income households on an interest free basis (Turks and Caicos);
3. the encouragement of hotels and tourist complexes to attend to their own needs by installing their own desalination units (Turks and Caicos);
4. the use of treated sewage effluent for irrigation of recreational areas (Cayman); and
5. the generation of hydropower as a by-product of bulk export of water (Dominica).

### Groundwater

The project has been particularly active in the provision of hydrogeological assistance within the Region, and has assisted national coordinators of a number of islands in the preparation of hydrogeological maps for inclusion in the Regional atlas which UNESCO is expected to publish in the coming year. This atlas will locate and, wherever possible, show the extent and character of the important groundwater sources in each island, and will be a valuable instrument to water authorities in their planning and resource management. There will still, however, be need for more refined investigation prior to exploitation. The project has carried out much detailed geophysical work to assist in the planning of production drilling programs and the success achieved in production has been proof of its cost effectiveness. Preliminary investigation of this nature has greatly assisted the drilling contractor by alerting him to the approximate limits of the aquifer or lens. The project has encountered many instances of salt water intrusion in existing well fields caused not solely by over pumping, but by the incorrect positioning of well screens too near the salt water interface. The use of geophysical methods beforehand and careful logging of the wells during construction would likely have prevented this.

### Surface Water

Experience has shown that surface water resources throughout the islands are not well documented. Whereas rainfall data is extensive and recorded over a long duration, river flow gauging has been particularly poor, so that accurate correlation to determine reliable abstraction levels for supply schemes has not been possible. More recently, greater emphasis has been placed on the installation of flow gauges on principal water courses, but so urgent is the need for this valuable information that one of the top priorities of the coming decade should be implementation of an intensive regional program of river flow gauging conducted preferably by a regional institution, such as CIHM (Caribbean Institute of Hydrology and Meteorology) who would, thereafter, be in a position to provide flow data to local water authorities when it is required.

### Deterioration of Existing Resources

Current service levels in the more developed islands demonstrate a generally favorable supply situation. However, there have been factors in recent years which have caused seasonal shortfalls in supply, as well as a general deterioration in the quality of raw water.

Catchment areas throughout the Region have been denuded of natural vegetation, either to provide fuel, or to allow the planting of cash crops. This has caused erosion of the soil, an increase in turbidity of raw water, rapid runoff in the wet season and a decrease in flow by as much as 50 percent in the dry spell. Surface water quality has been adversely affected by the extensive use of pesticides within the catchment areas, while groundwater has in some instances been contaminated by salt water intrusion and illegal dumping of wastes in restricted areas.

The problem is further aggravated by the fact that supply shortages generally coincide with the season of intensive tourist activity. In those islands where groundwater as well as surface water is available for supply, seasonal depletion of river water can be compensated for to a certain extent by judicious conjunctive use of groundwater. In this way, well water is used to supplement depleted river flows in drought periods, while in the wet spell supplies are drawn more intensively from more abundant river sources, to allow well fields to recuperate.

In one island where a well field has been seriously contaminated by salt water, new spring sources are being tapped in the locality as an alternative source so as to allow the well field to recuperate over a long period.

The protection of catchment areas from erosion, denudation and contamination is a matter of urgency to be supported by appropriate legislation, accompanied by an official, comprehensive government policy, and an intensive public awareness campaign.

#### Water Legislation

Existing legislation in general fulfills many of the operational needs of the water sector. There is, however, a continuous need for review and updating to keep abreast of development. The previously mentioned need for catchment protection and rational resource allocation are cases in point, while the current trend for sewerage to be included as a responsibility of newly created Water and Sewerage Boards, necessitates a major revision of existing statutory legislation.

One of the early activities of the UN project was the collection and review of existing water resources legislation in a number of islands. Where requested, suggestions for improvement were made, and in the case of Cayman and Turks and Caicos, assistance was given in the drafting of completely new legislation. This basic work is currently being continued by FAO under its regional water legislation project, and the problem of catchment preservation in particular is being dealt with from both the agricultural and drinking water standpoints.

The UN project has found that, whereas, existing legislation often grants water authorities extensive control over the allocation of groundwater resources, the control of surface water is not well defined.

#### Allocation of Water Resources

In the rare cases, where a government body has been instituted to control the allocation of water resources, it has been found that this body has not been entirely free of the "self interest" of one or other of the competing users. An appropriate independent body should be entrusted with the responsibility of allocating to competing users, on a priority basis, the limited water resources available. Its terms of reference should be well defined, and its powers given full government support with the necessary legal backing.

The current policy of granting priority to drinking water is commendable up to levels necessary for good public health. Once this need is satisfied, however, there is some justification for priority allocation to be based on appropriate cost/benefit criteria. Use of water for locally grown cash crops may, for example, compete very favorably from a macro-economic standpoint with a more generous though nonessential allocation of drinking water.

Many islands, particularly those without domestic metering, have no real basis for determining design norms for service levels. Service levels must essentially be tailored to suit the availability of sector water resources and must not be established on arbitrary principles. Once these have been set, restriction of consumption to within these limits may be achieved effectively by an appropriate pricing mechanism which penalizes excessive usage. An equitable system of resource allocation and the establishment of appropriate design norms for service levels are areas where independent Water Resource Units may provide valuable assistance in resource management which transcends the sectorial level.

#### Waste Reduction and Pricing

Leakage in distribution systems coupled with wastage and extravagant usage is high in most islands, and levels of "unaccounted-for" water are frequently as high as 50 percent of production. Notable exceptions are those islands with extensive domestic metering where lower figures of about 25 percent obtain.

The project has found that, as a general rule, domestic water supply is not being metered at the present time, the rate structure in use being based on assessed property valuation, water consumed (when metered), the number of fixtures, or on a combination of all these.

Current rate structures based on property evaluation are an inducement to waste, particularly in highly valued properties which pay high rates, where owners are declined to use water extravagantly to justify their expenditure.

Universal metering would permit water authorities to establish a more equitable tariff structure based on "ability-to-pay" criteria. In such a tariff, a low price may be charged on a minimum "lifeline" supply which would meet the affordability threshold of the low income family, while punitive charges would be imposed on extravagant, wasteful usage.

The reduction of unaccounted for water to more reasonable levels of 20 to 25 percent should be a priority issue during the next Decade. Such a reduction would permit the extension of existing systems without need for greater abstraction from existing sources. The increased sales, so incurred, would produce a higher return on capital investment.

### Sector Organization

Responsibilities within the regional water sector for planning, design, construction and operation of water works, as well as the retail of water to the public, rest generally with Water Boards or Commissions which enjoy varying degrees of autonomy and financial independence. There are exceptions where operations, wholly or in part, are carried out by private bodies, while in other instances, these functions are still carried out by government departments. With the increased usage of water-borne sewerage within the Region, the responsibility of sewage collection and treatment is being placed with newly created joint Water and Sewerage Boards or Authorities.

Large financial deficits in water supply operations in recent years have prompted some governments to consider seriously the placement of these responsibilities, in whole or in part, in the hands of private companies. It appears to be accepted in some quarters that at least part privatization is desirable, i.e., that some, but not necessarily all, of the operations involved in the supply and distribution of water should be privatized. Limited privatization would have certain practical merits; the privatization of maintenance functions by "service-contracts" is an approach which is being increasingly employed in some South American water authorities and should be considered, while follow-up operation and maintenance services are becoming a standard feature of supply contracts for complicated equipment such as desalination plants, and other mechanically intensive units.

### Water Quality Control

Most water authorities maintain adequately equipped laboratories with staff capable of performing the routine water quality analyses. The project has assisted in the setting up and equipping of laboratories where such assistance was required, and has arranged and financed the training of laboratory technicians. It is not uncommon, however, to find that sampling and analysis are not being carried out on a regular and systematic basis and it has been noted in some instances that there have been lapses in maintaining chlorination facilities in good working order. This would obviously have been detected and rectified within an efficient quality control system.

Also of concern is the delegation of responsibility for drinking water quality monitoring. The ultimate responsibility for monitoring water quality, as it affects public health should lie with the Ministry of Health, but in practice it has been found that in most instances, they do not have the testing facilities to carry out this function effectively. Water quality control is, therefore, passed on to the water authorities, who do so with the prime objective of maintaining efficient standards of operation.

To fulfill their duties effectively, the Public Health Department should conduct their own sampling program, make an independent analysis, and exert their full authority by compelling the operating authority to take action where necessary. They should possess the means and resources to implement such a program of quality monitoring in an objective manner.

Data Banks as a Management Tool

Management and planning within the water sector is being seriously handicapped by lack of basic data. A deficiency in equipment is a major cause, but a lack of motivation to collect data, has also been a handicap. In all islands, but particularly in those where there is a multiplicity of water resources, the establishment of a computerized data bank is of paramount importance. By this means data in the following basic categories may be stored:

- |                           |               |
|---------------------------|---------------|
| Rainfall                  | Storage       |
| Water catchments (runoff) | Distribution  |
| Groundwater               | Demand        |
| Treatment plants          | Water quality |

This information may be programed so as to give management a more precise status of the water supply system at any time. With further development, it will permit the forecasting of resources availability and will help to determine the optimum strategy to achieve maximum utilization of available resources. These efforts would be enhanced by the appointment from within the authority of a computer specialist trained in water resources computer technology. Through this specialist, the authority would be better equipped to assimilate up-to-date techniques, and to receive outside assistance, particularly from neighboring countries already proficient in this field.

Water Sector Coordination

Water sector coordination has improved markedly over recent years. Formal round-the-table quarterly meetings between the various interested international agencies, aimed at rationalizing regional sector inputs, are attended by bilateral, as well as multinational agencies. Representatives from each of PAHO, CDB and UNCTAD form the "core committee" elected to stimulate coordination activities within the sector, and assist the monitoring of regional progress towards Decade objectives. A major outcome of these meetings has been the avoidance of duplication, particularly in the field of training, in which the program of the Caribbean Basin Water Management Project has focussed its major input. Often such rationalization has allowed project components duplicated in other programs to be diverted for other useful purposes.

International Drinking Water Supply and Sanitation Decade (IDWSSD)

On the specific subject of the "Decade," it must be mentioned that the islands of the Region, although generally in accord with the overall goals have shown a relatively detached interest in their implementation outside the Region. They have rather involved themselves in the specific issues of their own particular sector needs. This may very well have arisen out of the comparatively high water service levels which exist in the larger islands, where the availability of house service connections and the needs of a sophisticated tourist industry seem to be more of a concern than the degree of

accessibility to potable water supply. This is illustrated in the accompanying Table which indicates the water service levels obtaining in 1987. A significantly large investment is still being made in the water sector for the continued improvement of its service and in its institutional strengthening, particularly by the bilateral agencies. It should be noted, however, that the favourable situation experienced in the major islands is not shared by some of the smaller islands; the Turks and Caicos Group, the outer islands of the British Virgin Islands, and the Grenadine Chain, have many communities which still have to subsist on roof catchment systems and dubious well sources yielding in the drought period less than five gallons per capita per day. Considerable investment is needed to bring them within accepted Decade goals.

The corresponding picture in the sanitation sector is somewhat different. Efficient water-borne sewerage and disposal facilities are rare and have only recently been considered seriously in conjunction with the problems of groundwater, marine and coastal pollution. Service coverage by other forms of disposal may still, however, be considered comparatively extensive. It is probably in this aspect also that a concerted effort should be made to meet the goals of the Decade. UNDP is currently funding regional studies in marine pollution, and German Aid (GIZ) in association with PAHO and CARICOM are about to embark on the strengthening of the Caribbean Environmental Health Institute (CEHI) with the objective, among others, of improving its capability to formulate sector policies and to provide a means for coordinating and channelling sector investments.

#### Human Resources

The lack of trained personnel is a universal problem hindering effective management in all sectors, and is a major reason behind inefficiency and burgeoning financial deficits in some public sector operations. Attempts to rectify this situation and to achieve greater self reliance have been frustrated to some degree by lack of human resource potential. Privatization has been perceived as a solution to the problem, particularly as this expedient has already had favorable results in other sectors. However, greater self-reliance through continued efforts at human source development should still remain a top priority.

The provision by the project of expatriate professional staff has possible fostered a tendency in some islands to be over dependent on outside assistance. The project is, however, sensitive to this issue and has encouraged self-dependence through the provision of fellowships and training. In some instances, where populations are small and education limited, it would appear that some reliance on expatriate professional staff will continue for some time to come.

#### Centralized Support Services

The duties of management, planning, operation and normal design are sensible performed by the permanent staff of water authorities at the place of duty. This staff may be supplemented as required by expatriate staff seconded

WATER SERVICE LEVELS IN EASTERN CARIBBEAN ISLANDS (1987)

Island	% Population with easy access to Public Water System			% Population drawing water from other sources
	S.C.	P.S.P.	Total	
Antigua	62	38	100	0
Anguilla	18	30	48	52 (1)
B.V.I.	62	0	62	38 (2)
Dominica	36	54	90	10
Grenada	52	23	75	25
Montserrat	94	6	100	0
St. Kitts	73	24	97	3
Nevis	30	50	80	20
St. Lucia	42	43	85	15
St. Vincent	48	42	90	10

S.C. = Service Connection  
P.S.P = Public Stand Posts

(1) 73% of population served by private roof catchment systems.

(2) Population has access to 70 public wells.



from international agencies, or for special assignments, by private consulting companies. There are, however, certain specialized services which are constantly in demand within the Region as a whole, but which it would not be cost effective to provide in each individual island on a permanent basis. Such services include: hydrogeology, hydrology, training, research, water quality management, an information services (library, data bank, etc.).

These could most effectively be provided by specialist staff permanently employed at regional institutions. This principle has already been partly established. CIHM currently trains hydrological staff from the various islands, collects and stores met data and undertakes hydrological and hydrogeological assignments.

Regional training, both managerial and at the operator level, is carried out effectively by the Caribbean Basin Water Management Project. The Caribbean Environmental Health Institute (CEHI) undertakes the training laboratory technicians, performs specialized water quality analysis and is being increasingly active in the execution of regional pollution studies. The UN Regional Project has been active in providing hydrogeological, and hydrological services, as well as the training of technical staff.

One centralized service which has been proposed and discussed at some length, and which has considerable merit is the provision of a drilling rig and trained crew, centrally located, which would be capable of carrying out investigatory and production drilling through the Region as and when required. There is already a large work load awaiting this service, and more detailed consideration of the proposal would be worthwhile. The responsibility, management and operation of this facility would sensibly rest with the regional institution designed to provide hydrogeological services.

The main goals of Project RLA 82/023 have essentially been achieved. Earlier frustrations caused by the lack of local counterpart staff have now been eased by greater availability of trained engineering personnel and the successful efforts of water managers to recruit them. In the small islands where no local qualified water engineering personnel exist, governments have now decided to create permanent posts for recruitment from within the Region. The UN project personnel are, therefore, being employed more on specific assignments than on day to day operational aspects.

It is unlikely the Project will be able to continue its activities much beyond the end of 1989, and it is both opportune and appropriate to preserve the project's vital infrastructure, its experience and acquired knowledge, by transferring some of its functions to already established regional institutions. UNDP will, of course, continue to provide technical assistance to the sector on an ad-hoc basis, within the limits of local and regional funding.

With the assistance of outside agencies initially and with long range commitment for their support from within the Region, these institutions, strengthened in their various field of specialization, should in time assume the responsibility of providing other centralized support as required.

### Regional Sector Strategy for Next Decade

Having regard for the issues identified in the foregoing presentation, any strategy for the improvement of the regional water sector over the next Decade, should include, but not necessarily be limited to the following:

1. The implementation of a vigorous program of leak detection and water prevention aimed at reducing "unaccounted-for" water to a reasonable level. These measures should be supported by the installation of bulk supply meters at key points, and the gradual introduction of universal domestic and commercial metering, together with tariff structures which discourage excessive usage. Such tariff structures should be the subject of in-depth studies of water demand, annual expenditures, and socioeconomic factors, carried out preferably by suitably qualified consultants, who would also examine fully the capital and maintenance costs of metering and the benefits derived therefrom.
2. The improvement of service in the more developed islands mainly by extending coverage, but also by increasing the proportion of house service connections, as this will help reduce wastage and improve cost recovery.

The implementation of improvement programs on less populated islands, currently without a public supply, aimed at bringing service levels to within IDWSSD goals.

Where projects have been defined in order of priority in development plans, these must be prepared and formalized, funding commitments obtained and implementation initiated. Capital investment must be accompanied by an official, comprehensive government policy, supported by appropriate legislation to guide the long range development of the sector.

3. The establishment of sectorially independent Water Resources Units, working within well defined terms of reference, and empowered to allocate water resources to competing users on a priority basis. They will also assist water authorities to establish design norms for service levels which correspond with resource availability.
4. The provision to Public Health Departments of the means and resources to conduct their own quality monitoring sampling programs and to make independent analyses, so as to enable them to exert their full authority by compelling water authorities to take remedial action where necessary.
5. The formulation of a well defined policy on the protection of catchment areas, and the prevention of pollution of ground and surface water resources, to be enforced by appropriate legislation.

6. The initiation of an extensive regional program of flow recording on designated water courses, preferably under the direction of a regional institution, such as CIHM, who would record the data and subsequently provide flow criteria to local water authorities to assist them in the design of river abstraction projects.
7. The strengthening of regional institutions, such as CIHM and CEHI with the objective of enhancing their capability to provide centralized support services to the Region as a whole, and to provide guidance on sector policy issues. Hydrological and, to a lesser extent, hydrogeological support is already being provided by CIHM, but this needs to be bolstered to meet extended responsibilities. The proposal to furnish a regionally owned drilling rig with a trained crew for test and production drilling within the Region should be studied in detail.
8. The establishment of computerized data banks in all islands, but particularly those relying on a multiplicity of resources, initially to store resource information, but eventually to serve as a management tool to help determine optimum strategy for resource utilization.
9. The continued training and development of human resources in the water sector both at the managerial and operator level, to be provided at a regional level through the services of the already established CBWMP training program.

D. Technical Papers by Representatives of Regional Institutions

Economic Developments in the Caribbean Region  
and Their Influence on the Water Sector

Cecil Pemberton  
Project Officer, Caribbean Development Bank (CDB)

1. Introduction

It is now well established that water is one of the most important resources available to man as most human activities involve the use of water in one way or another. Also, well established is that the wastewaters from man's use must be safely disposed of so as not to pose a public health hazard or be a source of pollution to the environment. The practice of water supply and wastewater or sewage disposal constitute what hereafter will be referred to as the water sector.

A Decade ago, those charged with the responsibility for the water sector were motivated by the benefits to be derived from the promotion of community health. Today, however, availability of water is regarded as essential for sustained economic development, leading to an enhancement of the quality of life. MacNeil, the Secretary General of the World Commission on Environment and Development, estimates that in 80 developing countries (the Caribbean included), water is already a serious constraint on development.

In the Caribbean Region, the optimum availability and use of water for supply purposes is constrained by:

- a) the economic climate presently existing in many of the countries in the Region;
- b) pollution due to improper disposal of wastewaters emanating from households and industries and increasingly from agricultural runoff; and
- c) improper watershed management manifested as deforestation and unplanned physical developments.

While a fair degree of progress has been achieved in the water supply subsector, including the substantial achievement of some goals set under the International Drinking Water Supply and Sanitation Decade (IDWSSD), the same does not hold true with respect to wastewater disposal. The stench emanating from our roadside drains, the continuing destruction of many of our coral reefs, sea-bed grasses and wetlands; in addition to the presence of floating solids, grease, scum and high turbidity of our sea-bathing waters, are all ample evidence of the need to institute adequate measure to collect, treat and dispose of our wastewaters.

This paper will broadly present some issues pertaining to the economies of Caribbean countries as they impact on the water sector. Special emphasis will be placed on the Borrowing Member Countries (BMCs) of the Caribbean Development Bank (CDB). The issues raised with respect to these countries will, in most instances, be applicable to other countries in the wider Caribbean Region.

## 2. Economic Activity and the Water Sector

The economies of Caribbean countries have traditionally been dependent on agriculture, and to a lesser extent, tourism manufacturing and mining. Generally, the last Decade has witnessed a mixed performance in the agricultural sector, an expansion in tourism and manufacturing, and a general decline in mining. This has taken place amidst efforts on the part of governments to grapple with the problems of:

- a) unemployment;
- b) fiscal deficits; and
- c) a persistent deficit in balance of payments and the resultant deterioration in foreign exchange reserves.

### Agriculture

The agricultural sector is, to a large extent, dominated in the Caribbean by sugar and banana production.

Up to 1988, the glut of sugar products on the world market has resulted in a falling price trend. However, 1988 saw a reversal in this trend with the improvement in prices to the highest level in just under five years. All indications point to sugar production in the Caribbean continuing to be one of the main sources of employment and a generator of foreign exchange. However, price fluctuations are expected throughout the 1990's in keeping with world market trends.

Notwithstanding the importance of sugar to the economies of several Caribbean countries, there have been major developments with respect to production. Commenting on sugar production in the Region for that year, the CDB's 1988 Annual Report states:

" Jamaica and Trinidad and Tobago increased sugar production by about 17 percent each. Nevertheless, overall regional production declined by about 2.6 percent primarily because of a 27 percent drop in production in Guyana. Performance was adversely affected by a number of factors, including unfavorable weather conditions, labour shortages and industrial disputes. More importantly, the report points to ongoing rationalization programs in Barbados, Belize and Guyana which have led to substantial cutbacks in acreage planted."

conditions, many utilities have had to resort to the relocation of river intakes higher upstream, or in some cases, forced to consider the construction of relatively expensive dams and impounding reservoirs, desalination or even the importation of water from other islands blessed with an abundance of supply, such as the island of Dominica.

Farmers throughout the Region, in an effort to boost production, have also resorted to the extensive use of pesticides, weedicides and fertilizers. The runoff from agricultural plots treated with these agrochemicals has resulted in the abandonment of many river intakes that have traditionally been used as a source of water. Treatment of water contaminated with agrochemicals is complicated and prohibitively expensive. It is also debated in some quarters whether the treatment is complete.

The foregoing adverse effects of agricultural activities on the Region's water supply can be solved by:

- a) appropriate watershed management, including the control of the location of land that will be put under agriculture; the establishment of land use plans with enabling legislation; and
- b) placing controls on the type and quantity of the agrochemicals used. In this instance, although appropriate legislation is essential, there is need for education of farmers.

### Tourism

The tourism sector, described by a former president of CDB as 'white gold,' has shown a marked growth in countries of the Region. Between 1985 and 1988, there was an average 6 percent growth per year. Tourism expenditure in these countries also showed a marked increase of 3 percent between 1985 and 1987 in keeping with the increased visitor arrivals. A breakdown of tourism expenditure in the EMCs for the years 1985, 1986 and 1987 is shown at Appendix 1.

In recognition of the importance of tourism to the economies of countries in the Region, many governments have adopted a policy of providing the necessary infrastructure for the industry. This includes the supply of potable water. In many islands, supplies to hotels are often given preferential treatment to supplies to residential communities. This situation becomes more critical when the per capita demand of a tourist of over 80 L/d is compared to the domestic per capita demand of under 200 L/d. Clearly, in areas of scarcity, there is need for rationalization of distribution. In addition, consideration should be given to the hotel industry contributing towards the capital expenditure of water projects. Also, tariffs should be structured so that appropriate charges are levied on the hotel industry consistent with the importance of water supplies to their continued existence and growth.

In Trinidad & Tobago, the government is actively pursuing a policy of taking 3,000 acres of land out of sugar production and diversifying into non-traditional crops, such as paddy rice, citrus and cassava and livestock rearing.

In 1988, regional banana production rose by an estimated 33 percent with the islands of Saint Lucia and St. Vincent and the Grenadines, Dominica, and Jamaica, accounting for the majority of the production. The expansion of regional banana production over the past few years has been associated with measures to improve operational efficiency and fruit quality. The success of these measures is demonstrated by improvement in the financial position of the industry. The performance of the regional banana industry is being further enhanced by the increase in the average price of the commodity on the world market which rose from about \$498 per ton in 1987, to an estimated \$512 per ton in 1988.

The single European Economic Community (EEC) market, which is due to come into effect in 1992, may have a marked effect on regional banana exports and, hence, on the entire banana industry. Under the proposed agreement, the guaranteed market now presently enjoyed by regional banana exporters may no longer exist. In this regard, CDB's 1988 Annual Report states:

"The possibility that this preferential status will expire at that time (1992) suggests that regional producers should accelerate efforts to reduce the industry's production costs, thereby, improving competitiveness...."

It is also apparent that serious consideration will have to be given to diversifying out of banana into other crops.

Resolving the issues of diversification and increasing productivity facing both the sugar and banana industries, has major implications for future water supplies. In both instances, crop irrigation would appear to be a viable option. Therefore, in allocating the water resources of any particular area to the various sectors, it is now imperative that engineers assess future irrigation needs and the possible integration of such needs into water supply projects. Such considerations were actively pursued in the feasibility study for the Roseau Basin Water Supply Project for the Island of Saint Lucia. Under this project, a dam is to be constructed to impound a reservoir which would allow for the irrigation of a banana plantation on the lower reaches of the catchment. It is noteworthy that at present, the water resources of the area would not allow for the irrigation of this plantation.

Increased banana cultivation has contributed to massive deforestation of large tracts of land throughout the islands. These lands often form the catchment for rivers used as a source of water. These rivers become flashy and in periods of high runoff, colored and heavy with suspended matter. The raw water at such times is difficult and expensive to treat for public consumption. The deforestation of the land also has the effect of reduced flows in the dry season with some rivers drying up completely. Under these



APPENDIX 1

SELECTED ECONOMIC INDICATORS ON CDB'S BORROWING MEMBER COUNTRIES

<u>Country</u>	<u>Tourist Expenditure</u>		
	<u>(\$ million)</u>		
	<u>1985</u>	<u>1986</u>	<u>1987</u>
<u>MDCs (Total/Average)</u>	-	-	-
Bahamas	870.0	1,105.0	1,175.9
Barbados	309.0	323.7	378.7
Guyana	-	-	-
Jamaica	406.8	486.2	595.0
Trinidad & Tobago	97.3	83.9	93.7
<u>LDCs (Total/Average)</u>	<u>438.9</u>	<u>536.7</u>	<u>762.5</u>
Belize	10.7	11.7	47.3
<u>OECS (Total/Average)</u>	<u>229.9</u>	<u>268.6</u>	<u>412.0</u>
Antigua & Barbuda	83.6	93.9	186.7
Dominica	4.5	10.6	12.8
Grenada	24.4	38.4	42.1
Montserrat	7.7	8.1	9.4
St. Kitts & Nevis	31.0	22.6	47.4
St. Lucia	55.7	68.0	78.4
St. Vincent & the Grenadines	23.0	27.0	35.2
<u>Other LDC (Total/Average)</u>	<u>198.3</u>	<u>256.4</u>	<u>303.2</u>
Anguilla	8.9	16.4	19.2
British Virgin Islands	91.7	119.0	140.0
Cayman Islands	85.5	93.5	120.0
Turks & Caicos Islands	12.2	27.5	24.0

Government's policies for the tourism industry often do not include consideration of adequate means for wastewater disposal. This is cause for concern. In some instances, wastewater from hotels is discharged without treatment directly into receiving waters, including sea-bathing areas, resulting in pollution problems. In other instances, packaged sewage treatment plants with their attendant problems have proliferated. Clearly, the decision of the Government of the Bahamas, Barbados, Grenada and Saint Lucia to install central sewerage systems to serve areas of heavy tourism development must be repeated in all the islands where such development has taken place or is being contemplated.

### Manufacturing

The More Developed Countries (MDCs), including Jamaica and Trinidad & Tobago have a long history of heavy and light industries, while in the Less Developed Countries (LDCs), there has only been a recent thrust towards light manufacturing industries.

Caribbean countries presently enjoy mixed fortunes with respect to manufacturing. During 1988, some recorded growth in manufacturing over their 1987 levels. For example, in Barbados the growth was 5.9 percent, Belize 9.8 percent and Grenada 10.3 percent.

The principal objectives of most governments to the development of the manufacturing sector are:

- a) creation of employment; and
- b) earning of foreign exchange.

The development of industrial estates is a principal avenue for the promotion of the manufacturing sector in BMCs. In the islands of Antigua and St. Vincent, the lack of factory space is already a deterrent to the expansion of this sector. These industrial estates must be adequately serviced with water to be used in the manufacturing processes, where required, and by workers. In most instances, it is neither economical nor practical for industrial establishments to provide their own water supply.

The wastewater from these estates must be adequately disposed of. Therefore, it is imperative that the site selection study for industrial estates take due consideration of:

- a) the demand for water, vis-a-vis, residential and other demand; and
- b) protection of receiving waters from the pollutive effects of some industrial wastewaters. This is especially so where these receiving waters are to be treated for public consumption. Here again, the removal of trace chemicals is prohibitively expensive and also whether such treatment is complete is debatable.

### Mining

The main mining activities in the Region include:

- a) oil production in Trinidad & Tobago;
- b) bauxite mining in Guyana and Jamaica; and
- c) aggregate production throughout most of the islands.

These activities have had minimal impact on the water supply subsector in terms of demand.

With respect to aggregates, there has been a dramatic increase in production in keeping with construction activity throughout the Region. Statistics on aggregate demand and production were not available at the time of writing this paper. However, there are persistent reports of shortages throughout the financial assignments in setting up crushing plants. In Trinidad & Tobago, the runoff from aggregate production has resulted in an inordinate increase in the suspended load of some water sources resulting in problems in abstraction and treatment. Efforts must be taken to ensure that similar situations do not arise in other islands.

On a positive note, in Trinidad, the oil-producing companies are a valuable source of geological data essential for the development of water-producing wells.

### 3. Financing the Water Sector

#### Demand for Services

Statistics show that in most of the regions, the demand for water has been increasing at between 3-5 percent per year which translates into a doubling of demand every 14 to 23 years.

The reasons for the increase in the demand for water include:

- a) population growth;
- b) the accelerating influence on consumption of improved standards of living;
- c) the shift in service standards from standpipes to house connections;
- d) the expansion of tourism and manufacturing sectors; and
- e) the relatively low tariffs levied on customers for water and sewerage services as compared with other utilities.

Most countries have been implementing programs aimed at increasing the supply of water to meet the increasing demands, improving the reliability of existing systems and providing for the safe disposal of wastewater. In general, water shortages in urban areas, inadequate sewerage systems and a growing problem of environmental pollution are still evident in several Caribbean countries. In the rural water supply subsector, the major problem arises from limited system coverage. However, efforts under the 'Water Supply and Sanitation Decade' have seen many countries make a commendable effort at redressing this situation.

### Investments

The rising pattern of demand and the need for wastewater disposal facilities dictate that substantial capital investments are required to improve and expand the services. In addition, the cost of operating and maintaining existing services is increasing due to:

- a) emoluments and other benefits to workers;
- b) energy costs;
- c) cost of chemicals; and
- d) cost of plant, equipment and spare parts.

Increases in activity in the major economic sectors, together with financial prudence on the part of most governments, have resulted in prospects of an enhanced economic outlook for many countries in the Region. For instance, with the exception of Guyana and Trinidad & Tobago, the other BMCs recorded growth in real Gross Domestic Product (GDP) with the growth in the British Virgin Islands (BVI), and Cayman Islands reaching as high as 10 percent.

In those countries with negative or marginal growth rates, notably the countries of Guyana, Jamaica and Trinidad & Tobago, governments have embarked on economic stabilization and structural adjustment programs.

Notwithstanding the economic outlook, in each country there is need for substantial investments in both social and economic infrastructure. The implications are that such expenditure cannot be met from current account surpluses, where they exist, and governments have to resort to internal and external borrowings and in particular, borrowing from donor agencies such as CDB.

CDB's activities in the water sector include project loans supported by an integrated program of technical assistance for institutional strengthening, staff training and the financing of preinvestment studies.

CDB's operations have encountered the following major constraints to an expanded flow of financial assistance to the sector:

- a) inadequately defined government policies;
- b) lack of comprehensive sector planning;
- c) inadequate project preparation and implementation capability;
- d) inadequate management of water resources; and
- e) institutional weaknesses.

The solution to these and other problems will be outlined later.

Many BMCs have established authorities charged inter-alia, with the responsibility for the water sector. These authorities have achieved mixed success, especially in their operations and many suffer from inter-related problems of:

- a) weak finances brought about by a lack of financial and administrative autonomy;
- b) inappropriate charging policies characterized by low tariffs and inefficient billing and collection systems; and
- c) inability to attract and retain manpower in critical areas, such as technical and financial management.

In the past, expenditures in the water sector have been promoted on the basis of their social rather than their economic benefits. Subsidization by governments of water supply and sewerage operations was the practice. Today, in an effort to reduce government subsidy and also in keeping with modern worldwide economic concepts, these authorities are being mandated to operate well-managed and financially viable utilities.

With respect to revenue generation, water and sewerage services are no longer considered as 'free' to customers, and again, in keeping with worldwide economic cost of the service by the setting of realistic tariffs based on three basic objectives:

- a) to recover costs of the services, including debt servicing requirements;
- b) to maintain an equitable distribution of costs among customers; and
- c) to influence consumption patterns.

In keeping with the policy of reduced government's financial support and general involvement in the affairs of authorities, privatization of these authorities would appear to be appropriate. For the purposes of this paper, privatization will be taken to include the sale of equity to private buyers, management contracts or the leasing of assets to private sector operators. The prospects are that once privatized, the performance of these authorities will improve due to several factors including:

- a) better and more responsive management;
- b) easier access to capital;
- c) simplicity of operations; and
- d) reduced exposure to political decisions.

Among the BMCs, the Dominica Water and Sewerage Authority Company Ltd., has been recently established replacing the government agencies that were responsible for water and sewerage. It is still too early to comment on the performance of this private company.

Whether operating as conventional authorities or as private companies, as we look into the 1990's, it is imperative that governments of the Region formulate clear policies at the national level within which water sector utilities should operate. Such policies should address issues as:

- a) medium-and long-term goals with respect to service standards, physical coverage and institutional performance;
- b) financing strategies;
- c) cost recovery;
- d) coordination between governmental agencies; and
- e) priorities for sector development.

For their part, water sector institutions have to embark on comprehensive sector planning, the primary purpose of which is to provide a link between government policy direction and detailed operations and project planning, thus, ensuring an optimum expansion of the water sector consistent with the development goals of the respective country.

#### 4. Conclusion

Adequate water supply and wastewater disposal are prerequisites to sustained economic development and an enhancement to the quality of life. Those charged with responsibility for the water sector in the Caribbean countries have, with varying degrees of success, attempted to deal with the many problems inherent in managing water sector utilities. It is imperative that from a public health perspective that the achievements of the International Drinking Water Supply and Sanitation Decade (IDWSSD) are sustained and attention be now focussed on setting new goals for the 1990's and beyond. With respect to the economic activities in the Region, water supply must not be a deterrent to development nor must the wastewater derived from present and future development be a public health hazard or be a pollutant to the environment.

Caribbean Environmental Health Institute (CEHI)

Naresh Singh  
Senior Scientist, CARICOM/CEHI

1. History

The Institute was established in response to the interest expressed by the countries of the Caribbean Region in the improvement of human health through better environmental conditions, protection of the natural resources against pollution, and incorporation of these goals into national plans for economic and social development, as detailed in the Caribbean Environmental Health Strategy adopted in 1978.

The Fourth Conference of Ministers of Health (1978) requested the Secretary-General to assemble a Committee of Experts to examine the proposal for setting-up the Institute at the Morne, Saint Lucia. Later that year, at a workshop in Grenada, the Caribbean Environmental Health Strategy was formulated.

At the Fifth Conference of Ministers of Health (1979), the Ministers approved the strategy, agreed to the establishment of the Institute and accepted the proposal for extrabudgetary support on a project basis, as recommended in the Feasibility Study conducted by the Committee of Experts. It was considered that the Region has an increasing need for an instrument to provide highly specialized technical and scientific cooperation to the Member Countries of CARICOM as a complement to the assistance already offered by international and bilateral technical cooperation agencies.

A basic agreement which made provision for, inter-alia, membership, objective, structure, administration, revenue and ratification was prepared by July 1980 and submitted to Member Governments for approval.

Since 1979, successive conferences of Ministers responsible for Health have approved resolutions to stimulate growth and development of the Institute.

During 1980, discussions took place with UNEP on the initiation of a project entitled, "Protection of Marine and Coastal Environment of Caribbean Islands." Meanwhile, countries were being requested to expedite signature of the agreement and to deposit the Instrument of Ratification.

In 1981, the Seventh Meeting of the Conference of Ministers of Health took the decision that CEHI should commence in 1982 and the CARICOM Secretariat should arrange for the operation of the UNEP funded project. The Secretariat implemented both these decisions.

From 1981 to 1986, the Secretary-General at the Meeting of Conference of Ministers of Health and including the First Intersessional Meeting of Committee of Health Officials, 1985, urged countries to pay their outstanding quota contributions and to deposit the Instrument of Ratification.

It is also important to note that PAHO, through its Regional Office, the CPC Office in Barbados, has actively supported and collaborated closely with CARICOM/CEHI through the whole process of evolution. The Institute was finally ratified and became a legal entity on 31 August 1988.

## 2. Functions

The functions of the Institute may be summarized as follows:

- a) provide technical and scientific advisory services to the Member States in the field of environmental sciences and engineering, including project development;
- b) promote, collaborate and support the development of human resources of the Region;
- c) act as a regional reference center in environmental sciences and engineering, including the gathering, preparation and distribution of technical and scientific information, and as a focal point for various environmental monitoring networks;
- d) promote and coordinate problem solving research, the provision of laboratories and other related environmental services, uniformity in professional practice and technical methods in environmental management, conduct special studies and surveys; and
- e) an important implied and recognized function of the Institute is that of mobilizing national and international resources to attain the objectives.

In addition to the broad environmental concerns for CEHI, action defined in the General Agreement, the Caribbean Environmental Health Strategy (1980), the environmental health component of the Action Plan for the Caribbean Environmental Program, 1983, the Action Plan for the International Drinking Water and Sanitation Decade, and the Caribbean Cooperation in Health initiative complement the objectives and functions.

In light of recent discussions held with national authorities, it appears that the above objectives and functions set for CEHI, as a specialized environmental health institution can accommodate, with some modifications, most present priority concerns. Others, such as environmental impact assessment and chemical safety could be added. Should the agreement be revised, the objectives and functions could be synthesized. The agreement also provides for the Executive and Director to prepare a three-year plan to be updated yearly. The preparation of a plan of action is of the highest priority and should be one of the first tasks of the Executive Director, assisted by a small group of experts.



3. Capabilities

The institute currently has capabilities in the following:

- a) Coastal and marine pollution monitoring (chemical, bacterial and ecological);
- b) pesticide residue analysis and monitoring and pesticide management in general;
- c) environmental impact assessment;
- d) industrial chemicals management;
- e) postgraduate research facilities in environmental sciences;
- f) staff expertise currently include an ecologist, a microbiologist and a chemist;
- g) equipment include gas-chromatography, ultra-violet-visible spectrophotometry, fluorometry, field kits and a computer; and
- h) laboratory technician training for environmental monitoring.

4. Future Development

The current capability will be maintained and expanded according to priority needs of the Member States.

In addition, major new areas of work will be undertaken. These would include drinking water quality monitoring, liquid and sewage waste disposal, solid waste management and toxic chemicals and hazardous waste management. An environmental health information system is being planned. The physical infrastructure of the institute and its analytical capability would be further developed and a core staff put in place.

5. Role of CEHI in Implementation of the Environmental Health Improvement Project (EHIP)

The Institute will be the implementing agency of the EHIP. In this role, it will be strengthened as a regional environmental health institution and be better able to serve all CARICOM Member States in its areas of competence.

At the same time, it will coordinate project implementation at the national level of the beneficiary states and act as the focal point for the distribution of goods, services and information under the terms of the project agreement and the plan of operation.

## The Port of Spain Accord on the Management and Conservation of the Caribbean Environment

Issued by  
The First CARICOM Ministerial Conference on the Environment

Port of Spain, Trinidad and Tobago  
31 May-2 June 1989

We, Ministers of the Caribbean Community with responsibility for Environmental Matters, met in Conference in Port of Spain, Trinidad and Tobago, on 31 May-2 June 1989 with the objectives of

- (a) achieving increased appreciation of the significance of the issues and needs relevant to management and protection of the Caribbean environment, and of the relationship between Environment and Development;
- (b) identifying matters for priority attention in the Region in relation to the environment; and
- (c) identifying approaches that would allow for better regional coordination and monitoring of activities, agencies and resources.

We were profoundly gratified that high-level delegations from twelve (12) Member States of the Community, and from four (4) Observer countries were present, and that we had the honour of being addressed by The Hon. A.N.R. Robinson, Prime Minister of the Republic of Trinidad and Tobago, the host country, who declared the Conference open.

We were also pleased to welcome the valuable contribution to our deliberations by observer regional and international institutions which were in attendance.

In our discussions we were very conscious of the fact, as indeed the Hon. Prime Minister of the Republic of Trinidad and Tobago reminded us in his address, that with improved understanding over the last two decades of the impact of man's activities on the environment,

there has been a transformation in attitudes towards and perspectives on environmental issues in the world as a whole. We recognised that the historic 1972 Stockholm Conference on the environment spawned the foundation of the United Nations Environment Programme, the production of the 1980 World Conservation Strategy and the 1987 Report of the World Commission on Environment and Development which highlighted the relationship between the environment and sustainable development.

In our own CARICOM Region, concern about the environment has been no less intense. The spirit and policy of the Treaty of Chaguaramas establishing the Caribbean Community and the deliberations of several Community fora including the Conference of Heads of Government, the Conference of Ministers responsible for Health, and the Standing Committees of Ministers responsible for Agriculture and for Foreign Affairs, have recognised the importance of sound management of the Region's environment to the quality of life of the Region's peoples.

We have conducted our Conference in the spirit of the Declaration of Brasilia, in the formulation of which several Ministers of the Caribbean Community participated.

We therefore perceive our Conference as coming within this tradition and constituting an opportunity to provide fresh political impetus to the coordinated identification, development and execution of policies, programmes and projects for addressing the identified deficiencies in our arrangements for effective management of the environment.

## Priority Issues and Problems

In identifying the priority issues to be addressed in our quest for the protection of the Caribbean environment we have proceeded on the basis of full acceptance of the fact that central to all our environmental concerns is our shared desire for man's survival in a manner that is both in harmony with nature and consistent with human welfare.

We have also proceeded on the basis of the recognition that prominent among the features of the natural environment of our countries are our marine spaces and the extensive forest cover of some of our territories.

We have agreed that the following represent the principal areas in which we must organize ourselves at the national and regional levels, with the support of the international community, to develop urgent strategies for action:

- (a) orderly land use planning and coordination;
- (b) housing and human settlements;
- (c) degradation of the coastal and marine environment;
- (d) prevention and mitigation of the effects of oil spills;
- (e) solid and liquid waste management;
- (f) management of toxic and hazardous substances including the control of agri-chemical residues;
- (g) dumping of extra-regional, hazardous and toxic wastes in the Region;
- (h) water quality and supply;
- (i) forest and watershed management;
- (j) preservation of genetic resources;
- (k) vector control;
- (l) disaster preparedness;
- (m) preservation of cultural, archaeological and historical resources;
- (n) air and noise pollution.

## Strategic Approaches to the Solution of the Problems

We are convinced, and agree, that in order to effectively address the problems in these areas, our efforts must be based on use of the following urgently needed strategic approaches which will result in an integrated approach to their solution:

(a) the promotion of public education and awareness at all levels in our societies to enhance consciousness and respect for the environment on the part of our peoples, and to encourage behavioural patterns conducive to its preservation. In this connection we agree that there should, inter alia, be full observance in the Caribbean Community of World Environment Day (5 June) and to coordinate, as far as possible, our respective national programmes for that purpose;

(b) the provision of training and development of human resources in order to produce the cadres of experts within the Region whose vocation will be to undertake the many and varied facets of environmental management;

(c) the formulation of policies and plans, including the requirement for environmental impact assessment, which

are essential prerequisites to the rational management of our environment;

(d) the collection, management and dissemination of the information critical to the development of policies, programmes and projects which must be implemented to address the identified problem areas;

(e) the promotion of research based on the reality of the Caribbean situation and aimed at generating solutions to the environmental problems of the Region;

(f) the development of legislative frameworks adequate to the requirements of sound environmental management, and the required machinery for their enforcement;

(g) the promotion of the development of economic pursuits including small scale enterprises which are geared to the enjoyment and enhancement of the environment;

(h) the harnessing of all available political, institutional, and community based resources relevant to the solution of particular environmental problems.

## **Institutional Arrangements for Consultation and Coordination**

It is our clear recognition that in order for practical action to unfold on all the matters that we have set out above, it is absolutely essential that there be effective institutional arrangements at the national and regional levels. We acknowledge that such arrangements are critical for systematic consultation on and coordination of policy formulation and implementation of programmes and projects.

We are aware that certain institutional arrangements do exist. However, there is need for strengthening some of these and for identifying and filling any existing gaps.

**We therefore:**

(a) agree that at the regional level Ministers with responsibility for Environmental Matters should meet at appropriate intervals for the purpose of conducting policy and programme review and establishing the goals and guidelines for action; to this end we support the proposal by the Prime Minister of the Republic of Trinidad and Tobago that a Standing Committee of Ministers responsible for the Environment be established;

(b) approve, also at the regional level, the establishment of a consultative forum of agencies whose activities in the region are relevant to the development of Caribbean environmental programmes and projects. The function of this forum will be to pursue the identification of, and the allocation of responsibility for action on programmes, projects and studies relating to the priority problems and strategic approaches set out above.

The CARICOM Secretariat will have the responsibility for convening this forum;

(c) reiterate the Community's commitment to the effective development of the Caribbean Environmental Health Institute as a Regional technical, advisory and project implementing facility in the environmental field.

We mandate the CARICOM Secretariat to arrange consultations and negotiations with donor agencies for support to Caribbean environmental programmes and projects on the basis of the policies and guidelines laid down at ministerial level and the results of the work of the consultative forum. In this connection, we express appreciation to those bilateral and multilateral agencies which have been actively supporting these programmes.

We strongly recommend to all governments of the Community that they establish arrangements that would permit an integrated approach to environmental management at the political, technical and administrative levels, and that such arrangements should include a designated focal point which would relate in a coherent manner to the regional and international levels.

In conclusion, we reiterate our firm and unswerving commitment to the rational use and conservation of our environmental resources. We call upon all Caribbean peoples to exercise the respect and reverence for the environment which will ensure its protection for the benefit of future generations.

Port of Spain,  
Trinidad and Tobago

2 June 1989

E. Statement by External Support Agencies

British Development Division in the Caribbean

M. F. Sergeant  
Senior Engineering Adviser, BBDC

1. General

1.1 The British Development Division in the Caribbean (BDDC), located in Barbados, is the Regional Office of the British Overseas Development Administration (ODA), which is itself the "Aid Wing" of the British Foreign and Commonwealth Office. BDDC has 35 professional, administrative and clerical staff. In common with the Pacific Development Division, but unlike those in South East Asia, East Africa and Southern Africa, it functions as a self-contained geographical department of ODA so that all program managers and most professional advisers live and work in the Region. As a consequence, those making decisions are in constant contact with the Region and it is hoped to have a better understanding of the problems facing the countries and territories of the Caribbean.

1.2 In addition to the bilateral program, the ODA is a major contributor to most of the multilateral agencies working in the Region, particularly the European Community, the Caribbean Development Bank and the World Bank. It is ODA policy that BDDC should work closely with these agencies and with other bilateral donors to ensure that the development needs of countries in the Region are met in a sustainable and cost-effective manner.

1.3 The provision of clean and reliable water supplies is essential to the good health of people everywhere. The new British Minister for Overseas Development, Mrs. Lynda Chalker, has underlined ODA's commitment to this sector by stating that she sees clean water as one of the three priority areas for her time in office. It can be expected, therefore, that ODA will become even more committed to the water sector and that BDDC will continue to be prepared to give very sympathetic consideration to well conceived project proposals and be ready to provide technical assistance when needed.

2. Country Programs

2.1 BDDC funded projects and manpower assistance in the individual countries and territories are as follows:

2.1.1 Anguilla

Technical Cooperation Officer (TCO) Water Engineer, B. Haworth.

2.1.2 Barbados

Groundwater Quality Control Study, jointly undertaken by British Geological Survey and Barbados Water Authority.

2.1.3 British Virgin Islands

Roadtown Sewerage Extension in progress, total project allocation L725,000.

N. Wijanayagan (OSAS), Deputy Chief Engineer.

B. Hannaby (TCO), Technician Supervising Sewerage Extension.

2.1.4 Dominica

Giraudel/Eggleston Water Supply Scheme approaching completion, project allocation L45,000.

Additional support to small water sector schemes through Community Development Projects.

2.1.5 Grenada

Grand Roy Water Supply Project under consideration, estimated cost L350,000.

2.1.6 Montserrat

Water Reticulation Project, approved, work to start January 1991, project allocation L600,000.

Fire Hydrants Project provision and installation of 200 hydrants, L100,000 plus.

Parsons/Amersham Drainage, project allocation L185,000.

2.1.7 St. Kitts/Nevis

St. Kitts

- Frigate Bay Reservoir, proposed L645,000.

Nevis

- North Nevis Water Development Phase 2, approaching completion L310,000.

- South Nevis Water Development Stage 2, under consideration L250,000.

- B. Kennedy (TCO) Engineer and Manager, Nevis Water Department.

2.1.8 Saint Lucia

- WASA twinned with Wessex Water Authority.
- Integrated Water Development Phase 3, in progress, L443,000.
- Castries Urban Drainage, recently completed, L275,000.
- W. Weekes (TCO), Water Engineer, WASA.

2.1.9 St. Vincent

Support to small water sector schemes through Community Development Projects.

2.1.10 Turks and Caicos Islands

Grand Turk

- Emergency 12,000 gpd reverse osmosis plant, approved L40,000.
- Salt Water Flushing System, under consideration L91,000.

Providenciales

- Bight Wellfield Upgrading, under consideration L270,000.

All islands

- PVC Water Tanks for private low income housing L60,000.
- Support to small scale water projects through Minor Infrastructure Rehabilitation Projects.



F. Papers and Statements by Private Companies and Manufacturers

Groundwater Exploration on the Smaller Volcanic Islands  
of the Eastern Caribbean

Dennis A. Lowen  
Project Engineer, Ker Priestman and Associates Ltd.

Introduction

Ker, Priestman and Associates Ltd. (KPA), Consulting Engineers from Victoria, Canada, have been active in groundwater exploration projects in the Eastern Caribbean since 1981. The work has taken place on the islands of St. Kitts-Nevis, St. Eustatius and Saba. KPA was contracted by the Canadian International Development Agency and the Government of the Netherlands Antilles as the executing agency for projects on the respective independent and Dutch Islands. Groundwater exploration and development and follow-up water system infrastructure improvement work has been completed.

A location plan of the islands concerned is shown in Figure 1. Island areas and population are given in the following table:

<u>Island</u>	<u>Area (Km<sup>2</sup>)</u>	<u>Population</u>
St. Kitts	168	35,000
Nevis	101	10,000
St. Eustatius	21	1,500
Saba	13	1,050

Objectives

The main objectives of the groundwater exploration work have been twofold:

- a) to locate sources of fresh groundwater sufficient to meet the potable water deficit; and
- b) to produce a comprehensive hydrogeology report including an estimation of the groundwater resource development potential.

Methodology

Location, review and analysis of existing information sources are the first steps for initiating a groundwater exploration program. Some examples of existing information are: topography, geology, geomorphology and soils maps; rainfall records, well logs, spring flow data and geophysical survey results. Geology, hydrogeology and historical reports may also be available.

In making the analysis both positive and negative indicators should be considered. Some positive indicators are: large watershed area, permeable soils and good groundwater quality. Some negative indicators are: impermeable rock types, sulphur or hot springs and saline groundwater. By studying these indicators and plotting them on a map, we can identify promising areas for well drilling. As well we can eliminate unsuitable areas.

In some cases, the initial analysis has been followed-up with a geophysical survey. The earth resistivity method has been employed. This method consists of passing an electric current through the ground and then interpreting the soil and rock types according to their electrical properties. For example, clay soils have low resistivity, whereas, sand and gravel have high resistivity. Electrical surveys can help to predict subsurface conditions and, therefore, minimize the number of unsuccessful wells.

When all of the above information is integrated, drilling sites are selected. Drilling results are analyzed as they become available and future site selections are modified according to the results at hand.

### Results

After studying drilling results from the islands, we can see a pattern emerging. The physical controls that create the pattern have not been identified conclusively, but we have formulated a theory. The lower slopes of the islands, generally below 100m elevation, are less steep (20° average slope) and are composed of predominantly volcanic sand and gravel (tuff). The deposits are permeable and a water table type coastal aquifer has developed. The fresh water aquifer zone is annular shaped in plan view but interrupted in places by impermeable rocks or saline water intrusion zones. Figure 2 shows the typical aquifer shape. Beneath the central portion of the Island, nearer to the volcanic core rocks, the water is likely to be hot and highly mineralized. This is so because the groundwater here is circulating through hot rocks, which have not yet cooled from their eruptive past. Convection currents may also exist which circulate deeper saline waters upward to mix with fresh infiltrated water. Therefore, the fresh water lens does not extend beneath the central portion of the island. A cross sectional view of a typical volcanic island is shown in Figure 3. This general pattern may hold for most younger volcanic islands, older volcanic islands may have cooled completely and most of its rocks may become cemented or lithified.

The overall water balance for an island can be expressed as follows:

$$\text{Precipitation} = \text{Runoff} + \text{Infiltration} + \text{Evapotranspiration}$$

Each variable on the right hand side of the equation is then a portion of the total precipitation. The range of these portions we estimate as follows:

Runoff = 1 to 5 percent

Infiltration = 5 to 20 percent

Evapotranspiration = 75 to 95 percent

The infiltration rate ultimately governs the groundwater abstraction rate. We recommend that in general the abstraction rate for a single basin should not exceed one-third of the infiltration rate. Then two-thirds of the fresh recharge water is reserved to maintain the fresh water lens.

The infiltration rate will vary with topography and geology. Flat areas with permeable soils will have higher infiltration rates. Areas with no apparent surface drainage or areas where streams disappear likely have higher infiltration.

One more thing to consider when determining the exploration target zone is that the fresh water lens "pinches out" at the shoreline and thickens as we move inland. This is because the water table rises above sea level and according to the Ghyben-Herzberg relationship: 1m of water above sea level supports 40m of fresh water below sea level. This means a well located too near the shoreline cannot produce a great quantity of fresh water without causing saline water intrusion.

The target zone then is an annular shaped area with the lower boundary at approximately 20m elevation and upper boundary at approximately 75m elevation. These boundaries will vary up and down somewhat around an island or from one island to another, but the general shape will persist, see Figure 2. Drilled wells below this zone will have low yield and those above will produce hot and brackish water.

Well yields within the target zone will vary considerable as yield is proportional to aquifer transmissibility and this can range over 5 orders of magnitude. The transmissibility depends primarily on the grain size of the aquifer material and the proportion of fine material. The maximum transmissibilities found often occur in narrow bands which are oriented with the direction of the slope. These narrow bands may be buried stream channel deposits which contain clean and well sorted sand and gravel.

It may be possible in some cases to find buried channel deposits using the earth resistivity method. However, the fact that these are narrow features, buried at great depths, make these difficult targets. Drilling beside present day stream channels can increase the likelihood of hitting a buried channel at the well intake depth.

The average well depth was 70m and overall results are listed below:

	<u>Number of Wells Drilled</u>	<u>Combined Yield m<sup>3</sup>/day</u>
St. Kitts	36	13,000
Nevis	35	3,000
St. Eustatius	8	125

The yield obtained exceeded the original objective in all three (3) islands. Ker, Priestman and Associates Ltd. is presently working on all three (3) of the above islands in improving the water infrastructure. We are also preparing to do exploration drilling on the Island of Saba, Netherlands Antilles.

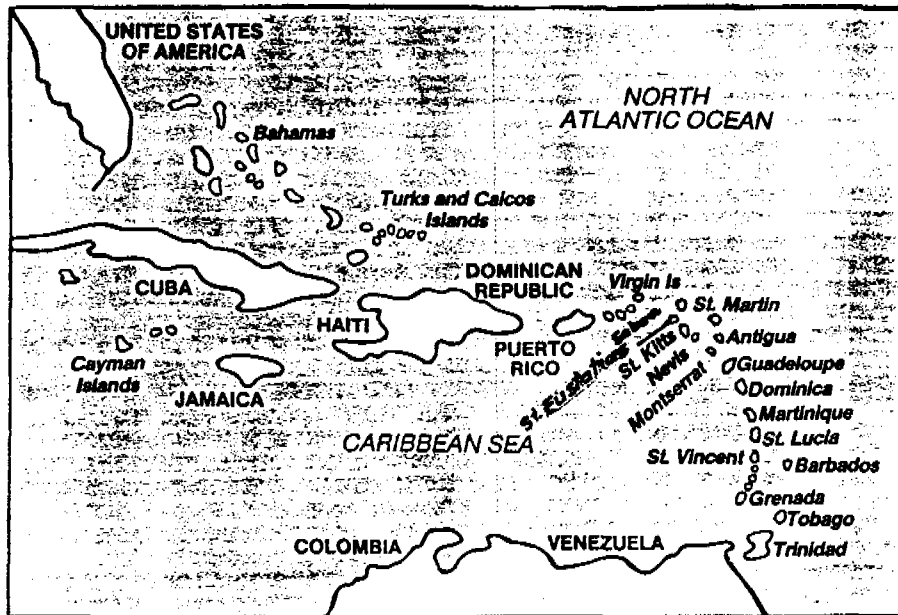
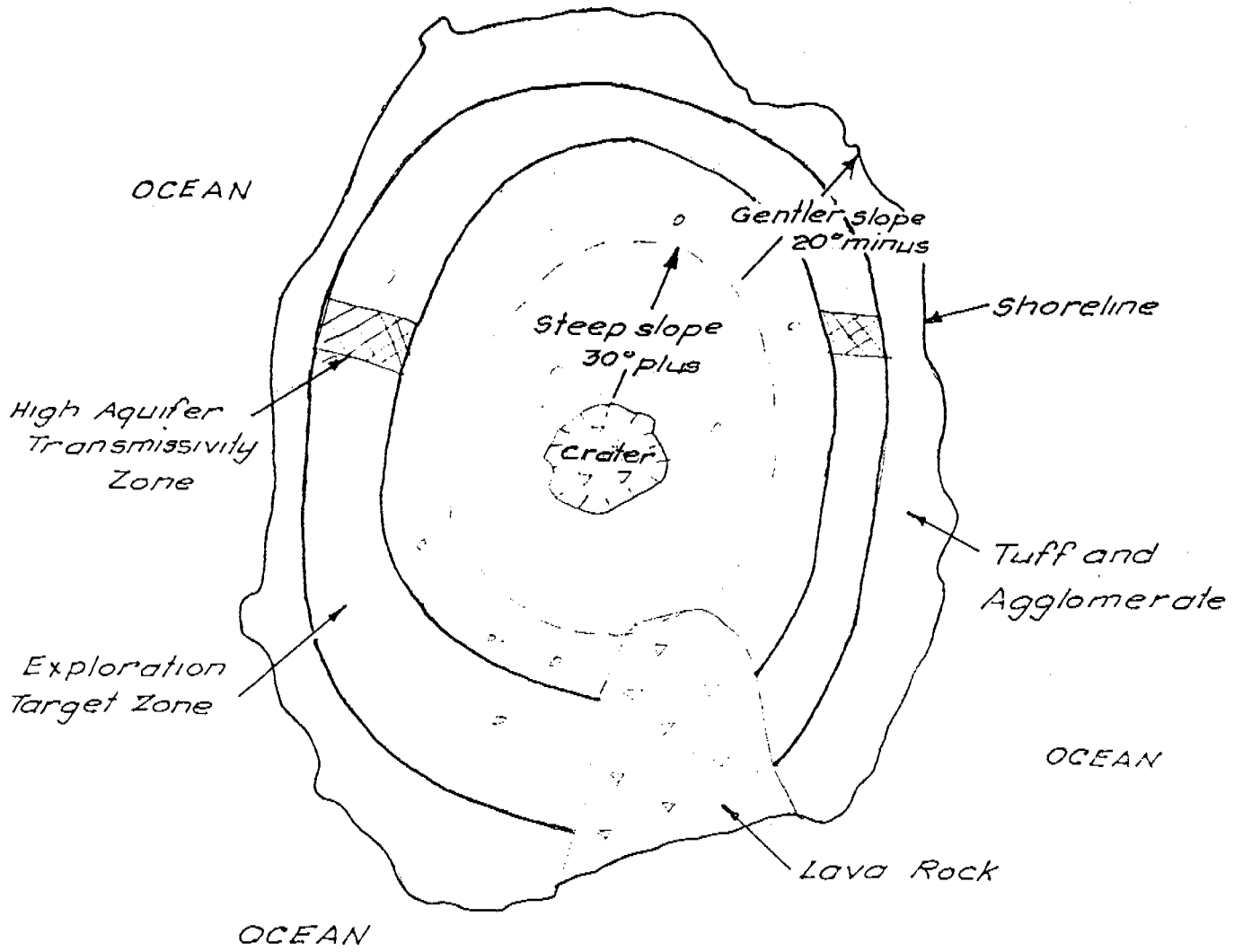
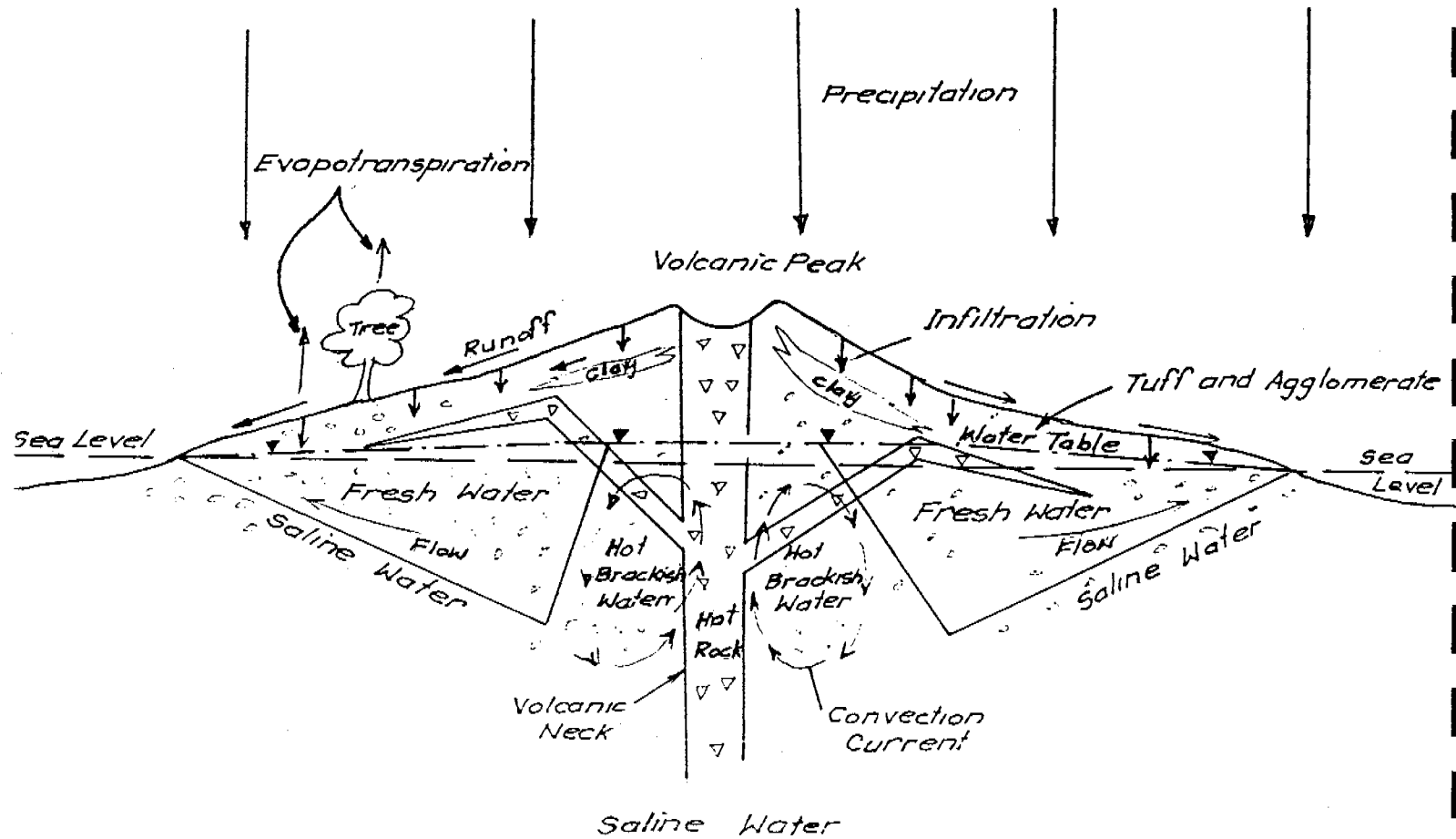


FIGURE 1.  
LOCATION PLAN



**FIGURE 2**  
**TYPICAL AQUIFER SHAPE**  
**PLAN VIEW**



WATER BALANCE :

$$\begin{array}{rcccc}
 \text{PRECIPITATION} & = & \text{RUNOFF} & + & \text{INFILTRATION} & + & \text{EVAPOTRANSPIRATION} \\
 100 \% & & 0 \text{ to } 5 \% & & 5 \text{ to } 20 \% & & 75 \text{ to } 95 \%
 \end{array}$$

FIGURE 3  
TYPICAL CROSS-SECTION

Statement

Patrick Grayson  
General Manager, Kent Meters Ltd., Isabela, Puerto Rico

I would just like to take a few moments to update you on what has been happening with Kents over the last 12-18 months.

Several years ago, the large Swiss Company, Brown Boveri bought 57 percent of our parent company Geuge Kent Ltd. In 1988, B.B. merged with the Swedish Giant ASEA. So now Kent meters is a part of the ASHA-BBC Group of companies. The turnover of the group is around \$20 Billion, and we employ around 180,000 people in offices and factories all over the world.

Within the meter division, we have also been growing by acquisition. In 1988, we bought the German Meter Company, Bupp & Renter, by this means we captured a large share of the German market;

In July of 1989, we bought a Spanish Company called IBERCONIA. This company has about 60 percent of the Spanish market, plus subsidiary companies in Colombia, Ecuador, Mexico and Venezuela. This acquisition not only strengthens our position in Europe, but gives us good access into South and Central America.

We believe that we are now, the largest meter manufacturer in the world. We have manufacturing companies in 13 countries, including Australia, Canada, Malaysia, Puerto Rico, South Africa, Spain, Zimbabwe, plus now Mexico, Venezuela, Colombia and Ecuador.

The tremendous variety of market has helped us to improve product and our service. With the variations in water conditions, and the different technical problems experienced we have had to come up with solutions to particular problems, that have then been incorporated in our meters for every customer's benefit.

In addition, because of our size, we can purchase in large quantities the raw materials, such as copper at competitive prices. This enables us to give our customers a good product at a competitive price.

Locally, we have been involved in Meter Reading and Maintenance - through our experience with IBERCONIA, we have been requested by four Water Authorities to get involved in a degree of privatization. We have been requested to make a proposal for the reading, maintenance, and installation of meters.

~~This would involve reading all the meters each month or each two months,~~  
and supplying bills to the Water Authority for them to send to the customers.



Our responsibility would be for reading the meters, and refurbishing approximately 10 percent of the meter each year. The 10 percent is based on an estimated 10 year life. We would also have to repair or replace any meters that stopped, or were damaged.

Our initial estimates, based on a city with 10,000 meters installed was \$10/meter per year. The total cost to the utility being \$100,000. The revenue returned by the meters was estimated at around \$1,200/month per meter of \$12 million per annum for an outlay of \$100,000.

We also believe that by using this service, we can also evaluate the distribution system and help the utility to reduce its losses, and maximize its revenue collection. The Water Authority can also save costs of meter repair shops and meter maintenance.

One of the Water Authorities responsibilities is for the reliable distribution of portable water. Because of certain governmental attitudes to government employees (holidays, bonus, medical plans, etc.)

Certain unrelated activities, such as meter reading and maintenance can be accomplished at a lower cost by privatization.

In relation to maximizing revenue, Combo Meters - I have been surprised at the low level of sales on our combination meters. These meters use are Standard Helix 3000 turbines in parallel with the domestic PSM meter. The flow range is from 1/4 gallon/minimum upwards, with an accuracy of  $\pm 2$  percent.

In applications like hotels, hospitals, etc., where there are high flow rates during the day, dropping to very low flow rates at night these meters record both extremes.

We have seen application on the United States where revenues have been increased by 40-50 percent using the Combo Instead of the Helix.

We have such a sales offer in the United States, whereby, we will supply a combo meters on a sales on return basis. After six months of installation if the authority does not see a dramatic increase in revenue it can return the meter. However, if they see sufficient benefits, they can buy it.

This offer also applies to the Caribbean.

Publications are limited because of difficulty in getting last years materials from Montserrat, however, I will send you publications.

For those involved with Waste Detection - many of you sent employees to PR for our Waste Detection Course given in 1988. Regrettably, the very simple gate type meter demonstrated to record rate of flow of few has been discontinued. Spares, of course, are still available.

We are now using the Helix 3000 range, that can be fitted with rate of flow indicators, and chart readers. So for those of you still involved in Waste Detection, remember of standard Helix 3000 can be used.

### Strainers

One other area that might be of interest. We are recommending that on mainlines where Helix meters are installed strainers are fitted in front of the meter. We are receiving a lot of meters back for repairs and it can be seen that the propeller assembly has been damaged lumps of wood, bricks or stones.

A strainer will extend the accurate life of your Helix meter and help prevent expensive maintenance.

### Training Course - 1990

With the kind assistance of the Caribbean Development Bank and Mr. O. K. Yhap, we are planning another workshop in Puerto Rico, sometime in the first half of 1990. We will circulate details when the date is known. The course will cover selection, repair and maintenance of water meters.

I would like to hear from you regarding the previous courses we have given, and if there are any area where we can do better.

Any questions?

Finally, I would like to thank you all for listening to me, and for your continued support, we look forward to serving your needs in 1990.

Cocktail Party at 7:00-8:30 p.m., at the Ocean Terrace Inn, Pool Side tonight.

Statement

Leslie Goodchild,  
General Engineering Corporation

Good Morning, Ladies and Gentlemen, I would like to take just a few moments of your time to present a different concept of Liquid Storage. For your consideration, but let me first tell you briefly about my Company, who I am, Leslie Goodchild.

I work for General Engineering Corporation, which is a wholly-owned subsidiary of Tampa Tank & Welding, a company started in 1953 to fabricate various types of storage tanks. Since that time, we have evolved into a total steel fabrication and erection company successfully serving the needs of the chemical, oil, power, refining, mining, water and wastewater treatment, air pollution control, pulp and paper, commercial and industrial buildings, and other industries in the Continental United States, South America, and Caribbean, West Africa and the Middle East.

We have three fabrication plants in Florida with shipping capabilities to all parts of the world. Our Engineering Department is experienced in all phases of design and engineering to various codes:

American Society of Mechanical Engineers (ASME)  
American Petroleum Institute (API)  
American Water and Waste Water Institute (AWWA)

The GEC Company was formed to better serve our overseas customers in their need for steel fabrication and erection; predominantly in the liquid storage field.

As you are all aware, there are many forms that storage has taken. To name a few:

Pond Storage - for water and effluents  
Wooden Tanks - for water and alcohol  
Concrete Tanks - for water storage  
Steel Tanks - for water, petroleum products and many chemicals  
Stainless Steel - for food products and many chemicals  
Aluminum Tanks - for water, food products and chemicals

Through all of this time, industry has been looking for the storage medium, that is:

1. Will store the product without affecting its properties.
2. Long life.

3. Ease of installation in the field.
4. Minimal maintenance.
5. And last in my list is cost. Although listed last, as we are all painfully aware, this does have a bearing on our decision making.

Tampa Tank & Welding, having fabricated and erected steel and stainless steel tanks for the past 36 years, has seen many changes in this time and although carbon steel storage tanks are still 85 percent of our business; we still recognize steel has some restriction in its many applications.

One of the more successful innovative ideas is a bolted aluminum tank with a butyl rubber liner manufactured by Franklin Hodge Industries. An English company based in Hartfordshire, Franklin Hodge has been fabricating these tanks since 1965 and has erected many of them throughout Britain, Europe, the Middle East, Africa and the West Indies.

The tanks are of a round configuration with flat bottom and low profile bridge, supported roof with a butyl rubber liner, and can range from a capacity of 20,000 gallons to 1-1/2 million gallons.

They are designed to the criteria laid down in the AWWA D-103 Code for bolted tanks.

This system of tankage uses two of the tried and true methods of liquid storage tanks - the bolted or riveted steel tank and the rubber containment bladder.

The outer shell supports the liner, that in turn, holds the product.

General Engineering Corporation became involved with Franklin Hodge Industries, about six years ago to market and erect the bolted aluminum tank throughout the United States, South America and the Caribbean.

We feel that this type of tankage answers some of the problems involved with the standard storage systems, because:

1. Ease of Field Erection

The shell is fabricated from sheets of aluminum, approximately 4'-0" x 8'-0". The roof trusses come in prefabricated lengths. The butyl liner (depending on its size) comes prefabricated and rolled up, and of course, lots of nuts and bolts.

With all of these materials being small and light to handle, the tank is erected by hand; no cranes or heavy equipment, no welding equipment. We do like electric power for our nut runner. If that is not available, we will tighten every nut and bolt with a hand wrench (and that's a lot of nuts and bolts).

We can transport the tank materials up a mountain, transport to an island, as we have done in Florida, or carry the individual pieces in an elevator to the roof to be erected there. And, of course, as an afterthought, they can be unbolted and moved to another site.

## 2. Minimal Maintenance

The tank shell, roof and support structures are fabricated from 5083 H321 aluminum commonly known as Marine Grade Aluminum, which is an aluminum magnesium alloy and is used for marine and other corrosive environments. A 5083 Grade Aluminum possesses a greater yield strength than 283 Grade C carbon steel, which is commonly used in the construction of storage tanks.

This means the aluminum tank is never painted, so you never need to touch up in 10 to 12 years ago to the expense of a total sandblast and repainting job.

These tanks have been erected in coastal areas, continually exposed to the salt laden air and water. They also have been erected in the desert of Egypt and exposed to the hot sun and sandstorms; all with no ill effects. No cathodic protection is required.

The bolting and fitting are either stainless steel or galvanized. The majority of our customers have requested stainless steel, which again is non-corrosive.

The outer surfaces of the tank develop a slightly oxidized finish which protects the finish.

The butyl rubber liner is an open bag type with hot vulcanized seams, custom made for each tank. They are fastened around the top of the shell of the tank, thereby, support it which takes away any weight of the liner hanging from its fasteners. This type of butyl rubber can stretch to three times its size. These butyl rubber liners are approved by the FDA for potable water, and are often used for the storage of many other liquids, including Gilbey's Gin and Chevas Regal.

Other types of liners are available for products not compatible with butyl rubber like petroleum products.

The butyl liner has been laboratory tested to an excess of 35 years. Of all the thousands of bolted aluminum tanks erected since 1986, no tanks have developed leaks.

We often line concrete tanks and cisterns that have developed leaks with our type of liner.

### Foundations

Foundations are normally the ringwall type with a compacted backfill topped with three inches of sand. We do install a polyester mat to act as a cushion between the liner and the sand.

These tanks can also be mounted on a solid slab, which may be existing or newly poured, whichever the customer prefers.

As you can see from the points we have covered:

- 1) No corrosion problems
- 2) Painting never necessary
- 3) No cathodic protection
- 4) No special foundations
- 5) No heavy erection equipment required
- 6) No field welding
- 7) Easily transported to the job site

### Costs

Costs vary with the size of the tank and the accessibility of your island to shipping, so it is difficult to give an across-the-board gallon price.

They are very competitive to standard steel tanks and very cost effective against concrete.

Normally, a 500,000 gallon water storage tank of bolted aluminum will cost about 45 cents per U.S. gallon. This is total cost of tank erected, but not the foundation (we will design the foundation for you, dependant upon the soil bearing you will give us).

Remember when comparing cost, consider your maintenance costs, which are non-existent on the aluminum tank.

I will be happy to supply you with budget cost at any time for your storage tankage.

Gentlemen and ladies, I thank you again for these moments of your time.

G. Statements by Participants of the Countries of the Region

## Water and Sanitation in Anguilla

Barry Howarth  
Water Engineer, Department of Water and Electricity  
The Valley, Anguilla

### 1. Country Description

1.1 Anguilla is the most northwesterly of the Leeward Island or Lesser Antilles at approximately Latitude 18°N and Longitude 63°W. The country consists of the main island of 35 square miles and several uninhabited cays or islets. Average annual rainfall is 40.04 inches (1931-1986), but potential evapotranspiration is estimated to be considerably higher than this at about 70 inches per annum. The Island is relatively flat with the highest point at only 227 feet above sea level. Generally, the Island has cliffs along the north coast with the land sloping to the south coast. However, there are a number of low lying areas inland which are only a few feet above sea level. Some of these low lying areas are at or below sea level and have salt water ponds at sea level. There are no perennial rivers and indeed surface runoff is only observed during or after exceptionally heavy rainfalls. The geology of the island consists of a dense argillaceous limestone and mostly interbedded clayey horizons of early Motion age overlying Tertiary volcanic rocks. The volcanic deposits are generally at about sea level along the north coast and dip southwards far below the limestone deposits. The limestone is frequently karstic and in most areas has very little or no soil cover.

1.2 The population of Anguilla is estimated at 7,300 having grown from 6,842 enumerated at the 1984 census. Most Anguillians own their own land and due to cultural and economic reasons have built their houses on their land wherever their plot may be. For this reason, there are no distinct community centers with the exception of The Valley where most government offices have been constructed and which form the commercial center of the island. The economy of the island has changed tremendously over the Decade of the 1980's from being a 'Grant in Aid' economy relying mainly on grants from the United Kingdom and remittances from Anguillian export labor to the present when, for recurrent expenditure at least, the island is now self-sufficient and even much of the capital expenditure program is self-sufficient.

The change in the economy is due to the investment in tourism and the benefits now being accrued. There is now almost no unemployment whereas at the start of the Decade unemployment was probably in excess of 50 percent of work-force. Indeed, Anguilla is now attracting back some of the emigrants from earlier times and has to import labor to maintain its growth rate.



## 2. Water and Sanitation Development

### 2.1 National Development

It is the policy of the present Government to promote growth of the economy at a rate that can be sustained by the resources of the country.

The very rapid growth experienced in the past few years is beginning to cause some problems in that the infrastructure has not been able to expand sufficiently rapidly to keep up with both the development and the aspirations of the inhabitants who now have a considerably higher income and standard of living.

The competing requirements for funding of health, education, power supplies, roads, water and sanitation together with the competition for human resources is having to be carefully managed.

Notwithstanding the limitations, the government's policy can be summarized as follows:

#### Health

The best health care and service consistent with the available resources and size of the community is to be provided.

#### Education

Education is to be provided free of charge to all children between the ages of five and eighteen. It is recognized that the future of Anguilla will be largely shaped by the skills of the youth of today and those skills are to be encouraged and supported by the provision of higher education to meet the future requirements of Anguilla.

#### Labor

It is recognized that there are insufficient numbers of indigenous labor and insufficient skilled and qualified personnel to meet the present requirements of the country. However, labor is to be strictly monitored and controlled so that the indigenous work-force is given priority for vacancies and that the indigenous population receives sufficient education and training to be able to replace expatriate personnel at the earliest possible time.

#### Public Works and Communications

Transport and communications are to be enhanced so as to support the development of the island in a smooth and efficient manner.

### Water Supply and Electricity

Government water supply and electricity supply are to be provided at cost to any member of the community who requests the supply. The water supply is to be improved so that eventually potable water reaching international standards will be available to all consumers. Electricity supply is to be improved to give a much more reliable supply in terms of reduced voltage fluctuation and reduced outages.

### Environmental Health

Developments are to be controlled so as to reduce any damaging impact on the island or its environment.

### Tourism

Tourism is to be promoted such that small scale up market developments are encouraged. Investment by Anguillians is to be encouraged. The rate of development is to be controlled such that the island's resources are sufficient to support the developments.

### Lands

The alienation of land from the indigenous population is to be strictly controlled.

### Finance

Expenditure is to be controlled so as to not exceed the collected revenues. In the short term, revenue is to be raised from existing sources without imposing new taxation.

2.2 Clearly the national objectives are largely interrelated, particularly in respect to environmental health, water supply and sanitation. The competing requirements of each sector on the government revenue or indeed the funds available from funding agencies are such that careful management and programming are required. Considerable changes in the existing management of resources are required to maximize the efficiency of each sector and in the disbursement of funds to allow sectoral management to operate effectively.

## 3. Water and Sanitation Sector

### 3.1 Service Quality Water Coverage

As described in 1.2 the construction of housing in Anguilla, the size of the country and the population size have reacted so that there are no urban and rural communities as such, but a scattered development in part concentrated by the location of roads and access.

Historically, this has meant that the provision of services has been extremely costly per unit household and consequently services have been provided very slowly. In addition, the public water supply is drawn from denigrator which is of poor quality in terms of concentration of salts (particularly sodium chloride and calcium bicarbonate). These two factors have persuaded inhabitants to be self-sufficient in water supply and almost every building has a 'private' water supply consisting of roof catchment and cistern. Similarly, it has not so far been economically feasible to construct central sewage collection and disposal systems and disposal has been by means of pit latrines or, more frequently these days, by individual households having septic tanks and soakaways.

The coverage of water supply is, thus, very high in terms of accessibility to water (approximately 95 percent of households have private roof catchment/cistern supplies), but considerably fewer households have connected to the government supply (approximately 40 percent). There are government standpipe supplies in many areas of the island where distribution pipes have been laid. At present, there is an average of one standpipe to each 76 persons. However, the distribution and location of these standpipes is not based so much on population density or requirement by disadvantaged groups, but more on constituency requirements of elected representatives.

### 3.2 Status of Water Supply and Sanitation Sector

At present, water supply is part of a government department tied loosely to the Electricity Section, but under the overall management of the Chief Engineer of the Public Works Department.

On the other hand, there is no Department of Sanitation, but the responsibilities for sanitation control lies with the Environmental Health Officer under the Health Department.

Control of funds is notionally under the direct control of the Heads of Department, i.e., the Chief Engineer, PWD, and the Health Administrator. Budgets are allocated by the House of Assembly and are generally considerably less than the estimate prepared. Revenue is collected by the Department of Finance and are entered into the general fund rather than passed directly back through the budget account.

This management structure has been recently criticized by consultants who have been studying the water supply and other consultants studying the electricity supply. It is hoped that both the water and electricity supply sectors will be further divorced from treasury control, either together or separately, and be run as integrated commercial entities responsible for funding and revenue collection, as well as for operation and maintenance of supply.

The separation of utilities from absolute government control will leave a void in the existing organization structure in that revenue collection and accounting will have to be done by the utilities rather than having shared personnel with the Public Works Department and Finance Department. This is not seen as problematical.

Of more serious concern, at least in the short term, is the limited skilled manpower available on the island. As a result of the recent upturn in the economy, there is now nominally full employment and considerable competition for labor. This, of course, drives up wage rate and salaries which are difficult to negotiate under the public service conditions.

The economy can possibly meet the operation and maintenance costs of the sector and a considerable portion of the capital expenditure program. However, once again there are difficulties in raising revenue or water rates while these are still controlled by the government through the Executive Council and the House of Assembly.

### 3.3 Health Status of People

Out of the total population of 7,300 about one third are school children and approximately ten (10) percent are over 65 years of age.

Infant mortality rate in 1987 was 22 compared with 39.6 percent in 1977. Information on fatalities through disease is scarce and probably of little value with such a small population. However, gastroenteric illness is not uncommon (49 cases in 1987) and fish poisoning (cigatera) is not infrequent (16 cases in 1987). Not enough information is available to determine the vectors for gastroenteric viruses.

### 3.4 Needs, Obstacles and Possibilities

The needs for the future are relatively easy to identify. These include in the first instance a requirement for a more definitive government policy in many sectors together with guidelines and standards to be achieved. Secondly, a prioritization of policy and goals so that the distribution of funds can be planned and programed over say 5-or 10-year programs. Thirdly, enhanced management and planning either divorced from Treasury with independent financing, particularly in the water and sanitation sector or within the Treasury, but with long term strategy and planning/programming tied in with the funding.

The major obstacles are also relatively easily identified. The first is one of funding a large capital expenditure in an uncertain climate and pace of future development. The competing requirements on the available sources of funding are political decisions which are determined by emotive issues of public awareness, where there is a lack of long term planning development and funding are difficult to achieve.

External agencies have recognized many of the problems within the present organization and funding agencies have been requiring major changes in the management and degree of accountability prior to funding required capital works. If the government will accept these changes, there could well be an opportunity for managed industries, including the water supply and sanitation utilities.

### 3.5 Achievement During the International Drinking Water Supply and Sanitation Decade (1981-1990)

The government with the assistance of the Canadian International Development Agency (CIDA), has commissioned consultants to investigate the water resources and supply of the island. This study has been carried out between 1985 and 1989 and has resulted in a detailed report "Anguilla Water Development Program" giving estimates of future demand and resources with various options to meet the future demand. The report indicates a development strategy of water supply up to the year 2000 and beyond together with funding requirements and means of collecting the revenue to carry out the operation of the program. Further, the Canadian International Development Agency have agreed, in principle, to fund part of the program if the government will accept the report and wish to implement a program.

The duration of the study and the uncertainties of the final "development program" have delayed necessary funding on upgrading of the present system (in case such upgrading may be redundant within the overall scheme of the program). However, on learning of the basis of the plan considerable expansion of the system has taken place outside of the areas covered by the plan. The population served with private water connections has tripled throughout the first nine years of the Decade and the amount of water provided to supply has doubled between 1983 and 1988, whereas, the quantity metered delivery has only increased by 50 percent in the same period.

In the sanitation sector, there have been few developments within the Decade. The handling of solid waste is treated on a crisis management basis, i.e., with day to day management rather than to any long term planning or policy.

Sewage and excreta disposal has improved throughout the Decade with more flush latrines having been constructed than pit latrines. Disposal is via septic tank and soakaway for the effluent. This form of treatment is now more popular due to increased health awareness and increased income. Assistance from government agencies is restricted to advice or occasional sale of slabs, seat and cover for pit latrines.

## 4. Water and Sanitation Programs

### Types and Structures of Programs

At present, there is no sanitation program to report on. In the water supply sector, there is a final draft report entitled, "Anguilla Water Development Program" funded by CIDA, which has yet to be discussed and

accepted. If accepted, the program will go a long way into solving many of the problems that bedevil the existing system of water supply. The program recommends that much of the older portion of the existing water storage, distribution, and well source are replaced due to inadequate capacity, old age and inadequate strength and poor design. This would reduce the unacceptable high losses in the present system and release much of the existing resources for utilization. The report also recommends satisfactory management structure and financial structure that would allow the water supply sector to operate in a businesslike manner and carry out the required maintenance of the future system.

The water development program allows for the addition of a desalination plant when demand reaches the supply resources and the storage and distribution capacities have been designed to incorporate this additional source of water.

At present, the most economical way of producing desalinated water appears to be by a distillation plant utilizing the water heat from the electricity generation station. A large increase in generation capacity is required over the next three (3) to five (5) years, and it is envisaged that the new generators will be ordered so that they may easily (and cheaply) be adapted to provide waste heat for a distillation plant.

#### 5. Specific National Issues Related to Water Sanitation

It is clear that groundwater will form the major source of water in the short-to medium-term and will still form an important component of a melded groundwater/desalinated sea water source for the foreseeable future. As such, the groundwater resource must be protected as much as is possible to protect the wholesomeness of supply.

Protection of the groundwater supply will require zoning of certain commercial ventures and, in the future, may require protection from sewage effluent from poorly constructed and operated septic disposal systems. Of greatest concern at present is the possibility of pollution from petroleum, petrochemical, herbicidal and other toxic substances.

The management of waste and excreta disposal are topics presently causing national concern and it is hoped that ongoing studies may provide solutions to the present problems.

Country Statement - Bahamas

Godfrey E. Sherman  
Sewerage Engineer, Water and Sewerage Corporation

General

The Bahamas constitute a chain of some twenty (20) or so inhabited islands spread over a 350 mile area off the Florida Atlantic Coast. The total land area of the islands is approximately 5,400 square miles. The greater part of the population is almost 251,000 is concentrated in the four (4) islands of New Providence (168,000), Grand Bahama (37,000), Eleuthera (11,904) and Andros (9,386). These four islands together account for about 90 percent of the total population of the Bahamas.

Rainfall in the island ranges from 30 inches a year in the southeast Bahamas to 60 inches a year in the northwest (Abaco and Grand Bahama). More than 75 percent of annual rainfall occurs during the wet season from May to November. The water resources of the islands consist mainly of groundwater, which occurs as a two density system with fresh water in the form of a thin lens floating on the heavier seawater.

Given the nature of the groundwater system, water abstraction has to be carefully controlled so as to minimize the intrusion of seawater into the freshwater aquifers. This means that water abstraction has to be carried out at low rates over wide areas, so as to effectively skim the surface of the freshwater lens and, thereby, avoid any significant upconing of seawater.

Water and Sanitation Service Levels

It is estimated that about 86 percent of the population of the Bahamas is served by a piped water supply system while the other 14 percent rely mainly on private wells, roof catchment systems or water supplied by mobile tanker. The service coverage is about 90 percent on New Providence and about 8 percent in the Family Islands. About 180,000 persons are served by 40,000 house connections while an estimated 47,000 persons are served from 600 public standpipes.

In New Providence, the largest demand center, water quality problems are posed by a relatively high concentration of chlorides, totally dissolved solids and hardness in the water. However, since the water is chlorinated before being pumped into the distribution system, there are only rare causes of bacteriological contamination and they are usually carried by illegal cross connection between the public water supply system and contaminated individual systems.

On New Providence, there exists several relatively large centralized sewerage systems and numerous, in excess of twenty, smaller systems in various states of repair providing coverage to approximately 2,000 acres of the

island. The total acreage of the island is in the region of 54,000 acres of which in the order of 50 percent is developed. So approximately 8 percent of the developed areas are served and it is estimated that in these areas some 9 percent of the population resides.

The large majority of the population not served by centralized sewerage system use septic tanks and soakaways or disposal wells with the remainder using pit latrines.

New developments are required to install centralized sewerage and new subdivisions that have been developed in the last five years have installed facilities as specified by the Water and Sewerage Corporation. Typically, sewerage in new developments will be made up of a combination of some if not all of the following, minimum diameter 8-inch pvc sewers, duplex and triplex wet well submersible pumping stations, field erected secondary and tertiary wastewater treatment plants with facilities for recycled water for irrigation and flushing, sludge drying beds and effluent disposal via double cased deep wells.

In existing developed areas, which are usually served by means of septic tanks, the intention of the Corporation is, as the sewerage system expands infrastructure (plant) will be extended into these areas and a centralized service will be provided, replacing the obsolete septic tank, which when installed in accordance with the Bahamas Building Code, should be so located to facilitate easy tie into the new sewers.

Previous experience show little community involvement in the planning of water and sewerage facilities in the country, but the public are becoming more aware of the implications of these services on their health and environment.

With the rapid expansion and development of the economy and the resultant demands on Corporation facilities, financing of programs to provide adequate service has been sought from various sources, including the World Bank, European Investment Bank, Caribbean Development Bank and governmental sources. Cost recovery for the services provided for water is based on metered consumption and in the case of sewerage the charges are based on a unit rate associated with the number and type of plumbing fixtures in a property. In global terms, 94 percent of the Corporation's revenue is accrued from the sale of water and the remaining 6 percent from provision of sewerage services. The finance associated with sewerage only covers approximately 50 percent of the cost and the Corporation is actively pursuing means to realize a more sensible sewerage tariff for these services.

#### Public Health and Waterborne Diseases

An attempt was made to compile statistics on the incidence of six waterborne diseases over the period 1976-1986. The study identified gastroenteritis, dysentery (amoebic and bacillary) and hepatitis as the three most prevalent waterborne diseases in the Bahamas. The data is presented in Table 1.



B A H A M A S

W A T E R B O R N E D I S E A S E S ( N O O F R E C O R D E D C A S E S )

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Gastroenteritis	N/A	1137	2414	2131	1146	1129	2644	2054	1998	1405	1931
Dysentery (Amoebic & Bacillary)	29	390	263	109	179	142	134	138	88	142	101
Hepatitis	22	6	26	16	24	43	59	33	21	29	39
Typhoid	11	-	-	2	3	2	2	-	2	2	3
Leptospirosis	-	-	-	-	-	-	1	6	5	2	-
Hookworm	-	-	-	-	-	2	5	8	4	4	1

Sources: (i) Statistical Abstract 1985, Department of Statistics February 1987

(ii) Annual Report of the Community Health Services for 1986

TABLE 1

### Sector Organization

The water supply and sewerage sector is under the overall responsibility of the Ministry of Consumer Affairs, which in consultation with the Ministry of Health, formulates national sectoral policies. In 1976, the government established the Water and Sewerage Corporation (W&SC) to replace the then existing Water and Sewerage Department of the Ministry of Works and Utilities. W&SC's main functions are to:

- a) control and ensure the optimum development, use and protection of national water resources;
- b) provide adequate supplies of suitable water for domestic and industrial use; and
- c) provide adequate facilities for drainage and the safe disposal of sewage and industrial effluent.

Prior to July 1989, the responsibilities of W&SC were limited to the island of New Providence with the Family Island Water Supply Division of the Ministry of Works and Utilities being responsible for providing water and sewerage services to urban settlements in the Family Islands. In July 1989, however, the responsibilities of the W&SC were widened to include the provision of water and sewerage services to the Family Islands. The Family Islands Division, therefore, with its staff of about 123, is gradually being integrated into the organization structure of W&SC.

W&SC is presently implementing a major program of capital works aimed at addressing the deficiencies in the sector. Most of the program for New Providence falls into the framework of the New Providence Island Water Supply and Sewerage Rehabilitation Project, which is being funded by a consortium of national and international agencies comprising the World Bank, the Caribbean Development Bank, the European Investment Bank, the National Insurance Board of the Bahamas and the Government of the Bahamas. The project is estimated at a cost of \$33.5 million). W&SC is also implementing a sewerage project for the Cable Beach area of New Providence. This project which is estimated to cost \$9.6 million is being partially funded by the Caribbean Development Bank.

### Sector Development and Strategies

Priorities within the national development program have been identified as:

- a) tourism and resort development, the major industry in the country which provided in the Region of 35 percent of the Gross National Product and 50 percent of the employment;
- b) the provision of better quality new homes and the upgrading existing properties, especially in poorer areas such as Grants Town; and

- c) the improvement of health care and environmental health throughout the Bahamas;
- d) the provision of water supply, electricity, telecommunications, docks, harbors, and airports; and
- e) improve network of roads in the country.

All these priorities are seen as the means for providing relief and comfort for Bahamians.

The main deficiencies in the water and sewerage sector in the Bahamas are:

- a) the poor physical condition of much of the water and sewerage infrastructure caused by a combination of age and the corrosive effects of the hard groundwater;
- b) insufficient water supplies in New Providence and several of the Family Islands;
- c) water quality problems brought about largely by limited resource availability (which forces utility companies to maintain higher than optimum abstraction rates) and the absence of disinfection facilities in some systems;
- d) high levels of unaccounted-for-water which is linked to the poor physical condition of pipelines in many of the systems; and
- e) limited sewerage coverage in the developed areas of New Providence.

The Corporation has an ongoing training program for its operations staff, although due to its relatively recent exposure to wastewater treatment, it has been necessary to send key personnel overseas to gain experience in their operation and maintenance.

The Water Supply Strategy sets out the Corporation's basic strategy to deal with the water supply problems of New Providence, while the capital works program outlines the program of works which the Corporation intends to implement over the period 1990-1994 to deal with the water and sewerage problems of New Providence and the Family Islands.

Improvements will be expected under a Capital Works Program, the \$96 million program of works is designed to:

- a) increase the supply of water to consumers on New Providence from the present (1989) level of 6.8 million gallons per day to at least 10.5 million gallons per day by 1995;

- b) improve the quality of the water supplied by reducing salinity levels and upgrading the physical condition of distribution pipes;
- c) reduce unaccounted-for-water in New Providence to no more than 30 percent;
- d) rehabilitate and expand water supply systems in the Family Islands so as to provide an acceptable level of service to all communities;
- e) rehabilitate the old sewerage system in downtown Nassau, and construct new sewerage schemes to serve major subdivisions and the tourism development area of Cable Beach; and
- f) and with specific regard to policies for sewerage development, the government commissioned a firm of British consultants to prepare a study of the sewerage of New Providence in 1972. On completion, the recommendations made became known as the Master Plan for Sewerage and subsequent development has, on the whole, been guided by those proposals; following along those lines exactly where feasible or, in any event, installed plant would facilitate sensible integration in the future.

## Water and Sanitation - Barbados

### Introduction

Ever since attaining political independence in 1966, successive Barbados Governments have placed tremendous emphasis on education and health. This policy has its genesis in the notion that the only resource which the island has is its people. In fact, in the 1988-1993 Development Plan of \$989.91 million in projected Capital Expenditure, \$359.59 million are allocated to Social Services, and of this amount \$163.57 million are set aside for education and \$150.79 for Health.

The philosophy of the Government regarding health is that the "right to health care is a fundamental human right," since healthy people in a healthy environment forms a major part of production and income earning capacity of the country. It should surprise no one then that long before the International Drinking Water Supply and Sanitation Decade (IDWSSD), infrastructure was in place for achieving the almost total coverage of the island by a wholesome public water supply.

Capital Expenditure in the water sector during the period 1981-1988 was \$22.05 million, while for Sanitation the figure was \$14.0 million. Additionally, in 1981, the first municipal sewage treatment plant was commissioned at a cost of \$43.5 million.

As a result of these efforts, Barbados today has a water supply system which is capable of delivering 29.5 million gallons of water per day through a distribution network of 1,100 miles (1,800 km) of mains to a population of approximately 250,000 people. About 95 percent of the homes have piped-in water, and just over 50 percent have waterborne sewage disposal systems.

### Short History

The development of public water supply and sanitation in Barbados has a long history. The earliest water supplies were from shallow wells, springs and ponds which seemed to have been more numerous then than now.

In the mid-1800's, not even Bridgetown, the capital, had a public water supply. Drinking water was obtained from springs, such as Beckles Spring situated on the nearby Bay Estate, and from here water was carted in casks to various parts of town where it was sold at two (2) cents for four (4) gallons.

In 1854, an English engineer reporting on the possibility of a water supply and sewerage system for Bridgetown wrote: "Few towns offer a greater accumulation of evils arising from want of good sanitation measures than this city." His report identified a number of possible sources of water supply.

Following upon this, the Waterworks Act (1857) established the Bridgetown Waterworks Company which was guaranteed a government subsidy of L5,000 per year, to supply Bridgetown with 500,000 gallons per day of pure and wholesome water.

But the rural population was still dependent on ponds, and when many of these dried up in the year 1870-1872, the then Governor requested the Superintendent of Public Works to prepare a Paper on the water supply of the island. Further, droughts prompted the setting up of a Commission in 1885 to investigate and suggest an efficient and economical mode of supplying the rural areas.

In 1886 the Legislature passed the Water Supply Act which established the Barbados Water supply Company with a mandate to supply the rural areas up to the 750 feet contour with potable water distributed by 400 public taps, each giving not more than 5,000 gallons per day. The Company was to be paid an annual subsidy of L5,000.

The dry year 1886, saw the Bridgetown Waterworks Company searching for new sources of supply after it was found guilty by a Commission of not fulfilling its contract to Supply Bridgetown with 500,00 gallons of water per day. In the meantime, the Barbados Water Supply Company was not very successful in developing new sources, and was constantly appealing for more time to fulfill its original contract.

As fate would have it, both companies went to court over the rights to the development of the Bowmanston Stream, and in the end the Barbados Government bought over both of them by the Waterworks Act (1895), thereby, establishing the Waterworks Department.

#### Organization and Management

In Barbados, two (2) Ministries are responsible for formulating policies related to water and sanitation: these are the Ministry of Health and the Ministry of Transport & Works (M.T.W.). In the case of the latter, the responsibility rests with the Barbados Water Authority which is part of the Ministry of Transport & Works.

The Ministry of Health secures its authority under the Health Services Act 1969, which enables the establishment of the various regulations designed to protect water quality, and to ensure sanitary practices in all public and private places. Their personnel have authority to enter homes, work places, restaurants and food-processing plants to examine compliance with the regulations.

The Sanitation Services Authority which is part of the Health Ministry is charged with the disposal of solid waste, while the Environmental Engineering Division is concerned with matters of pollution on the beaches and near shore waters.

The Barbados Water Authority Act, 1980 established the Barbados Water Authority to supply water for domestic, agricultural, industrial, commercial and other prescribed purposes. In carrying out this mandate, the Barbados Water Authority can enter any premises and divert or impound the water from any stream, spring or pond, but is liable to compensate the owners or occupants of these premises. The Barbados Water Authority is only excused from carrying out this mandate in the event of a drought or other extraordinary event.

Water for irrigation is controlled by means of a permit mechanism.

There is close collaboration between the above mentioned Ministries and the Ministry of Agriculture, and senior personnel from the Ministries of Health and Agriculture sit on the Board of the Barbados Water Authority.

Other personnel from these Ministries sit on various Committees, i.e., RAMCID, South & West Coast Project Committee as part of the multidisciplinary approach to problems that affect more than one Ministry.

Surface drainage and recharge is presently the responsibility of the Ministry of Transport & Works as part of their public works program.

#### Water Quality

With a population density of 1,500 per square mile, Barbados is the most densely populated country in the Western Hemisphere. When this is viewed against a background of improving living standards through the use of waterborne systems and attempts to industrialize, we can easily see why protection of water quality assumes such importance.

The policy in respect of water quality protection falls under the Health Services Act, and was in vogue since 1963. The island is divided into five (5) zones with specific restrictions applying to each zone. Example, no new development is permitted in Zone I which comprises the area around an existing or proposed well source. Zone II requires that the sewage be discharged via a septic tank to a soakaway pit. Petrol and fuel oil installations are prohibited in this zone. Zone V has no restrictions except that no new petrol or fuel tanks may be constructed without Barbados Water Authority's approval. New industrial enterprises are banned from Zone I, while in Zones II-V industrial effluent disposal must be approved by the Barbados Water Authority.

This policy has been very effective in protecting our groundwater from biological contamination, but is seen as too conservative in some quarters. In recent times there have been calls for revising and relaxing these policies, but the Barbados Water Authority is of the opinion that a more comprehensive set of regulations are needed encompassing zoning of industry and limiting fertilizer applications in the existing Zone I areas.

### Water Supply and Demand

In recent years, the demand for water has increased significantly in Barbados, probably reflecting the acquisition of water using gadgets, i.e., W/Cs and washing machines as living standards have risen. These figures are shown in Table I below:

Table I

	<u>1975</u>	<u>1980</u>	<u>1981</u>	<u>1985</u>	<u>1988</u>	<u>1989</u>
Demand (MGD)	19.2	24.3	24.6	25.6	27.5	29.5

At the beginning of the International Drinking Water Supply and Sanitation Decade (IDWSSD), there were some 71,103 water connections with approximately 98 percent of the urban area covered and 74 percent coverage in the rural area. At the end of 1988 the number of connections had risen to 79,270 with virtually all the increase taking place in the rural areas which were now 87 covered.

Barbados is not predisposed to universal metering and has opted for progressive metering instead. All new buildings are now required to be metered, and any flat rate customers who wish to can request a meter.

During the Decade, sanitation has improved with about 55 percent of premises in the urban area using W/Cs and about 50 percent of the rural areas. General improvement is confirmed by statistics which show that none of the leading causes of death are water related, and that life expectancy in 1988 is now 67.2 years for males and 72.5 years for females. But these improvements have put severe strain on the water supply system, with the result that seasonal outages are now experienced in some areas.

However, a Water Resources Study done in 1978 by a firm of Canadian consultants concluded that developable water resources are adequate to beyond the year 2000.

### Water and Sanitation Programs

To meet this growing demand for water, the Barbados Water Authority plans in the first instance to sink three (3) wells - one in the North, one in the Central Area and one in the South of the island. The combined output is expected to be 3.5 MGD, and should be capable of meeting the increase in demand for the next ten (10) years. One reservoir is also planned to improve storage capacity in the Bridgetown area.

The annoying presence of discolored water in parts of the distribution system has led us to believe that treatment beyond simple chlorination will be necessary in the future. One existing well source has already been under scrutiny and a monitoring program is in place. The conversion from pumping station to treatment plant is expected to be costly.



In the field of sanitation, a South and West Coast Sewerage Study has been undertaken aimed at improving near-shore water quality, and the condition of the coral reefs along the South and West Coasts of Barbados. Efforts are concentrated on the South Coast where details of system design are being worked on.

#### Project Financing

Since 1970, water supply projects in Barbados have been partly financed by loans from the Canadian International Development Agency (CIDA). By agreement, materials (largely pipes and fittings) were bought from Canada, while local costs, e.g., supervision and labor were met by the Barbados Government. three (3) such loan schemes were approved between 1970 and 1986.

Financing of sanitation projects was largely done through the IADB, of which Barbados is a member. This was the case with the 1978, Bridgetown Sewerage Project and the South and West Coast Sewerage Studies. It is expected that this pattern will continue in the future.

#### Future Issues

In Barbados, the fundamentals of a good water and sanitation system are in place. However, there are certain factors which will combine to set the agenda for future issues related to the sector - these are high population density resulting in pressure for more water and developable land, disposal of solid and liquid wastes as by-products of improved living standards and disposal of wastes from industry.

The existing Zone I areas in which all forms of development are prohibited occupy about 8 percent of the island's land area. Some of this land is close to Bridgetown or on the ridge overlooking the scenic West Coast. This land is, thus, attractive to developers, some of whom have put forward schemes for the release of this land for development. The Barbados Water Authority feels that the existing Zoning Regulations should be maintained and rigidly enforced, since to do otherwise and succumb to short-term gain might jeopardize the integrity of our water resources in the long-term.

The maintenance of chemical water quality is expected to assume growing importance in the future. There is evidence to suggest that pesticides and fertilizers have impacted somewhat on the groundwater quality. In addition, some industry and trade waste which is presently discharged into the ground in some instances is thought to pose a problem.

We believe that, in addition to the present Zoning Regulations, a new set of regulations aimed at zoning of industry to protect chemical water quality will have to be devised. Under these regulations, limits will have to be imposed on the use of pesticides and fertilizers in Zone I, and this could render landowners liable for some compensation.

Barbadians generate approximately 250,000 tons of solid waste each year and disposing of this volume is becoming increasingly difficult as areas suitable for landfill become more and more difficult to locate. Further, there is worry over the possibility of relocates reaching the groundwater. This problem will need rapid resolution in the coming Decade, and already the Government is examining various options including incineration.

Finally, water consumption at 1989 (29.5 MGD) is some 10 percent higher than projected. Although the resource is there to meet our needs beyond the year 2000, demand must be curbed in order to postpone the day when expensive surface sources will have to be commissioned. As 70 percent of this demand is domestic, curbing domestic consumption must be given priority. As we do not advocate the policy of universal metering, future action in this area will likely to be a combination of progressive metering and a public relations program.

#### Constraints to Sector Development

The water and sanitation sector in Barbados is likely to remain high priority for future governments, especially with the renewed emphasis on Tourism.

However, it is generally recognized that this sector has grown beyond its formative years, and will have to compete with other sectors for available scarce financial resources.

With more attention being placed on project viability, the greatest constraint to sectorial development in the next Decade might be the attitude of lending institutions for projects whose internal rate of return is deemed too low.

#### Service Improvements (1990's)

Improvements in sanitation are likely to be more dramatic than improvements in the water sector where almost universal coverage has been achieved. As stated earlier, water quality will be the major issue and already a Water Quality Monitoring Program has been undertaken by the Ministry of Health in collaboration with PAHO and the British Geological Survey. Further improvements are expected when the South and possibly the West Coasts are sewered.

In the water sector apart from three (3) new well sources, the Barbados Water Authority will continue its program of laying approximately sixteen (16) miles of trunk and distribution mains each year.

Guidelines for Country Statements in  
Conference on Water and Sanitation Sector in the Caribbean  
British Virgin Islands

1. Water and Sanitation in Development

1.1 National Development

Broadly, the aim of the Government as far as health is concerned is to provide health care for all residents regardless of color, nationality, wealth or circumstances. Within this broad goal, the water and sanitation sector strives to make available to all residents, a potable water (WHO 1984 Guidelines for Drinking Water) supply at all times and to provide a sewage and solid waste collection and disposal service.

1.2 Water and Sanitation Sector

Presently, all water and sewerage matters are handled by the Water and Sewerage Department while solid waste collection and disposal matters are handled by the Public Health Department. The Water and Sewerage Department falls directly under the Ministry of Communications and Works while the Public Health Department falls under the Ministry of Health, Education and Welfare.

There currently exists a territory-wide solid waste collection system while disposal is done largely by sanitary landfilling.

Within the water sector, the Water and Sewerage Department serves about 2,100 accounts territory-wide. Within the urban area, a piped water supply is available to properties below the 250-foot contour. This also holds true for the residential areas on the two ends of the main island of Tortola - West End and East End. Overall over 60 percent of the British Virgin Islands population (12,000) has piped water available to them, while only about 25 percent is actually connected. Approximately 80 percent of the connections are in the urban areas.

All water connections are metered with rates being divided into four categories - domestic, commercial, water to ships and water delivered by trucks. The water supplied is all of ground water origin with chlorination being administered throughout and about 75 percent of the daily demand of 275,000 imperial gallons being desalted using reverse osmosis units.

Properties not having a public water supply connection are supplied by underground cisterns which collect runoff from roofs. The Land Development Control Authority and the Building Authority require buildings to have at least ten gallons cistern capacity for every square foot of roof area.

These bodies also require buildings to have adequate sewage disposal systems.

The Water and Sewerage Department operates a sewage collection and disposal system, processing approximately 100,000 gallons of sewage daily. The system is confined to the urban area and serves approximately 280 properties. The sewage is collected and without treatment, pumped out to sea through an outfall.

The Water and Sewerage Department currently employs the services of three engineers and a qualified laboratory technician among its 45-member staff. One of these engineers serves as the manager and is answerable to the Ministry's permanent secretary.

Solid waste disposal is handled by a team of about five Public Health inspectors with the Chief Public Health Inspector being answerable to the Chief Medical Officer, who is in turn answerable to the Permanent Secretary in the Ministry of Health, Education and Welfare.

According to the Chief Medical Officer, the British Virgin Islands population is a healthy one with a fairly comprehensive public health system in place.

During the International Drinking Water Supply and Sanitation Decade (1981-1990), 79 percent of the existing water storage capacity was installed while connections to the sewerage system grew by approximately 150 percent. Desalination was also introduced during the Decade, thereby, allowing the water supplied to be truly potable. Prior to desalination, all water supplied could only be termed as brackish. It is also safe to say that the accessibility of water to households was increased by more than 50 percent.

### 1.3 Water and Sanitation Programs

The Government is at the moment contemplating the cogeneration of electrical power and potable water by using waste heat from a new power plant, and the incineration of solid waste to operate a seawater desalination plant. This project is expected to become operative during the 1990's.

The highest priority during the Decade was assigned to making piped water available to a wider British Virgin Islands population. The second priority was to protect urban water resources while cleaning the main harbor. This was achieved by extending the sewerage system in the urban area. The third broad priority assigned to the water sector was to improve the quality of water provided in light of the territory's increasing development in the tourism sector.

These priorities would carry over into the 1990's with water supply projects being planned for a sub-urban area of Tortola and the development areas of Virgin Gorda. The sewerage of Cane Garden Bay, a rural area of Tortola is also planned due to its proximity to one of the territory's more important beaches.

## 2. Project Development and Finance

The basic problem of and major constraint to project development and financing in the British Virgin Islands Government's context is the absence of a full-fledged and functional planning body or institution. The present Planning Unit was established some years ago, but has not yet received the status it needs to function as a development planning institution. Problems of staff decentralization, lack of adequately trained permanent staff and general indifference towards its existence and role at the higher decision-making levels hamper the development of this vital unit and, therefore, one of the terms of reference, project development and financing. Appreciation of the situation described below requires the statements above to be kept in mind.

### Project Identification

The identification and selection of water projects is guided by a "complete" study of water requirements and resources of the British Virgin Islands. The proposals and recommendations of this study are used to identify projects; however, final selection and priorities are determined by the Ministry responsible for Water and Sewerage, on an ad-hoc basis. There is a need for an explicit system or machinery to identify and select water projects. Last year, the Planning Unit of the Chief Minister's Office contributed to the identification process with its annual project list and review exercises.

The Richards and Dumbleton consultants' report on Sewerage in British Virgin Islands and the Planning Unit's annual project list and review exercises are the major sources of project identification.

Policies of international agencies and National Government influencing project selection include:

1. BOD's self-financing project stipulation for water projects.
2. EDF/BOD's requirement for local technical manpower components in projects excludes project activities such as Resistivity survey and other water investigations.

It is also Government's policy to finance only self-financing water projects. This was the prime reason for rather socially smooth water tariff increases recently.

The lack of expertise in carrying out field investigations, geological information, etc., for project selection is a serious problem. Inability to reach a consensus at ministerial level on the priority of projects also poses a problem for water projects. Indecision as to the extent of the sewerage system necessary for British Virgin Islands is derived from the technical level. The overall problem in identifying and prioritizing projects is found in the present status of the Planning Unit.

### Project Documentation

The fact that statistical data is not available poses a problem for project preparation and appraisal. The huge deficiency in the data base of the British Virgin Islands and its lack of adequate information essential for the various stages of project documentation causes delays in project documentation and funding decision making. Requests are frequently made by donor lending agencies for data to support and justify certain relevant project components. This is time-consuming and also leads to multiple updates of original project documents.

Generally, the capacity exists for proper documentation but the ministries involved are reluctant to involve Planning Unit officials at the "Project Profile" level and; consequently, the results are less than adequate presentation of project ideas to lending agencies.

The consensus is that donor agencies' requirements are too "precise and accurate" and unnecessarily time-consuming. The opinion has been expressed that certain stages of appraisal could be omitted for smaller projects and social projects such as water supply.

Project appraisal and general documentation skills need to be appreciated and improved in order to overcome this problem. Training for all senior civil servants should be done at the orientation level, and at more intensive working level for personnel in the various ministries normally responsible for project documentation and development. CDB/PAHO could be of assistance in this area for training and some UN agency could provide literature on project development.

UN, CDB, DECS, CARICOM and individual government could enter into bilateral and multilateral arrangements in order to form a technical staff pool to complement deficiencies in expertise available in project documentation in different countries. Donor agencies may assist by a critical examination of their documentation requirements in the light of the limited expertise in this field, especially in the smaller countries of the Region. Agencies could attempt to limit requirements to levels consistent with proper project and system control in each country, thereby, allowing a greater measure of flexibility.

### Project Funding

#### Government

The British Virgin Island has a good credit-rating and has generally been able to obtain loan funding. Recently donor agencies have raised the issue of per capita excesses and, therefore, aid proposals have been reviewed with this as the uppermost factor. In addition, due to both the documentation problem outlined and the slow study carried out by donor agencies, loan agreements have taken some time and money.

Many constraints and obstacles in obtaining external assistance are:

- a) Lack of centralized government approach to agencies instead of individual ministry approach;
- b) Inadequate documentation; and
- c) Per capita income relatively high for developing country.

There is no formal policy for seeking external assistance. In the past, this has led to much confusion; however, most aid requests are now channelled through the Development Aid Coordinating Officer and in some cases the Ministry of Finance.

Special problems and constraints in obtaining funding are:

- a) Inter-Country Projects - British Virgin Island is not a member of certain regional institutions and is, therefore, excluded from certain aid projects.
- b) Project Phases or Elements - The usual difficulties of multi-agency funded project proposals.
- c) Incomplete Projects - Due to the unavailability of soft funds and the tendency for government and donors policy towards self-financing, these projects are falling back in priority.

There is a possibility of mobilizing internal/local resources for funding water and sanitation projects from the local capital budget. However, these funds would be limited.

### 3. Sector Support Programs

The human resources needs of the British Virgin Islands are increasingly being met by locals being trained regionally and abroad. When qualified personnel are not available locally, recruitment is done regionally and them further afield. Also, in these cases, personnel are supplied by programs, such as the United Nations Development Project (UNDP), Commonwealth Fund for Technical Cooperation (CFTC), Overseas Development Administration (ODA), and Volunteers Services Overseas (VSO).

Personnel development is handled by various local, regional and international training programs. Regionally, the British Virgin Islands is a participant of the Caribbean Basin Water Management Project (CBWMP), a project headquartered at the Caribbean Development Bank (CDB) and dedicated solely to training personnel in the water supply sector in the Region. This project is in addition to holding training workshops and seminars, supplies, training material and facilities, short-term fellowships and attachments for various personnel.

The British Government through its British Development Division in the Caribbean (BDDC), and the Canadian Government through its Canadian International Development Agency (CIDA) provide scholarships for long-term training needs as part of their overall support to the sector.

The Pan American Health Organization (PAHO) provides technical assistance in the form of short-term consultancies and training material. The United Nations Education and Scientific Organization (UNESCO) provides regular publications in the sector and is, currently also, in the process of preparing a hydrogeological atlas of the Caribbean which would include the British Virgin Islands. The hydrogeological survey of the British Virgin Islands was done largely by the British Geological Survey.

Currently, there is an effort to form the Caribbean Water and Waste Water Association to facilitate the professional development of regional professionals and technicians in the sector. Such a body is desperately needed in the Region, if the level of service rendered in the sector is to be elevated.

In the sanitation sector, there is the Caribbean Environmental Health Officers Association which is currently in its formative years.

Regionally, the sector is served by institutions such as the University of the West Indies, the Community College of Barbados, the University of the Virgin Islands and the Caribbean Environmental Health Institute.

The future of the sector in the British Virgin Islands, as well as in the region depends to a great extent on the consolidation of the regional bodies and the education of the general public and the political directorate on environmental matters.

In addition to public education, regional support bodies could perhaps be strengthened by the passage and subsequent enforcement of environmental guidelines and/or standards in the various countries.

A stronger commitment of regional professionals and technicians within the sector, and perhaps, the unifying of the different regional bodies are definite imperatives to improving and increasing sector support programmes.

#### 4. Constraints to Sector Development in the 1990's

##### Human Resources

Human resources continues to be a problem area in the British Virgin Islands, as well as in the Region within the water/sanitation sector. Trained and trainable personnel are in rather short supply in the Region. From this limited pool, the sector has to compete with other sectors which are often more attractive financially and socially. As a result of this scarcity, technical personnel are sometimes recruited from abroad to fill those positions that



simply cannot be left unfilled. These officers and technicians are often gone in two years' time and sometimes replaced. This replacement is often very disruptive and continuity and momentum suffer as the replacement is being recruited and acclimatized to the Region.

Because of these reasons, training within the sector must continue to be given priority through the 1990's. Some effort must also be made to retain trained personnel whether by means of better salaries, career incentives or whatever means.

#### Better Financial Management Within the Sector

It is my view that the lack of proper financial management within the sector has severely retarded progress. This shortcoming is particularly highlighted when trying to justify funding for new projects or maintenance.

This is definitely an area that must be given some serious consideration during the 1990's.

#### Data Collection and Record Keeping

The availability of historical technical data and the lack of proper records is another constraint area within the sector. Again, this shortcoming affects the proper design and development of projects. A greater emphasis is going to have to be placed on this area during the 1990's.

#### Environmental Legislation

The lack of meaningful environmental legislation and/or the enforcement of such is another obvious area of weakness. There must be the political will to implement and enforce necessary environmental legislation. Enforcing agencies in the British Virgin Islands must be given more practical means of enforcing what legislation there is.

The development and acceptance of standard guidelines for the Region is something that must be done during the 1990's.

### 5. Proposal to Improve Service Quality in 1990's

#### British Virgin Islands

The following is an outline of an active program to improve service quality during the 1990's:

- a) Improve communication and coordination with the Public Health Department, which is responsible for sanitation. Presently, the Water and Sewerage Department falls under the Ministry of Communications and Works, while the Public Health Department falls under the Ministry of Health, Education and Welfare.

- b) Improve the quality and availability of water supplied.
- c) Promote legislation to better facilitate the collection of revenues for sewerage services.
- d) Improve financial management of the sector.
- e) Improve data collection and record-keeping.
- f) Emphasize and exercise preventive maintenance programs.
- g) Have ongoing training.

#### Caribbean Region

- a) Development of regional guidelines and codes of practice.
- b) Exchange attachments of personnel to other regional utilities for professional development and stimulation.
- c) Consolidation of regional bodies, such as the Caribbean Water and Wastewater Association, the Caribbean Environmental Health Officers Association, the Caribbean Environmental Health Institute and the Caribbean Basin Water Management Project.
- d) More regional projects like the Caribbean Environmental Health Institute's coastal water pollution monitoring project.

#### Cane Garden Bay Sewerage Project

Cane Garden Bay is essentially a rural residential community with a mixture of commercial establishments, such as restaurants and small tourist resorts ringing what could be considered as one of the territory's more popular and scenic beaches. One industry is present, the Callwood rum distillery. The tourist resorts are closer to multi-family homes than to major hotels.

Because of elevated total and faecal coliform counts discovered in the waters of the beach, and considering the economic importance of this beach in light of the territory's tourist economy, sewerage of the shoreline was recommended by the Canadian consulting firm of Dillon Consulting Engineers.

The sewage collection system being proposed would run parallel to the shoreline from East to West. The system would be a force main fed with grinder type sewage pumps.

Because much of the line would be below the water table, it will be necessary to anchor the pipes to prevent floating. Initially, this system would serve only properties along the shoreline. Houses located up the hillside would be difficult to service because of the steep grades. These houses could be added to the collection system at a later date if necessary.

It was also recommended that a secondary sewage treatment plant be installed to treat the sewage. The type of plant suggested was a Rotating Biological Contactor type. This would be sited at the West End of the beach and connected to a seawater outfall with a depth of almost 40 feet. This location would permit the treated effluent to be discharged in an area where natural flushing is at a maximum.

The 1988 estimated costs are as follows:

Sewage Collection System	US\$626,000
Sewage Treatment System	US\$355,000

Country Statements - Guyana

1. Water and Sanitation in Development

Government policy is to supply potable water to every home by the year 2000 and to create a healthy environment. However, much emphasis has not been placed in the water and sanitation sector.

Water Sector

The urban areas are nearly completely served by some water system, but the situation is still quite alarming. In the capital city of Georgetown, there is a deficiency of approximately thirty-five (35) cubic meters per day which has resulted in low water pressure in most cases. Leaking pipes and connections and frequent power outages have also compounded the problem.

Poor water quality has resulted from old and inefficient equipment and also by an unreliable supply of chemicals.

On the rural and hinterland areas, the coverage is about 75 percent. Many of the mechanically operated systems are working well below the desired efficiency. A total absence of standby equipment results in many communities having to do without water for several days while repairs are effected.

Sanitation Sector

The only central collection system is found in the capital Georgetown. It is a water-borne system covering approximately 200 hectares. The system is divided into 24 artificial sewerage basins each with a pump which discharges into a force main. The force main in turn discharges into the Demerara River. The system is presently undergoing major rehabilitation and should be completed by year end.

In other urban areas, septic tanks and pit latrines are used.

In the rural areas, septic tanks and pit latrines are utilized.

Status of the Sector

The responsibility for health administration lies with the Ministry of Health and the Guyana Agency for Health Sciences Food Policy and Environment. The Guyana Water Authority operates under the direction of the Office of the President. Georgetown and New Amsterdam have their own operating units. The Regional Mining Enterprise operate most of the rural systems. The Guyana Mining Enterprise operates the systems at Linden and Ituni. Twenty-two systems serving the sugar estates are operated by the Sugar Labor Welfare Fund Committee.

All of these agencies come under the direction of the Guyana Water Authority as prescribed in the 1972 Guyana Water Authority Act.

Water in Guyana is obtained from:

- a) Rainwater
- b) Springs
- c) Ground Water
- d) Surface Water

#### Health Status

The following cases of environmental related diseases were reported between 1984 and 1988 with prevalence of gastroenteritis among children under five years.

	<u>1988</u>	<u>1987</u>	<u>1986</u>	<u>1985</u>	<u>1984</u>
Dysentery	308	330	93	126	155
Gastroenterites (under 5 years)	4,396	5,220	3,750	4,449	3,499
Gastroenterites (under 5 years)	408	524	317	323	408
Typhoid Fever	158	68	133	244	193
Infections Hepatitis	241	193	312	126	169
Diarrhoea	202	38	14	42	53

#### Needs Obstacles and Possibilities

The major issue which caused projects not to be implemented has been the performance of the economy of the country. The lack of foreign exchange not only affected new projects, but had a serious effect on the operation and maintenance of water and sewerage systems due to the unavailability of spares for the effective maintenance of equipment.

Rehabilitation of the Georgetown Sewerage System by the EEC. Further assistance is expected next year, which will allow for major rehabilitation of the urban water systems in Georgetown and New Amsterdam.

Assistance is also expected from IDB in the preparation of a Master Plan for the improvement of the Georgetown Sewerage and Water Systems. This will be a follow-up to the institutional strengthening project now in progress.

#### Achievements

During the International Drinking Water Supply and Sanitation Decade (IDWSSD), over twenty (20) wells have been drilled in various parts of the country for private agencies and the regions. New pipe lines were installed in areas which previously received little or no water for years.

Programs

- European Economic Community - Rehabilitation of the Georgetown Sewerage System.
- Interamerican Development Bank - Institutional strengthening program.
- UNICEF - Improvement of rural water supply systems in conjunction with the Women Affairs Bureau.

At present, the country is experiencing a serious manpower shortage and this has affected the water sector. Skilled personnel cannot be easily obtained.

Many projects have not gotten off the ground because Government is unable to generate funds to meet the local cost of the projects.

2. Specific National Issues

- a) Development and implementation of a Master Plan for the City of Georgetown.
- b) Improving the water supply system nationally.
- c) Finding suitable site for disposal of solid waste.

3. Financing

Most projects cannot be financed locally due to performance of the economy, but funding has been received from UNICEF - US\$0.25 million to improve water supply. EEC US\$2.0 million to rehabilitate the Georgetown Water Supply and Sewerage System. The EEC is also providing US\$3.6 million for an emergency project.

4. Sector Support

The problem in Guyana is the lack of skilled and unskilled manpower. There should be full autonomy of the water sector in order to attract skilled personnel. Government should also place more emphasis on the water sector.

5. Constraints

With the improvement in the economy the situation would improve.

6. Proposals

Even though funds may be provided by external agencies, there would still be a deficiency in skilled personnel to implement the projects.

Water and Sanitation Sector in the Caribbean

Pierre Sajour  
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Service National D'Eau Potable, Haiti

1. Water and Sanitation in Development

1.1 Background and Objectives

The Republic of Haiti is located in the western half of the island of Hispaniola with population of nearly six million and a total area of 27,000 square kilometers, it is considered as one of the largest and most populated country within the Caribbean Region.

Early in the 1980's, the country has subscribed to the mandates of the International Drinking Water Supply and Sanitation Decade (IDWSSD) for improvement of coverage and accessibility within the sector. Specific goals were established which stated that coverage will be extended to 80 percent of the urban population and 50 percent of the rural population for water supply and an overall 40 percent for sanitation.

1.2 Water and Sanitation Sector

During the International Drinking Water Supply and Sanitation Decade various projects have been identified and executed at the sector level. The strong orientation toward water projects to the prejudice of construction of latrines, sewers wastewater treatment plants and solid waste disposal facilities is mainly explained by the structural incoherence existing at that period within the agencies involved in sanitation.

To better understand the service quality coverage achieved at the end of the Decade, an overview of the population distribution is presented in Table 1

Table I

Population Distribution in Haiti

	<u>Urban Zone</u> <u>t=5%</u>	<u>Secondary</u> <u>cities t=2, 8%</u>	<u>Villages and</u> <u>Rural Area t=1,3%</u>	<u>Total</u>
Population in 1988	1,000,000	550,000	3,900,000	5,500,000
Population in 1995	1,385,000	670,000	4,324,000	6,380,000

The majority of the population in Haiti is distributed throughout villages and the dispersed rural area. As such, an increase in coverage would impact effectively on the bulk of the population.

### 1.2.1 Water and Sanitation Coverage

The objectives for water and sanitation coverage as described in the National Plan have not been achieved if 1988 situation data area considered. Table 2 establishes the evolution of coverage during the reporting period.

Table 2  
Water and Sanitation Coverage Level in Haiti

<u>Issues</u>	<u>(Percent)</u>		
	<u>1980</u>	<u>1985</u>	<u>1988</u>
Urban Water Coverage	48	54	51
Water Coverage in Secondary Cities	47	65	66
Water Coverage in the Rural Area	7.5	30	36
Sanitation Coverage in the Urban Area	41	42	42
Sanitation Coverage in the Rural Area	10	13	14

In actual numbers, a population of 2,238,000 has access to water supply, which represents 41 percent of the total population.

Water distribution at the urban and rural level is offered either through private connections or public fountains, whereas, basic sanitation services includes the construction of latrines, cesspools or septic tanks at the urban level, and latrines and cesspools at the rural level. No public services for wastewater collection exist at the moment in Haiti.

### 1.2.2 Status of Sector

#### 1.2.2.1 Sector Management

The water and sanitation sector is currently facing some difficulties mainly attributable to the lack of coherence, and coordination. Three ministerial bodies are involved in the management of the sector in as much as their main activities overshadow their responsibilities toward the water and sanitation sector. These are:

- Ministry of Public Works
- Ministry of Health and Population
- Ministry of Agriculture, National Resources and Rural Development



Several agencies appear under the headings of the Ministries listed above and they function quite independently. As a result, environmental issues are not addressed effectively, resources mobilization is inadequate, the sector as a whole is not supervised by a single entity and cannot respond to the needs and expectations of the population. To this list can be added: major conflicting interferences, between institutions, agencies that are understructured, under equipped and under funded. The following Table 3 articulates the extent of the problem which undoubtedly has reached crisis proportion.

Table 3

Names and Responsibilities of Agencies  
Involved in the Water and Sanitation Sector

<u>Ministries</u>	<u>Agencies</u>	<u>Responsibility</u>
Ministry of Public Works	SNED	Water supply systems throughout the country except the capital.
	CAMEP	Water supply system in the capital.
	SMCRS	Solid Waste Disposal at the capital.
Ministry of Health and Population	DHP	Public Hygiene, Latrization and Basic Sanitation, Vaccination, Epidemiology, Water Quality Control.
	POCHEP	Construction Project of Water Systems for the Rural Area.
Ministry of Agriculture, Natural Resources and Rural Development	SNRE	Control and Management of Water Resources.

1.2.2.2 Natural Resources

Water resources within the country are relatively abundant. Unfortunately, because of lack of water resources management, this water is lost to the sea or evaporates. The following data is representative of the existing situation:

- Yearly precipitation	40 billions M <sup>3</sup>
- Runoff (30 percent)	12 billions M <sup>3</sup>
- Evaporation (60 percent)	24 billions M <sup>3</sup>
- Infiltration (10 percent)	4 billions M <sup>3</sup>

### 1.2.2.3 Human Resources

Specific programs targeted on human resources development have not been established. But yet, data on manpower requirements for sector management can be extrapolated based on acceptable performance ratios and estimated workloads. These manpower objectives for the year 1990 which coincide with the end of the Decade have been equated to the existing statistics and clearly indicate that manpower availability is not a serious issue within the sector. Table 4 presents the various skill levels within the various agencies and objectives to attain.

Table 4

#### Manpower Availability and Objectives Within the Sector

<u>Post Description</u>	<u>Position Filled at the end of 1988</u>	<u>Position Required at end of 1990</u>
Planning and Management	195	214
Technical (all levels)	460	560
Skilled Technicians	142	270
Clerk	296	296
Unskilled Labor	794	794

### 1.2.3 Health Status of the Population in Haiti

Health status of the population is generally poor, with water and sanitation problems as being the major contributors of the existing conditions. A summary of available statistics is presented below:

- Life expectancy at birth is estimated to be between 48-54 years of age;
- The crude death rate is 6.5 per 1,000 population;
- Infant mortality is about 100 - 120 per 1,000 population;
- Maternal mortality is 32 per 10,000 population;
- Maternal diseases are estimated at 200,000 cases a year;
- Active tuberculosis affects 2 percent of the population; and
- Malnutrition and infectious diseases are widespread with mothers and children under five (5) years.

#### 1.2.4 Needs, Obstacles and Possibilities

##### 1.2.4.1 Needs

Water supply systems have received priority during the International Drinking Water Supply and Sanitation Decade (IDWSSD) in Haiti as opposed to sanitation.

Considerable efforts still need to be made to achieve the goals set forth in the National Plan.

However, needs should be expressed not only in terms of increasing present coverage, but also in terms of the sector's ability to maintain acceptable level of coverage, anticipate and provide for further demands, and impact positively on health status of the population.

Those needs can be filled only if sector reorganization becomes a reality and the following issues are addressed effectively:

- Implementation of a Water Resources Management Program.
- Redistribution of qualified personnel within the various agencies.
- Creation of a high level coordinating body.
- Establishment of a Health Education Program.
- Establishment of an Urban Planning Program
- Availability of Census Data.
- Existence and Enforcement of Environmental Regulations.

##### 1.2.4.2 Obstacles

The water and sanitation sector is facing various obstacles that may prevent its ability to perform effectively. These obstacles are:

- Political instability - government priority is to maintain order within the country and the emphasis is not to create anymore restrictions on the population that may overburden an already weak economy.
- Weak Regulatory capacities - although many regulations already exist in the books, enforcement is very limited. Law enforcement activities are concentrated in giving security to the population and fighting drug abuse.

- Lack of legislative power - in the absence of a legislative body, new agencies or regulation proposals do not receive much attention. Plans for a coordinating body has been unsuccessfully introduced twice during the International Drinking Water Supply and Sanitation Decade.
- Poverty - financial capabilities of the population are limited. A high percentage of the population not capable of paying for the services they receive, whereas, others perceive this benefit as a Government responsibility.

#### 1.2.4.3 Possibilities

A strong commitment exists at the national level and within the international organizations to restructure and reorganize the sector, but only a political commitment can instorat the leadership and achieve the level of performance expected.

#### 1.2.5 Achievement During the International Drinking Water Supply and Sanitation Decade (1981-1990)

In a previous chapter, statistics for Decade achievements have been presented. Other achievements are worth mentioning, these are:

- The International Conference on Community Participation held in Port-au-Prince in 1983. This Conference regrouped worldwide experts for exchange of experience on the subject. It should be mentioned that Haiti had taken a leadership position in the field of community participation and organization at the rural level for small water system management.
- The creation of CONADEPA which is the national committee for coordination and promotion of activities for the water and sanitation Decade.
- The strong focus on improvement of existing conditions at the rural level, area that was very much neglected in the past, and the decentralization of activities toward increasing local autonomy.

#### 1.3 Water and Sanitation Programs

An action program has been elaborated in the national plan for the Decade. Unfortunately, many projects are being implemented out of planning. As mentioned earlier, numerous are the agencies intervening within the water and sanitation sector. Countless non-governmental agencies (NGOs) are also active in this area, and undoubtedly, these NGOs are contributing to the confusion existing within the sector.

Two main reasons can be cited for most of the deviation from the national plan; namely,

- a) The majority of the agencies implement their programs independently; and
- b) Activities within the sector are basically influenced by program priorities of international funding agencies.

Nevertheless, a number of important projects aimed at improving level of coverage are worth mentioning.

- Construction of water supply systems for villages under 2,000 people.
- Rehabilitation of water systems serving secondary cities.
- Installation of hand pumps for villages and dispersed rural populations in low lying areas.
- Reinforcement of the water supply system in the capital.
- Community organization and promotion of community participation in the rural area.
- Wastewater management in selected secondary cities.

#### 1.3.1 Relationship with Programs of Other Sectors

The development of water supply system is dependent on current programs within the agricultural sector. It is reported that high withdrawal rate of water from alluvial aquifers are already creating a deficit condition. Groundwater recharge has not received the level of attention to reverse the trend.

Also, recent programs for low cost housing construction in marginal areas is increasing the pressure on the existing water systems. These projects have encouraged partially the extension of existing water systems to improve service level in areas that were traditionally neglected. Sanitary facilities are also being promoted within these projects boundaries to offer increased access to sanitary conditions and health. This strategy exemplifies integration of water and sanitation.

Within the objectives of the health sector, the Diarrheal Disease Control Program identified three (3) major components for action:

- a) Potable drinking water and sanitation;
- b) Oral rehydration; and
- c) Encouragement of breast-feeding.

### 1.3.2 Resources Development and Mobilization

At the onset of the International Drinking Water and Sanitation Decade, the Government of Haiti had officially pledged 10 percent of the National Budget to finance programs with the water and sanitation sector. However, more realistic goals had to be established based on the projected financial capabilities of the country.

Considering the adverse economical conditions registered in the 1980's, the sector had to rely heavily on external support to carry out important projects. Contribution of international and bilateral agencies is estimated at 90 percent of the overall cost of the projects.

For additional input, the sector had also relied on community participation, which often accounts for as much as 25 percent of the total cost of the project. Naturally, communities were involved early in project identification and planning.

## 2. Specific National Issues Related to Water and Sanitation

### 2.1 Urbanization

On a countrywide level, the capital city and most secondary cities are experiencing rates of increase that are far superior those reported for the rural area. Uncontrolled fragmentation of agricultural land, soil erosion and the infamous government program for slaughtering indigenous pigs have created an imbalance within the rural population already fragile economy. These events resulted in an accelerated migration to the cities.

This migrating population invade available government properties and have also settled in overcrowded marginal slums. Cities, therefore, have expanded at very fast pace, thereby, exercising more pressure on existing services that do not have the capacity to meet the demands of the new settlements.

Urban planning and rehabilitation programs of marginal areas should be high national priorities in order to formulate water and sanitary projects that will improve accessibility to safe drinking water supply and maintain sanitary conditions within the population.

### 2.2 Unserved/Underserved Population

The National Plan for the Decade, rightfully so, had limited water coverage at the rural level to 50 percent of that population. Water accessibility improvement for the dispensed population living on poorly accessible mountain tops is infeasible. It is very unlikely that future water developments would ever reach these population.

Another area of concern is the unreliability of occupational data per household. When planning water projects, international norms are considered, but the theoretical per capita volume is not being supplied to these

households. One major reason for the discrepancy in estimates lies in the lack of knowledge concerning transitional population data. Because of the absence of secondary schools in the rural area, migration of school age population toward cities has become an important issue. Neither should we under estimate the additional water demands caused by small merchants who travel to market places within the cities.

### 2.3 Waste Disposal Management

Responsibility for waste disposal management is covered at the municipal level in most cities. Within the capital, a specific agency has been created under the Ministry of Public Works. The responsibility for this agency was later transferred to the municipality, but because of budget difficulty and equipment inadequacy, the agency was transferred again to the Ministry of Public Works. Planning is presently underway to privatize the agency. It is expected that this operation budget will originate from fees to be imposed on every household.

Currently, a program sponsored by the German Government is under implementation. This program will assist several cities in the area of wastewater management.

### 3. Financing Water and Sanitation Projects

International donor agencies have been instrumental in the financing of water and sanitation projects. Their contribution was essentially in terms of material and equipment. Counterpart funds were required of the government to finance most local expenses. A list of agencies and their contribution is presented as follows:

		<u>US\$</u>
FENU	Water Resources Investigation, SNRE, 1979-1988	2,000,000
	Water Project Marginal Area, CAMEP, 1986-1990	2,166,700
	Water Project Secondary Cities, SNEP, 1980-1983	1,500,000
	Water Project for Villages, SNEP, 1980-1989	<u>385,000</u>
		<u>6,051,700</u>
USAID	Water Project for Villages, SNEP, 1980-1989	<u>8,102,000</u>
IDB	Water Project for Villages, POCHEP, 1981-1986	4,234,000
	Supplemental Projects, POCHEP, 1987	700,000
	Technical Assistance, POCHEP, 1987-1989	600,000
	Drainage Project, TPIC, 1980-1985	<u>38,800,000</u>
		<u>44,334,000</u>

		<u>US\$</u>
COCE (France)	Water Project, CAMEP, 1987-1989	11,300,000
OPEP	Drainage Project, TPTC, 1981-1985	2,653,000
CEE	Water Project for Villages, POCHEP, 1981-1986	2,000,000
	Water Project in Mountain Area, 1985-1988	2,700,000
		4,700,000
KFW	Water Project, Port-au-Prince, CAMEP, 1987-1988	191,000
	Water Project Secondary Cities, SNEP, 1980-1985	10,140,000
	Rehabilitation Water System, SNEP, 1985-1986	1,256,000
		11,587,000
UNICEF	Water Project, Rural Area, SNEP, 1980-1989	1,097,000
	Water Project and Sanitation for Marginal Area, CAMEP, DHP, 1985-1989	240,000
	Hand Pump Program, SNEP, 1987-1988	2,280,000
		3,617,000
GIZ	Institutional Development, SNEP, DHP, 1986-1990	4,600,000
UNDP	Water Resources Investigations, SNRE, 1979-1988	1,300,000
	" " " " , 1988-1990	1,973,000
	Water Projects, Rural Area, SNEP, 1980-1988	100,000
	Water Projects, Marginal Area, CAMEP, 1987-1989	242,000
		3,615,000

#### 4. Sector Support Programs

##### 4.1 Human Resources

Improvements within the water and sanitation sector has been carried out with a strong emphasis on human resources development. At the national level, WHO/PAHO has been very active in sponsoring qualified technicians. They have made available funds for training both within and outside the country. This organization has also been instrumental in sponsoring seminars for ideas interchange and policy making within the sector.



Special attention was also given to human resources development at the local level. Given the existing strategy to decentralize management and maintenance of water systems in the rural area, training programs are currently being supported by agencies such as WHO/PAHO and USAID. As an immediate impact, there is strong evidence that most water supply systems built in the past three years, where local technicians have benefitted from this intensive training program have experienced very few service interruptions or failure.

#### 4.2 Information

Information exchange still remains a weak point in sector improvement efforts. Haiti, being somewhat isolated because of the language barrier and the non-integration with neighboring developing countries has not really benefitted from the normal interchange of expertise with other Caribbean or Latin American countries. Horizontal exchanges should reinforce the technical and organizational expertise within the sector.

Thus far, exchanges were limited to the activities of international expatriates who bring with them experiences acquired from other countries with different problems specificity.

#### 4.3 Future Needs for Sector Support Activities

In order to achieve the required performance level for sector improvement, efforts should be concentrated on the following activities:

- Training programs as a permanent activity to establish know how within local communities.
- Specialized training programs to create expertise in specific fields.
- Information interchange with other developing countries.

And at both national and regional levels the following support program improvements are recommended:

- Proper backing of professional organizations.
- Seminars on a specific problem within the water and sanitation sector confronting a country.
- Monitoring of sector achievements and weaknesses.
- Call for action to governments for political support.

#### 5. Perspectives for the 1990's

With the International Drinking Water Supply and Sanitation Decade being us and the outlook focussed toward the future, we should look into ways to continue promotion of a healthy environment for the population.

Some important subject still need to be addressed; namely,

- Implementation of a comprehensive sanitation program.
- Effective integration of water and sanitation projects.
- Promotion of health education programs.
- Water resources, development and management.
- Reforestation.

Paper on Leak Detection

H. L. Baker  
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1. Introduction

Mr. Chairman, Ladies and Gentlemen, it is a pleasure for me to be participating in this 18th Caribbean Water Engineers' Conference and to be representing the National Water Commission of Jamaica. I understood that the theme of this Conference is "The International Drinking Water and Sanitation Decade and Issues in 1990's." I would like to share with you some of our experiences in Leak Detection and unaccounted-for water, an area which has always been of great concern to us which we are now taking steps to deal with, especially in the 1990's.

2. Purpose

Against the background of increased energy and operating costs, very old pipes, some poor installation practices in the past, and scarcity of resources for developing new sources and infrastructure, we see Leak Detection and the Management of unaccounted-for water as the most viable solution to some of our problems.

3. History

Our modern history in Leak Detection actually started sometime in 1968, on the Port Antonio Water Supply scheme in eastern Jamaica, when a review was done, waste zones identified and waste detecting meters purchased. The program was actually carried out between 1971 and 1973, during which time approximately 0.5 mgd. of water was saved.

Similar programs, with some degree of success, were carried out in Savanna-la-mar in 1976, Falmouth in 1977, Ocho Rios in 1979, May Pen in 1981, Charles Town/Duncans in 1982, Port Maria in 1986 and in Morant Bay in 1987.

The problem, however, with these programs was that they were not continuous, hence, after a short period, the systems reverted to their former state.

Our plans to overcome this problem is to have individual Leak Detection Units attached to each of the five regions of the island. This has commenced with the establishment of the Leak Detection Unit for the Central Region in Mandeville.

4. Greater Mandeville - General

The production, transmission and storage elements of the Greater Mandeville Water Supply System were completed and connected to the existing distribution system in July 1986. Some of the distribution pipes being 60 years old or over, which previously received little or no water, were now constantly charged under pressure. Over 600 surface leaks in the first four months were observed and repairs employing several repairs crews on a 12-hour basis. Due to the geological conditions in and around Mandeville - predominantly limestone and overlaying pockets of bauxite - it was concluded that underground leaks were occurring that could only be detected by the use of specialized Leak Detection equipment. Leak Detection Survey and repairs were included in the Loan Agreement with the IDB for the construction of the Greater Mandeville Water Supply Project as an integral part of the project.

5. Pilot Zone - Mandeville

In January 1989, a Local Consulting Firm in association with a United Kingdom Consulting Firm were employed to develop a Leak Detection Program in Mandeville by way of assessing leakage levels and effecting repairs in an initial pilot zone and training a core group of personnel in the Region to carry out the work. The period of work took place between January to September 1989, with the pilot zone now fully completed and initial works commencing in two other zones by the trained NWC staff.

The program was based on the "traditional" Leakage Control Policy approach of establishing bulk metered waste zones. Initial open reading tests on individual zones isolated from the rest of the distribution system and fed through a single metered point, provided a minimum night flow (MNF) parameter potentially indicative of leakage levels. This was followed by step tests in the waste zone followed by specific leak detection on the individual steps using leak noise detectors and correlations. Following leak repairs, a repeat open reading test provided a new MNF and, thus, provided a direct evaluation of the quantity of water saved by the leaks repaired. The work was conducted using data loggers downloaded to portable computer for collection and collation of flow and pressure information.

Initial results in the Pilot Zone of 309 accounts or properties representing 7 percent of the system of 4 percent of the population that was 59 percent metered, indicate unaccounted-for water (UFW) representing approximately 59.5 percent of the water supplied. The zone was then 100 percent metered and while the consultants have not yet submitted their report and recommendations, initial results are as follows:

About 53 leaks were repaired in the zone over the period with a reduction in MNF of 932.5 IG/hour representing a saving of 8.16 MIG/year or \$43,000/year (based on energy and chlorine costs only for operation at \$6.32/1,000 IG).

Investigation was carried out on 160 individual consumer premises in the Pilot Zone of which 29 premises were registering 1,180 IG/hour due to leaks.

For the Zone, the following data was obtained:

- a) Legitimate Consumption by Consumers - 53 percent of water supplied.
- b) Leakage on NWC's Distribution Mains - 11.5 percent of water supplied.
- c) Leakage on Consumer Premises - 35.5 percent of water supplied.

These figures indicate that 88.5 percent of the water supplied actually reached consumer premises. As stated before most of the 11.5 percent leakage on the Distribution Mains were located and repaired. However, if this zone is anywhere near being representative of the entire system, the number one problem to be addressed is leaks on consumer premises, for the following reasons:

- a) Only approximately 70 percent of the 3,880 premises or accounts for the entire system is metered.
- b) Unmetered premises are billed at flat rate with no penalties for wastage or no incentives to conserve water.
- c) After leaks are corrected on metered premises in most cases, the Commission writes off about 50 percent of the bills as loss revenue.
- d) It takes a long time to realize leaks on metered premises - in most cases it is only after consumers are billed and the bills appear to be abnormal that the consumers' query the bills rather than checking for leaks.

Initial policy implications with respect to leaks on consumer premises may require the following:

- a) To effect 100 percent consumer metering for the Mandeville System as early as possible.
- b) To implement public awareness campaigns for consumers to do simple checks on meters for leaks on their premises.
- c) To establish more adequate and competent crews to assist consumers in checking for leaks on their premises.

#### 6. Other Zones - Mandeville

It is expected that Mandeville will be divided into 25 waste zones which will be established and assessed in about 2 years by the trained NWC staff. Estimates of water usages in Mandeville's system suggest that wastage on metered premises and unmetered premises, excess consumptions and leakage on

consumer premises, amount to approximately 2.52 MIG/D or over 62 percent of the 4.02 MIGD supplied. At present, no legislation mechanisms are in force to effectively deal with consumer leakage in a timely fashion. No effective mechanisms are in place to monitor the efficiency of the billing sweeps against any target levels and unmetered premises provided opportunities for large wastage of water. These matters will have to be addressed in a broader "unaccounted-for water management" program. The Leak Detection Unit will have to play a pivotal link in the integration of the Commercial and Distribution Departments to provide efficiency targets for Commercial billing in the zones.

7. Other Leak Detection Programs

Mandeville is a forerunner to Leak Detection to be carried out on other systems, e.g., Negril, Montego Bay, Ocho Rios, etc. International Funding may have to be sought to implement these programs.

8. Recruitment and Training

Recruitment of additional staff with experience in Leak Detection is presently being pursued through advertisements in the local media. Senior engineers and managers are to be sent on Comprehensive Leak Detection Courses abroad. Training will also be conducted locally. The end result is to develop expertise in Leak Detection in order to effectively solve the problem islandwide.

9. Conclusion

The National Water Commission is determined to succeed in the area of Leak Detection and the management of unaccounted-for water in the 1990's as this will improve to a great extent the efficiency of the organization. We hope to be of some assistance to our Caribbean neighbors in passing on some of the experiences we have gained in this area.

Country Statement - Saint Lucia

1. Water and Sanitation in Development

1.1 General Description and National Development

Saint Lucia, a member of the Windward group of islands, is volcanic in origin and located at latitude 14 degrees North.

The island 238 square miles (616 km<sup>2</sup>) in size is 14 miles wide and 27 miles long. Topographically, the island is characterized by numerous mountains and ridges with approximately 20 percent of the total surface are being flat.

The climate is tropical with dry season typically from January to June, and a wet season from July to December. The seasons are, however, not always distinct. Annual rainfall ranges from 50 inches on the coast to 180 inches in the mountains.

The population is approximately 145,000. There is an uneven distribution of population around the island with the greatest concentration approximately 40 percent existing around Castries, the capital and center of the country's administrative, commercial and industrial activities.

The rest of the population is distributed among the towns of Vieux Fort, Soufriere, Gros Islet and the remaining villages.

The economy of the island is largely dependent on agriculture and to a lesser extent on tourism and light industry.

Because of development of services, islandwide and the Government's thrust to decentralize and essential services, Government has partly succeeded in arresting the trend of migration from the rural areas to Castries.

The Water and Sewerage Authority formally known as the Saint Lucia Central Water Authority now responsible for both water and sewerage assumed responsibility for sewerage in 1986 almost two years after the passage of the Water and Sewerage Authority Act No. 18 of 1984.

The declared national objectives for development and health can be summarized as follows:

- a) Health for all by the year 2000.
- b) All communities with 10 or more households to have access to safe drinking water through standpipes or house connections by the year 1990.

## 1.2 Water and Sanitation Sector

### Water Supply Situation

The water supply is managed by the Water and Sewerage Authority. The water supply has been developed almost entirely from surface sources. The whole of the island is a Water Supply Area with no deliberate discrimination between urban and rural supplies.

Water supplied by the Authority is subjected to all or some of the following treatment processes after it has been abstracted at the intake structure: filtration, coagulation where necessary, and disinfection by chlorination.

While some 33 individual systems for water supply exist (the large number of systems because of the island's topography), there are, however, three main systems at Sarot, Hill 20, and Vieux Fort. The overall daily production from all sources averages about 7.0 MDG.

Currently, the water supply coverage is as follows:

- a) House connections - 50 percent of population
- b) Served by standpipe only - 40 percent of population
- c) No access to first time supply - 10 percent of population.

### Sewage/Excreta Disposal

In Saint Lucia many different sewage disposal practices are utilized depending on geological conditions, and economic status of residents in specific areas.

The privy pit is still very much the method of excreta disposal among the low income residents in the rural and some suburban areas.

The septic tank with a soakaway is the method of onsite sewage treatment and disposal in areas where the soil conditions are conducive to satisfactory absorption. There are, however, numerous areas, e.g., Northwest Saint Lucia, Micoud, where the hard volcanic subsoil limits absorption of effluents with the resultant pollution of terrestrial surrounding streams and rivers in the flat coastal areas where ground water level is high, the inevitable pollution of the coastal area and the sea results from piping septic tank and package treatment plants' effluent into the sea and quite often on to beaches, and subsoil infiltration.

### Package Sewage Treatment Plants

This is the method of sewage treatment at many coastal hotels and some commercial and industrial properties. The Ministry of Health, in monitoring of the effluent quality and operations of these plants has found both the effluent and the plant operations at some locations to be below the required public health standards.



Up to the end of 1987, the Ministry of Health and the Development Control Authority has frozen development in most sectors of Rodney Bay area, because of poor soil absorption conditions, unsatisfactory operations of some package sewage treatment plants and to ensure that levels of pollution of the coastal water remained below certain acceptable limits.

The coverage involves:

- a) Castries city center - approximately 7 km (4.3 miles) of sanitary sewer installed in 1951, disposing through a very short outfall into Castries harbor.
- b) Castries suburbs - approximately 5 km (3.5 miles) of sanitary sewer installed in the late 1960's and early 1970's discharging into the above noted outfall. The combined connections of (a) and (b) are 1,200 residential and 180 commercial, serving 5,400 people.
- c) Hotels - under the individual operation of the private hotels there are seven package treatment plants. The Saint Lucian Hotel plant also treats sanitary sewage from a section of the Rodney Bay Development.
- d) Rodney Bay Marina - privately operated package plant to service the Rodney Bay commercial and yacht basin areas.
- e) Other Sewerage Facilities - for those premises not connected to the piped systems disposal is by septic tanks, pit latrine or bucket system and public installations. Nightsoil is disposed into the Castries City system and the septic tank sludge into the Union Treatment Plant. Collection and charging is carried out by City Council.
- f) Union Treatment Plant - for the disposal of septic tank sludge; consists of three digestors and sludge drying beds, supernatant is disposed of by a soakaway system. The plant is operated by the Ministry of Health.

#### Status of Sector

The Water and Sewerage Authority is a statutory body. While the overall responsibility for the operations of the Authority falls under the portfolio of the Minister of Health, the Authority operates under the direction of a Board, which is responsible for the policy and its general administration.

The Authority is expected to operate viably so that its collection must at least equal its cost of providing and maintaining the service to its consumers. Charges to the consumer must be approved by a Public Utilities Commission.

The Authority's Organizational Structure has been designed to allow streamlining to its functions into:

- Operations
- New Works
- A Commercial Sector
- Finance and Administration

The Authority has managed its operations from financial resources generated internally and from both grant and loan funds obtained from financial institutions through the Government.

#### Health Status of the People

It is estimated that the population of the country is growing at the rate of approximately 2.5 percent per year.

Over the last 70 years or so, Saint Lucia's population grew at an increasing rate as can be seen in the following table:

<u>Census Year</u>	<u>Population</u>	<u>Annual Rate (Percent)</u>
1921	51,505	
1946	70,113	1.24
1960	86,108	1.47
1970	100,583	1.55
1980	123,773	2.10

There is no doubt that the steady increase in the rate of growth is largely due to improvements in public health. The quality of life has improved to such a level that the death rate has been lowered to a mere 6.0 per 1,000 persons in 1985.

Some indications of the trends in health over the years can be seen from figures produced from the Ministry of Health records for the years 1979 to 1985 for various diseases:

<u>Disease</u>	<u>Year</u>						
	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>
Gastroenteritis	895	376	377	606	300	1,331	1,000
Typhoid Fever	4	7	14	10	5	18	8
Dengue	26	6	23	31	0	0	0
Dysentery	175	153	103	19	40	100	49
Schistosomiasis	24	39	32	27	18	59	4

Achievement During the International Drinking Water Supply and Sanitation Decade (1981 - 1990)

It can be stated that Saint Lucia is well on the way to fulfilling its main Water Supply and Sanitation Decade objective.

Some of the objectives set that were achieved include:

- a) Review of WASA organizational structure to increase efficiency and effectiveness of structure.
- b) Review of manning and operational methods.
- c) Implementation of computerized systems for billing and payments.
- d) Continued expansion of supply so that by 1990 every community with 10 or more households will have access to safe drinking water.

Water and Sanitation Programs

During the last few years, the Water and Sewerage Authority has developed a number of water supply and sewerage disposal programs.

These programs are in various stages of development fizz: feasibility, design, implementation.

Funding for these programs is either:

- a) Local
- b) External Grant
- c) External Loan Funds

As examples to give some illustration of the type and structure of the programs, the following list of programs is highlighted:

- a) Roseau Dam Program
- b) CDB Third Loan Program
- c) Integrated Water Development Program
- d) Medium-Term Feasibility Study for expansion of sewage disposal in Castries.
- e) Rodney Bay Sewerage Project

Structuring of the program has been influenced by procurement procedures of the funding agencies and this varies from limited in-house design and implementation and to use of consultants and contractors.

The Roseau Project is of special interest because it involves funding using multi-donors and consists of a mix of grant funds as well as loan funds.

## 2. Specific National Issues Related to Water and Sanitation Urbanization

Where urban areas develop, there is a tendency for people to migrate and concentrate in such areas.

This creates increased demand on existing systems and sometimes results in extreme pressures being placed on limited existing resources - human, natural and financial.

This clearly supports the need to ensure that during the design of systems as accurate projections as possible need to be made to ensure that infrastructure once laid down would be adequate for the medium-term with the flexibility of expansion to meet long-term needs.

### Waste Disposal and Management

With the passage of legislation, making WASA responsible for the disposal of waste, this sector is becoming more organized.

There is no doubt that this will lead to improved management in the sector.

## 3. Financing of Water and Sanitation Projects

The programs embarked on in this sector are within the national capacity of the country.

The role of international and bilateral agencies should include but not be limited to:

- a) Providing finance - grant or soft loan conditions
- b) Providing specialist advice
- c) Providing technical assistance
- d) Assisting in development of indigenous expertise
- e) Developing local markets
- f) Assisting in improving skills
- g) Providing financial support for developing STC to carry-out training in the various disciplines within the sector.

4. Sector Support Programs

Saint Lucia has been fortunate as a result of its existing sector plans in both water and sewerage. Studies carried out have identified a series of sector support programs required.

The support programs identified include:

- a) Institutional strengthening
- b) Deficiencies in existing legislation
- c) Management Information System needs
- d) Regulations
- e) Telemetry

5. Constraints to Sector Development in the 1990's

The greatest constraint to sector development in the 1990's from Saint Lucia's point of view are:

- a) Limited financial resources
- b) Availability of natural resources

6. Proposal to Improve Service Quality in the 1990's

One issue of interest to Saint Lucia is the improvement of water quality and level of service being provided in all rural communities.

To this end, Saint Lucia suggests that the year 1990 be designated "Water Quality Year," regionally and perhaps internationally also.

Country Statement on Water and Sanitation - St. Kitts

National Development

The National Development Plan for St. Kitts seeks to transform the nation's economy from a dominant monoculture to a diversified stable economy. The emphasis is to be on agriculture; industry, tourism and human resource development as the main catalyst for stimulating economic growth and development. Increased economic activity in these sectors is projected to create opportunities for the people to realize their greatest potential.

On the matter of health, the basic tenets that will guide the Government in the improvement and for the development of the health services in St. Kitts are that:

- a) Good health is a fundamental right of each citizen
- b) Every individual citizen and the community as a whole has a responsibility to preserve condition conducive to good health.
- c) Improvement of health is fundamental to the country's socio-economic development program; and
- d) That the mass of the people must become actively involve in the process of achieving a qualitative level of a good health care delivery system.

Water and Sanitation

An adequate supply of water is a necessary prerequisite in the achievement of the goals above. Expansion in agricultural, tourism and industrial development depends on a well structured program of water resource development. Considerable emphasis will, therefore, be placed on expanding and upgrading the water services in St. Kitts.

A major factor which has constrained the development of the water service is the inadequate supply of funds. This has limited the program of maintenance, improvement and expansion of the water supply systems.

The inability to adequately maintain and upgrade the supply systems has created a number of problems. Among these are the distribution and transmission lines which are old and heavily tuberculated. As a result, many transmission lines are now too small lacking the carrying capacity to supply the increased water needs of these areas.

In view of the problem and constraints facing the development of water resources and also in light of the objectives and targets identified, the Water Department proposes to continue its comprehensive water development program. The following projects are proposed.

- a) Increasing the supply of water in St. Kitts from 2.6 mgd. to 4.0 mgd.
- b) Upgrading of the Basseterre system.
- c) Upgrading of the Dieppe Bay system.
- d) Upgrading of the Conaree system.
- e) A waste prevention program.
- f) The continuation of Phase 2 of the well drilling program; and
- g) The chlorination of all rural water supplies. Only Basseterre and its environs have access to treated drinking water. The rest of the population which relies on surface water is, therefore, served with treated water. In the 1990's every attempt will be made to:
  - i) Provide treated water and improved sanitation for the rural and under population.
  - ii) Improve the system management of solid waste including efficient collection, disposal and treatment.

External capital resources will provide the major source of financing.

Projects carried-out during the International Drinking Water Supply and Sanitation Decade (1981-1990) were:

- a) The upgrading of the Cayon system.
- b) The upgrading of the Phillips/Lodge system.
- c) The Exploratory Drilling Program;
- d) The installation of the South Eastern Peninsula Pipeline; and
- e) Two thousand seven hundred sixty-four (2,764) private connections were made in the 1980's. Nine hundred fifty (950) in Basseterre and 1814 in the rural areas.

Manpower planning and human resource development represent an integral and important part of the development process. At the local level, pipefitters will continue to be trained at the St. Kitts/Nevis Technical College, and at the regional level, the Water Department will continue to participate in the Caribbean Basin Water Management Training Project. The Water Department will also avail itself of scholarships by donor agencies for university training.

Water Supply and Sewerage - Suriname

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1. National Development

According to the outline of the Government Policy (1988-1993), the Suriname Government fully adopted the "Mar del Plata Action Plan" for the "International Drinking Water Supply and Sanitation Decade (IDWSSD)," to contribute as much as possible to reach Suriname's aim of 100 percent potable water supply. The problems concerning the national drinking water supply shall be taken up with priority, in order to further improve the living conditions of the population and to support the Health for All by the year 2000.

The necessary legal and organizational provisions for water management and groundwater investigations shall be completed with assistance from the OAS, UNESCO, PAHO and other bilaterals.

The sewage system shall be improved in the Metropolitan and other urban areas.

With respect to health care, each individual shall have the right to adequate health care.

1.2 Water and Sanitation Sector

The responsibility for water and sanitation administration is shared between five ministries.

The Ministry of Health has programs concerning vector control, eradication of malaria and Aedes aegypti, schistosomiasis, general sanitation, food and drug control, water quality and laboratory services.

The Ministry of Public Works Telecommunication and Architecture is in charge of solid waste collection and disposal, sewerage, drainage and land reclamation and master planning.

The Ministry of Regional Development is in charge of drainage of rural settlements, permits and regulatory services. The District Commissioners are appointed by this Ministry and are charged with the government's administration and operation in each Districts.

The Ministry of Natural Resources is in charge of all Public Water Supply, controls the environmental impact on large scale development projects, land use conservation of resources, regulates mining and wildlife conservation.



The Ministry of Agriculture has a peripheral connection in pesticide and other pollution control.

### 1.3 Health Status of People

The life expectancy at birth was calculated in 1980 is 64.5 years approximately. The death rate (1980) is 6.9 per 1,000 population and infant mortality per 1,000 live birth is 41.9. Death rate in children under five (5) years of age is 14.7 per 1,000 population (Ministry of Health, 1980).

The lack of reporting is a handicap to accurate assessment and health planning since few reliable statistics are available.

### 1.4 Water Supply

#### Present Situation

Suriname has many large and perennial rivers. However, most of this water, in the populated areas is brackish and, therefore, not suitable for drinking water supply purposes. Only Marowijne River on the eastern border of Suriname could be used for water supply. The brackish water line in the other large rivers extends between 50 km and 75 km inland. Because of abundant supply of groundwater and the flatness of the terrain, it is not economical of use surface water.

Groundwater in the populated areas are well known as to extent and quality. With assistance of the UNDP/PAHO public water supply and sewerage project (1969-1973) bilateral development aid (1980-1985), it was possible to carry-out hydrologic investigation programs to gather information about the existence of groundwater. Only groundwater is used for drinking water purposes in the coastal area where 90 percent of the total population of Suriname lives. In the interior where generally abundant fresh river water is available it is used for water supply.

The first water supply system in Suriname was built in 1930 by the Suriname Water Company.

In 1948, the Government took over all shares of the Company. This Company supplies water in Paramaribo and surroundings (capital city), New Nickerie (western border) and Albina (eastern border). The population served is approximately 90 percent of the total population of the country. The groundwater used comes from wells. Well depths are ranging from 20 to 30 meters in the south to about 270 meters in the coastal plain.

The treatment consists of aeration and filtration through seashells and sand filters. The water is not always chlorinated. Fully aware of further need of safe potable water in rural areas, the Government created in 1962, a Water Supply Section under the Ministry of Public Works.

This task was transferred to the Ministry of Natural Resources which Ministry is also the Government representative and, hence, the only stockholder of the Suriname Water Company. The relation between the Government and the Company are such that although all shares are in the hands of the Government, the Company functions as an autonomous business enterprise. The Water Supplies Service of the Ministry of Natural Resources is responsible for development, operation and maintenance of water supplies in rural areas.

The responsibilities of the Government in connection with Water Supplies can be specified as follows:

- a) Development, operation and maintenance of water supply systems.
- b) Provide water through private house or yard connections.
- c) Research and planning for water supplies in general.

These connections may be divided into:

- i) One single Fordilla valve without meter inside a private yard.
- ii) One single ordinary screw tap in the yard or inside the house with metered service.
- iii) A variety of plumbing fixtures with metered service.
- d) Provide water through public standposts with tap from a supply system. This is done in several areas to serve poor people who cannot afford to have a private connection.
- e) Provide water through public standposts with water directly from shallow wells (dugwells). This is done in areas where the population concentration is so small that it is not justified to install a water supply system.
- f) Provide water by water carriers (by truck, train or boat). This is done without water supply. The carriers are filled from water supply system and transported to the houses where drums are filled.

With the assistance of WHO/PAHO and UNDP, a comprehensive study on water supplies was carried out (1969-1973), resulting in a water supply program until the year 2000. Also, a three-year study program financed by Dutch Development on the Commewijne and Rijdsdijk area.

Besides the Suriname Water Company and the Water Supplies Service of the Ministry of Natural Resources, there are also some private companies which have built water supply plants for their employees.

### 1.5 Service Quality Water Coverage

At present, there are 56 water supply systems operating in Suriname. The systems are operated by the Suriname Water Company covers the urban area of Greater Paramaribo, Nieuw Nickerie and Albina.

The Water Supply Service of the Ministry of Natural Resources is in charge of 40 systems covering areas that are considered rural.

Other private or government institutions operate 10 more water supply systems. Three of this last group, the Moengo and Paranam Systems operated by the Suriname Aluminum Company (SURALCO), and the Wageningen System operated by SML (Foundation for Mechanized Agriculture), serve areas considered urban. In summary, there are 47 systems serving the rural population. The latest estimates of the Water Supply Service ascertain that:

- a) Nearly 90 percent of the urban population is served by house connections and remaining 10 percent has easy access to safe potable water;
- b) In rural areas, approximately 70 percent of the population is served by house connections while about 20 percent has easy access to safe potable water, leaving only 10 percent unserved.

The water supply systems under government care have been financed with national and international funds. The Dutch Government Aid funds have been of great importance and also five projects in the interior of the country, those of Paradise, La Vigilantia, Tijgerkreek, Henar Polder and Wanhatti have been partly financed by a UNICEF grant of Sf.500,000.

### 1.6 Needs, Obstacles and Possibilities

Due to guerilla activities in the east and southern parts of the country, much urbanization occurs which effected the water demand in other parts of the country especially the metropolitan area and the nearby districts.

Another mayor problem with maintenance and expansion programs for water supply is the economical crisis of the country of the past five years, after the cutoff of the Dutch Development Aid in 1983.

After the election in 1987, and the appointment of a democratic Government, negotiation with the Dutch Government result in a program for rehabilitation and upgrading of the water supply system, which will be started in 1990 and will result in adequate supplies up to 1993.

### 1.7 Sewerage

It is acknowledge that in order to improve public health emphasis should be placed not only upon the provision of safe water, but also upon the removal of waste waters, largely in the form of domestic sewage and industrial liquid

wastes, and upon final disposal by sanitary means. The removal of storm waters from populated areas also poses special problems in Suriname, especially in the most populated coastal areas where the flat terrain makes natural drainage difficult.

### 1.8 Present Situation

There are no public sanitary sewerage systems in most of the country with the exception of Central Paramaribo, the area of Half Flora within the city and the Santo Boma prison area. However, the Paramaribo system, in itself, does not constitute a sanitary collection and treatment facility. The waste water collected into a storm drainage system is mostly effluents of septic tanks. This combined system transports its water to outfall pumping stations for disposal in the Suriname River.

As Paramaribo expands, the existing combined sewers are often surcharged.

Some of the lines need rehabilitation. Part of the system consist of open canals, which are hydraulically inefficient subject to excessive weed growth, trash dumping, and industrial concerns dump untreated wastes into this canals. During the dry season the total discharge of these ditches is partially treated or untreated sewage.

The ditch grade are flat and they are built at only a slightly lower elevation than the surrounding ground. Installation of culverts out of grade, debris accumulation and trash dumping result in conditions of stagnation where sewage frequent becomes septic. During the rainy season, it overflows due to lack of hydraulic capacity which results in the spreading of contaminated water. This is further aggravated by the need to close sluice gate when the tide is high. Septic tanks sludge is trucked to a lock in the river wherein it is discharged through a hopper.

The Suriname River at Paramaribo carries some oil slick and floating materials and the banks are accumulated waste articles cardboard paper and others.

In addition to the public systems mentioned, there are small sewerage works built by private companies to serve small subdivisions where employees live. Such as the case with the Moengo and Paranam systems and with the Via Bella System in Paramaribo.

### 1.9 Existing Facilities for Sewerage

#### Urban

As previously stated, a small part of the City of Paramaribo is served by storm drains which receives septic tank effluents from individual residences, hotels, restaurants, service stations and other business and industrial establishments. The only treatment is dilution in the Suriname River Tidal Basin.

The community system in Suriname which at present collects and treats domestic sewage is Via Bella and Flora. The Via Bella system is a separate system that serves a residential subdivision and secondary treatment (activated sludge) is attained in a small plant. The Flora plant is an advanced treatment plant of the oxylation ditch (carrousel) type with provisions for sludge dewatering and post-chlorination. The final effluent is discharged into an open drainage canal.

The Half Flora System was designed for a population of 15,000 and at present the load is approximately 80 percent, since the housing scheme has not been completed. Some problems have arisen with the construction of the sewers that show a large flow of infiltrated water.

However, 1,000 houses are connected and the plant is in operation.

### Rural

In the rural areas and also in some built-up areas, pit latrines are extensively used and there are also areas where no facilities at all are provided. Larger dwellings often have septic tanks with seepage areas or drain fields. Little regard is given to the sanitary requirements of pit latrines.

Cleaning of latrines, where the size is insufficient to develop decomposition of excreta, requires workers to breakup solid fecal material by hand followed by water mixing and pumping. In addition to this unsanitary practice, the depth of the pit and the high elevation of the water table result in contamination of the groundwater. Shallow wells are contaminated by the proximity of latrines especially in small lots where there are no means of exercising control.

The overflowing of latrines during the rainy season and the custom of defecating in the open are related to the Schistosomiasis problem. The snail vector is confined to the shell ridges in the coastal area and this appears to be the reason why the disease is not widespread. In the Saramacca area, construction of drainage ditches recommended by the Bureau of Public Health resulted in a sensible decrease of morbidity in an area where schistosomiasis was endemic.

### 1.10 Projected Coverage

In connection with the Paramaribo system, the Ministry of Public Works investigates the sewerage and drainage problems in the city, to provide solutions. As a result of this study, the consulting engineers observed among other things that the Paramaribo system was functioning in adequately. As a result, a series of lift stations have been designed and implemented.

Two main truck lines for flood control in the Central Paramaribo area including a new pumping station and rehabilitation of the existing facilities (total about 2.8 km) are now in construction.

Status of Water and Wastewater Sector and Progress of  
the Decade 1981-1990 - Trinidad and Tobago

Emmanuel Romain  
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1. Introduction

1.1 The Republic of Trinidad and Tobago consists of two islands. The larger island, Trinidad is located approximately 9 km off the North East corner of Venezuela. The sister island of Tobago lies North East of Trinidad and is separated by approximately 35 km of sea. The population of Trinidad and Tobago is approximately 1.2 million people.

1.2 The Water and Sewerage Authority (WASA) of Trinidad and Tobago is the sole agency responsible for the development of water resources, the conservation and proper use of water, and the collection, treatment and disposal of wastewater. For administrative purposes, the country is divided into three (3) regions (North, South and Tobago), eight (8) districts and twenty-six (26) distribution areas.

2. Water and Sanitation Development

The Government of the Republic of Trinidad and Tobago, in its Draft Medium-Term Macro Planning Framework (1989-1995), states its primary policy objectives as:

- a) to ensure the provision of an enhanced infrastructural base that is supportive of a high level of diversified growth;
- b) to foster balanced regional development;
- c) to create an environment that is conducive to the effective operation of the private sector;
- d) to promote rural development;
- e) to foster a more equitable distribution of income;
- f) to secure the continued improvement in the quality of life of all citizens.

Objective (6) bears a direct relation to the water and sanitation sectors, and is in keeping with the Authority's stated mission, that is:

- a) to provide an adequate and reliable water supply;
- b) to effectively collect, treat and dispose of wastewater;
- c) to promote conservation and effectively manage the country's water resources.

## 2.1 Water and Sanitation Sector

At present, the WASA produces approximately  $650 \times 10^3 \text{ m}^3/\text{d}$  of water, 75 percent from surface sources and 25 percent from ground water sources. It operates and maintains three (3) major central sewerage systems and five (5) package wastewater plants.

In addition, there are also approximately one hundred and fifty (150) package wastewater plants that are operated by the National Housing Authority and Private developers.

### 2.2.1 Coverage and Levels of Service

Population in Thousands  
As of 31 December 1988

#### Estimated Population

Urban	840	68.3%
Rural	390	31.17%
Total	1,230	

#### Populations Served with Water

a) Urban population served by house connections	730	59.3%
b) Urban population without house connections but with reasonable access to public standpipes	110	8.9%
c) Rural population with reasonable access to safe water	340	27.6%

#### Population Served with Excreta Disposal Facilities

a) Urban population served by connections to public sewers	250	20.3%
b) Urban population served by household systems (pit privies, pour-flush latrines, septic tanks, etc.)	590	48.0%
c) Rural population with adequate disposal, such as pit privies, pour flush latrines, etc.)	380	30.9%

## 2.2 Status of Sector

The Authority is staffed by some 5,000 employees of which 2,531 are salaried employees and 2,469 are daily rated employees. The workforce is subdivided in the various categories as indicated below:

<u>Category</u>	<u>No. of Filled Positions</u>
Planning and Management	20
Professional and Technical	1,575
Craftsmen/Artisans	1,492
Administrative/Clerical	936
Manual Workers	977

Advances in the delivery of primary health care and implementation of measures aimed at ensuring a safe healthful environment have made major contributions towards the present comparatively good health status of Trinidad and Tobago. Towards achieving the goal of continued improvement in the quality of life of all citizens, WASA has identified that it will need to:

- a) Improve the level of water and wastewater services to its customers;
- b) Develop its human resources;
- c) Reduce its dependence on funds from Central Government.

The Authority has also identified some of the major constraints to achieving its efficiency:

- Funding limitations
- Inadequate cost recovery framework
- Insufficiency of professional and subprofessional staff
- Lack of corporate planning
- Inefficiencies and inadequacies in the transmission and distribution systems.

## 2.3 Achievements During the International Drinking Water Supply and Sanitation Decade (1981-1990)

The International Drinking Water Supply and Sanitation Decade (1981-1990) has been punctuated by a number of significant achievements:

- a) The commissioning of the Caroni Arena Water Supply Project in 1981 which brought a 60 percent increase in the water supply.



- b) The implementation of a water quality network, which was developed with the assistance of a short-term consultant from the Pan American Health Organization commenced in 1988. In the water quality network, all sampling locations for the entire country were located on maps with specific site sketches for each sampling location. The sampling locations were:
  - i) chosen jointly by the Public Health Inspectorate and WASA
  - ii) were randomly selected within the distribution systems.
- c) The reorganization of the Operations and Maintenance Department to:
  - i) facilitate the separation of the wastewater section from the water section;
  - ii) increase productivity levels;
  - iii) decentralize the activities of the Operations and Maintenance Department by creating new districts and distribution areas;
- d) The grant of a rate increase from the Public Utilities Commission in 1986.

#### 2.4 Water and Sanitation Programs

During the Decade, the Authority also undertook to:

- develop a number of small local sources
- strengthen the distribution system by replacing undersized and encrusted mains
- use the self-help concept to provide pipeborne water supplies to small communities
- develop a mapping program utilizing computer and drafting
- train water and wastewater operators
- train maintenance personnel in water and wastewater collection systems
- reduce the level of system losses
- reorganize the commercial systems in order to improve customer registration and billing

## 2.5 Relationship with Programs of Other Sectors

WASA's efforts to make more water available was in response to the increase in development of the housing sector, and the demand created by the thrust in industrialization, tourism and the commercial and agricultural sectors.

## 2.6 Essential Inputs

During the Decade, the Authority received technical assistance from external agencies for the development and implementation of a number of projects, namely:

- Leak Detection
- Mapping
- Pollution Control
- Water Quality Network and Monitoring
- Rationalization of the Package Wastewater Treatment Plants

The agencies which provided technical assistance were:

- Pan American Health Organization
- United Nations Development Program
- Wessex Water Authority of England
- Interamerican Development Bank

Priority was given to:

### Mapping

- to enhance the management of the water and wastewater systems in an attempt to improve the customer records and the collection of rates
- to strengthen the water system in order to reduce the level of unaccounted-for-water

### Water Quality

- development of water quality network

### Pollution Control

- monitoring discharges of trade wastes and effluents and rivers  
formulation of legislation and codes of practice

### Development of Wastewater Policy

- rationalization of packaged wastewater treatment plants

### 3. Specific National Issues Relating to Water and Sanitation

As the Decade draws to a close, there continues to be three (3) major issues facing the Authority:

- a) the deficit in water supply to County St. Patrick or South West Trinidad.
- b) the provision of a water supply to the planned Government Settlements Program
- c) the takeover of the privately-owned wastewater treatment plants.

### 4. Financing of Water and Sanitation Projects

#### 4.1 National Sector Capacity

During the Decade, the Central Government was unable to fund the major planned infrastructural projects, due to the decline in Government revenues. As a result, the Authority sought funding for capital projects from the Interamerican Development Bank. Its application, however, was unsuccessful because of its continued high operating deficit.

The Authority has, however, been able to obtain funding from the European Economic Commission for the improvement of the water supply in country St. Patrick.

### 5. Sector Support Programs

#### 5.1 Human Resources

Financial viability continues to be major bug bear for the Authority and it has, therefore, taken the necessary steps to rationalize the staff in order to achieve financial self-sufficiency by 1991. The program entails the downsizing of the workforce by 40 percent, so as to attain an employee customer ratio of 20 employees per 1,000 customers.

#### 5.2 Information

The Authority is concentrating on establishing a department with responsibility for the Management Information Systems with the assistance of the Wessex Water Authority. The intent is to decentralize the Authority's activities on a regional basis, and to enhance the flow of information to assist managers in decision making.

#### 5.3 Future Needs

In terms of future needs, the Authority sees Institutional Strengthening as a priority:

- a) Research, Planning and Programming
- b) Project Management
- c) Budgeting
- d) Accounting
- e) Operations and Maintenance
- f) Human Resources Development and Manpower Planning
- g) Management Information Systems
- h) Commercial Operations
- i) Public Education and Information

6. Constraints in the 1990's

It is envisaged that constraints for sector development will still be:

- Funding for capital works
- Operating deficit
- Cost recovery framework
- Inadequate number of professionals.

Priority list of issues:

- Universal metering
- Expansion of the wastewater section
- Improvement in the water supply deficiency areas
- Expansion of the Authority's customer base
- Takeover of privately owned wastewater plants.

7. Proposals for Improved Service Quality in the 1990's

Under the IDB preinvestment program, a study is to be carried out in order to develop a plan for the implementation of universal metering.

The completion of the Scarborough Wastewater Project. The undertaking of a feasibility study for the sewerage of South West Region of Tobago.

The laying of 28 km of 800 mm diameter ductile iron pipes from La Romain to Point Fortin to improve the water supply to County St. Patrick.

Construction of the Richmond Waterworks which will improve the water supply situation in Tobago. The project entails the following:

- impounding reservoir
- water treatment plant with capacity of 22,500 m<sup>3</sup>/d
- transmission pipeline and storage facilities

The takeover of privately-owned package wastewater facilities.

Technical cooperation is, therefore, being sought in the following areas:

- the formulation of a master plan for comprehensive water supply supervisory system in Trinidad and Tobago.
- the development of a Management Information System Department.
- institutional strengthening of the Water and Sewerage Authority.

Though not previously mentioned, the Water and Sewerage Authority has identified a project of importance to Trinidad and Tobago, which will significantly impact on the improvement of the quality of life to the citizenry. It is the Eastern Main Road Communities Sewerage Project.

Contract documents for the construction of the Eastern Main Road Communities Sewerage Project were completed in 1982, but the project was not implemented due to the lack of funds. The project consisted of the following:

- 25 km of trunk sewers
- 200 km of laterals
- Pumping stations
- Central Treatment Plant

The Eastern Main Road Communities Sewerage Project was then estimated to cost One Hundred and Fifty Million Dollars US currency.

It is recommended that the above named project can be undertaken in phases.