

**REPORT ON THE CEPPOL SEMINAR ON MONITORING  
AND CONTROL OF SANITARY QUALITY OF BATHING  
AND SHELLFISH-GROWING MARINE WATERS IN THE  
WIDER CARIBBEAN**





Caribbean Environment Programme

United Nations Environment Programme

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Intergovernmental Oceanographic Commission

**Report on the CEPPOL Seminar on Monitoring and  
Control of Sanitary Quality of Bathing and  
Shellfish-Growing Marine Waters in the Wider Caribbean  
Kingston, Jamaica, 8-12 April 1991**

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CEPPOL SEMINAR ON MONITORING AND CONTROL OF SANITARY  
QUALITY OF BATHING AND SHELLFISH-GROWING MARINE  
WATERS IN THE WIDER CARIBBEAN

KINGSTON, JAMAICA, 8 - 12 APRIL 1991

REPORT OF THE MEETING

Introduction

1. The IOC/UNEP Regional Workshop to Review Priorities for Marine Pollution Monitoring, Research, Control and Abatement in the Wider Caribbean Region (San José, Costa Rica, 4 - 30 August 1989) established the joint IOC/UNEP CEPPOL Programme as a regionally co-ordinated comprehensive programme for the assessment and control of marine pollution in the Wider Caribbean.
2. Among the components of the CEPPOL Programme, Annex III "Monitoring and Control of the Sanitary Quality of Bathing and Shellfish-Growing Waters", represents an important effort for the development of a monitoring and research programme that will ensure the sanitary quality of these waters and the development and enforcement of the adequate quality criteria and control measures. To this end and as a preliminary activity within the programme, this Seminar was convened in Kingston, Jamaica, 8 - 12 April 1991, at the Regional Co-ordinating Unit of the Caribbean Environment Programme of UNEP.
3. Most of the sewage is released into the coastal waters of the Wider Caribbean region without adequate treatment. Pathogenic organisms which may reach the coastal waters through inadequately treated sewage are common throughout the region and therefore sewage contamination of these waters is widely recognized as a potential public health problem for the bathers and consumers of marine food. Recent events in South America, where the largest cholera outbreak this century continues to spread, have demonstrated the potential threat which the discharge of raw sewage to the tropical marine environment represents. It is clear that a high priority must be given to preventing such catastrophies from occurring in the Wider Caribbean region.
4. The monitoring of the sanitary quality of the bathing and shellfish growing waters and the enforcement of adequate environmental quality criteria for these waters is a basic prerequisite for protection of public health. The monitoring is usually based on indicators of faecal contamination which in most cases are not pathogens per se.

However, it seems that research would be needed to determine whether or not under tropical conditions monitoring based only on "classical" indicators of faecal contamination may be misleading.

5. The main objectives of the Seminar were the following:
  - (i) To review the present state of pollution in the Wider Caribbean coastal waters by sewage;
  - (ii) To examine the present practices in monitoring the sanitary quality of bathing and shellfish-growing areas, as well as the adequacy of these practices;
  - (iii) To analyze the environmental quality criteria used in the region, the experience gained in their application and their adequacy in safeguarding public health;
  - (iv) To recommend measures needed to improve the control of contamination of coastal waters by sewage and to diminish the public health risk from such contamination; and
  - (v) To formulate a monitoring and research programme leading to the development of environmental quality criteria suitable for the region and on which a rational public health protection strategy could be based.
  
6. The participants in the Seminar were selected by the CEPOL Secretariat and were invited to attend as experts in their personal capacity. In selecting the participants, the Secretariat was guided by the relevance of the participants to the subject matter of the Seminar. A list of the participants is provided in Annex I of this report.

Agenda Item 1: Opening of the Meeting

7. The meeting was opened on Monday, April 8, 1991, at 10:00 a.m. at the Conference Room of the United Nations Law of the Sea Office in Kingston by Mr. Sálvano Briceño, Coordinator of the Caribbean Environment Programme who welcomed the participants and highlighted the main aspects and importance of the CEPOL Programme for the region. In particular, he emphasised the relevance of

the subject matter for the Wider Caribbean as it affects the natural environment, the economic activities and the health and well-being of the population. He recognized that without the appropriate regional co-operation between the countries and the international organization, it would be impossible to achieve the objectives of CEPPOL and thus encouraged the participants to consider this type of co-operation during the deliberations of the meeting. Mr. Enrique Mandelli, acting Interim Co-ordinator of CEPPOL, briefly outlined the main points leading to the convening of the Seminar and summarized its main objectives.

Agenda Item 2: Administrative Arrangements

Agenda Item 2.1: Adoption of Agenda

8. The meeting adopted the agenda (IOC/UNEP-SWQ-I/1) with minor modifications, which is attached as Annex II to this report. The list of documents (IOC/UNEP-SWQ-I/4) is appended as Annex III to this report.

Agenda Item 2.2: Election of Officers

9. The meeting unanimously elected the following officers:

Chairman:	Mr. Henry Salas of PAHO/CEPIS
Vice-Chairman:	Mr. Fred Kopfler of US/EPA
Rapporteur:	Mr. Anthony Vlugman, PAHO Engineer attached to CEHI

Agenda Item 3: Present State of Marine Pollution  
by Sewage in the Wider Caribbean

10. The Secretariat presented the document, "Review on the Present State of Marine Pollution by Sewage and Present Monitoring and Control Practices in the Wider Caribbean" (IOC/UNEP-SWQ-I/6 prov.) and highlighted the main points of the document. The participants were made aware of the fact that the document had been prepared using only information available at the RCU and therefore it was not

known if it accurately reflected the actual status of sewage pollution in the Wider Caribbean. In view of the above, the participants were requested to update and complete the document as appropriate prior to the closing of the meeting. Additionally, the meeting recommended that the document should be distributed to all the governments of the region prior to its final publication in order to ensure its accuracy. The document was introduced by making a graphic presentation of the region and by summarizing the main pollution problems found in the coastal and island States of the region, in particular with regard to sewage. Although it was recognized that marine pollution problems by sewage in the Wider Caribbean were not as severe as in other regions of the world, such as the Mediterranean, given the better circulation patterns and the lower population numbers, it was stressed that coastal pollution by sewage is a major problem for the region as domestic wastes are often discharged without treatment directly or indirectly at sea or following very poor treatment, a situation which could have severe implications not only to the marine environment and the health of the population, but also to the economy of the region as most of the countries greatly depend on tourism as a source of income and foreign exchange. It was agreed that the monitoring of sanitary quality is limited to coastal waters receiving sewage wastes adjacent to urban areas, and, in some cases, bathing waters at popular beaches. No routine bacteriological monitoring is done in shellfish-growing waters in the region, with the exception of the U.S.A.

11. The recommendations listed in the document were brought to the attention of the participants and several comments were made in this regard. The importance and feasibility of carrying out epidemiological studies was particularly discussed. It was agreed that it was very difficult to carry out epidemiological studies which could result in a valid correlation between indicator and illness. The expense of the study and the difficulty of controlling all the possible factors affecting the results, made epidemiological studies a not very practical approach to be pursued by the region as a priority at the moment, as other more practical studies could be carried out which could provide very valuable and useful information as well in terms of indicator organisms. The meeting decided to discuss this matter further and propose the relevant recommendations during Agenda Item 6.



Agenda Item 4: WHO/PAHO and WHO/CEPIS Activities on Health Related Aspects of Marine Pollution by Domestic Wastes Inside and Outside the Region

12. Mr. Henry Salas of PAHO/CEPIS made a presentation on the activities carried out by his agency in the Caribbean and Latin America and on the present sewage disposal practices in that area. In 1983, a total of 76 cities with a population greater than 100,000 inhabitants were located in coastal or estuarine areas with a total population of 58.1 million inhabitants. Common practice in a majority of these coastal cities is to discharge untreated wastewaters to the nearest or most convenient water body which in some cases is on or very near recreational bathing beaches. A brief outline of the main alternatives available for sewage disposal in coastal cities was provided. After reuse, Mr. Salas mentioned that the long submarine outfall alternative with pretreatment (milli-screens) or primary treatment is a more attractive disposal method relative to secondary treatment with near shore disposal in terms of reliability, efficiency, cost and low operational and maintenance requirements, especially for bigger urban centers. A brief introduction to submarine outfall disposal systems was provided which included factors to be considered prior to their design and construction such as the physical hydrodynamic and environmental conditions of the proposed disposal area (current structure, depth, indicator organism die-off rates, natural existing biological communities, etc.). These factors will determine the location, length and diffuser design of the outfall, which is critical for the adequate dilution required of organic matter and micro-organisms. Based on a survey conducted by CEPIS/PAHO, in Latin American and the Caribbean in 1983, 79 outfalls were constructed, in construction or in the final project phase with lengths of 500 metres or greater. It was emphasized that the minimum outfall length of 500 metres was simply applied here as a reference point and outfalls longer than 500 metres would usually be required for major sewage discharges to comply with microbiological indicator standards. The greatest number of outfalls were located in Venezuela (39), Puerto Rico (14), Brazil (13) and Mexico (9). Outside of Puerto Rico, only one other outfall of more than 500 metres existed in the Caribbean in 1983, which demonstrates the minimal use of this type of disposal system in this region. Additionally, the improvement of bacteriological water

quality in Ipanema Beach of Rio de Janeiro after the construction of a submarine outfall system without any treatment was presented. Mention was also made of the cholera epidemic in Peru and that the literature indicates that the Vibrio cholerae organism outlives most indicator organisms.

13. The concept of outfalls with treatment, versus outfalls without treatment was discussed and many participants expressed their preference towards treatment prior to discharge in the outfall. Mr. Salas emphasized that in an open ocean situation, secondary treatment is superfluous for a long outfall disposal system with a properly designed diffuser which can achieve dilutions of 100 to 1. However, it was stressed that in the Caribbean context, the location of outfalls discharges in the vicinity of sensitive natural biological communities such as coral reefs should be avoided. Mr. Salas re-emphasized that properly designed long outfalls with pre or primary treatment was the more attractive disposal system alternative for coastal communities for the reasons already mentioned. Cost curves for submarine outfalls were presented and it was noted that although initial capital investment may be high, the operational and maintenance costs are relatively low, resulting in lower overall costs in the long term in comparison to secondary treatment systems with near shore disposal. For example, costs for outfall installation varied from US\$5,000 per metre (diameter = 2m) to US\$400 per metre (diameter = 0.25m) using high density polyethylene (HDPE) plastic for the latter case applicable to small communities. Microbiological criteria and/or standards for primary contact recreation and shellfish harvesting presently in use in Brazil, México, Peru, Puerto Rico and Venezuela were presented. It was noted that except for Brazil and Peru, most of the criteria/standards applied in the region were based in the US/EPA criteria (pre 1986) with minor variations. Additionally, Mr. Salas introduced the Cabelli *et al.*, research which concluded that enterococci is the better indicator organism with regards to gastrointestinal diseases. Based on an acceptable risk of 19 gastrointestinal illnesses per 1,000 bathers, the EPA recommended in 1986, a criteria of 35 (geometric mean) per 100 ml for marine waters. A summary table of other epidemiological studies conducted in Canada, Hong Kong, Egypt, Israel, Spain and France was presented which showed that in addition to enterococci, other indicator organisms such as E.coli and faecal streptococci proved to be promising. Also the results of a epidemiological study conducted in the bathing waters of the state of

Sao Paulo, Brazil in 1987, was presented. This study showed enterococci to be the better indicator organism in comparison to faecal coliforms with regard to associated gastrointestinal symptoms. The Brazilian correlation curve slopes were similar to those of the Cabelli *et al.*, results although interceptors were different with higher Brazilian sickness rates resulting at a given enterococci concentration. These results will be published shortly in a peer reviewed international journal. Mr. Salas stressed that epidemiological research was needed in the tropical waters of the Caribbean and highlighted the importance of using comparable methodology for further studies.

14. He concluded his presentation by summarizing his agency's main activities in the region. CEPIS work has concentrated on providing technical assistance to governments for environmental sanitary problems, dissemination of technical information and development and promotion of appropriate technologies, with regard to sewage disposal systems, as for example, reuse via lagoons, submarine outfalls, etc. Technical assistance is provided upon member government request. CEPIS also has an analytical laboratory.
15. Mr. Rafael Mujeriego speaking on behalf of Dr. Louis Saliba of WHO/EURO, presented the work of WHO/EURO in the Mediterranean and the experience of the MEDPOL programme of UNEP. He mentioned that the Mediterranean receives 100 million visitors every year and therefore one of the main concerns in the area is sewage contamination of bathing waters and seafood as it relates to public health. A detailed presentation was made on MEDPOL and in particular on the component related to the control of marine pollution by sewage. MEDPOL Phase I concluded that it was better to concentrate on faecal coliforms and faecal streptococci analysis, as these seemed to be the best indicators and to use and accept a common methodology either membrane filtration or multiple tube analysis (MPN). Their intercalibration exercises proved that the results are comparable if the methodology is followed accurately. MEDPOL has recently proposed to use as media for faecal streptococci M. Enterococcus agar at 37° C as KF media gives many false positives. With regard to epidemiological studies, only few studies have been conducted in the Mediterranean and all have shown very different correlation. With regard to shellfish, he informed that the accepted criteria in MEDPOL is 75% < 300 faecal coliform per 100g of meat and intervalvular liquid, which is used as an indicator of the water

quality.

16. Finally, Mr. Mujeriego concluded his presentation with the following inserts from a paper prepared by Mr. Saliba for the Seminar: "In a region as heterogeneous as the Mediterranean with regard to the stage of development of its coastal states and their immediate capability to enforce marine pollution prevention and control measures, it has been found impossible (for obvious reasons) to achieve joint adoption by 18 different States of anything other than compromise on a least common denominator basis. While the adoption of any agreed-on measure, however unsatisfactory as an end-point, does represent a step forward, there is a natural tendency to regard it as the finished product. This can both lull States into a false sense of security and, more important, result in infrastructural development schemes becoming geared to compliance with the "interim" measure. This could have serious consequences in the case of treatment plants and submarine outfall structures, where compliance with set quality standards has to be incorporated into the design."
17. "It has been suggested that one alternative method would be for recommendations on standards and criteria to be made in the same way as is currently done by WHO and other UN Agencies, i.e. to prepare recommended standards and criteria specially for the Mediterranean region on the basis of expert opinion, satisfying technical requirements while concurrently taking the feasibility factor into account. Such recommendations would in no way require formal adoption by countries involving legal commitments, but would serve as a guideline for countries, either to adopt voluntarily as part of their national legislation, or to adapt in line with their specific circumstances. Such an alternative could achieve a better long-term result at both national and regional levels".

Agenda Item 5: Environmental Quality and Criteria for Bathing and Shellfish Growing Waters and Effluent Guidelines for Sewage Discharges

18. The Secretariat presented the draft document "Environmental Quality Criteria of Coastal Areas in the Wider Caribbean Region-A Compilation", (IOC/UNEP-SWQ-I/4). It was explained that the document contained a general overview of the water quality criteria for

coastal waters, including for bathing and shellfish growing waters, which are currently in use by the different countries of the region. It was noted that the document had been prepared as a background document for a regional workshop on coastal water quality criteria and effluent guidelines, recently convened by CEPPOL and that the contained information had been provided by the governments or had been obtained from the RCU files. Therefore, the participants were invited to examine the document and to provide any comments and amendments as appropriate.

19. Additionally, the Secretariat presented the "Report of the CEPPOL Regional Workshop on Coastal Water Quality Criteria and Effluent Guidelines for the Wider Caribbean, San Juan, Puerto Rico, 5-15 November 1990" (IOC/UNEP-WQC-I/3) in particular, Annexes IV and V of the document, as it contained the interim quality criteria for bathing waters and shellfish, as well as the effluent guidelines for sewage discharges as proposed for the region at the above-mentioned workshop. The participants were requested to carefully review the document, paying special attention to the proposed criteria and activities and to provide specific and relevant recommendations in this regard.
20. After a long debate on the appropriateness of the interim criteria recommended at the Puerto Rico Workshop (Annex IV of the report), the meeting decided to support the proposal that faecal coliforms, E. coli and enterococci be included in the monitoring programmes of the region in order to provide baseline information such as indicator organism ratios, among others. In addition, it was also recommended to include faecal streptococci. It was recognized, however, that such efforts could probably be carried out as demonstration projects initially limited to countries with the adequate laboratory facilities and adequately trained personnel.
21. It was agreed that in order to establish the appropriate criteria for the region, further information and data are required and consequently, it is necessary to conduct some relevant studies in the region, including epidemiological studies when possible. It was decided that although recent studies in other parts of the world seem to indicate that enterococci are better indicators for faecal contamination, those countries of the region which have been measuring total and faecal coliforms and have presently the capabilities to continue measuring

contamination which in most cases are not pathogens per se. However, it seems that research would be needed to determine whether or not under tropical conditions only those parameters, should continue to do so until more conclusive data is available on indicator organisms. Thus, with regards to bathing water bacteriological criteria, it was agreed that those countries which have already adopted standards or guidelines based on EEC, WHO and pre 1986 EPA bacteriological criteria or have developed their own should continue to use these as interim measures for the next 3 to 5 years, at which time sufficient data may be available to select more appropriate indicator organisms.

22. For those countries in which criteria do not exist, two alternatives which serve as interim measures are suggested as follows:

1) the adoption of faecal coliform criteria based on the above-mentioned international criteria. These are:

EEC - 95% < 2000 FC/100 ml

WHO - 50% < 100 FC/100 ml and  
90% < 1000 FC/100 ml

EPA - geometric mean < 200 FC/100 ml and  
90% < 400 FC/100 ml

This option would provide consistent and comparable database among the majority of the States and Territories of the region.

2) the adoption of the enterococci indicator organisms as recommended by the USA/EPA. It was noted that although the laboratory infrastructure of the region is currently directed toward total and faecal coliform measurement, presumptive enterococci and E. coli tests are not considered significantly more difficult to perform.

23. In reference to shellfish-growing waters, no specific criteria was recommended as very little information is available on the region and regular monitoring of shellfish-growing waters only seems to occur in the U.S. states bordering the Gulf of Mexico. However, it was

recognized that in other countries of the region, such as Cuba and Mexico, the shellfish harvesting industry is also an important activity. Thus, for those countries in the region with shellfish industries, the Seminar recommends the adoption of either the USFDA or EEC guidelines for shellfish harvest water quality as interim measures.

24. Regarding the recommendations on sewage effluent standards presented at the Puerto Rico Workshop (Annex V of the report), the meeting considered those recommendations and decided to further discuss the subject of treatment technologies in the next agenda item and to propose the relevant recommendations. In general, the meeting supported these particular recommendations of the Puerto Rico Workshop but some participants expressed reservations with the contents of recommendations 10 and 11 of Annex V.

Agenda Item 6: Development of Microbiological Environmental Quality Criteria Adequate for the Wider Caribbean Region

25. Ms. Christine Moe, a microbiologist at the Center for Disease Control in Atlanta, presented interesting findings of a drinking water study conducted in the Phillipines examining the relationship between several indicator organisms and the risk of gastrointestinal illness. She noted the different characteristics of some indicator organisms in tropical waters, including longer survival, indigenous populations and possible regrowth in the environment. Additionally, she outlined several desirable attributes for an ideal indicator organism such as:
- i) it should be easily measured, unambiguous and consistent,
  - ii) it should be present in water in greater numbers than pathogens,
  - iii) it should survive in water longer than pathogens,
  - iv) it should be more resistant to treatment processes than pathogens,
  - v) it should not multiply in the environment,

- vi) it should not have any non-faecal sources, and finally,
- vii) the concentration of the indicator organism in water should have a quantifiable relationship to health risk.

Ms. Moe discussed the difficulty of conducting epidemiologic studies not only in terms of laboratory analyses but also the difficulty of assessing other factors which affect the health of the study population. The Phillipine one year epidemiological-microbiological study evaluated four bacterial indicators of tropical drinking water quality (faecal coliforms, E. coli, enterococci and faecal streptococci) and their relationship to prevalence of 690 children under two years old. The study concluded that enterococci and E. coli were better predictors than faecal coliforms of the risk of waterborne diarrhoeal disease. Methods to enumerate E. coli and enterococci were less subject to interference from the thermotolerant, non-faecal organisms that are indigenous to tropical waters. Little difference was observed between the illness rates of children drinking good quality water (<1 E. coli/100 ml) and those drinking moderately contaminated water (2-100 E. coli/100 ml). Children drinking water with > 1000 EC/100 ml had significantly higher rates of diarrhoeal disease than those drinking less contaminated waters. This threshold effect suggests that in developing countries where the quality of drinking water is good or moderate other transmission routes of diarrhoeal disease may be more important; however, grossly contaminated water is a major source of exposure to faecal contamination and diarrhoeal pathogens.

26. A question was raised on the feasibility of the routine methodology for the analysis of E. coli, enterococci, faecal coliforms and faecal streptococci and the degree of difficulty in performing these analyses. As mentioned above, it was agreed that all four presumptive tests require similar skills to be performed. Regarding the best methodology to be performed for these types of analyses, membrane filtration was recommended as the most reliable for measuring these organisms because it permits discrimination between the target indicator organism and interfering background growth. However, it was recognized that the choice of methodology also depends on local environmental factors and capabilities, which in many cases in the region would only allow for multiple tube analysis which is less costly.



27. Ms. Moe also presented the results of a pilot study conducted by NOAA, EPA and the University of North Carolina to determine if a number of water quality indicators could be correlated to disease incidence in human volunteers consuming raw oysters harvested from two sites on the eastern coast of the U.S. The preliminary results of this study suggest that levels of total and faecal coliforms, *E. coli* and enterococci in the oyster harvest waters were associated with the occurrence of gastrointestinal illness in volunteers in the first seven days after shellfish consumption. Levels of standard plate count bacteria and F+ coliphage in oyster meat were also correlated with gastrointestinal illness in volunteers consuming raw shellfish. F+ coliphages were proposed as potential indicator organisms for tropical marine waters because they can not multiply in the environment and their survival rates may be comparable to those of enteric viruses. Also the techniques involved in the analysis for F+ coliphage in water are not very complicated.
28. It was also brought to the attention of the meeting that the Cabelli *et al.*, epidemiological study conducted in the USA has found enterococci to be a better indicator organism than commonly used indicators in marine waters with relation to health risk. However, this study was conducted in primarily temperate waters and the shortcomings in its methodology have been subjected to significant criticism. Other epidemiological studies on a worldwide basis suggest that in addition to enterococci other indicator organisms such as *E. coli* and faecal streptococci may be promising health related indicator organisms (see Table 1).
29. The meeting agreed upon the importance of conducting epidemiological studies in the region, in order to provide data and information to fill gaps of knowledge on the appropriate quality criteria and the health risk and indicators. However, it was recognized that perhaps other studies are more feasible to conduct and could also provide valuable information to satisfy gaps of knowledge. Additionally, it was mentioned that it was important to consider other diseases, such as skin, ear and nose infections for epidemiological studies rather than gastrointestinal infections alone.

30. The overall conclusion of the meeting was that in view of the evidence of the lack of correlation between faecal coliform and health effects and the controversy of its survival and regrowth in tropical waters, this parameter may be phased out in the long term in lieu of a more health oriented indicator organism. The enterococci seem to be the most promising at the present time based on the USA and Brazilian epidemiological studies and thus, the States and Territories of the region should be considering this approach. However, the final selection of which of these indicator organisms will be the best for the Wider Caribbean should await the results of additional studies, such as a proposed demonstration epidemiological project in Trinidad and Tobago which could provide information in the context of tropical marine waters. It is recommended that "seed" money and technical support should be provided by the international agencies especially UNEP and PAHO for this project. Also, financial support should be sought from the EPA and other US agencies in view of the vested interest of the USA in their Gulf coast and the extensive USA tourism in the region. This demonstration project should be conducted as soon as possible after obtaining the necessary background data and should be subjected to peer review by experienced experts during its planning and execution.
31. Additionally, it was recommended that the countries should begin to evaluate their health statistics to ascertain what relative public health risk associated with primary contact recreation in coastal waters would be acceptable. This information subsequently combined with attainability of the indicator organism criteria will be used to determine the final standard for each State and Territory. The long term goal is to provide a health risk indicator relationship which will allow each country to establish its standards based on health goals.
32. The meeting was also requested to consider and discuss appropriate technologies for the region for sewage treatment. It was noted that, in general, conventional sewer systems require large pipes, deep excavations and pumping stations or mechanical systems to raise the effluents. These methods are very costly both in terms of initial investment and operational costs which would make them not very suitable for the region. Other less

conventional and more economical methods were discussed and their effectiveness was considered. One of the methods includes a system of holding tanks and small diameter pipes which follow the natural slope of the land. A significant amount of solids are retained by the holding tank. This method has been utilized in other tropical and less developed areas of the world and has proven to be efficient in particular for smaller communities. Some drawbacks of this method were highlighted such as the fact that the effluent was anaerobic (strong odour) and could be highly corrosive. Additionally, it still presented the problem of removal, treatment and disposal of the sludge. Thus, although the initial investment cost could be minimal, especially if already existing septic tanks were to be utilized, the operational and maintenance costs could be high. Another treatment system presented as an alternative method was the Anaerobic Up Flow Reactors, which seems to be more efficient in terms of treatment and costs. This anaerobic method can even be used for individual households and the sludge which is produced is highly mineralized and achieves a considerable degree of pathogen inactivation. Additionally, it produces gases ( $CH_4$ ) as the main product which could then be positively utilized as energy source. The major drawback of this method seems to be the collection and final use of the gas which could require an additional process. Other alternative methods were also considered and supported such as stabilization ponds and submarine outfalls which were further discussed under agenda item 7.

33. The meeting agreed that these systems as well as other existing methods should be considered and explored as alternative treatment technologies for the region. The participants suggested that a literature review should be conducted on the effectiveness, suitability for the region and costs of these technologies prior to being recommended arbitrarily to the region, as it is expected that different methods would work for different countries depending on the local conditions and characteristics. Additionally, water saving, reuse of sewage effluents and the reduction of waste water generation were recognized as essential approaches to reduce sewage pollution in coastal and marine environment and of particular importance for those areas where fresh water resources

are limited and stressed. The meeting agreed that where possible, the use of treated sewage for agricultural and landscaping irrigation, as well as for toilet flushing should be promoted. The meeting recommended that a comprehensive literature review should be prepared as well on water saving and waste water reuse and reduction. Finally, the meeting recognized that the need to seriously assess the ecological and physical characteristics of the receiving environment prior to the selection of any treatment and disposal technology had to be highlighted in the report, as on many occasions the efficiency of the treatment in terms of polluting load removal and its cost were the major factors considered. To this end, it was also recommended that further oceanographic studies have to be carried out in the region in order to obtain additional information on the ecology and oceanographic characteristics of this part of the world.

Agenda Item 7. Development of Pilot Sanitary Monitoring Programmes and Orientation of Research Activities

34. The participants were invited to present the monitoring and research activities carried out in the region by their national institutions on the assessment and control of coastal and marine pollution by sewage. The representative of Costa Rica presented the studies carried out in his country, which included the monitoring of the sanitary quality of the major beaches on both the Caribbean and Pacific coasts of Costa Rica. On the Caribbean side, Costa Rica has 212 km of total coastline of which 82 km are beaches. The quality of the water (total and faecal coliforms and faecal streptococci) as well as the sources of pollution are monitored regularly and although quality criteria is in place and waters have been categorized accordingly, no enforcement is applied and waters unsafe for swimming are not closed to the public. He explained that the main polluters in this area include the municipal sewerage systems and a hospital which discharges its sewage directly into the sea as well as all the pathological wastes as no incinerator exists. He mentioned that the sampling sites and frequency of sampling were determined based upon the population numbers and the importance of the beach as a tourist attraction. Additionally, although no epidemiological studies were conducted, their programme included research on the use of Salmonella as an indicator for health risk and a correlation was established

between faecal coliforms and Salmonella. Their findings concluded that in waters with levels of more than 240 faecal coliforms per 100 ml, 70% of the samples contained Salmonella. They also found that in 80% of the samples, 63% of the total coliforms were faecal coliforms and that there was no relationship between the aesthetic conditions of the water (turbidity, etc.) and the presence of coliforms. Based on guidelines used in other countries and on the findings of his own institutions, guidelines for water quality criteria have been established for Costa Rica and all the monitored beaches are classified in three categories: 1) safe for swimming, 2) safe for swimming but subject to periodic monitoring and 3) unsafe for swimming. In Costa Rica, waters safe for swimming (category 1) are those with less than 200 TC (total coliforms) and 100 FC (faecal coliforms) per 100 ml (geometric mean) or 80% less than 460 and 240 MPN (respectively). Waters unsafe for swimming (category 3) are those with a geometric mean of more than 240 faecal coliforms per 100 ml (with a minimum of twelve samples a year).

35. The question was raised on the validity of using Salmonella for establishing a correlation with faecal coliforms and it was noted that although it is not the best method, it is an alternative approach given the difficulty in conducting other studies such as epidemiological exercises. The frequency of monitoring and sampling was highlighted and some participants raised their concern with regard to having only 12 samples per year, as it may not necessarily be representative of the quality of the water. Thus, emphasis was placed by the participants on the design of the monitoring programme, as the sampling technique can introduce differences of two or three orders of magnitude. It was agreed that the most important points in these type of studies are to establish a common protocol and criteria for sampling, including time of day and frequency, to obtain reliable and comparable results and to adopt a protocol for their interpretation.
36. The representatives from the Natural Resources Unit and Water Authority of the Cayman Islands informed the meeting that all sewage in their country is first treated in septic tanks and then disposed of in the subsoil through properly constructed deep wells. The exception

to this is the west coast of Grand Cayman where the vast majority of hotels and other tourist facilities are located. Here, sewage is collected in a sewer system and treated in waste stabilization ponds. The effluent from the ponds is currently injected into the subsoil via a deep well. Plans are underway to further improve the quality of the effluent so that it can be reused for irrigation. A joint monitoring programme for sewage pollution in the Georgetown Harbour has recently been initiated in response to allegations that sewage may be leaking from cracked septic tanks into the Harbour. Bacterial parameters being monitored include faecal coliforms and enterococci following WHO guidelines. As very low levels of faecal contaminants have been observed to date it was recommended that nutrient analysis be attempted as this may be a better indicator of the infiltration of sewage from cracked septic tanks into the Harbour. However, they noted that the necessary laboratory capacity does not exist at present to allow for this analysis but every effort would be made to comply with this suggestion. The participants expressed their interest in the concept of stabilization ponds, as it has also been proven as a good method in other parts of the region. It was highlighted that the main constraint with the establishment of this type of ponds is land availability, as it is estimated that the criteria utilized is that 0.8 square metres of land are required for each person served by the sewerage system.

37. The representative from the Institute of Marine Affairs (IMA) informed that it was mainly the North and North Western coastal areas of Trinidad and the South Western coastal area of Tobago which have been found to be affected by sewage pollution. The main causes of sewage pollution appear to be broken and leaking sewage pipelines, sewage overflows and outfalls in inshore water, seepage of sewage from pit latrines into coastal waters and malfunctioning sewage treatment plants. Although no routine monitoring programme is currently in place in Trinidad, the IMA conducts bacteriological surveys of bathing beaches upon request by various governmental institutions. A combination of the pre 1986 US/EPA; EEC and the WHO standards and guidelines are used for determining the sanitary quality of bathing waters in Trinidad and Tobago. The microbiology laboratory facilities at the IMA have not yet been established. All

surveys thus far have been conducted using the laboratory facilities at the Trinidad Public Health Laboratory. When the microbiology laboratory facilities are established at IMA, probably within the next 2 months, a routine sanitary quality monitoring programme of bathing waters will be initiated. Additionally, the IMA is in the process of developing a pilot epidemiological study which could be initiated shortly. As mentioned under agenda item 6, this initiative was of particular interest to the meeting and was supported by many participants as it was suggested that the study could provide useful baseline data which is presently lacking on this particular matter for the region.

38. The representative from the Caribbean Environmental Health Institute (CEHI) presented a general description of the objectives and activities of this institute and in particular as it relates to marine pollution monitoring in the less developed islands of the eastern Caribbean. With reference to monitoring the sanitary quality of coastal waters, he outlined the type of assistance provided by CEHI to the islands, which includes a) the provision of training in the required sampling and analytical techniques, b) general programme development including the selection of representative sampling points in each monitoring area, and c) definition of the sampling regime. In most instances, CEHI provides the final analysis of the data and preparation of the final report as some islands do not have the required infrastructure to do so. The methodology used by CEHI is generally based on the standard reference methods developed and published by UNEP and WHO. It was recognized that support to CEHI activities had been provided mainly by CARICOM and UNEP, but that more recently additional sources of funding had to be sought. UNEP's support was limited at the moment to the dissemination of information, services through the RCU in Kingston and technical assistance in terms of methodology manuals and training. He highlighted that the major constraint in the region relates to the lack of financial resources and the prioritization of issues at the national levels, as although training and assistance is provided to government personnel, in many instances there is a lack of regular follow-up and compliance to the recommended programme. Regarding quality criteria, he stressed the need to adopt common methodologies and standards for the region as at the moment a combination

of EEC, EPA and WHO guidelines are being used in the region. He supported the use of the proposed new indicator organisms, E. coli and enterococci, and stressed that all laboratories need to develop the capability to conduct the verification tests for these organisms. However, he made emphasis on the cost and time implications and recognized that these studies are many times not feasible for most of the smaller island States.

39. The WHO/PAHO Sanitary Engineer at CEHI made a presentation on the status of treatment plants in the Caricom countries. He expressed that the most common waste water disposal method is the septic tank and soak-away system. In some countries, raw waste water is directly disposed into shallow or deep wells. Previous studies indicated that about 10% of the population in the area is connected to a sewerage system, which does not always have treatment plants. About 80% of the treatment plants do not meet the levels of 25 mg/l BOD (biological oxygen demand) and SS (suspended solids) or 85% reduction of these parameters. Plant operators, when available, have generally not received appropriate training. Maintenance of equipment and systems is limited and in some cases not existent, due to lack of training and spare parts. Consequently, most of the waste water is discharged without treatment or in some instances, following poorly applied treatment. Little environmental legislation exists and is being very slowly implemented and enforced. The most common type of secondary treatment utilized in the study area is activated sludge plants. In most cases, sludge is not regularly removed or not removed at all. Sludge is only treated in a few cases and in most cases disposed in landfills or applied on agricultural lands. Only in one case it was reported that the sludge is disposed into the sea. However, frequent reports were received of illegal disposal of sludge also from septic tanks into the sea. Effluents of treatment plants are partly re-used for irrigation and toilet flushing, disposed in the marine environment or discharged into ground water aquifers. Disinfection of effluents is in general very ineffective, because of bad disinfection practices applied and high suspended solids levels. At this point, the discussion concentrated on appropriate technologies for wastewater treatment, and the conclusion made was that treatment and disposal technologies that are reliable and require simple operation and minimal maintenance (e.g. land treatment, waste stabilization



ponds and long sea-outfall) should be promoted. Additionally, it was highlighted that many times the effluents from ponds could be utilized for irrigation purposes without need of further treatment. However, the point of the availability of land was pin-pointed as these ponds require relatively big land spaces. Also, the meeting realized that capital costs for the implementation of wastewater collection, treatment and disposal facilities are in most cases financed by external funding agencies and that cost for operation and maintenance are paid with revenues from the local operating authority. It was therefore agreed that those projects with high capital costs and low operational and maintenance costs should be encouraged and supported. The alternative of submarine outfalls was again brought to the attention of the meeting by another participant and it was noted that this type of treatment seemed feasible for urban centers provided that the environmental and physical conditions of the receiving area would allow it.

40. Brief presentations were made on the monitoring of coastal pollution by sewage in other island States such as Jamaica and Cuba. In Jamaica, no monitoring programmes are in place to establish the sanitary quality of beaches but sporadic surveys are conducted which have provided some insight on the levels of bacterial contamination in those waters. In general, pollution by sewage does not seem to be a problem for most beaches in Jamaica and although beaches have been closed to the public, this measure has only been based on logistic reasons and not on scientific or quality criteria findings. EPA and WHO criteria have been incorporated in the Jamaican Health Act which is used as a standard for determining the sanitary quality of bathing waters in Jamaica. There are 35 sewage treatment plants in the area of the capital, Kingston, which has more than one million people. Ten of the plants discharge their effluents into a section of Kingston Harbour and the rest discharge into rivers and gullies which eventually flow into the Harbour. Although swimming activities no longer occur at the Harbour, popular beaches are located in its vicinity and the limited available data indicates that those beaches are not subject to bacterial contamination. A bottom fish and shrimp survey of the harbour revealed in 1968 that there was the potential for a small scale trawling industry there. At present the bottom dwelling communities of fish and shrimp have been destroyed by pollution.

41. Cuba is the biggest island of the region with a population of 10 million people and an area of 110,000 km<sup>2</sup>. Regular monitoring of the sanitary quality of popular bathing waters is carried out in Cuba and the results so far suggest that contamination of coastal waters by sewage is not a major problem in this country. The capital, Havana, with approximately 2 million people, is connected by a sewerage system and the waste water is disposed at sea through an old emissary only 150 mts long. The physical conditions of the coastal waters in the area have allowed for this waste disposal system to work in Cuba with excellent results. Simultaneous to the bacteriological studies, other studies are conducted in Cuba to assess the general coastal water quality. Diagnostic assessments on the environmental quality of the coastal areas and the impact on the natural communities are done through the use of statistical analysis techniques, such as multiple lineal regression, models of multiple lineal regression and cluster analysis. The routine bacteriological parameters measured include total coliforms, faecal coliforms and faecal streptococci, as well as Clostridium perfringens in sediments. In this regard, a database exists in Cuba with data which goes back up to 10 years on the main bays and harbours of the country, as well as on the coastal area of Havana City.
42. It was recognized by the meeting that the present monitoring practices on the sanitary quality of bathing and shellfish-growing waters were limited in the region and that only in few countries regular monitoring programmes were in place. Additionally, it was highlighted that the methodology used had not been standardized for the region and therefore many times the available results and data were not comparable. Furthermore, there are many areas in the region which are likely to be suffering from extensive sewage contamination but for which no monitoring data is available. The meeting recognized the efforts made by CEHI in the development of monitoring programmes in the eastern Caribbean and in the use of the standardized methodology developed by UNEP and WHO. The meeting recommended that continued support should be provided to CEHI to allow for the continuation of such activities. The meeting agreed that it is essential for the region to achieve uniformity in the sampling and analytical methodology including data

processing and interpretation, prior to considering further studies and that a wider coverage of the region should be sought when establishing monitoring programmes. However, it was also highlighted that once the state of the pollution problem has been assessed, further monitoring programmes should not be encouraged as efforts should be concentrated on controlling the pollution source and solving the problem. Additionally, it was agreed that a monitoring programme on the sanitary quality of bathing waters could be initiated in the region with few laboratories which have the appropriate facilities to standardize their procedures, and eventually additional institutions could be incorporated into the programme as appropriate.

#### Agenda Item 8: Recommendations

43. Following the deliberations of the meeting, taking into consideration the objectives of the Seminar and the recommendations contained in document IOC/UNEP-SWQ-I/6 prov., as well as those relevant to the Puerto Rico Workshop; and recognizing the apparent need for most of the region for a comprehensive monitoring and control programme for coastal bathing and shellfish-growing waters, the meeting recommended that the following be considered as priority activities within CEPPOL, taking into consideration the limited funding available:
  1. Those countries, which have already adopted EEC, WHO or pre 1986 US/EPA standards or guidelines for the bacteriological quality of bathing and recreational water quality, or who have developed their own, should continue to use them until sufficient information is available to select more appropriate water quality criteria indicator organisms for the region.
  2. For those countries in which the above criteria do not exist, two alternative interim measures are recommended:
    - a) the adoption of a faecal coliform criterion based on the recommendations of either the EEC, WHO or US/EPA pre 1986 as outlined in paragraph 22 of this report; or

- b) the adoption of enterococci indicator organisms as recommended by the EPA 1986 criteria, using a selected health risk factor.
3. To examine the relationships among faecal coliforms, enterococci, E. coli and faecal streptococci concentrations in tropical waters and the survival rates of these organisms. Research should be conducted into the potential use of other indicator organisms, such as F+ coliphages.
  4. Countries should develop adequate monitoring programmes to assess the state of faecal pollution of bathing waters as well as its sources. Those programmes should be based on a common methodology and standardized procedures for sampling, analyses, statistical interpretation and evaluation for the above parameters. Sampling and analysis for faecal coliforms is the recommended minimum activity. The recommended methodology is contained in the Regional Seas series of Reference Methods for Marine Pollution Studies.
  5. Baseline studies should be conducted to determine the sampling frequency, time and depth, as well as the siting of sampling points.
  6. To minimize faecal contamination of bathing waters, treatment and disposal technologies that are reliable and require simple operation and minimal maintenance (e.g. land treatment, waste stabilization ponds and long sea out-falls) should be promoted and supported whenever possible.
  7. As faecal pollution of bathing waters is not an isolated problem, a holistic approach should be adopted in the search and implementation of solutions to the problem of wastewater treatment and disposal.

8. Epidemiological studies should be conducted to determine the relationship between the above mentioned indicators and health risk from recreational water contact. While the Seminar recognizes the difficulty and the expenses involved in conducting such studies, the valuable information collected would contribute towards the establishment of regional health-based criteria.
9. The countries of the region should begin to evaluate their health statistics to ascertain what relative public health risk associated with primary contact recreation in coastal waters would be acceptable.
10. For those countries in the region with shellfish industries the Seminar recommends the adoption of either the USFDA or EEC guidelines for shellfish harvest water quality as interim measures.
11. Literature reviews should be conducted to determine the appropriateness and feasibility of alternative sewage treatment technologies such as the small bore (diameter) sewer system and the anaerobic upflow reactor, among others, as wastewater collection and treatment alternatives.
12. Re-use of sewage effluents and reduction of wastewater generation should be promoted, especially where fresh water resources are limited and stressed. To this end, a literature review should be prepared on the advantages, implications and available methods for water saving and for wastewater reduction and reuse.
13. Additional technical and/or financial support should be provided to the national institutions, in particular to those with the least infrastructure, in order to ensure a wider participation of laboratories in the previously recommended studies.

Agenda Item 9: Other matters

44. The meeting was invited to raise any other matters not covered during the previous agenda items but relevant to the subject of the Seminar. At this point, Mr. Carlos Fonseca, the representative of the Insitute of Natural Resources and Environment (INDERENA) of Colombia, made a presentation on sanitary and environmental technologies. He initiated his presentation by comparing the current approach towards environmental management with the approach required for the future, which includes preventive, alternative, innovative and interdisciplinary concepts rather than the remedial, conventional, sectorial and specialized approach being utilized at the moment. Additionally, he briefly outlined the environmental management sequence being used in his country for the approval and implementation of development projects. Furthermore, the various points which make a treatment technology appropriate were highlighted, such as the use of natural energy, the use of the available infrastructure and the consideration of the local environment and realities. The conventional and non-conventional sewage treatment technologies were discussed, including their investment and operational costs, their treatment efficiency and their pollutant load removal. He noted that one of the objectives of non-conventional technologies and which has proven to be more appropriate is to decrease, as much as possible, the amount of effluent generated through treatment and to obtain mainly a dry waste as the main product. Water-saving was therefore highlighted as an important element to facilitate wastewater treatment. The holding tanks coupled with small diameter pipes, the anaerobic up-flow system and the oxidation and stabilization ponds were among the types of appropriate and innovative technologies recommended, given their efficiency in terms of costs, energy, water-saving and removal of solids, organic matter and bacterial contamination.

Agenda Item 10: Adoption of the Report

45. The Chairman presented the report of the Seminar to the meeting including its recommendations and requested that the participants adopt it with ammendments, if required. The report was adopted with ammendments.

Agenda Item 11: Closure of the Meeting

46. The meeting was closed at 6:30 p.m. on Friday, 12 April 1991, by Mr. Enrique Mandelli, from the CEPPOL Secretariat who presented the closing remarks and thanked all the participants for their valuable contributions, cooperation and interest in the Seminar. The Chairman thanked UNEP and the CEPPOL Secretariat on behalf of the participants, for a well organized and interesting meeting and the RCU staff for their support and kindness during their stay in Jamaica.

TABLE 1. SUMMARY RESULTS OF THE MAIN CABELLI-STYLE  
PROSPECTIVE EPIDEMIOLOGICAL STUDIES<sup>a</sup>

Author	Date	Country/area	Fresh/sea	Indicator	R <sup>2</sup> <sup>b</sup>	Symptoms <sup>c</sup>
Stevenson	1953	United States of America	Both	Total coliforms	NR	ENT/GI/R
Cabelli	1982	United States of America	Both	Enterococci	0.56	GI
Seyfried	1985	Canada	Fresh	Total staphylococci Faecal coliforms Faecal streptococci	0.19 0.08 0.03	R/GI
Chcung	1988	Hong Kong	Sea	<i>E. coli</i> Staphylococci	0.53	S/GI
El Sharkawi	1983	Egypt	Sea	Enterococci <i>E. coli</i>	0.79 0.77	GI
Fattal	1986	Israel	Sea	Enterococci <i>E. coli</i>	NR NR	GI GI
Mujeriego	1982	Spain	Sea	Faecal streptococci	NR	S/E/ENT/GI
Foulon	1983	France	Sea	Faecal streptococci Total coliforms Faecal coliforms	NR	E/S/GI

a. After Jones, F. & Kay, D. *Recreational water quality: the relationship between epidemiological studies and recreational activities in water*. Report of a biological standards seminar, Middlesex Polytechnic, 9 February 1980.

b. R<sup>2</sup> - Coefficient of determination; NR - not reported.

c. E - eye infections; S - skin complaints; GI - gastrointestinal symptoms; ENT - ear, nose and throat infections; R - respiratory illness.



**ANNEXES**

ANNEX I

LIST OF PARTICIPANTS

Christine BULLOCK  
Resident Microbiologist  
Institute of Marine Affairs (IMA)  
P.O. Box 3160, Carenage Post Office  
Trinidad & Tobago  
Tel: (809) 634-4291/9  
Fax: (809) 634-4433

Gina EBANKS-PETRIE  
Natural Resources Unit  
P.O. Box 486  
Grand Cayman  
Cayman Islands  
Tel: (809) 949-7544  
Fax: (809) 949-8469

Carlos FONSECA  
Sub-gerente Medio Ambiente  
INDERENA  
Diagonal 34 No. 5-16  
Bogotá, D.E.  
Colombia  
Tel: (571) 285-6338  
Fax: (571) 285-9987

Barrington HARVEY  
Senior Scientist  
Environmental Control Division  
LOJ Bldg., 5th Floor  
61 Half-Way Tree Road  
Kingston 10  
Jamaica  
Tel: 92-96463 / 92-94365  
Fax:

Fred KOPFLER  
Chief Scientist  
Gulf of Mexico Programme  
U.S./EPA  
Building 1103  
Stennis Space Center Ms. 39529  
USA  
Tel: (601) 688-3726  
Fax: (601) 688-2709

Doreen LEVY-WELLINGTON  
Environmental Scientist  
Environmental Control Division  
LOJ Bldg., 5th Floor  
61 Half-Way Tree Road  
Kingston 10  
Jamaica  
Tel: 92-91605  
Fax:

Raul MEDEROS  
Marine Pollution Senior Scientist  
CIMAB/IIT  
Apartado 17029, CP 11700  
Habana 17  
Cuba  
Tel: 624-387 / 621-557  
Tlx: 0511181 / 0511350

Christine MOE  
Center For Disease Control  
Building 7, Room SB-50  
Mailstop G04  
1600 Clifton Road  
Atlanta, GA 30333  
U.S.A.  
Tel: (404) 639-2396  
Fax: (404) 639-3645

Darner MORA ALVARADO  
Laboratorio Central de A y A  
450m Norte de la Iglesia de Tres Rios  
La Unión, Cartago  
Costa Rica  
Tel: (506) 795-118  
Fax: (506) 795-973

Rafael MUJERIEGO  
Professor of Environmental Engineering  
School of Civil Engineering  
Universidad Politecnica de Cataluña  
Gran Capitan, S/N  
08034 Barcelona  
Spain  
Tel: (343) 401-6465  
Fax: (343) 401-7357 / (343) 401-6504

Henry SALAS  
CEPIS/PAHO  
Los Pinos 259  
Urbanización Camacho  
Casilla Postal 4337  
Lima 100, Peru  
Tel: (5114) 354-135  
Fax: (5114) 378-289

Thomas VAN ZANTEN  
Water Authority - Cayman  
P.O. Box 1104  
Grand Cayman  
Cayman Islands  
Tel: (809) 949-6352  
Fax: (809) 949-0094

Adrianus A. VLUGMAN  
PAHO Sanitary Engineer  
Caribbean Environmental Health Institute  
CEHI  
P.O. Box 1111  
La Morne, Castries  
St. Lucia  
Tel: (809) 452-2501 / 452-1412  
Fax: (809) 453-2721

Rickardo WARD  
Scientific Officer  
Caribbean Environmental Health Institute  
CEHI  
P.O. Box 1111  
La Morne, Castries  
St. Lucia  
Tel: (809) 452-2501/452-1412  
Fax: (809) 453-2721

SECRETARIAT

Enrique MANDELLI  
IOC Consultant for CEPPOL  
c/o UNEP (CAR/RCU)  
14-20 Port Royal Street  
Kingston, Jamaica  
Tel: (809) 92-29267/9  
Fax: (809) 92-29292

Alessandra VANZELLA-KHOURI  
Programme Officer  
UNEP (CAR/RCU)  
14-20 Port Royal Street  
Kingston, Jamaica  
Tel: (809) 92-29267/9  
Fax: (809) 92-29292

ANNEX II

AGENDA

1. Opening of the meeting
2. Administrative arrangements
  - 2.1 Adoption of agenda
  - 2.2 Election of officers
3. Present state of marine pollution by sewage in the Wider Caribbean
4. WHO/EURO and PAHO/CEPIS activities on health related aspects of marine pollution by domestic wastes inside and outside the region
  - 4.1 National and regional programmes
  - 4.2 The Mediterranean Experience
5. Environmental quality criteria for bathing and shellfish growing waters and effluent guidelines for sewage discharges
  - 5.1 Quality criteria and effluent guidelines in use within the region
  - 5.2 Recommended interim quality criteria and effluent guidelines for the region
6. Development of microbiological environmental quality criteria adequate for the Wider Caribbean region
  - 6.1 Indicator organisms and methodologies
  - 6.2 The feasibility within the region of epidemiological studies
  - 6.3 Development of effluent standards
  - 6.4 Development of appropriate and feasible control technologies for the region
7. Development of pilot sanitary monitoring programmes and orientation of research activities
  - 7.1 Presentation of monitoring and research studies carried out in Costa Rica

- 7.2 Monitoring carried out by CEHI in the smaller island states of the Eastern Caribbean and treatment plants and disposal of effluents and sludges in CARICOM member states
- 7.3 Other national studies and proposed programmes
  - a) Trinidad and Tobago
  - b) Cayman Islands
  - c) Jamaica
  - d) Cuba
8. Recommendations
9. Other matters
10. Adoption of the report
11. Closure of the Meeting

ANNEX III

LIST OF DOCUMENTS

Working Documents

IOC/UNEP-SWQ-I/1	Agenda and Timetable
IOC/UNEP-SWQ-I/2	Annotated Agenda
IOC/UNEP-SWQ-I/3	Report of the Seminar
IOC/UNEP-SWQ-I/4	List of Documents
IOC/UNEP-SWQ-I/5	List of Participants
IOC/UNEP-SWQ-I/6	Review on the present state of marine pollution by sewage and present monitoring and control practices in the Wider Caribbean

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5. WHO/UNEP, 1978      Monitoring of recreational coastal water quality and shellfish culture areas. WHO Regional Office for Europe, Copenhagen (English only)
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8. EPA, 1988            Introduction to Water Quality Standards, September 1988.
9. NOAA, 1986          National Estuarine Inventory: Classified Shellfish Growing Waters by Estuary by Marlene A. Broutman and Dorothy L. Leonard. December 1986.
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17. IOC/UNEP, 1990 Marine Pollution Assessment and Control Programme for the Wider Caribbean region - CEPPOL. IOC Workshop Report No. 59 Part 2 (English, French and Spanish)
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