UNITED NATIONS

ECONOMIC COMMISSION FOR LATIN AMERICA AND THE CARIBBEAN - ECLAC

Distr.
GENERAL

LC/G.1374(SES.21/26)
5 December 1985

ORIGINAL: ENGLISH

Twenty-first session

Committee on Human Settlements

Mexico City, 17-25 April 1986

827 AAL 85

LIBRARY
INTERNATIONAL REFERENCE CENTRE
FOR COMMUNITY WATER SUPPLY AND
SANITATION (IRC)

# CODES, REGULATIONS AND STANDARDS ON WATER SUPPLY, SANITATION AND SOLID-WASTE DISPOSAL WITH EMPHASIS ON LOW-INCOME COMMUNITY REQUIREMENTS IN LATIN AMERICA AND THE CARIBBEAN */

*/ This document was prepared by the ECLAC/UNCHS Joint Unit on Human Settlements.

85-9-1288

027 AAL 85
6526

(070) 81 ... 11 ext. 141/142
ISN 6526
827 AAL85

CONTENTS

Summary

For some time now concern has been expressed over the perceived application of inadequate codes, regulations and standards for the design and construction of water supply and sanitation systems and solid-waste disposal facilities, the above situation being especially important when these standards are applied to low-income settlements in developing countries.

The problem of correspondence between a determined economic and socio-cultural reality and an interrelated adequate standard of technology is especially complex in the Latin American and Caribbean region, where people aspire to the cultural models of developed nations without having the means to reach them.

The region has already accumulated many years of experience in the application, or tentative application, of imported standards and technologies. There is also a wealth of information on "appropriate technologies" from other regions. The above two sources of empirical data, plus the evaluation of indigenous technology, can provide a good foundation to support the elaboration of a technology concept adequate to the diverse regional economic and socic-cultural conditions.

The main objective of the study is to elaborate guidelines and recommendations for the preparation and/or improvement of codes, regulations and standards applied in the design, construction and operation of water supply, sanitation and solid-waste disposal systems, adequate to the economic and socio-cultural conditions prevalent in Latin America and the Caribbean, especially in lower income groups.

To achieve this objective, a review is made of the codes, regulations and standards currently applied in the region, evaluating their suitability to present circumstances and identifying areas that need further development and improvement. It is hoped that the formulated conclusions and recommendations will be an initial step in developing, at the national level, the legislative and normative framework necessary to promote the research, development and application of techniques suitable to the region's conditions.


/I. INTRODUCTION

# I. INTRODUCTION

## A. Background

It is some time now since different organizations and professionals working in the water supply, sanitation and solid-waste disposal sector began to voice their concern over the perceived application of inadequate codes, regulations and standards for the design and construction of water supply, sanitation and solid-waste disposal systems. Their main argument is that these standards are, in most cases, based on (or referred to) standards developed and applied in other regions with different economic and socio-cultural realities, the above contradiction being maximized when these standards are applied to low-income settlements in developing countries.

The problem of correspondence between a determined economic and socio-cultural reality and an interrelated adequate standard of technology is especially complex in the Latin American and Caribbean region (referred to hereinafter as "the region") Although the region has a degree of economic development (as understood in western capitalist society) radically different from those of developed nations, the cultural patterns of the majority of the people either i) tend to follow, or ii) aspire to reach, the cultural models of the developed nations in question.

Without entering into elaborate conceptual justifications to establish the existence of a close interrelationship between culture and technology, we can attribute to the common disregard of this interrelationship the failure of repeated efforts to introduce "appropriate technologies" in the region. As a consequence, "appropriate technology" has often come to be viewed as sub-standard or cheap technology, imported from other regions (less developed) with different conditions and therefore not applicable to the Latin American reality.

A seemingly logical conclusion of the above arguments would be that the region should develop its own technology for its own reality. It seems difficult, under present conditions, to start this policy from scratch. The fact is that the economic, institutional and research capacity of the region's countries cannot keep pace with the growing needs. However, it is not necessary to start from scratch. The region has already accumulated many years of experience in the application, or tentative application, of imported standards and technologies. There is also a wealth of information on "appropriate technologies" from other regions. The above two sources of empirical data, plus the evaluation of indigenous Latin American technology, can provide a good foundation for the elaboration of a technology concept adequate to the diverse regional economic and socio-cultural conditions. The region should strive to find its own technical standards, accepting that there are lessons to be learnt both from more and from less developed regions as well as from both old techniques and from the latest technical developments.

Sanitary engineering in the region has traditionally been based on North American and, to a lesser extent, on European practices. These practices, that even now seem difficult for those nations to maintain, were developed in a particular historical context. Following this reasoning, an attempt may be made to identify the most important "conditions" currently present in the Latin American reality that could be determinant of the type of technology or standards to be developed. These should be:

/a) The

a) The need to provide, or to attempt to reach, a level of comfort for the user close to the levels provided in Western developed nations;
b) The limited availability of water resources, or the limited (economic/technical) capacity for tapping potential water resources;
c) The limited capacity of the environment to absorb and regenerate wastewaters, and the limited (economic/technical) capacity to provide treatment facilities;
d) The initial inadequacy of administrative, operational and maintenance units to take care of the installed systems. The need to create these units and make them operational (efficiently), and the need to motivate the political will to do so;
e) The absence of adequate national industrial capacity for the competitive production of household and communal components of water supply and sanitation installations;
f) The need to assume realistic design safety factors to cater for unpredictable changes in design assumptions (growth, peak factors, etc.) and for gaps in empirical knowledge of water supply, sanitation and solid-waste disposal techniques;
g) The need to maximize the use of local labour and skills, while however trying to avoid the creation of inefficient systems and operations as a consequence of an irrational policy of labour use;
h) The presence of cultural patterns, especially in urban areas, tending to create a non-collaborative (even antagonistic) attitude towards the official institutions responsible for the implementation of water supply and sanitation services. The absence, in most situations, of strong community organizations, unless of a temporary character aimed at securing ad hoc objectives;
i) The absence, in certain sectors of the population, of adequate knowledge of public health and personal hygiene practices;
j) The limited economic and financial capacity of the unserviced population and government agencies for the provision of infrastructure services;
k) The obligation that each activity related to the provision of water supply and sanitation services should be a direct and immediate contribution to labour employment and economic development in general. Thus, every service provision activity should have a direct multiplying effect on socio-economic development, and
l) The need to mobilize the community (beneficiaries) to actively participate in community development activities (project implementation, operation, maintenance, etc.), so that the local level can take over some of the functions and responsibilities from the central government.

## B. Low-income settlements

Despite the fact that the present work intends to focus on low-income settlements, it is important to note that the provision of services to higher-income sectors of the population in Latin America has similar conditionants to those present in low-income sectors. It is now no longer possible to have radically separate criteria for providing services to different sectors of the population, since the physical, economical and social interrelationships between these groups preclude this approach. However, strategic considerations for achieving an eventual 100% coverage of the population with similar service levels might dictate the initial

/provision of

provision of infrastructure installations at different service levels for different sectors of the population, for later upgrading to the perceived acceptable level. These criteria of "differentiation" and "upgrading" would,of course, also be applicable to the overall contribution that each sector of the population makes to the integral system of water supply, sanitation and solid-waste disposal.

A possible approach to defining what are perceived as "low-income settlements" is to describe their most common or repeated characteristics. Thus, the Interregional Review of Technologies for the Provision of Infrastructure in Low-income Settlements (UNCHS, 1985): describes such a settlement as a place that does not provide healthful living conditions for its inhabitants, that lacks the minimum of amenities and infrastructure to sustain the harmonic development of the community where its inhabitants do not have readily perceived resources to improve this condition by themselves, or whose improvement demands efforts beyond the capacity of local or national agencies.

Settlements of this type occur in both rural and urban contexts. It could be said that rural communities generally have a closer interaction with primary agricultural activities, lower numbers and densities of population, greater isolation from centres of industry, commerce and communications, and a more spontaneous pattern of settlement. Low-income rural and urban communities have special characteristics that differentiate them from higher-income settlements. These features can be conveniently classified into socio-cultural, economic, physical, infrastructure and services, and health and education aspects. As these characteristics have been described elsewhere, this document will only review briefly those related to physical aspects, since the others are implicit in the "conditions" for technology development listed in section I-A.

Most rural settlements in developing countries arise spontaneously out of the need to provide shelter for the people engaged in agriculture. A first category of rural settlement provides shelter to those whose daily activity is the exploitation of the land. Their location is mainly conditioned by physical factors such as proximity to the locations of agricultural activities, protection against natural elements, suitability of land for building and availability of basic natural resources. A second and more elaborate category of rural settlement comprises centres for the provision of services, trade and communications. These focal centres provide a link between the rural community and the nation as a whole. The provision of conventional basic infrastructural services, such as roads, drinking water and energy, to rural communities is very costly due to the scattered pattern of settlement and their isolated location. This fact, coupled with the low economic capacity of the communities and scarce national resources, generally precludes the provision of satisfactory basic infrastructural and community services to these settlements.

Low-income urban communities are mainly represented by slums and squatter settlements. Some slums consist of deteriorated housing in established parts of the city. Originally they were constructed in accordance with legal requirements, but after years of neglect their structure and infrastructural services comply neither with the minimum requirements of national by-laws nor with minimum perceived standards for an adequate living environment. In addition to this type of slum in older parts of the city, some squatter areas and low-cost institutional

/housing schemes

housing schemes have sometimes developed the characteristics of slums. Housing densities in slums are generally high because the settlements are near the limit of their growth. Overcrowded slum dwellings are typically deteriorated structures with several households in one dwelling unit. Infrastructural services are usually inadequate, having been designed for lower demands and different requirements than their present use. Squatter settlements are uncontrolled low-income residential areas located, in most cases, on illegally occupied land. They spring up as the inevitable result of demographic pressure in cities that cannot provide shelter for the growing established and immigrant population. Squatter settlements are often located on the periphery of a city or on land that is considered unsuitable for conventional residential, commercial or industrial development and therefore lacks the minimum infrastructure and community services. Until recently, official agencies generally followed a policy of not servicing squatter settlements, because of their questionable legality and also in order not to encourage the continuous illegal invasion of land.

The above physical characteristics and the socio-cultural conditions in a settlement combine with the specific environmental conditions to determine the most appropriate technology to be applied in a particular situation.

## C. Methodology of the study

### 1. Objective

According to the conceptual considerations given earlier, the main objective of the study is: "to elaborate guidelines and recommendations for the preparation and/or improvement of codes, regulations and standards applied in the design, construction and operation of water supply, sanitation and solid waste disposal systems adequate to the economic and socio-cultural conditions prevalent in Latin America, especially in the lower-income groups". To achieve this objective, it is necessary to carry out a review of the codes, regulations and standards currently applied in the region, evaluating their suitability to present circumstances and identifying areas that need further development and improvement. It is hoped that the formulated conclusions and recommendations will be an initial step towards developing, at the national level, the legislative and normative framework necessary to promote the research, development and application of techniques suitable to the region's conditions. An attempt is also made to provide a methodology or guidelines for the implementation of these changes in a realistic manner.

### 2. Definitions

For the purpose of this study, the following definitions are used in accordance with the International Organization for Standardization:

Regulation: a binding document which contains legislative, regulatory or administrative rules and which is adopted and published by an authority legally vested with the necessary power;

Code of practice: a rule describing recommended practices for the design, manufacturing, setting up, maintenance or utilization of equipment, installations, structures or products;

/Standard:

Standard: a technical specification or other rule based on consensus, approved by a recognized standardization body for repeated or continuous application.

### 3. Sequence of activities

The study was developed according to the following sequence of activities:

a) Selection of those elements of water supply, sanitation, and solid-waste disposal systems that will be included in the study;
b) Development of a system for information gathering. Submission of requests for information to selected national focal points;
c) Analysis of the information obtained and preparation of preliminary conclusions and recommendations;
d) Review of the preliminary conclusions and recommendations by selected national and international agencies and professionals;
e) Elaboration of final recommendations for the development and improvement of the codes, regulations and standards currently applied for the provision of water supply, sanitation and solid-waste disposal services, especially in low-income communities.

### 4. Elements covered by the study

Taking into account the multiplicity of elements covered by codes, regulations and standards in the area of water supply, sanitation and solid-waste disposal, it was decided, for practical purposes, to limit the scope of the same. Thus, emphasis has been given to those aspects which are more critical (through their importance or through their repetition in the selection, design and operation of systems) in water supply, sanitation and solid waste systems. Another critical factor in the study was the necessity to concentrate on those elements for which there is information ready available. This, of course, has led to the realization that in certain countries there is still a need to develop their own codes, regulations and standards for certain elements of water supply, sanitation, and solid-waste disposal systems.

The elements of water supply, sanitation and solid-waste disposal systems to be included in the study fall within the three main groups indicated below. In addition, the data on each element have been classified according to their main area of application, i.e., rural, urban, or both simultaneously when applicable.

Regulations: In this section, rather than trying to carry out a detailed analysis on the contents of existing regulations or legislation in the areas under study, an attempt has been made to determine the extent of present-day coverage by regulations or legislation, identifying possible gaps and areas that need further development;

Codes of practice: Initially, emphasis was given to the study of codes of practice dealing with design aspects. However, within the limits of available information, further analysis is carried out on codes of practice dealing with construction,operation and maintenance activities;

/Standards:

Standards: Here, the aim was to determine the extent and contents of current standards related to construction materials and equipment for water supply, sanitation projects and solid-waste operations.

A detailed list of the elements which should be considered for inclusion in adequate legislation and normalization of the water supply, sanitation, and solid-waste disposal service sector is shown below. However, it should be noted that not all of these elements have been covered by the present work due to limitations in the procurement of information. As indicated before in this respect it is expected that further studies will be carried out to complement the findings of this study. The structure and elements included in the list have been selected according to the way in which these are normally presented in the documentation of normalization or standardization organizations.

4.1 Regulations and legislation - water supply, sanitation and solid-waste disposal

These form the legal framework for the setting up and development of institutions and activities in the area of water supply, sanitation and solid-waste disposal, and regulation of the internal and external relations necessary to carry out the activities of the corresponding service institutions. They would cover, *inter alia*:

i) the setting up and organization of service companies, authorities or agencies;
ii) powers and rights of the service institution in relation to the users and the services to be provided;
iii) powers and rights of the agency in relation to society, other institutions and citizens in general.

4.2 Codes of practice covering design aspects of water supply

i) Water demand:
- specification of water uses: domestic, industrial, recreation, agricultural, others;
- population to be served (present and future);
- design period;
- average water demand;
- demand factors;
- water reuse at household and community level;
- field surveys (physical and socio-cultural).

ii) Water source:
- types of sources specified for tapping;
- source capacity;
- systems for abstraction of water.

iii) Treatment:
- water quality according to uses;
- treatment processes;
- treatment capacity;
- disinfection criteria;
- household treatment.

/iv) Storage:

iv) Storage:
- storage/regulation capacity. Fire fighting. Applied design factors according to use;
- storage units;
- household storage.

v) Distribution:
- hydraulic capacity;
- permissible pressures;
- network design and recommended formulas;
- use of materials. Selection of materials according to site conditions/costs/hydraulic requirements;
- permissible diameters;
- permissible velocities;
- intermitent supplies;
- house connections. Metering/tariff;
- communal water taps/lavatories/laundries (population per unit, walking distance/time, metering/tariff, installation details);
- revision/modification of design criteria to suit low-income groups or according to socio-economic conditions.

4.3 Codes of practice covering construction aspects of water supply

- Pipelaying. Location (also in relation to other services) and depth.

4.4 Codes of practice covering design aspects of sanitation

i) Quantity and quality of effluent:
- classification of effluents: domestic, industrial, others;
- population to be served (present and future);
- design periods;
- unitary effluent discharge;
- permissible velocities in sewers;
- permissible gradients in sewers;
- minimum diameter;
- field surveys: physical and socio-cultural.

ii) Specification of final disposal of treated or untreated effluent.

iii) Classification and specification of treatment systems.

iv) Technology selection and technology options.

v) Communal systems.

vi) Revision and/or modification of design criteria to suit low-income groups.

4.5 Codes of practice covering construction aspects of sanitation

i) pipelaying;
ii) manholes (inspection chambers).

4.6 Standards

i) Water supply:
- pipes (PVC, polyethylene, asbestos-cement, ductile/cast iron, steel, concrete);
- valves;
- water taps;
- inspection chambers;
- household sanitary fittings.

ii) Sanitation:
- pipes (u PVC, asbestos-cement, ductile/cast iron, clay, concrete, others);
- channels;
- household sanitary fittings;
- construction of sanitation units;
- chambers, manholes.

4.7 Solid waste

a) Codes of practice:
- classification of solid wastes;
- household collection/storage requirements and procedures;
- communal collection/storage requirements and procedures;
- disposal criteria;
- treatment specifications.

b) Standards:
- storage containers (household and communal);
- collection vehicles;
- treatment systems;
- disposal systems.

/II. ANALYSIS

## II. ANALYSIS OF THE INFORMATION OBTAINED

It was originally intended to obtain the information on codes, regulations and standards through purpose-made questionnaires only, to be circulated among the countries of the region. It was also decided to address the questionnaires directly to two or more specialists of each country, in order to minimize the number of cases of failure to answer. Despite these precuations, the response was generally low. This has been the main limiting factor of the present study, and on the basis of it a first general recommendation could be made: namely, to further strengthen regional information networks, such as REPIDISCA, which is operated by the Pan-American Centre for Sanitary Engineering and Environmental Sciences (CEPIS). In this way, the existing information on codes, regulations and standards, which we believe is substantial, could be disseminated through the region.

Therefore, the basic data for the study was obtained through:

a) Completed questionnaires, and
b) Copies of actual documentation submitted as a supplement to the questionnaires.

In addition to the above, it was possible to obtain, through secondary sources, other documentation related to the study which was thought to complement the data already available.

### A. The documents reviewed

A list of the documents reviewed in detail as part of the study is given below.*/ It should be noted that many documents in addition to those listed below were also available, especially regarding standards for materials and accessories, but their presentation in this document would have made it unnecessarily long.

#### 1. Questionnaires

Three countries returned completed questionnaires (see annex 1 for questionnaire format):

a) Colombia: National Institute for Municipal Promotion, April 1985 (urban) 1/
b) Uruguay: State Sanitary Works, 5 March 1985 (national) 2/
c) Jamaica: National Water Commission, 21 February 1985 (national).3/

#### 2. Official documentation

Published standards and regulations were obtained from the following countries:

---

*/ The title of each document, in its original language, is given in the list of references.

/a) Brazil

a) Brazil

i) Preparation of preliminary reports for sanitary sewerage systems. P-NB-566. 1975. Brazilian Association of Technical Standards.4/
Scope: Defines elements and activities necessary for the preparation of preliminary reports for urban sewerage systems. They cover separate systems (domestic-industrial-commercial) which do not discharge through submarine outfalls.

ii) Preparation of sewerage projects. P-NB-567. 1975. Brazilian Association of Technical Standards.5/
Scope: Provides the elements and conditions to be observed in the design and preparation of separate urban sewerage projects. They cover separate systems for sewer sizes not exceeding 1 500 mm diameter.

iii) Preparation of projects for interceptor sewers. P-NB-568. 1975. Brazilian Association of Technical Standards.6/
Scope: Provides the elements and conditions to be observed in the design and preparation of projects for separate urban interceptor sewers. Applicable in areas with main sewers over 1 000 mm diameter and interceptor lengths over 5 kilometers.

iv) Preparation of projects for sewage pumping stations and emissors. P-NB-569. 1975. Brazilian Association of Technical Standards.7/
Scope: Provides the elements and conditions to be observed in the design and preparation of projects for separate urban sewage pumping stations and mains, excluding submarine outfalls.

v) Preparation of hydraulic and sanitary projects for wastewater treatment systems. P-NB-570. 1975. Brazilian Association of Technical Standards.8/
Scope: Provides the elements and conditions to be observed in the design and preparation of projects for separate urban wastewater treatment plants. They include only conventional systems: screens and grit removal, primary sedimentation, biological filters, activated sludge, secondary sedimentation, and sludge treatment (digestion, thickening, lagoons and drying beds).

b) Chile

i) Guidelines for the preparation and presentation of water supply and sewerage projects. March 1979. National Service for Sanitary Works.9/
Scope: Provides the requirements and procedures necessary for the preparation and presentation of water supply and sewerage projects for urban (over 3 000 inhabitants) communities. It does not provide design parameters, but does deal with water demands. It includes a methodology for the appraisal of conventional projects.

/ii) Design

ii) Design standards (water). Rural programme. July 1983. National Service for Sanitary Works.10/

Scope: Provides the elements and conditions required for the preparation of rural water supply projects (less than 3 000 inhabitants). Gives basic design parameters and project presentation requirements.

iii) Public health engineering: design of water and drainage systems; presentation of documents. NCh1104. Of78, 11 April 1978. National Institute of Standardization.11/

Scope: Provides the requirements and procedures for project presentation (water supply and sewerage). It refers to conventional projects and is of "national" coverage, without any urban/rural differentiation.

iv) Drinking water - Part 1: requirements. NCh409/1. Of84, 16 January 1984. National Institute of Standardization.12/

Scope: Establishes standards of drinking water quality. Maximum permissible contents of chemical and radioactive elements and physical and bacteriological requisites to be met by such water. National coverage.

v) Drinking water - Part 2: sampling. NCh409/2. Of84, 16 January 1984. National Institute of Standardization.13/

Scope: Establishes procedures and frequency for inspection and sampling of drinking water to determine its physical, chemical, radiological and bacteriological characteristics. National coverage.

vi) Drinking water. Water supply sources and abstraction works: terminology, classification and general requirements. NCh777. Of1971, 3 November 1971. National Institute of Standardization.14/

Scope: Provides a definition and classification of drinking water sources according to their nature and type of abstraction works: surface water (streams, lakes, springs); groundwater (shallow wells, deep wells, driven wells, drains and infiltration galleries); and other types of extraction (rainwater and sea/brackish water). National coverage.

vii) Potable water - conveyance, regulation and distribution. NCh691. Of78, 11 April 1978. National Institute of Standardization.15/

Scope: Provides the basic design criteria for the transport, storage and distribution of drinking water from the source to the house connections. National coverage.

viii) Regulations for household water supply and sewerage installations and manual of technical standards. 16 September 1980. National Service for Sanitary Works (SENDOS).16/

Scope: Establishes general regulations for the design, construction and commissioning of household water supply and sewerage installations at national level. Gives information on minimum diameters, pressures, gradients, etc., to be used on household connections (water, sewerage) and those that have an effect on communal service.

/ix) Design

ix) Design of sewerage systems. 1977. Manual of the Seminar on "Norms for the design of water supply and sewerage works" (17-29 April 1975). Publication 0-9, Faculty of Physics and Mathematics, Sanitary Engineering Section. University of Chile.17/

Scope: (Note: Although this document is not an official publication, it is presently being used as a design reference in the absence of an official document.) Provides the basic design criteria for the design of conventional sewerage systems at national level (does not specify whether urban or rural).

x) In addition to the above regulations, there are other "Preliminary versions" of tentative regulations on water supply and sewerage. All are included in the Manual of the Seminar on "Norms for the design of water supply and sewerage works" (17-29 April 1975). Publication 0-9. Faculty of Physics and Mathematics. Sanitary Engineering Section, University of Chile.

They include, among others, design criteria for conventional drinking water and wastewater treatment plants.17A/

c) Colombia

i) National Sanitary Code: Law No. 09 of 1979, 24 January 1979. Ministry of Health.18/

Scope: Provides the legislative base for preserving and improving public health conditions and procedures for legislating and regulating environmental protection (sanitary control of water uses, liquid effluents, solid waste, excreta disposal, etc.), water supply, occupational health, sanitation in buildings, food, drugs and medicaments, epidemiological monitoring and control, disasters, cemeteries, domestic appliances. Establishes monitoring and control structures to enforce those regulations, and the rights and duties concerning public health.

ii) Regulations for water use and the discharge of liquid effluents. Decree No. 1594. 26 June 1984. Ministry of Health.19/

Scope: Provides the regulations to comply with Title I of Law No. 09 of 1979. Establishes comprehensive regulations to legislate the use of water sources and the discharge of liquid effluents. Establishes the sanitary measures, penalties and enforcement procedures to ensure compliance with the given regulations.

iii) Regulations on solid waste. Decree No. 2104. 26 July 1983. Ministry of Health.20/

Scope: Provides regulations to ensure compliance with existing legislation on solid wastes. The decree covers the following aspects: storage, collection, transport, sanitary disposal, treatment and other aspects related to solid waste. It also establishes the sanitary measures, penalties and enforcement procedures to ensure compliance with the given regulations.

/iv) Regulation

iv) Regulation on the purification of water for human consumption. Decree No. 2105. 26 July 1983. Ministry of Health.21/
Scope: Provides regulations regarding water purification for human consumption. Gives drinking water quality standards (physical, chemical and bacteriological) and a classification of water supply systems according to population size. Indicates the requirements for design, operation and maintenance of systems according to the above classification. Establishes sanitary measures, penalties and procedures to ensure compliance with those regulations.

v) Septic tanks. DISA Manual No. 4. Environmental Sanitation Division, Ministry of Health.22/

vi) Regulations for the administration of rural water supply and sanitation systems. Agreement No. 014. 11 May 1983. National Health Institute. Ministry of Health.23/
Scope: Regulates the organization and administration of rural water supply and sanitation systems for communities with less than 2 500 inhabitants. Indicates the compositition and functions of the administration committees according to their type: rural location, regional systems, associated systems, municipal heads and special committees.

vii) Norms for the design and preparation of rural water supply projects. By-Law No. 001356. 21 September 1971. Ministry of Health.24/
Scope: Lays down the minimum requirements for the execution of preliminary studies, design and preparation of rural water supply projects. Gives design criteria for intake works, transport, storage, distribution and treatment of water.

viii) Norms for the design of rural sewerage projects. By-Law No. 0023-10. February 1970. Ministry of Health.25/
Scope: Lays down the minimum requirements for the execution of preliminary studies, design and preparation of conventional rural sewerage projects (separate systems). Gives design criteria for flow calculations, sewers, manholes and pumping stations.

ix) Procedures for the preparation of sewerage projects for urban development. No date. Bogotá Water Supply and Sewerage Company.26/
Scope: Lays down procedures for project preparation and gives the minimum design standards for conventional sewerage systems for the city of Bogotá.

x) Regulations for the registration, classification and qualification of contractors (water supply and sewerage works). August 1983. Resolution No. 000431. National Institute for Municipal Promotion.27/
Scope: For urban areas with a population of over 2 500 inhabitants.

/xi) Regulation

xi) Regulations for the registration, classification and qualification of consultants (water supply and sewerage works).28/
Scope: For urban areas with a population of over 2 500 inhabitants.

xii) Reorganization of the National Institute for Municipal Promotion. Decree No. 2804. 19 December 1975. Ministry of Health.29/
Scope: Establishes the organizational structure and responsibilities of the NIMP for urban areas.

d) Ecuador

i) Norms for the provision of services and infrastructure in rural settlements (Preliminary version, 1981.) National Development Council.30/
Scope: Lays down standards for the provision of services to rural communities: education, health, administration and support to productive activities, recreational areas and roads, water supply and sewerage. Gives design criteria for water supply and sewerage projects according to the community's size (less than 200, 200 to 1 000 and 1 000 to 2 000).

ii) Tentative norms for the design of water supply and sewerage systems in urban and rural areas (Draft 1982). Ecuadorian Institute of Sanitary Works.31/
Scope: Provides comprehensive procedures and criteria for the execution of preliminary, feasibility and design studies for conventional water supply and sewerage projects at national level. Provides criteria for project presentation and design of conventional components of systems for water supply (abstraction, transport, treatment, storage, metering and distribution) and sewerage (sewers, drainage, conventional treatment and pumping stations).

e) Peru

i) Norms and requirements for water supply and sewerage projects for urban communities. 1972. Title II. National Construction Codes.32/
Scope: Provides criteria for project preparation and for the design of conventional urban water supply and sewerage projects. Gives design standards for water supply (abstraction, transport, storage, and distribution of drinking water) and sewerage (flows, sewers, manholes and effluent disposal).

### 3. Other sources of information

a) Honduras

i) Measures to reduce costs in low-cost infrastructure and housing projects. Field Report No. 46. June 1982. WASH (USAID).33/
Scope: Proposes design and construction criteria to be applied in the provision of water supply and sewerage facilities in low-income settlements.

/B. Presentation

## B. Presentation of information by subject

In this section the information obtained on each of the subjects indicated in section I-C-4 will be presented according to its country of origin. As indicated before, it was not possible to obtain data on all the subjects mentioned. Moreover, the information obtained from some countries is limited to only some of the aspects under study. Each of the documents reviewed has been given a reference number, shown in section II-A, that will be quoted as appropriate.

### 1. Regulations and legislation

#### 1.1 General

The three countries which answered the questionnaires indicated the existence of regulations providing the legal framework for the operation of the agencies working in the water supply and sanitation sector. Colombia also has provisions for the solid-waste disposal sector.

a) Jamaica: the National Water Commission Act, 23 July 1981 regulates the operation of the National Water Commission, including such aspects as rates and charges. Its coverage is national (i.e., urban and rural) for both domestic and industrial users.

b) Uruguay: the Organic Charter of the State Sanitary Works, 1951 (with later amendments) regulates the functions of this agency. Its coverage is national for both domestic and industrial users.

c) Colombia: the information on regulations is very comprehensive and includes actual documentation. The information provided in the following sections is based on these sources.

#### 1.2 The setting up and organization of service companies, authorities and agencies (Colombia)

- The National Sanitary Code (Ref. 18) establishes the overall responsibility of the Ministry of Health for the implementation and regulation of activities in the area of environmental protection, which includes water supply, sanitation and solid waste disposal.
- The National Sanitary Code authorizes specialized agencies of the National Health System to apply and enforce legislation in the sector.
- Decree No. 2804 (Ref. 29) establishes the legal base for assigning to the National Institute for Municipal Promotion (INSFOPAL) the responsibility for implementing government policies in the water supply, sanitation and public cleaning sector for urban areas (over 2 500 inhabitants). It mentions that the body responsible for rural areas is the National Health Institute (NHI).
- The regulations indicate that the main functions of INSFOPAL are to:
  - prepare and propose plans for improving services;
  - finance the organizations responsible for execution;
  - promote the creation of regional and municipal Executing Organizations;
  - control the correct implementation by the Executing Organizations of regulations on design, contracting, supervision, construction and operation of services;

/- make

- make recommendations on tariff structures to the responsible organizations and;
- assume the administration of Executing Organizations when considered appropriate.

- Decree No. 2804 (Ref. 29) also establishes rules on the capital formation of INSFOPAL and its financial and administrative procedures.
- INSFOPAL is given the power to promote and create regional and municipal Executing Organizations. Each of these Organizations is administered as a decentralized agency under a governing council and is regulated by the Code of Commerce.
- The organization and administration of rural water supply and sanitation systems is regulated by the National Health Institute of the Ministry of Health (Ref. 23). The administration of services is entrusted by law to Administration Committees, whose functions and membership are specified.

## 1.3 Powers and rights of the service institutions in relation to users and services to be provided (Colombia)

The National Sanitary Code (Ref. 18) gives to the Ministry of Health the power to establish standards for water use and effluent discharge. Subsequent decrees to regulate this legislation transfer these faculties to:

a) Water administration agencies, which are responsible for planning, execution, operation, maintenance, administration and control of water supply systems (Ref. 21).
b) Public cleaning agencies, responsible for providing solid-waste collection and disposal services in the municipalities (Ref. 20).
c) Resource management and administration agencies, responsible for the administration of water resources for consumption and effluent discharge (Ref. 19).

As already stated, for water supply and sewerage these agencies will be the National Health Institute (rural) and the National Institute for Municipal Promotion (urban), acting through regional, municipal and local administrative agencies. Current legislation specifies, inter alia, the following duties and powers for these agencies:

a) to prepare plans and manuals for the operation and maintenance of water supply systems, covering extraction, transport, treatment, storage and distribution;
b) to organize and establish public cleaning systems (solid waste);
c) to set up a register of users and installations for the provision of services;
d) to monitor and control the implementation of legislation in the sector;
e) to apply sanitary measures and sanctions to those not complying with existing regulations.

/1.4 Powers

1.4 Powers and rights of the agency in relation to society, other institutions and citizens in general (Colombia)

Here, mention will be made of some aspects that are relevant to the operation of service agencies and that have an effect on the type and level of service provided to the users.

a) Contract procedures

Colombia (INSFOPAL) has detailed regulations for the registration, classification and qualification of contractors for consultancy and construction works (Ref. 27). They include:

- definition of agencies or individuals that can apply for registration;
- documents and procedures required for registration;
- procedures to appraise requests for registration;
- criteria for suspension and termination of registration;
- classification of consultants and contractors;
- guidelines to qualify consultants and contractors according to given classification.

b) Financial mechanisms and tariff structure

Normally, the same legislation creating the agencies responsible for water supply, sanitation and solid-waste services establishes the financial basis for their operation. For example, the assets of INSFOPAL are composed by law (Ref. 29) of:

- fixed assets, properties and rent thereof;
- amounts assigned by the central government, departments, municipalities etc.;
- profits on their operations;
- other income from the provision of services.

As regards water tariffs, current legislation does not give an indication as to the possible types of tariff structures, except in respect of the calculation of rates for effluent discharge, but it does indicate that users will be charged for the services in all cases (Refs. 1, 23 and 24).

c) Administration and protection of natural resources and the environment

The Ministry of Health has issued detailed legislation on the use and preservation of water resources through its "Regulations for the use of water and discharge of liquid effluents" (Ref. 19). They cover the following aspects:

i) conditions for the allocation and use of water sources;
ii) classification and description of water uses (human/domestic consumption, preservation of flora and fauna, agriculture, cattle breeding, recreation, industry and transport), and sources (surface, ground, sea, estuaries, effluents);

/iii) permissible

iii) permissible water quality standards according to the intended water use;
iv) criteria for calculating charges for effluent discharge;
v) right of the administering agency to request environmental effect and impact studies in respect of any discharge with possible noxious effects on the environment. Cases where this situation may arise are listed and aspects to be covered by the studies are indicated;
vi) conditions for obtaining and monitoring water rights and discharge permits;
vii) minimum effluent quality standards according to the type of discharge and to the characteristics of the disposal site or receiving body;
viii) sampling and analysis methods for monitoring discharges and water quality;
ix) the responsibility of the administering agencies for the monitoring and control of this legislation, and their capacity to apply the corresponding sanitary measures and sanctions.

Similar legislation has been adopted by the Ministry of Health to regulate solid-waste disposal (Ref. 20), covering such aspects as:

i) classification of solid waste (normal/domestic and special);
ii) normal solid-waste disposal processes (storage, household handling, collection, transport, transfer, treatment, sanitary disposal and street cleaning);
iii) special solid-wastes handling, covering pathogenic, toxic, combustible, inflammable, explosive, radioactive, volatile and other wastes;
iv) resource recovery;
v) criteria to initiate and carry out environmental impact studies;
vi) responsibility of the administering agencies for the monitoring and control of this legislation, and their capacity to apply the corresponding sanitary measures and sanctions.

d) <u>Special mechanisms for promoting community participation</u>

No specific legislation to promote the participation of the community in all the stages of project implementation was found. The only reference to community participation in urban areas concerned the participation of a community representative in the management committees of the Municipal Executing Organizations (Ref. 29). However, this representative is nominated or removed by the Director of the National Institute for Municipal Promotion.

In rural areas, the community has strong representation in the management committees (Ref. 23), all the members of which, with exception of a representative of the National Health Institute, are elected by a general assembly of all the users. However, the functions of the management committees are focused on the operation and administration of constructed services, and no information is available on their participation in the initial stages of project identification, planning, design and construction.

/e) Project

e) Project preparation

The inclusion of "project preparation" in the section dealing with legislation is arbitrary, since it might perhaps more fittingly have been included under "codes" or "standards". However, since it relates to the relation of the agencies with other institutions and is wide in coverage, it was decided to keep it here.

Most of the documentation reviewed included extensive and very detailed list of activities and information required for project preparation. The information of national coverage obtained does not specify different requirements for project preparation and presentation considering the type of serviced community, urban or rural, or whether it is a low-income group or not.

Since the reproduction of this information for all the countries studied is not necessary, only the case of Chile is presented here. Although the Chilean "Guidelines for the preparation and presentation of water supply and sewerage projects" (March 1977, National Service for Sanitary Works - SENDOS) (Ref. 9) are for urban communities, they represent the general tendency followed by Latin American agencies as regards project preparation in urban and rural areas.

i) Scope: the guidelines indicate the requirements and procedures for the preparation and presentation of projects for communities of over 3 000 inhabitants (urban communities).

ii) General aspects: these give indications on the coverage of the project and its flexibility as regards the introduction of changes when required (subject to appropriate justification).

iii) Development of a project

- Preliminary report. This forms an integral part, with the feasibility study, and should cover the following aspects:

  Information and characteristics of the project area
  - location
  - climate
  - hydrology
  - transport and communications facilities
  - rainfall
  - population
  - political-administrative organization
  - main economic activities in the area
  - income levels
  - other macro-economic indicators

  Diagnosis of existing services
  - present level of service
  - technical description of existing services
  - economic and financial performance of existing services
  - operation and administration of existing services

/Future water

Future water demand and sewage production
- urban development plans
- population to be served
- water demands

Information for technical-economic analysis and identification of alternatives
- land surveys
- water quality analysis
- hydrogeology
- energy supply
- soil mechanics

- Feasibility study: this is complementary to the preliminary report and focuses on:
  - identification of alternatives
  - selection of alternatives with emphasis on: construction programme, investment programme, operating and maintenance costs and cost recovery
  - economic and social appriasal of selected alternatives
- Preliminary design report: this develops the alternative approved by the administering agency and includes:
  - description of required materials, labour and equipment and works to be executed
  - budget
  - work programme, by construction phases
  - other information, calculations and drawings
- Design report: this consists of the development to construction details of all the elements of the preliminary design report, including drawings, calculations, technical specifications, bill of quantities and work programme
- Handing over of project description: this is carried out by the consultant in conjunction with the administering agency
- Supervision of works

iv) Presentation of projects

Formats and requirements for project presentation are provided.

## 2. Codes of practice covering design aspects of water supply

All the countries reviewed have their own codes of practice or design manuals providing the general criteria for the design of water supply systems. In addition, some of them also refer to textbooks on the subject, for direct consultation. Furthermore, these textbooks, mainly from developed countries, are sometimes also listed among the references used in the preparation of national codes and manuals.

### 2.1 Water demand

2.1.1 Specification of water uses. Here, the uses of water to be distributed through the public network are indicated.

/a) Jamaica:

a) Jamaica: urban and rural: domestic and industrial (Ref. 3)
b) Uruguay: urban and rural: domestic and industrial (Ref. 2)
c) Chile: urban: domestic, commercial and industrial (Ref. 9)
rural: domestic (others not indicated) (Ref. 10)
d) Colombia: urban: domestic (others not indicated) (Ref. 1)
rural: domestic (Ref. 24)
e) Ecuador: urban and rural: domestic, industrial, commercial, public (Ref. 31)
f) Peru: urban: domestic (others not indicated) (Ref. 32)
g) Honduras: urban: domestic (Ref. 33)

2.1.2 Population to be served. This item gives the criteria for estimating the present population to be served and future growth.

a) Chile
- Urban: The use of official government statistics and projections going up to the year 2005, for present and future population estimates is specified (Ref. 9);
- Rural: When there are no statistics the population is determined by multiplying the number of serviced households by 6. To this figure will be added 15% of the student population or 85% of the student population in the case of boarding schools (Ref. 10).

b) Colombia
- Rural: The present population is determined by a survey of households and population in the project area. Floating population is taken into account. For future populations, the use of geometric growth projections is recommended (Ref. 24).

c) Ecuador
- Urban and rural: The present population is determined on the basis of actual demographic data and surveys. Floating population is taken into account. Future population projections must take into consideration demographic, geopolitical, economic and social factors. It is specified that projections should be calculated using at least three growth patterns and/or methods chosen among the following: arithmetic, geometric, differential increases, logistic, graphic comparative, decreasing percentages, and according to zones of equal densities (Ref. 31).

d) Peru
- Urban: The present population is determined on the basis of actual demographic data and surveys. Future population projections must take into consideration demographic and socio-economic factors and be in agreement with existing development plans (Ref. 32).

2.1.3 Design periods

a) Chile
- Rural: 20 years, but 10 years for pumping equipment (Ref. 10)

/b) Colombia

b) Colombia

- Rural: 30 years for treatment works (in two phases); 20 years for intake works, wells, grit removal, storage, transport and water mains; 5 years for pumping equipment (Ref. 24)

c) Ecuador

- Urban and rural: 20-30 years for new services, 15-20 years for extensions and three to five years for emergency works. In general, periods under 15 years are not allowed and plans must be implemented in not more than two phases. (Ref. 31)

d) Peru

- Urban: 15 years for populations between 2 000 and 20 000 inhabitants, 10 years for populations with more than 20 000 inhabitants. (Ref. 32)

2.1.4 Average water demand

a) Jamaica

- Urban: 182-455 litres per person per day (lppd) (Ref. 3)
- Rural: 136-227 lppd (Ref. 3)

b) Uruguay

- Urban: 250 lppd (Ref. 2)
- Rural: 150 lppd (Ref. 2)

c) Chile

- Urban (Ref. 9): Community standpipes: 50 lppd.
  Demands involving house connections are determined according to population size, including domestic, commercial and industrial if this latter is less than 10% of the total demand, otherwise it must be calculated separately. The following table gives the recommended demands, in which water losses are included. Demands are in lppd.

| Population x 1 000 | 1.2-10 | 10-50 | 50-150 | 150-400 |
|---|---|---|---|---|
| Demand 1977 | 80-140 | 140-170 | 170-190 | 190-220 |
| Demand 1995 | 80-145 | 145-175 | 175-200 | 200-225 |
| Production 1977 | 135-230 | 230-285 | 285-315 | 315-365 |
| Production 1995 | 100-180 | 180-220 | 220-250 | 250-280 |

d) Colombia

- Urban: initial 185 lppd; final 215 lppd (Ref. 1)
- Urban Bogotá: 200 lppd (Ref. 26)
- Rural: 80-150 lppd (Ref. 24)

e) Ecuador

- National (Ref. 31): This fixes "basic demands" according to climate: cold: 30 lppd, temperate: 40 lppd and hot: 50 lppd. The "basic demands" have to be multiplied by a given factor, which ranges between 1.0 and 4.7, to obtain the "average daily demand" in the future. The factors are chosen considering the composition of the demand (domestic, industrial, commercial and public) and population size. The obtained demands must be multiplied by a factor of 1.15 to allow for water losses.

/f) Peru

f) Peru

- Urban (Ref. 32): classifies demand according to climate and population size (demand in lppd):

| Population | Cold | Temperate/Hot |
|---|---|---|
| 2 000 to 10 000 | 120 | 150 |
| 10 000 to 50 000 | 150 | 200 |
| Over 50 000 | 200 | 250 |

g) Honduras

- Urban (Ref. 33): 150 lppd plus 10% to allow for water losses.

2.1.5 Demand factors. These specify the daily variations in water demand. All the factors given below are expressed as multipliers of the average daily demand.

| | | |
|---|---|---|
| **a) Jamaica** | | |
| Maximum daily demand (urban and rural): | 1.2 to 1.5 | (Ref. 3) |
| Maximum hourly demand (urban and rural): | 2 | (Ref. 3) |
| **b) Uruguay** | | |
| Maximum daily demand (urban and rural): | 1.5 | (Ref. 2) |
| Maximum hourly demand (urban and rural): | 2.25 | (Ref. 2) |
| **c) Brazil** | | |
| Maximum daily demand (urban): | 1.2 | (Ref. 5) |
| Maximum hourly demand (urban): | 1.8 | (Ref. 5) |
| **d) Chile** | | |
| Maximum daily demand (rural): | 1.2 - 1.5 | (Ref. 10) |
| Maximum hourly demand (rural): | 1.8 - 2.25 | (Ref. 10) |
| **e) Colombia** | | |
| Maximum daily demand (urban and rural): | 1.2 | (Ref. 1 and 24) |
| Maximum hourly demand (urban and rural): | 1.8 | (Ref. 1 and 24) |
| **f) Ecuador** | | |
| Maximum daily demand (urban and rural): | 1.3 - 1.5 | (Ref. 31) |
| Maximum hourly demand (urban and rural): | 2.0 - 2.3 | (Ref. 31) |
| **g) Peru** | | |
| Maximum daily demand (urban): | 1.2 - 1.5 | (Ref. 32) |
| Maximum hourly demand (urban) | | |
| Population: 2 000 to 10 000: | 2.5 | (Ref. 32) |
| Population over 10 000: | 1.8 | (Ref. 32) |
| **h) Honduras** | | |
| Maximum daily demand (urban): | 1.2 | (Ref. 33) |
| Maximum hourly demand (urban): | 1.8 | (Ref. 33) |

2.1.6 Water re-use at household and community level

It was not possible to find codes of practice or other design references regarding the re-use of water at household or community level for uses such as gardening, irrigation, flushing sanitary fittings, etc.

2.1.7 Field surveys: physical and socio-cultural

Most of the codes of practice reviewed specify extensive physical field surveys and studies, such as those indicated in section "II-B-1.4-e" for the case of Chile (urban areas). The socio-cultural studies are normally limited, in most cases, to obtaining a few items of information with the aim of finding out the payment capacity of the population and its existing sanitary conditions. As an example, the contents of the "Preliminary socio-economic surveys" to be executed as part of the preliminary studies for rural water supply projects in Chile (Ref. 10) are given below:

/- income

- income levels of community members;
- sources of income and employment;
- existing community organizations;
- demography;
- felt needs of the populations;
- existing sanitary conditions (water supply and sewerage).

No information was found regarding more in-depth socio-cultural surveys to identify technology preferences, patterns of service use and motivation to participate in self-help programmes.

## 2.2 Water source

2.2.1 Type of sources specified for tapping

a) Jamaica (urban and rural): ground and surface water (Ref. 3)
b) Uruguay (urban and rural): ground and surface water (Ref. 2)
c) Chile (national): atmospheric, surface, ground, sea and brackish waters (Ref. 14)
d) Colombia (rural): ground and surface water and springs (Ref. 24)
e) Ecuador (urban and rural): ground and surface water (Ref. 31)
f) Peru (urban): ground and surface water (Ref. 32)

2.2.2 Source capacity

a) Chile (national) (Ref. 14)
- Streams: maximum daily demand (if there is storage)
  maximum hourly demand (if there is no storage)
- Lakes: average daily demand
- Springs, wells and others: according to specific conditions

b) Colombia (rural) (Ref. 24)
- Two to three times capacity of raw water main, where the capacity of the raw water main is:
  maximum daily demand (if there is storage)
  maximum hourly demand (if there is no storage)

c) Ecuador (urban and rural) (Ref. 31)
- Surface water: maximum daily demand plus 10%
- Groundwater: maximum daily demand

d) Peru (urban) (Ref. 32)
- Maximum daily demand in all cases

2.2.3 Systems for water abstraction, with indication of the type of permissible abstraction works and design criteria. Detailed design criteria for abstraction works normally include elements as indicated for Ecuador (Ref. 31):

- hydrological data to estimate yield of the source
- topography and geology to determine location
- soil characteristics, hydrogeology
- elements for protection of water quality
- elements to control flows
- elements to prevent erosion or sedimentation

/a) Chile

a) Chile (national) (Ref. 14)
- surface water abstraction (streams, springs and lakes): lateral intake works, intakes in lakes, ponds and dams, floating intake and mobile intake
- groundwater abstraction: shallow wells, deep wells, driven wells, drains and infiltration galleries
- atmospheric water: roof-yard catchment and storage
- sea water: does not specify

b) Colombia (rural) (Ref. 24)
- surface water: submerged and lateral intake works, springs
- groundwater: infiltration galleries, wells (shallow and deep)

c) Ecuador (urban and rural) (Ref. 31)
- surface water: submerged, lateral and caucasian intake works, intake in lakes, ponds and dams
- groundwater: shallow wells, driven wells, deep wells, infiltration galleries
- springs

d) Peru (urban) (Ref. 32)
- surface water: does not specify types of abstraction works
- groundwater: deep wells, shallow wells, infiltration galleries springs

## 2.3 Treatment

### 2.3.1 Water quality according to uses

All the countries for which documentation was available had standards for drinking water quality, and procedures for water sampling and quality monitoring. They also specify the minimum quality standards that must be satisfied by rain water (water at the source) in order for it to be suitable for further use as drinking water. In most of the cases, the quality parameters are classified as physical, chemical and bacteriological. Some countries (Chile, Colombia) also indicate the maximum permissible concentrations of radioactive elements. Most of these quality standards are based on, or are similar to, the "WHO International Standards for Drinking Water-1970". This study will not touch further on aspects related to adequate water quality standards, since they are already covered in a recent publication of the World Health Organization, "Guidelines for Drinking Water Quality: Vols. 1, 2 and 3, 1983".

### 2.3.2 Treatment processes

Where treatment processes are mentioned or listed and design criteria given, they refer mainly to conventional treatment units and conventional design parameters. Since the range of variations in treatment units and design parameters is so wide, this section will be limited to the treatment processes considered in the practice of each country.

a) Jamaica (urban and rural)
- surface water: physical and chemical treatment and disinfection as required
- groundwater: normally disinfection only (Ref. 3)

/b) Uruguay

b) Uruguay (urban and rural)
- surface water: physical and chemical treatment and disinfection as required
- groundwater: mainly disinfection only (Ref. 2)

c) Chile There are no official codes on water treatment processes, but there is a "preliminary version" on design criteria for conventional water treatment, published as part of the "Manual of the seminar on norms for the design of water supply and sewerage works" (Ref. 17-A)

d) Colombia
Urban: (surface and groundwater), physical and chemical treatment and disinfection as required (Ref. 1)
Rural: (surface and groundwater) the following processes as required: coarse sedimentation, aeration, sedimentation, slow sand filtration, disinfection (with chlorine) (Ref. 24)

e) Ecuador (urban and rural) for surface and groundwater as required: aeration, coarse sedimentation, chemical mixing, flocculation, chemical dosing, simple sedimentation, high rate sedimentation, filtration (slow gravity sand filters, rapid gravity filters: constant and declining rate, dynamic filters, pressure filters), disinfection (with chlorine) (Ref. 31)

f) Peru (urban) for surface and groundwater, disinfection is specified in all cases. It is indicated that water must be treated to meet drinking water standards, but the processes to be utilized are not specified (Ref. 32).

2.3.3 Treatment capacity
a) Colombia (rural) maximum daily flow (Ref. 24)
b) Ecuador (urban and rural) maximum daily flow (Ref. 31)

2.3.4 Disinfection criteria
a) Colombia (rural): to ensure complete disinfection and free residual chlorine concentrations of 0.2 ppm at the furthest point of the distribution network (Ref. 24)
b) Ecuador (urban and rural) to ensure complete disinfection and free residual chlorine concentrations of 0.1 ppm at the furthest point of the distribution network (Ref. 31)

2.3.5 Household treatment
It was not possible to find references to any type of household water treatment. In all the documents reviewed it is assumed that all the water supplied will comply with the established drinking water quality standards.

## 2.4 Storage

2.4.1 Storage capacity: design criteria are given for determining the storage volume: demand, regulation, firefighting, emergencies, etc.

/a) Jamaica

a) Jamaica (urban and rural): 50% of the average daily demand if economic conditions allow it. Firefighting volume is not considered (Ref. 3)

b) Uruguay (urban and rural): maximum: 33% of the average daily demand; minimum: 20% of the average daily demand. Supply-demand curves are considered. Firefighting volume is not considered (Ref. 2)

c) Chile
- Urban (Ref. 15): storage volume = regulation volume plus firefighting plus reserve, where:
  - regulation volume is based on supply-demand curves
  - firefighting volume is based on estimated fire duration and demand per hydrant
  - reserve volume is to be estimated for each particular case
  - the total volume must never be less than 15% of maximum daily demand
- Rural: 15 to 20% of maximum daily demand (future = 20 years) (Ref. 10)

d) Colombia
- Urban: 12 to 25% (normally 16%) of average daily demand (Ref. 1)
- Rural: (Ref. 24)
  - No storage is considered if a supply three times the maximum daily demand is ensured at any time
  - Normally 20 to 30% of the average daily demand is allowed, plus 10% reserve capacity when justified

e) Ecuador (urban and rural) (Ref. 31). The total storage volume must be equal to the regulation volume plus firefighting demand plus a reserve for emergencies. The actual volumes are calculated as indicated below:
- Regulation: population less than 1 000: 35% of average daily demand
  population 1 000 to 5 000: 35% of average daily demand
  population over 5 000: 40% of average daily demand
- Firefighting: population less than 3 000 (hot/temperate climate) or less than 5 000 (cold climate): no capacity allowed for
  population less than 20 000: use formula $Vi = 50\sqrt{P}\ m^3$
  population more than 20 000: use formula $Vi = 100\sqrt{P}\ m^3$
- Emergency: for populations over 5 000 the emergency volume must be 25% of the regulation volume, or based on estimates of an actual emergency

/f) Peru

f) Peru (urban) (Ref. 32). Regulation volume to be based on supply-demand curves. When data are not available, 25% of the average daily demand shall be taken. Firefighting capacity shall consider two hours' operation of an assumed number of hydrants. Reserve volume shall be considered only when properly justified

g) Honduras (urban) (Ref. 33). 20% of the average daily demand plus 9 350 lit/min x 2 hours

2.4.2 Storage units. Criteria are given for the location and individual design of the storage units

a) Chile (national). The use of standard designs already approved by the Administering Agency is specified (Ref. 10)

b) Colombia (rural). Criteria are provided for the location, structural design, pipework, and flow measurement and control systems for ground and elevated water storage units (Ref. 24)

c) Ecuador (urban and rural). Criteria are provided for the location and design of water storage units, both ground and elevated. Elevated tanks shall not exceed 100 $m^3$ capacity (Ref. 31)

d) Peru (urban). Specifies the use of flow measurement and control systems. Indicates that location of storage units shall be based on technical/economic studies (Ref. 32)

2.4.3 Household storage. Apart from Chile (Ref. 16), where it is specified that buildings shall have a water storage capacity of 70% of the average daily demand, it was not possible to find other references to non-public water storage. However, it is known that most national plumbing codes specify water storage for buildings of 30% and upwards of the average daily demand, although this specification does not normally apply to one-family lots. It was not possible either to find information relating the public storage capacity to the non-public (houses or buildings) storage volumes.

## 2.5 Distribution

Note: Raw water mains (water transport) have not been taken as separated units, since the basic hydraulic calculation factors applied to distribution mains are also used in their case. The only changing element is the design flow, which, for raw water mains (before demand regulation units), is normally the equivalent to the maximum daily flow (Refs. 15, 24, 31). Consideration is also given to water hammer allowances and location of fittings (air valves, washouts, thrust blocks, etc.).

2.5.1 Hydraulic capacity

a) Chile

- Urban (national) (Ref. 15). Maximum hourly demand or firefighting demand, whichever is greater, and verified with the maximum daily flow plus firefighting. The firefighting demand is calculated according to the following table:

/Population

| Population x 1 000 | Hydrants | | No. of simultaneous hydrants | |
|---|---|---|---|---|
| | capacity (l/s.) | dia. | centre | periphery |
| 0-4 | 16 | 100 | 1 | 0 |
| 4-10 | 16 | 100 | 1 | 0 |
| 10-25 | 16 | 100 | 2 | 0 |
| 25-60 | 16 | 100 | 2 | 1 |
| 60-150 | 32 | 125 | 1 | 1 |
| 150-500 | 32 | 125 | 2 | 1 |

- Rural (Ref. 10). Maximum hourly demand (20 years future).

b) Colombia. Rural (Ref. 24). Maximum hourly demand. No allowances are made for firefighting.

c) Ecuador. Urban and rural (Ref. 31). Maximum daily flow plus firefighting demand, verified with the maximum hourly flow. For populations less than 3 000 (hot/temperate climate) or less than 5 000 (cold climate), firefighting demand is not considered. For populations greater than the above, the following values are used:

| Future population | Hydrants used | Design hypothesis | |
|---|---|---|---|
| | | centre | periphery |
| 3 000 - 20 000 | 1 (12 lts) | | |
| 20 000 - 40 000 | 1 (24 lts) | 1 | - |
| 40 000 - 60 000 | 2 (24 lts) | 1 | 1 |
| 60 000 -120 000 | 3 (24 lts) | 2 | 1 |
| Greater than 120 000 | 4 (24 lts) | 2 | 2 |

d) Peru. Urban (Ref. 32)
Areas without firefighting system: maximum hourly flow.
Areas with firefighting system: the maximum hourly flow, or firefighting demand plus the maximum daily flow, whichever is the greater.

e) Honduras. Urban (Ref. 33). Maximum hourly flow verified with the maximum daily flow plus 374 l/min. (firefighting).

/2.5.2 Permissible

2.5.2 Permissible pressures

a) Uruguay (Ref. 3)
Minimum pressure: 1.5 bar for urban areas
1.0 bar for rural areas

b) Chile
National (urban) (Ref. 15): minimum pressures: cities with 2 story buildings: 1.2 bar
cities with taller buildings: 1.5 bar
maximum pressure: 7.0 bar
Rural (Ref. 10): minimum pressure: 0.8 bar
maximum pressure: 4.0 bar

c) Colombia
Urban (Ref. 1): areas with domestic demand: 1.0 bar
areas with industrial demand: 1.5 bar
Rural (Ref. 24): minimum pressure: 0.6 bar
maximum pressure: 6.0 bar

d) Ecuador. Urban and rural (Ref. 31)
Minimum pressure: 1.0 bar for maximum daily demand plus firefighting

e) Peru. Urban (Ref. 32)
Minimum pressure: 1.5 bar, 1.0 bar acceptable for small communities with adequate justification
Maximum pressure: 5.0 bar.

2.5.3 Network design and recommended formulas

a) Chile. National (Ref. 15)
Specifies design in circuits less than 2 000 m long and capable of being isolated.
Does not recommend a method for hydraulic calculations.

b) Colombia
Rural (Ref. 24). Specifies design of circuits (branch mains allowed if they end in discharge points).
Use of the Hardy-Cross method for network design is recommended.

c) Ecuador. Urban and rural (Ref. 31)
Specifies design of circuits. Branch mains are allowed in special cases or in communities with less than 1 000 inhabitants. The circuits must be between 500 and 2 000 m long.
Does not recommend a method for hydraulic calculations.

d) Peru. Urban (Ref. 32)
Specifies design circuits between 400 and 600 m long and capable of being isolated.
Recommends the use of the Hardy-Cross method and Hazen-Williams formulae for hydraulic network calculations.

2.5.4 Use of materials

a) Jamaica (Ref. 3)
The use of the following pipe materials is specified, according to field conditions and expected range of work pressures: u.P.V.C., asbestos-cement, ductile and cast iron, steel and galvanized steel. Of these pipes, u.P.V.C., asbestos-cement and galvanized steel are locally manufactured.

/b) Uruguay

b) Uruguay (Ref. 2)
The use of the following materials is specified: u.P.V.C., asbestos-cement, ductile and cast iron. Steel pipes are used only for special situations. Of these pipes, u.P.V.C., asbestos-cement and steel are locally manufactured.

c) Chile (Ref. 15)
It is indicated that the materials must be selected according to water and soil characteristics, flows and commercial sizes. Chile has standards for the manufacture of the following types of pipes: polyethylene, steel, asbestos-cement, iron and u.P.V.C.

d) Colombia (Ref. 1)
The use of the following pipe materials is specified: plastic (P.V.C.), asbestos-cement, ductile and cast iron, concrete and fibreglass. All these materials are locally manufactured.

e) Ecuador (Ref. 31)
It is indicated that the pipe material must be selected on the basis of water and soil characteristics, flows and commercial sizes. The following materials are acceptable: asbestos-cement, P.V.C., ductile iron, galvanized iron and steel (with adequate internal and external protection). There are no details on local production of these pipes.

2.5.5 Permissible diameters

a) Chile: national (Ref. 15)
Minimum diameter: 75 mm, but 50 mm allowed for low-income areas. Fire hydrants shall be connected to 100 mm diameter mains minimum.

b) Colombia: rural (Ref. 24)
Minimum diameter: 50 mm for asbestos-cement.
For plastic or galvanized iron pipes the diameters shall be as calculated.

c) Ecuador: urban and rural (Ref. 31)

| Population | Min. dia. Ring main | Min. dia. Secd. main |
|---|---|---|
| less than 3 000 | 25 mm | 18 mm |
| 3 000 - 20 000 | 50 mm | 25 mm |
| over 20 000 | 100 mm | 50 mm |

/Fire hydrants

Fire hydrants shall be connected to water mains as indicated: 12 l/s hydrants to 75 mm min. dia. Hydrants with over 12 l/s to 100 mm min. dia. Hydrants 150 mm dia. to 200 mm min. dia.

d) Peru. Urban (Ref. 32)
Minimum diameter: 75 mm, but 50 mm allowed for low-income areas. Fire hydrants shall be connected to 100 mm dia. mains minimum.

e) Honduras. Urban (Ref. 33)
Minimum diameter: ring mains: 50 to 75 mm dia. Secondary mains: 38 mm dia.

2.5.6 Permissible velocities

a) Colombia. Rural (Ref. 24)
Minimum velocity: 0.4 m/s
Maximum velocity: 2.50 m/s

2.5.7 Intermittent supplies

Colombia, Jamaica and Uruguay (Refs. 1, 2 and 3), indicated through the questionnaires that their codes do not make allowances for intermittent water supplies, urban or rural. For the other countries, it was not possible to find in the available documentation any specific reference to intermittent water supply.

2.5.8 House connections

a) Jamaica (Ref. 3)
Urban: house connections are specified. Meters must be installed and tariffs are charged on actual consumption.
Rural: house connections are provided for. A flat rate is charged for unmetered connections.

b) Uruguay (Ref. 2)
Urban and rural: house connections are specified. In all cases meters must be installed and tariffs charged on actual consumption

c) Chile
Urban (Ref. 16): house connections (each to serve one household) are specified. Meters must be installed and tariffs charged on actual consumption.
Rural (Ref. 10): house connections are specified with minimum 12 mm diameter.

d) Colombia
Urban (Ref. 1): house connections and the installation of meters are generally specified. Tariffs are applied in all cases.
Rural (Ref. 1 and 23): house connections are specified, the installation of meters being subject to local conditions. Tariffs are applied in all cases.

e) Ecuador
Urban and rural (Ref. 31): house connections are specified.

f) Honduras
Urban (Ref. 33): suggests one connection (18 mm dia.) to service two households (each with a 12 mm dia. pipe).

/2.5.9 Communal

2.5.9 Communal water taps/lavatories/laundry points

a) Jamaica. Urban and rural (Ref. 3). It is indicated that communal water taps are not specified; however, these types of units are being built without following a standard criteria.

b) Uruguay (Ref. 2). Communal water taps are specified for the rural sector only, according to the following criteria:
- inhabitants per tap: 100
- walking distance: 200 m maximum
- collection time (at the tap): 1 minute.

Tariffs are not charged.

c) Chile, Colombia, Ecuador, Peru and Honduras. There is no available specific information on the design of communal water taps.

2.5.10 Revision and/or modification of design criteria to suit low-income groups

It was not possible to find specific references allowing for the change of design parameters to make water supply services more accessible to low-income groups. Only in the cases of Chile and Peru is a small design criteria change allowed in this respect, in that the minimum diameter of the water mains can be 50 mm instead of 75 mm as normally specified.

## 3. Codes of practice covering construction aspects of water supply systems

### 3.1 General

Water supply systems are composed of different units and structures whose design requires the use of design and construction criteria in areas such as: structural engineering, soil mechanics, hydrogeology, geology, electrical and mechanical engineering, architecture, hydraulics and environmental engineering. The study and review of all the above elements, for the different units forming a water supply system, goes beyond the intended scope of this document. The present analysis will therefore only concentrate on pipelaying. The justification for focusing on pipelaying is that it is the element that is invariably present in any water supply system (with the exception of supply from shallow wells), and that it is the only component of most of the projects in low-income settlements, especially in urban areas. In addition, pipelaying and excavation works are important items of the project budget and should hence be looked at with more attention in order to achieve cost savings.

### 3.2 Pipelaying

3.2.1 Pipe location

a) Chile. National (Refs.: 15 and 17)

It is specified that water mains should be laid at least 2 m from any parallel sewer and 0.30 m over it. When crossing a sewer the water main shall always go over it (0.15 m clearance). It is indicated that water mains should be laid as far as possible (no minimum distance is given) from cables.

/b) Colombia

b) Colombia. Rural (Refs.: 24 and 25)
It is specified that water mains should be laid at one side of the road and should cross over sewer pipes (no clearance specified).

c) Ecuador. Urban and rural (Ref. 31)
It is specified that in roads over 20 m wide or with two carriageways, two parallel pipes must be installed, one at either side. One should take the design flow, while the other is a secondary main. Water mains must be laid at the opposite side of the road from that on which sewers are installed. Water mains must cross over sewers with 0.20 m minimum clearance and run parallel to sewers a minimum of 0.30 m over them.

d) Peru. Urban (Ref. 32)
It is specified that in roads less than 20 m wide, one water main shall be laid in the lower side of the road. In roads over 20 m wide, two pipes shall be installed unless otherwise justified by the number of house connections. The minimum distance to sewers shall be 2.5 m, otherwise, rubber ring joins shall be used. Water mains shall cross over sewers with 0.25 m minimum clearance. The minimum distance to electricity cables shall be 1.0 m.

3.2.2 Minimum depth (or cover over pipe)

a) Chile. Urban (household water supply) (Ref. 16)
Minimum depth below ground level: 0.90 m to the pipe crown.

b) Colombia. Rural (Ref. 24)
Minimum depth below ground level: 0.80 m to the pipe crown.

c) Peru. Urban (Ref. 32)
Minimum depth below ground level: 0.80 m to the pipe crown.

## 4. Codes of practice covering design aspects of sanitation

Although this and the following sections are devoted to sanitation, it will be seen that in actual fact they mainly refer to "conventional sewerage" systems. This is because all the current official codes of practice only contain regulations on conventional sewerage systems with off-site disposal and treatment. The number of officially published codes relating to non-conventional systems is negligible. A few countries have manuals or codes referring to the design and construction of septic tanks (Brazil, Colombia, Chile, Peru), but they are also based on conventional criteria. Concerning "on-site dry systems" it is known that there are codes of practice or standards that are normally used on rural sanitation projects. However, most of them do not have the status of a national code of practice, and therefore their application is restricted to the activities of the agency using them, which is often not the only agency working in latrine programmes or rural sanitation programmes in a country.

Before proceeding, it should be mentioned that some countries have, or are proposing, codes of practice for conventional wastewater treatment processes. In this respect, it is interesting to note that in most countries of the Latin American and Caribbean region there are few conventional wastewater treatment plants working efficiently, and almost all of them were designed and constructed with imported technology and criteria.

/4.1 Quantity

4.1 Quantity and quality of effluents

4.1.1 Classification of effluents

a) Brazil. National (Ref. 5)
It is specified that conventional sewerage systems shall accept domestic, industrial and commercial effluents. The sewerage system must be designed as a separate system (excluding storm water drainage).

b) Chile. National (Ref. 17)
It is indicated that conventional sewerage systems should accept domestic and industrial effluents. It is assumed that the sewerage system will be designed as a separate system.

c) Colombia
- National (Ref. 19). The Ministry of Health specifies the quality standards to be met by any discharge to a conventional sewerage system.
- Rural (Ref. 25). It is indicated that conventional sewerage systems should accept domestic and industrial effluents. The sewerage system must be designed as a separate system.
- Urban (Bogotá S.D.) (Ref. 26). It is assumed that conventional sewerage systems can accept domestic, industrial and commercial effluents. Provisions are given for the design of separate and combined (wastewater and storm water drainage) systems.

d) Ecuador. Urban and rural (Ref. 31)
It is assumed that conventional sewerage systems can accept domestic, industrial and commercial effluents. The design of separate systems is preferred, but criteria are also given for the design of combined systems.

e) Peru. Urban (Ref. 32)
It is assumed that conventional sewerage systems can accept domestic, industrial and commercial effluents and that they will be designed as separate systems.

f) Honduras (Ref. 33)
It is assumed that the systems will be designed as separate conventional sewerage systems that can accept domestic effluents.

4.1.2 Population to be served (present and future)
In general, these rules apply the same specifications and criteria summarized in section 2.1.2.

4.1.3 Design periods (conventional sewerage systems only)

a) Brazil. National (Ref. 4)
25 years is specified for economic comparisons and calculations.

b) Colombia. Rural (Ref. 25)
20 years for sewers, pumping stations, emissor and treatment works (in two phases); five to ten years for pumping equipment.

c) Ecuador. Urban and rural (Ref. 31)
30 to 40 years for new services, 20-30 years for extensions, 40-50 years for sewers and 10-15 years for pumping equipment. For treatment works the design period is based on probable financial arrangements:
- low interest rates: 20-25 years
- high interest rates: 10-15 years

/d) Peru

d) Peru. Urban (Ref. 32)
15 years for populations between 2 000 and 20 000 inhabitants,
10 years for populations with more than 20 000 inhabitants.

4.1.4 Unitary effluent discharge (effluent flows) (for conventional sewerage systems only)

a) Brazil. National (Ref. 5)
Sewers, maximum design flow: domestic plus infiltration
i) Domestic flow: 80% of the maximum hourly water demand, where the maximum hourly demand factor is 1.8 applied to the average daily demand;
ii) Infiltration: 1.0 litres per second per km of sewer (1/s.km)

b) Chile. National (Ref. 17)
Maximum design flow of sewers: domestic flow plus ground infiltration plus surface infiltration.
i) Domestic flow: the following factors should be applied to the maximum hourly water demand to calculate the maximum domestic wastewater flows:
- Residential areas with gardens: 70%
- High density residential areas: 90%
- Mixed areas: 80%
- Industrial areas 70% (unless otherwise specified)

It is assumed that average daily water demands (not production) shown in section 2.1.4-c are applied, as well as the corresponding factors for daily variations in demand.
ii) Ground infiltration: the following values are recommended: 0.8 to 1.0 1/s. km or 0.20-0.30 litres per second per ha (1/s. ha) of drained area
iii) Surface infiltration: (through manhole openings, etc.). It is recommended that this should be calculated according to the characteristics of the serviced area: the levels range from 0 to 20% of the maximum daily flow, with the zero value corresponding to desert areas, and 20% to rainy regions.

c) Colombia
- Rural (Ref. 25)
Maximum design flow of sewers: domestic flow, plus ground infiltration, plus others.
i) Domestic flow: 80% of the maximum hourly water demand, where the maximum hourly demand factor is 3.0, applied to the average daily demand;
ii) Ground infiltration: 0.116 to 1.157 1/s.km or 0.1 1/s.ha;
iii) Others: schools (30 litres per student per 8 hrs. work) and industries according to individual cases.
- Urban (Bogotá) (Ref. 26) (separate system)
Maximum design flow of sewers: (domestic flow, plus ground infiltration, plus industrial) x F
i) Domestic flow: 80% to 90% of the maximum hourly water demand, where the maximum hourly flow factor is 1.22, applied to the average daily demand (200 lppd) calculated according to official densities for different areas of Bogotá;

/ii) Ground

ii) Ground infiltration: This is calculated according to given infiltration areas for Bogotá: high infiltration area: 0.1 to 0.4 l/s.ha (0.1 rubber join - 0.4 old sewers). Medium infiltration area: 0.1 to 0.3 l/s.ha (0.1 rubber join - 0.3 old sewers). Low infiltration area: 0.05 to 0.2 l/s.ha (0.05 rubber join - 0.2 old sewers);

iii) Industrial: according to specific cases.
The total obtained from above must be multiplied by a factor F which is based on the size of the sewers as follows:
200-525 mm dia.: F = 1/0.6
600-1 200 mm dia: F = 1/0.7
over 1 200 mm dia.: F = 1/0.9

d) Ecuador. Urban and rural (Ref. 31)
Maximum design flow of sewers: domestic flow, plus infiltration, plus illegal connections, plus industrial.

i) Domestic flow: 70% to 80% of the maximum hourly water demand, where the maximum hourly demand is 2.0 to 2.3 of the average daily demand;

ii) Infiltration: According to local conditions, but not less than the following figures for different pipe sizes (in mm).
- 200 mm: 0.8 l/s.km - 350 mm: 1.4 l/s.km - 500 mm: 2.0 l/s.km
- 250 mm: 1.0 l/s.km - 400 mm: 1.6 l/s.km - 550 mm: 2.2 l/s.km
- 300 mm: 1.2 l/s.km - 450 mm: 1.8 l/s.km - 600 mm: 2.4 l/s.km

iii) Illegal connections (drainage of household rainwater): it is suggested that the following figures should be used: 80 l/hab. day (0.0010-0.0030 l/s.hab);

iv) Industrial: according to specific cases.

e) Peru. Urban (Ref. 32)
Maximum design flow of sewers: domestic flow, plus ground infiltration, plus surface infiltration.

i) Domestic flow: 80% of the maximum hourly water demand, where the maximum hourly flow factor is 1.8 applied to the average daily demand;

ii) Ground infiltration: to be justified with detailed studies of the area;

iii) Surface infiltration: to be justified with detailed studies of the area.

f) Honduras. Urban (Ref. 33)
Design flow of sewers: on the basis of domestic flow, where the sewage flow factor is 70% of the water demand.

4.1.5 Permissible velocities in sewers (for conventional sewerage systems only)

a) Brazil. National (Ref. 5)
Minimum velocity: 0.5 m/s at the start of the design period for the average flow
Maximum velocity: 4.0 m/s at the end of the design period for the average flow

/b) Chile

b) Chile. National (Ref. 17)
Minimum velocity: - Domestic effluent only: 0.6 m/s (0.45 m/s in special cases)
- Stormwater only: 0.9 m/s
- Combined sewage: 1.5 m/s
Maximum velocity: - Domestic effluent only: 4 m/s
- Stormwater only: 6 m/s

c) Colombia
- Rural (Ref. 25)
Minimum velocity: 0.4 m/s
Maximum velocity: 5 m/s (clay pipes) and 4 m/s (concrete pipes)
- Urban (Bogotá) (Ref. 26)
Minimum velocity: 0.6 m/s

d) Ecuador. Urban and rural (Ref. 31)
Minimum velocity: Domestic effluent (full section sewer): 0.6 m/s
Combined sewage (full section sewer): 0.75 m/s
Domestic effluent (partly full sewer): 0.3 m/s
Maximum velocity (for sewers only): 3.5-4 m/s for concrete, 4-6 m/s for clay and cast iron, 4.5-5 m/s for asbestos-cement and plastic.

e) Peru. Urban (Ref. 32)
Minimum velocity: 0.60 m/s for 50% of maximum flow
Maximum velocity: 5 m/s for clay, cast iron and steel, 3 m/s for asbestos-cement, PVC and concrete

f) Honduras. Urban (Ref. 33)
Minimum velocity: 0.5-0.66 m/s. In lateral sewers, a minimum of 0.33 m/s is accepted for a 2.25% minimum gradient

4.1.6 Permissible gradients in sewers (for conventional sewerage systems only)

a) Brazil. National (Ref. 5)
Minimum gradient: according to formula $Io = 0.01 \times Q_1^{-2/3}$
where: $Q_1$ = initial flow (l/s)
Io = minimum gradient
(for the start of a sewer line for an area with a population density of 200 inh/ha discharging 150 lppd to 100 m of sewer line, and an infiltration rate of 1.0 l/s.km, the minimum gradient would be: Io = 0.017 or 1.7%).

b) Chile. National (Ref. 17)
Minimum gradient: according to pipe diameter:
150 mm: 0.7% 250 mm: 0.3% 400 mm: 0.2% > 600 mm: 0.1%
175 mm: 0.5% 300 mm: 0.25% 450 mm: 0.18%
200 mm: 0.4% 350 mm: 0.22% 500 mm: 0.15%
Minimum gradient for house connections: 3%. If justified, and when pumping is required, 1% will be acceptable.

/c) Colombia

c) Colombia

- Rural (Ref. 25)

  Minimum gradient: that needed to ensure the minimum specified velocity (0.4 m/s)

  Minimum gradient for house connections: 2%

- Urban (Bogotá) (Ref. 26)

  Minimum gradient according to pipe diameter:

  200 to 375 mm dia.: 0.40 to 0.16%

  450 to 750 mm dia.: 0.12 to 0.06%

d) Ecuador. Urban and rural (Ref. 31)

It is assumed that the minimum gradient should ensure the minimum specified velocity.

Gradient for house connections: 2% to 20%.

e) Peru. Urban (Ref. 32)

The minimum gradient must ensure a minimum velocity of 0.6 m/s. The first 300 m of a sewer line must have a gradient of 1%.

Gradient for house connections: 1.5%

f) Honduras. Urban (Ref. 33)

Minimum gradient: 2.25% for lateral sewers.

4.1.7 Minimum diameter (for conventional sewerage systems only)

a) Brazil. National (Ref. 5)

Minimum diameter: 150 mm

b) Chile. National (Ref. 17)

Minimum diameter: 150 mm, applicable to dead end roads not more than 60 m long.

Minimum diameter for household connections: 100 mm.

c) Colombia

- Rural (Ref. 25)

  Minimum diameter: 200 mm

  Minimum diameter for household connections: 150 mm.

d) Ecuador. Urban and rural (Ref. 31)

Minimum diameter: 200 mm for separate (only domestic) sewers
250 mm for combined sewers
150 mm for house connections

e) Peru. Urban (Ref. 32)

Minimum diameter: 200 mm

f) Honduras. Urban (Ref. 33)

Minimum diameter: 150 mm

Minimum diameter for household connections: 100 mm to serve two plots

4.1.8 Field surveys: physical and socio-cultural

The same findings described in section 2.1.7 apply in this case. It can be assumed that since in official codes there is an almost complete omission of other alternatives to conventional sewerage, there is also no attempt to carry out socio-cultural studies to identify technology preferences. In other words, at the most, some possible "improvements" to conventional sewerage are mentioned in the documents reviewed, but not "alternatives" to it.

/4.2 Specification

4.2 Specification of final disposal of treated or untreated effluent

It was not possible to find official documentation indicating the possible disposal sites (e.g., sea, lakes, ground water recharge, rivers, etc.) for wastewater. What was found in the rules of Colombia's Ministry of Health (Ref. 18) was a prohibition to discharge liquid effluents in the streets, public places or other places where it could represent a danger to public health. Another Colombian regulation (Ref. 19) indicates the conditions required for the discharge of effluents to a body of water, to the sewerage system, and to other disposal sites (aquifer recharge, infiltration, sea, estuaries, etc.) according to the characteristics of the receiving body. The same regulation indicates the minimum effluent quality standards, according to the type of discharge. This regulation implicitly contains the concept that some wastewaters have to be treated before being discharged to the environment.

It should be clarified that the absence of documentation in this area does not mean that it is non-existent, but rather, that it was not possible to obtain it within the execution of this study.

4.3 Classification and specification of treatment systems (conventional sewerage)

All the official documentation reviewed on wastewater treatment systems referred to conventional processes to treat domestic effluents collected through a sewerage system. It was not possible to find codes of practice for on-site treatment and disposal of domestic effluents, unless septic tanks and percolation fields are thus considered. This section will be limited to showing the range of processes considered in the practice of each country for which information was available.

a) Brazil. National (Ref. 8)

Minimum design requirements for conventional wastewater treatment plants are provided. They apply to domestic effluents whose final disposal will not be through submarine outfalls. They include the following elements:

- screens and grit removal
- primary settling (sedimentation)
- biological filters
- activated sludge (extended aeration, total oxidation, etc.)
- secondary sedimentation
- sludge treatment (aerobic and anaerobic digestion, thickening, sludge lagoons, drying beds).

b) Ecuador. Urban and rural (Ref. 31)

The following elements are included:

i) submarine outfalls,
ii) removal of large solids: screens, grinders, cutters and shredders and grit removal

/iii) primary

iii) primary treatment
- primary sedimentation
- flotation and grease removal
- flocculation and chemical sedimentation
- Imhoff tanks

iv) secondary treatment
- percolation (biological) filters
- activated sludge: aeration tanks, aeration systems, secondary sedimentation, sludge thickeners, digesters, vacuum filtration, drying beds
- oxidation ditches
- oxidation (stabilization/biological) ponds.

### 4.4 Technology selection

As already noted, it was not possible to find official documentation providing guidelines for the execution of studies to select the sanitation technology most appropriate for a given situation. It was also not possible to find an official listing of possible or existing sanitation technologies and processes, with the exception of conventional sewerage and conventional septic tanks.

### 4.5 Communal systems

It was not possible to find official available information on communal sanitation services such as communal toilets and communal laundry and bathing places.

### 4.6 Revision and/or modification of design criteria to suit low-income groups

It was not possible to obtain official information regarding possible changes in design criteria to make sanitation services more accessible to low-income groups.

## 5. Codes of practice covering construction aspects of sanitation

### 5.1 General

As in the case of the previous section, the present chapter will cover mainly construction aspects related to conventional sewerage systems, despite the fact that it should be devoted to "sanitation" in a broader sense. It should be repeated that this situation is due to the lack of available official documentation on codes of practice relating to the design and construction of sanitation units other than conventional sewerage systems. The present analysis will focus on pipelaying and manhole construction, since these are the most important elements in conventional sewerage systems, at least in Latin America and the Caribbean, where major treatment works, pumping stations, etc., are minimized. Pipelaying and manholes (or inspection chambers) are also important components of non-conventional sanitation systems, thus, they are elements whose construction should be optimized.

/5.2 Pipelaying

## 5.2 Pipelaying (conventional sewerage)

### 5.2.1 Pipe location

a) Chile. National (Refs.: 16 and 17)
Sewers should follow the centre line of roads or the lower side of a road in irregular topography. In roads over 20 m wide an economic study will define the need for one or two parallel sewers.
It is not permissible to have more than one plot (household) served by a house connection.

b) Ecuador. Urban and rural (Ref. 31)
In separate systems, sewers must be placed on the opposite side of the road from water pipes. In combined systems sewers must follow the centre line of the road. In roads over 20 m wide, 2 sewers shall be laid, one taking the design flow and the other being designed as a secondary sewer. The sewer must drain all the houses by gravity.

c) Peru. Urban (Ref. 32)
Sewers must drain by gravity at least 2/3 of the plots, starting at 0.3 m below ground level and at a gradient of 15: 1 000. Plots on the lower side of a road may be allowed (if justified) to discharge through neighbouring plots. In roads less than 20 m wide, one sewer shall be laid along the centre line of the road. In roads over 20 m wide an economic study will define the need for one or two parallel sewers. If necessary, the latter sewers will go on the lower side of the road at 1.00 m from the footpath and at no less than 2.0 m from the property line. Sewers over 600 mm dia. can be laid in curves.

### 5.2.2 Pipe depth

a) Brazil. National (Ref. 5)
- Minimum depth: 1.20 m to pipe invert (smaller depth acceptable) if shown that all houses along the sewer can discharge by gravity.
- Minimum cover: 1.00 m over pipe crown (smaller cover requires calculation of pipe loads).

b) Colombia. Rural (Ref. 25) and urban (Ref. 26)
- Minimum cover: 1.00 m over pipe crown.

c) Ecuador. Urban and rural (Ref. 31)
- Minimum cover: 1.00 m over pipe crown.

d) Peru. Urban (Ref. 32)
- Minimum cover: 1.00 m over pipe crown.

e) Honduras. Urban (Ref. 33)
- Minimum cover: - 1.50 m over pipe crown (motor roads)
  - 0.75 m over pipe crown (pedestrians only).

## 5.3 Manholes (inspection chambers) (conventional sewerage)

### 5.3.1 Manhole location

a) Brazil. National (Ref. 5)
- Manholes shall be located at the following points: start of sewer lines (one manhole shall not serve more than one downstream line), change of direction, change of gradient, change of diameter, change of material, and at sudden drops in level.

/- The maximum

- The maximum distance between manholes shall be: 100 m for pipes less than 150 mm dia., 120 m for pipes 200 to 600 mm dia., and 150 m for pipes over 600 mm dia.

b) Chile. National (Ref. 17)
- Manholes shall be located at: start of sewer lines, intersections, changes of diameter and changes of gradient.
- The maximum distance between manholes shall be: 130 m for pipes less than 500 mm dia., 150 m for pipes 600 to 1 000 mm dia., and 200 m for pipes over 1 000 mm dia.

c) Colombia
- Rural (Ref. 25). Manholes shall be located at: start of sewer lines, intersections, and changes of diameter, direction and gradient.

d) Ecuador. Urban and rural (Ref. 31)
- Manholes shall be located at: start of sewer lines, intersections and changes of diameter, section and gradient. They must also be located at changes of direction, if sewer is not accessible from inside.
- The maximum distance between manholes shall be: 100 m for pipes 200 to 350 mm dia., 150 m for pipes 400 to 800 mm dia., and 300 m for pipes over 1 000 mm dia.

e) Peru. Urban (Ref. 32)
- Manholes shall be located at: intersections, and changes of direction, diameter and gradient pipes (600 mm dia. and over can be laid in curves).

f) Honduras. Urban (Ref. 33)
The maximum distance between manholes shall be 140 m.

5.3.2 Manhole dimensions

a) Brazil. National (Ref. 5)
Specifies internal diameter of manholes according to depth and size of the connecting pipes:

| Depth (m) | Pipe dia. (mm) | Manhole dia. (m) |
|---|---|---|
| up to 1.5 | 300 | 1.0 |
| 1.5 and over | 300 | 1.0 |
| | 300-500 | 1.5 |
| | over 500 | do + 1.0 (do = pipe diameter) |

b) Colombia
- Rural (Ref. 25). Specifies manhole internal diameter according to depth:

| Depth (m) | Manhole dia. (m) |
|---|---|
| Up to 1.10 m to pipe crown | 0.6 m |
| over 1.10 m to pipe crown | 1.20 m, but top 0.7 m shall taper down to 0.60 m at ground level |

/c) Ecuador

c) Ecuador. Urban and rural (Ref. 31)
Manhole diameter shall be 0.9 m for connecting sewers up to 600 mm dia. Larger sewer pipes require special manhole design.

d) Peru. Urban (Ref. 32)
For sewers up to 800 mm dia.: 1.20 m manhole diameter
For sewers up to 1 200 mm dia.: 1.80 m manhole diameter
For larger sewer pipes: special design.

e) Honduras. Urban (Ref. 33)
Manhole minimum diameter: 1.20 m.

## 6. Standards

### 6.1 General

The number of standards issued by Latin American and Caribbean countries to normalize materials and equipment used in water supply and sanitation works is quite extensive. They are also, in almost all of the cases, compatible with similar standards issued by the American Standards Association (ASA) and the International Organization for Standardization (ISO). Some of them also refer to relevant British Standards and German Standards.

Some of the standards currently applied in two countries of the region, Chile and Colombia, are presented below in order to illustrate the range of subjects being covered by present standards. The description of the contents of these standards is not given, since it would fall outside the scope of the present study. However, it should be remembered that most of these standards are similar to the standards applied in developed nations.

### 6.2 Water supply

a) Chile

The following standards are taken from those of the National Institute for Standardization (INN) and those used by the Metropolitan Sanitary Works Company (EMOS).

Pipes

| | |
|---|---|
| - NCh398-1980 | Polyethylene pipes for water supply (INN) |
| - NCh397.Of77 | Thermoplastic pipes for fluids conduction. External diameters and nominal pressures (INN) |
| - NCh399-1980 | Polyvinyl chloride (PVC) rigid pipes for conduction of liquids under pressure - requisites (INN) |
| - NCh402-1983 | Gray (cast) iron pipes and fittings for pressure lines (INN) |
| - NCh404.Of84 | Gray (cast) iron fittings for asbestos-cement pipes (INN) |
| - NCh925.EOf74 | Steel pipes and special fittings for water supply. Bitumen coat protection (INN) |

/- NCh996.EOf73

| | |
|---|---|
| - NCh996.EOf73 | Sanitary engineering - water supply - steel pipes - handling, transport and storage (INN) |
| - NCh1360.Of78 | Water supply - steel, cast iron and asbestos-cement pipes - field tests (INN) |
| - EMOS 340-00 | Copolymer polypropylene pipes for household connections |
| - EMOS 370-00 | Ductile iron pipes |
| - EMOS 374-00 | Joints for PVC pipes |
| - EMOS 393-00 | Rubber ring joins for asbestos-cement pipes |

Valves and fittings

| | |
|---|---|
| - NCh699-1980 | Water - valves and fittings - terminology and classification (INN) |
| - NCh700.EOf70 | Water - valves and fittings - for household use - general requisites |
| - NCh731.EOf71 | Water - valves for household use for drinking water - specifications |
| - NCh732.EOf70 | Water - self-closing taps for water standposts - specifications |
| - NCh784.EOf70 | Water - special pass valves - specifications |
| - NCh895.EOf83 | Sanitary engineering - drinking water - cast iron valves - specifications |
| - EMOS 341-00 | Saddle straps for household connections - 13 mm dia. |
| - EMOS 342-00 | Accessories to join alkathene and polypropylene pipes |
| - EMOS 343-00 | Alkathene pass valves |

Others

| | |
|---|---|
| - NCh643.Of70 | Centrifugal pumps - terminology and symbols |
| - NCh686.Of60 | Tests and reception |
| - NCh759.EOf70 | Water toilet tanks - float valves and fittings - specifications |
| - NCh1632.Of79 | Cast iron covers and frames for valve chambers |
| - EMOS 330-00 | Meters for cold water, multiple jet velocity type |
| - EMOS 331-00 | Meters for cold water, Wotmann vertical helicoidal type |
| - EMOS 338-01 | Oval gate valves |
| - EMOS 390-00 | Fire hydrants - stand type |

b) Colombia

The following standards are taken from the Colombian Institute of Technical Standards (INCOTEC)

| | |
|---|---|
| - INCOTEC-44 | Civil engineering and architecture. Asbestos-cement pipes for conduction of liquids under pressure |
| - INCOTEC-332 | Threads for pipes and fittings (steel) |
| - INCOTEC-382 | Rigid polyvinyl chloride (PVC) pipes for transport of fluids under pressure |

| | |
|---|---|
| - INCOTEC-1279 | Cast iron gate valves |
| - INCOTEC-1620 | Cast iron pipes |
| - INCOTEC-1901 | Water taps |

6.3 Sanitation

a) Chile

| | |
|---|---|
| - NCh403.Of58 | Cast iron pipes for sewerage |
| - NCh184.Of62 | Unreinforced concrete pipes for sewerage: specifications |
| - NCh185.Of62 | Unreinforced concrete pipes for sewerage: tests |
| - NCh407.Of55 | Ceramic sanitary fittings/ware |
| - NCh408.Of55 | Test methods for ceramic sanitary fittings/ware |
| - NCh725.Of74 | Sewerage - asbestos-cement pipes - specifications |

b) Colombia

| | |
|---|---|
| - INCOTEC-239 | Fittings for sanitary (sewerage) asbestos-cement pipes |
| - INCOTEC-401 | Reinforced concrete pipes for sewerage |
| - INCOTEC-920 | Ceramic materials: sanitary fittings/ware - specifications |
| - INCOTEC-1022 | Unreinforced concrete pipes and fittings for sewerage |
| - INCOTEC-1748 | Plastics - rigid polyvinyl chloride (PVC) pipes for sewerage |

## 7. Solid waste

Some of the legislation available in the area of solid waste, especially from Colombia, was given in section "II-B-1". In this section, it is intended to expand more the information previously given. As already indicated, the activities on solid-waste collection and disposal in Colombia are mainly regulated by:

- the National Sanitary Code (Ref. 18)
- regulations on solid waste (Ref. 20)
- technical manual on urban cleaning services (1980-INSFOPAL) (no copy of this document, which covers street cleaning, waste collection and disposal, was available).

/Some regulations

Some regulations applying to solid-waste disposal services, based on the above documentation, will be given below.

## 7.1 Classification of solid wastes

a) Domestic: those that by their nature, composition, quantity and volume are generated by household activities or other activities susceptible of being carried out in a household.
b) Commercial: those generated in commercial and mercantile establishments, such as stores, warehouses, hotels, restaurants and markets.
c) Institutional: those generated in establishments such as schools, government offices, military installations, prisons, religious installations, airports, ports and land terminals and office buildings.
d) Industrial: those generated by industrial activities as a result of production processes.
e) Special solid wastes: those whose size, volume and weight require special handling. In this category are also included the following types of solid wastes: pathogenic, toxic, combustible, inflammable, explosive, radioactive and volatile.

## 7.2 Household handling

### a) Household storage

i) solid wastes shall be stored in sanitary conditions
ii) domestic solid wastes shall not include liquid elements, excreta, and special solid wastes
iii) household storage containers shall avoid the contact of solid waste with the environment. Containers can be of the "returnable" or "disposable" type
iv) returnable containers shall have the following characteristics:
- appropriate weight and construction to facilitate handling during collection
- made of impermeable material, easy to clean and protected against corrosion and mould (e.g., plastic, rubber or metal)
- provided with a cover that does not disrupt the collection process
- shall not allow entrance of water, insects or rodents. Shall be watertight in walls and bottom
- shall have round edges and form to facilitate emptying
- capacity according to recommendations of the service agency

v) disposable containers shall have the following characteristics:
- shall be bags of plastic or similar material
- shall stand the stress of the stored solid waste and handling during collection
- capacity according to recommendations of the service agency
- preferably made of non-transparent material

vi) disposable container shall be presented for collection in a completly closed condition.

/b) Handling

b) Handling

i) households shall present for collection containers as specified above
ii) the containers shall be delivered by the householders to the established collection points
iii) the containers shall not remain in public places on days other than the established collection days.

## 7.3 Communal handling

There are regulations providing for the storage and handling of solid wastes on a communal basis, as long as such storage and handling is carried out within private property and not in public places. In other words, these regulations apply to multi-family buildings and other institutional and commercial establishments. There are no specific regulations regarding the storage of solid waste in public places (that is, public collection points).

## 7.4 Collection and transport

Among others, the following regulations apply to the collection and transport of domestic solid wastes:

i) the service agency shall establish the optimum collection frequency to avoid degradation of the waste that could encourage adverse public health conditions;
ii) the transport vehicles shall meet the specifications for this type of activity;
iii) all the vehicles and plant used for solid-waste collection shall be washed and cleaned at the end of the daily shift;
iv) transfer stations shall be constructed when considered necessary;
v) the design and construction of transfer stations shall meet existing public health and urban development regulations;
vi) environmental impact studies shall be carried out, if considered necessary, to determine the location of transfer stations;
vii) as a minimum, the location and operation of transfer stations must:
- facilitate the access of vehicles
- not to be located in the vicinity of, or obstruct the activities of, schools, hospitals, military installations and others
- not obstruct the traffic of pedestrians and vehicles or create aesthetic problem
- have a defined loading and unloading system
- have a stand-by operation system
- have a reliable water supply for washing and cleaning activities
- comply with existing regulations on environmental pollution
- have sewerage, electricity and telephone services.

/7.5 Treatment

7.5 Treatment

There are no specific regulations dealing with treatment processes or systems, but only general regulations indicating the need for new or existing treatment plants to comply with current legislation on public health and environmental protection.

7.6 Final disposal

i) It is indicated that the final disposal of domestic solid waste can be affected through the following processes:
   - landfill
   - sanitary landfill
   - sea disposal (only when other alternatives are not feasible)

ii) Every project for solid waste disposal shall be complemented by an environmental impact study.

iii) It is forbidden to dispose of solid wastes on open spaces, public areas, empty land and in bodies of ground or surface water.

iv) A disposal site must fulfil the following conditions:
   - be isolated from the surrounding area to avoid interference with activities being carried on there and risks to public health and the environment
   - have adequate sign boards and notices identifying the place and type of activities executed therein
   - have the necessary services for its operation, such as water supply, electricity, telephone and drainage for the leached liquor
   - have a firefighting system and comply with industrial safety and health regulations
   - keep records of operations and disposed wastes
   - keep sanitary conditions for the control of vectors and other animals
   - control the spread of dust and other solids outside the disposal site
   - exercise leachate control

v) Disposal sites can be put to later use after satisfying minimum structural and sanitary requirements

vi) A proposal for the construction of a sanitary landfill shall cover the following aspects:
   - peripheric infrastructure
   - landfill infrastructure
   - construction of the landfill
   - construction of special lots (areas for landfill)
   - control of leachate and gases
   - ancillary installations
   - landscaping.

/III. COMMENTS

## III. COMMENTS ON THE INFORMATION REVIEWED

### A. General

A first general conclusion of the study was given in the previous chapter. It referred to the need for the dissemination and exchange of information on codes, regulations and standards among the countries of the region, and also outside the region. In this respect, the most effective path to follow appears to be the strengthening of regional information and documentation networks. Since there is already a regional network in the area of sanitary engineering and environmental sciences, REPIDISCA, it would be necessary to ensure, mainly at the national level, that there is enough institutional and financial support for the operation of the national information focal points.

The second general conclusion refers to the actual scope and presentation of the codes of practice and design standards. While in most of the cases they limit themselves to providing design and construction criteria and parameters, there are still too many cases where they seem to provide an excess of information, dwelling unnecessarily on the description of methods and procedures for executing an activity, rather than describing only the desired outcome of that activity. This feature has the drawback of making some documents difficult to read, providing repetitive information which is, or should be, part of the basic knowledge of every technician or professional working in the sector. Furthermore, the more detailed the information on design "processes" (rather than design "criteria") is, the more rigid the codes will become in their application, inhibiting the designer from adopting innovative design approaches.

The above factors bring us to the first central question in the preparation of regulations and codes of practice: should it be assumed that the technical and ethical level of the professionals and other individuals working in the sector is so low that the standards and codes of practice should be as detailed as possible in order to minimize non-technical deviations and the occurrence of unacceptable practices, or should it be assumed that the professionals and individuals working in the sector have a reliable technical level and ethical formation, so that, if provided with guiding design criteria in the form of simple and flexible design parameters and indications of what is desirable or permissible, they can fill in the details and processes to comply with the given criteria? Undoubtedly, there will be many adherents to the first approach. However, it would appear that the only hope of making the implementation of projects in the sector more dynamic would be the adoption of policies closer to the second approach. Since, as occurs in other areas of applied sciences, often the problem does not lie in the science but in the people who apply it, the adoption of something closer to the second approach would require the strengthening of human resources development programmes, with great emphasis on ethical, technical and motivational aspects. This will allow the transfer into professional practice of the sense of order and duty implicit in detailed codes, while keeping alive the freedom for innovation and change. Finally, to control possible human weaknesses, which may always be present, the above measures should be accompanied by adequate supervisory and enforcing mechanisms.

/A final

A final general comment relevant to the focus of this study is that, despite a perceived differentiation between the codes of practice applying to urban and rural areas, based more on physical/technical than on socio-cultural aspects, current official practices do not contain substantive provisions for providing alternative specifications to make services more easily available to low-income groups. This situation creates other queries: should there be one national practice broad and flexible enough to allow for the adequate servicing of various possible physical and socio-cultural situations, or should there be a number of practices each covering a specific situation but all compatible with each other? The decision here is not easy, and both alternatives have elements in favour and against. Most probably, both approaches are adequate under different conditions. Thus, the only possible recommendation in this case would be that each country, or implementing agency, should decide on the best approach to suit its own institutional, geographical and socio-cultural realities.

Before proceeding, it is worth mentioning that the following comments on specific subjects will be of a qualitative rather than a quantitative nature. However, where there is the support from available research work or empirical data, some recommendations will be made on quantifiable design criteria.

## B. Legislation

Despite the fact that a detailed review of the documentation on legislation was carried out in the case of only one country, Colombia, there are reasons to assume that the majority of the countries in the region have legislation which regulates the drinking water supply, sanitation and solid-waste disposal sector in greater or lesser detail. This is shown by the indications from the other two countries which answered the questionnaires, Jamaica and Uruguay, and personal, although not documented, knowledge of the situation in other countries.

The coverage of the existing legislation in Colombia is very comprehensive. It can be said that the Ministry of Health, the National Health Institute (NHI) and the National Institute for Municipal Promotion (INSFOPAL) have issued between them legislation and regulations covering the most important aspects of the activities leading to the provision of water, sanitation and solid-waste disposal services. The following comments will touch on some aspects of the emphasis of the existing legislation.

### 1. Institutional aspects

1.1 The main policy behind the existing legislation in Colombia is to have two main national co-ordinating bodies for activities in the sector: INSFOPAL, dealing with urban areas and NHI, for rural areas. In the case of urban areas, the actual implementation of projects, operation and maintenance is the responsibility of regional or municipal executing organizations. The executing agencies are conceived as independent enterprises with legal, administrative and financial autonomy. Their boards of management are composed of representatives of local authorities and of the national government. Despite the apparent freedom of action of these companies, they have to submit their plans, projects and programmes to INSFOPAL for approval and have to report on aspects such as finances, administration, works, personnel, etc. This, together with the fact that most of the Directors of the companies are members of the National Health System or are nominated by INSFOPAL and that, by its constitution, INSFOPAL has greater capacity than local authorities to obtain credit and make financial commitments, makes the companies subject to INSFOPAL central policies and financial control. This tendency is offset in the big cities, where, because of the size of the operations and the vested interests of the local authorities, the executing organizations or companies which have been set up have to work as true local service companies. In these cities as in other areas serviced by regional authorities the involvement of INSFOPAL is negligible.

As indicated before in this study, different realities call for different solutions, and the type of institutional arrangements for organizing the delivery of services is no exception. However, experience tends to show that the more initiative and independence is given to local and regional organizations, the more motivated to operate effectively will they be. In this respect, legislation can allow and encourage this type of independence, centralizing technical and financial support if this is considered necessary for economies of scale.

1.2 The reviewed legislation does not have mechanisms that allow or encourage community participation in any of the stages of urban projects for the provision of services (water, sanitation, solid-waste disposal). In the rural sector the situation is different. The administration, operation and maintenance of rural water supply and sanitation systems is entrusted to the Administration Committees, composed in their majority by community members. However, from the reviewed documentation, it is not clear what their role is in the initial stages of project identification, planning and design.

Community participation in project implementation is desirable for many reasons, including the following:

- It strengthens the capacity and sense of responsibility of the people for determining the future of their community.
- It assists in the selection of adequate technologies and service levels.
- It allows the tapping of potential community inputs for the implementation of services projects.
- It assists in the administration, operation and maintenance of existing services.

The desirable condition of full community participation is normally conditioned by two strong elements. The first is the particular social and political reality of each country. Social structures, hierarchies and traditions, as well as political parties and systems of government, tend to restrict and/or direct the forms of community participation. Secondly, there is a tendency in the mass of the people to inertia, to delegate power and decisions to an active minority. This inertia can normally be broken by the motivation (caused by internal or external forces) to carry out a specific action or task. It is more difficult, however, to sustain this motivation for long periods or distant objectives, without creating a de facto transmission of decision-making capacity and power to a minority, that is, a sort of internal communal institutionalization.

/Legislation should

Legislation should promote and create the conditions for constant and realistic community participation. The conditions mentioned above should be kept in mind when designing legislation in this respect. Moreover, the community should not be asked to give more than could normally be expected from it under truly democratic conditions.

1.3 Related to the concept of community participation is the need to create legal instruments to regulate the execution and administration of projects by the beneficiary community or with their participation, along the lines of current contract procedures and regulations for formal contractors.

2. Tariffs

The existing legislation for Colombia specifies that water rates shall be charged in all cases. However, it does not go so far as to give general criteria for the design of a tariff structure, because this is normally determined at the operational level. Despite the above, it would be desirable for legislation to provide general criteria for the preferential treatment of low-income groups and mechanisms for transferring part of these charges to other groups with more capacity for payment.

3. Project preparation

Most of the countries for which documentation was available had long and detailed descriptions of the project cycle, indicating the studies and activities to be executed, documents to be produced and the way these documents should be presented for review and approval.

While acknowledging that in certain cases all the indicated studies, activities, etc., might be necessary, in many cases (and in most of the cases of low-income settlements) they are not required in the specified degree of detail. Since it is not possible to give several listings of information and investigation requirements for each situation, the regulations should at least include specific provisions for:

a) carrying out only those stages of the project cycle (identification, preliminary study, feasibility study, pre-design and design) that are applicable according to the conditions of the community to be served;
b) executing only those studies strictly necessary for the design and construction of the services (this would include socio-cultural and economic data as required);
c) lowering the requirements for the presentation of documents, reports, drawings, etc., for projects in low-income areas.

/C. Codes

## C. Codes of practice covering water supply

### 1. Water demand

#### 1.1 Population to be served

There is more or less general agreement that estimates of the present-day design population should be based on field surveys and/or official government surveys and statistics. However, there is a wide range of options chosen by the studied countries to estimate future population trends. Some countries specify that the calculation of growth projections should be done by different systems (arithmetic, geometric, etc.) and then the one best reflecting local conditions should be chosen. Other countries only indicate that future population estimates should be based on the study of local conditions, without indicating how the projections should be calculated.

It seems desirable that regulations on this subject should specify that the estimates of present population should be based on actual official statistics supported by limited field consistency checks. In the absence of official statistics, field surveys should be carried out. Future population projections should be based on the evaluation of the local conditions and be compatible with, or take into account, other demographic projections for the same area. Specific formulas to describe growth patterns should not be given, since they are bound to become obsolete or unrealistic.

#### 1.2 Design period

The design period, as here understood, refers to the number of years in the future for which the capacity of the water supply units will be designed. The selection of the optimum design period should be based on factors such as the useful life of the constructed structures or units, duration of the project cycle (identification, planning, design, construction), the estimated pattern of demand growth and financial considerations. From the financial point of view, the closer the "investments" curve is to the "demand for service" curve, the more financially efficient the system will be, since this means that the unutilized installed capacity (non-productive investment) will be minimized. Also, in an ideal situation, the length of the project cycle should not be of concern, since this can be a continuous process, one project overlapping the other to produce a constant flow of outputs. However, this ideal situation is limited in practice by the normal operation of service agencies, the official planning and budgeting cycles, and the non-matching cycles for loan and financial arrangements.

The pattern of demand growth will affect decisions as to the size of investments and cost recovery periods. Finally, the various components of infrastructure services have different useful lives, which together with the physical possibility of replacing, upgrading or complementing these units, will influence their design capacity.

In view of the above factors, codes of practice should allow freedom and flexibility in the selection of design periods. They should provide the criteria

/for the

for the selection of optimum values seeking to achieve periods as short as practicable. If desirable, details of empirical values of "useful life" should be given for various water supply units under local conditions.

1.3 Average water demand

The average daily water demand values reviewed range from circa 35 lppd (domestic only, in cold climate and rural areas - Ecuador) to 455 lppd (maximum considered value for the average daily demand in urban areas - Jamaica). In addition, some countries make allowances for water losses by adding between 15% and 40% to the given average demand.

The normal range of the average daily demand figure used in the region for large urban centres is from 180 to 250 lppd (Uruguay, Chile, Peru, Colombia). There is evidence that the average consumption (with minimum gardening) in upper middle class households (4 persons, 2 bathrooms, kitchen and washing facilities) in temperate climates is 190-200 lppd. These values are very close to the average values used for the urban areas as a whole. Thus, it can be assumed that they are near the average between large consumers (prosperous residential areas, small industry, etc.) and small consumers (low-income sectors). Therefore, there is no reason for using in the design of water supply systems for low-income sectors the average values of a city or the average values of large consumers. For these areas, a more realistic figure of water demand will be between 70 and 120 lppd.

Water demand figures for rural areas are normally lower than those for urban sectors. It is believed that, subject to local conditions, rural water demands should be in the range of 30 to 120 lppd.

In areas where water is scarce or expensive, codes of practice should promote the use of water-saving devices and the development of household saving attitudes.

1.4 Demand factors

In theory, the calculation of the factors describing the variations in the yearly and daily demand of water should be based on historical records of these variations. These types of records are seldom available for every settlement under study, however. Faced with this situation, most countries have extrapolated certain known values and made them of national application. The reviewed documentation shows similar values for urban and rural areas:

Maximum daily demand: 1.2 to 1.5 of the average daily demand
Maximum hourly demand: 1.8 to 2.3 of the average daily demand.

Low-income settlements tend to be more homogeneous in composition and functions than other areas. Also, the smaller the settlement the more pronounced the daily variations in the demand will be. Because of these factors, it seems reasonable to maintain the conservative values currently used. However, some flexibility should be allowed, permitting the use of factors outside the above values when they are justified or when special policies require their use (such as substantive reductions on costs, and control of demand).

/1.5 Water

1.5 Water reuse at household and community level

As indicated before, it was not possible to find regulations or codes of practice dealing with the reuse of water at household level or within the limits of the community. In this respect, regulations should consider the possible reuse of water in association with "water saving" measures. Regulations in this area should indicate the activities suitable for water reuse and give criteria for the sanitary conditions to be met.

1.6 Field surveys: physical and socio-cultural

Meaningful physical and socio-cultural surveys are not an end in themselves but a mechanism for the adequate selection and design of technologies and for determining the extent and most effective forms of community participation. Since technology selection and community participation are not duly considered in the current official practices, it is understood that the scope of present surveys is focused on other aspects (cost recovery, sanitary conditions). Therefore, it is necessary that codes of practice, supported by adequate legislation, should provide the criteria for the design of surveys (physical and socio-cultural) according to the intended importance to be given to the technology selection and community participation processes.

## 2. Water sources

Chile was the only country reviewed which has official codes (standards) covering the whole range of possible sources of drinking water, that is to say, the atmosphere, surface and ground sources, the sea and brackish waters. The other countries focus mainly on providing design guidelines for the various systems of ground and surface water abstraction. Codes of practice should add to the above indicated sources the possible reuse of water. In the light of current requirements, it seems appropriate that the sources should ensure a supply capacity equivalent to the maximum daily demand, either in a continuous or intermittent supply.

## 3. Treatment

Most of the reviewed documentation on treatment processes provides detailed design parameters for conventional treatment processes and units. In this regard it is necessary that codes of practice should rather focus on the provision of design criteria (technical, economic and operation/maintenance) for:

- selection of required treatment processes;
- selection of adequate treatment units;
- factors for the dimensioning of treatment units.

If it is desired to list in the standards the possible treatment alternatives, they should include, in addition to the conventional processes, other low-cost appropriate treatment alternatives.

Current practices do not include provisions for household treatment, which would mean the existence of complementary provisions allowing the supply of water below drinking water quality standards. It seems difficult, under present conditions to change this situation, and its desirability is also questionable in view of the well-established expectations of users regarding the water quality to be obtained from a public service.

## 4. Storage

Several criteria are applied in the region to calculate water storage capacity. The more conservative codes indicate that the storage capacity shall be a function of the regulation volume necessary to absorb the hourly variations in demand plus a volume for emergencies and an allowance for firefighting. Several methods are given for calculating the required volumes to satisfy the three indicated requirements.

It can be reasonably assumed that the majority of the low-income settlements, rural or urban (inserted in a larger urban context), have alternative sources of water regardless of their quality. Considering the above, and the almost impossible task of assuming safe and economical reserve volumes for emergencies and firefighting, it would be advisable for emergency and firefighting volumes not to be initially considered for low-income areas, unless there is a confirmed high risk of fire occurrence.

In the absence of water demand/supply curves, a regulation volume between 20% and 30% could be considered. However, there is also the possibility of having no regulation volume, thus forcing the users to install household storage facilities. This approach would be a sort of "forced" community participation by transferring some of the project costs to the community, and could have negative effects on the operation of a system. Notwithstanding the above, codes of practice should allow for this eventuality by providing the criteria for studying this type of alternative.

The design of storage units under the above conditions should allow for their future upgrading once it is possible or necessary to do so.

## 5. Distribution systems

### 5.1 Hydraulic capacity

There is general agreement, among the reviewed documents, that the distribution mains should be designed to take either the maximum hourly demand, or the maximum daily demand plus an assumed firefighting flow. Design criteria for low-income areas should consider a capacity of the distribution mains capable of catering for the maximum hourly demand. Firefighting capacity should be omitted for the same reasons already given in the previous section. This proposal is not in contradiction with the possible decision not to consider a water demand regulation unit (storage), since the upgrading of buried distribution mains is more costly and inconvenient than the progressive increase of storage volume, therefore it would generally be more economic to install water mains to the final desirable standards.

/5.2 Permissible

5.2 Permissible pressures

The range of permissible pressures specified in the region is:

- Rural: minimum: 0.6 bar (Colombia), maximum: 6.0 bar (Colombia)
- Urban: minimum: 1.0 bar (Colombia, Peru), maximum: 7.0 bar (Chile).

The majority of the households in low-income settlements of the region consist of one-storey buildings. However, after the initial consolidation of the settlements, especially in urban areas, larger two-storey buildings start to appear. A minimum water pressure of 0.6 bar would be enough to provide a satisfactory service to a one-storey house, while 0.8 bar would be enough for two-storey dwellings. These proposed minimum pressures would mean a fair distribution of costs among the users, since it would not be equitable to increase the cost of the overall distribution system to supply the few consumers that can develop larger house structures. Instead, the better-off consumers should assume the cost of water lifting within their own premises.

Maximum permissible pressures are a function of economic factors, the range of pipe classes (work pressures) available in the country and the work pressure of sanitary fittings. Thus, instead of specifying maximum permissible pressures, codes of practice should only provide the criteria to determine their most adequate values according to local conditions.

5.3 Permissible diameters

Most of the countries specify a minimum diameter of 75 mm, although some (Chile, Peru) allow the use of 50 mm diameter pipes in low-income areas. Proposed standards for Ecuador indicate the possible use in rural areas (less than 3 000 inhabitants) of 25 mm diameter pipes for ring mains and 18 mm diameter pipes for secondary mains.

Under normal conditions (average demand: 100 lppd, maximum hourly flow factor: 1.8, velocity: 0.3 m/s) for the maximum hourly flow, a 38 mm diameter non-ferrous pipe could serve approximately 168 people, that is, the average occupancy of a housing block in low-income areas. It could thus be advisable to allow the use of 38 mm diameter pipes in urban areas, keeping in mind that no allowances are made for firefighting. If firefighting service facilities are planned for the future, then allowances should be made for the use of larger mains (75 mm diameter and over) for this purpose. Minimum diameters should not be specified for ring mains in urban areas, or mains for rural settlements: instead, diameters should be based on actual flow calculations.

5.4 Permissible velocities

It does not seem appropriate to specify minimum velocities for distribution mains, given the wide variation of flow conditions and even the occurrence of back-flows in secondary mains. Maximum velocities are of greater importance, since it is known that high velocities tend to produce cyclical variable stress loads on the pipes due to flow variations. Velocities over 2.5 m/s tend to have

/this negative

this negative effect on rigid pipes, inducing fatigue of the materials, and therefore exceeding this value should be avoided wherever possible.

## 6. Intermittent supplies

Current practice in the region does not consider the design of intermittent water supplies. In this regard, it is advisable to start research in this area, especially for rural water supplies relying on pumping. Factors such as siphonage, contamination of water supplies due to negative pressures and effects on metering units should be considered.

## 7. House connections

Only Honduras has a proposal allowing service pipes (18 mm diameter) to supply two households. Considering the substantial savings in money to be achieved by reduced numbers of mains' tappings and service pipes, codes of practice should permit the use of these types of connections to serve two households or more. These regulations should include provisions for the installation of public service pipes in private property, together with criteria to ensure easy access to the installations, and the sorting out of legal aspects.

## 8. Communal facilities

It was not possible to find official information on the use of communal facilities (water taps, washing and laundry points) for urban areas. However, there is evidence that communal facilities are specified and used in rural projects. As indicated at the beginning of this document, cultural patterns in the region aspire to reach the standard of service enjoyed by more developed regions. This attitude tends to create, in urban areas, a strong preference for household water connections. This situation is slightly different in rural areas, where there is a long history of the use of communal service. However, as indicated elsewhere (Interregional Review of Standards and Technologies, UNCHS-Habitat, 1984), there seems in practice to be little difference between the cost of providing communal standposts and the cost of providing household connections. Taking the above factors into account, it would be desirable to provide criteria for the design of communal services, specifying that they should be used only in absolutely necessary cases, and always making allowances for their future upgrading.

## 9. Pipelaying

### 9.1 Pipe location

According to the reviewed documents, the main criterion for pipe location is that they should be laid in public areas, under carriageways, should cross over sewers, and be laid as far as possible from parallel sewers and service cables. Some countries also specify that, in wide roads, the desirability of installing two parallel pipes at either side of the road should be studied.

The above specifications should be complemented by the following aspects:

/- provisions for

- provisions for the installation of public water mains in private property (physical and legal considerations);
- provisions for the installation of water mains under footpaths and other areas where traffic loads (vehicles) are not expected;
- economic criteria should be provided to decide on the desirability of installing more than one main in a road, allowing also for the possibility of installing service pipes to supply several households;
- the type of protection against contamination of water mains crossing sewer lines should consider the actual local conditions;
- minimum distances to sewers and cables should be based on the study of specific local conditions;
- minimum distances to building structures should be based on the study of individual cases.

### 9.2 Pipe depth

It is recommended that minimum depths, or covers over the pipe crown, should not be specified since they are influenced by various factors, such as the pipe material, soil characteristics, type of pipe bedding and trench backfill, expected loads over the pipe (live and dead) and climate (although freezing temperatures are not common in most of the region). Thus, codes of practice should focus on giving the basic criteria to calculate the required pipe depths and backfilling specifications to take such loads.

Current values for minimum permissible cover over the pipe crown (0.8 m and above) could in many instances be reduced by calculating the actual intervening loads, and also by locating pipes in areas where heavy loads are not expected.

### 10. Design criteria for low-income settlements

A general conclusion of this chapter is that existing codes of practice and specifications do not make special allowances for serving low-income settlements. The recommendations given in the previous sections, together with the application of an "upgrading" concept, should assist in filling this blank area.

## D. Codes of practice covering sanitation

### 1. General

As already noted in section II (B 4 and 5), the reviewed codes of practice and specifications on sanitation services deal almost exclusively with conventional sewerage systems. There are specifications that regulate the design of septic tanks and dry pit latrines, but they apply conventional concepts. Therefore, it would be relevant at this stage to indicate some of the possible technology alternatives to conventional sewerage systems. It is not intended to provide design criteria for these units, since they are given elsewhere (World Bank, United Nations and other publications) and it is also felt that more research is required to make their design and operation suitable to conditions in the region. The list of technologies given is not exhaustive. Therefore, current legislation should only have provisions that allow the use of other technologies than

/conventional sewerage

conventional sewerage and lay down the basic conditions to be met by these technologies (economic, socio-cultural, sanitary, operation and maintenance, etc.).

The technologies given below are based on the list used in the questionnaire prepared to gather information for this study, and include:

<u>On-site systems:</u> Dry:
- Pit latrine
- Reed odourless earth closet
- ventilated improved pit latrine
- batch composting latrine
- continuous composting latrine

Wet:
- Pour flush latrine (with pedestal toilet)
- aqua privy
- septic tank

<u>Off-site systems:</u>
- Vault and vacuum tank
- vault with manual (hand pump) removal and cart or truck
- small bore sewerage.

## 2. Population to be served and design period

The same comments given in previous sections (C. 1.1 and 1.2) regarding water supply are also applicable to the determination of the population to be served and design periods for sanitation projects.

## 3. Maximum design flow of sewers (conventional sewerage)

It can be said that most codes of practice specify the design of sewer pipes for separate systems, with a capacity to take between 70% and 80% of the maximum hourly water demand plus ground and surface infiltration. In this regard, the following observations may be made:

- As design practice, it seems reasonable that the domestic design flows should be taken as a fraction of the maximum hourly water demand, that is, 1.8 to 2.3 of the average daily demand. This empirical assumption would allow for higher "instant" demands (as high as 6 or 7 times the average demand), reduced by the corresponding attenuation of these peak flows through the length of the sewers. There are no studies on low-income areas which support the assumption that the wastewater discharges correspond to 70-80% of the water flow in a given period of time. In this respect, more research should be carried out to confirm the validity of the above figures.
- Infiltration values should not be specified, but rather recommendations should be given on the correct way to evaluate infiltration rates, based on:
  - pipe size and material;
  - local conditions (soil, ground water, rainfall, climate, etc.);
  - expected level of workmanship.

  If desired, infiltration values may be given as a general guide, keeping

/in mind

in mind that under certain conditions (in arid areas for example) there could be net water losses due to percolation of wastewater to surrounding ground.

4. Permissible velocities

As a general norm, the countries of the region specify a minimum velocity in the sewers of 0.6 m/s. Ecuador and Honduras are exceptions, allowing the use of velocities of 0.3 and 0.33 m/s in partly full lateral (branch) sewers. The concept behind a minimum velocity of 0.5-0.6 m/s is to achieve self-cleansing velocities, that is, not to allow the settling of suspended solids, and to wash out solids settled during a period of slack or non-flow. There is experience outside the region on the satisfactory operation of sewers with velocities of 0.3 and 0.4 m/s. However, more research should be carried out in the region to support the validity of these figures. Special local factors affecting flow conditions should be taken into account. They include pipe materials and quality (roughness) and the expected level of workmanship to be achieved in projects for low-income areas. These considerations are especially relevant to the initial stretches of branch sewers, where wastewater flows are low and irregular.

Maximum permissible velocities are a function of the pipe material and desired flow conditions. Under normal conditions velocities in the range of 6.0-7.0 m/s could be acceptable for smooth-surface pipes.

5. Minimum gradients

Minimum gradients should be those required to ensure the occurrence of the minimum permissible velocities as indicated in the previous section for the most unfavourable flow conditions. Minimum specified values are 0.7% for 150 mm diameter sewers (Chile) and 1.0% (if properly justified) for 100 mm diameter house connections. These values seem quite reasonable and could even be reduced according to specific flow conditions, that is, the number of houses (flow) to be connected to a sewer. Thus, a 100 mm diameter sewer serving over 300 persons could be laid at gradients of 0.7%. Special consideration should be given to the flow régime in the initial stretches of such sewer lines, since they would not have the required flow conditions to achieve this velocity.

6. Minimum diameter

None of the reviewed standards specify minimum sewer diameters below 150 mm. However, as seen above, a 100 mm diameter sewer could easily serve an average housing block (50 households). Thus, 100 mm diameter sewers should be permitted for secondary mains, in view of the cost savings and better flow conditions to be achieved. Also, standard maintenance equipment can easily be adapted to serve 100 mm diameter pipes. The use of sewers below 100 mm diameter would require detailed studies of flow conditions, type of sanitary fittings being used, and adequate maintenance equipment.

/7. Field

## 7. Field surveys

As with the case of water supply, technology selection and community participation are not considered in the current official practice of the region. The scope of the specified project surveys lays emphasis on cost recovery and the evaluation of sanitary conditions. It would thus be necessary for codes of practice to provide criteria for the design of surveys according to the intended importance to be given to technology selection and community participation.

## 8. Treatment systems

The reviewed codes of practice on treatment systems are limited to conventional processes which in most of the cases are not affordable by the countries of the region due to their requirements as regards cost, energy, qualified personnel and maintenance. Therefore, codes should lay emphasis on the selection of adequate treatment technologies. In this respect, more research should be carried out on the local application of processes such as wastewater re-use, irrigation, aquaculture and energy production.

## 9. Communal facilities

The same comments given for water supply in section C. 8 of this chapter are also applicable to sanitation facilities.

## 10. Pipelaying

### 10.1 Pipe location

The main official criteria for sewer location is that they should be laid in public areas, if possible along the centre line of roads, should cross under water mains and be as far as possible from parallel water mains. In most cases, with the exception of the proposals for low-income settlements in Honduras, household connections can serve only one plot. Peru has more flexible specifications, permitting under special conditions the laying of household drain sewers across lower level adjacent plots. It also allows, when required, the laying of sewers at such a depth as to drain by gravity only 2/3 of the plots along a given line, while sewers over 600 mm diameter can be laid in curve alignments.

In addition to, or complementing, the above criteria, the following aspects should be considered in current regulations:

- authorization to lay public sewers in private property (front or back yards);
- authorization to lay household drain sewers across neighbouring plots if justified by cost; these two provisions should take into account all physical (inspection, maintenance, etc.) and legal implications;
- provision for the installation of sewer lines under footpaths and other areas where traffic loads are not expected;
- provision of economic criteria to decide on the desirability of

installing more than one sewer in a road, allowing also for the possibility of installing service sewers to take the discharge of two or more households;

- the minimum distances to water mains, cables and building structures should be based on the study of each specific case;
- criteria should be provided for laying sewer lines in curve alignments regardless of the diameter, taking into account the requirements for maintenance equipment.

### 10.2 Sewer depth

Minimum sewer depths (or covers) are a function of the assumed capacity to drain by gravity all the households that a line is serving, pipe materials, bedding and trench backfilling. Most of the countries in the region specify a minimum cover of 1.00 m over the sewer crown. Only the proposed specifications for low-income areas in Honduras consider a minimum cover of 0.75 m, if the sewers are installed under footpaths. Since houses having cellars or installations below ground level are rare in low-income settlements of the region, and assuming that if necessary on account of problems of level the drain pipes could discharge through adjacent lower-level plots, the criterion of conditioning sewer depths to the minimum depth needed to drain all households by gravity could be omitted. Thus, the expected loads over the sewer pipe would become the limiting factor determining sewer depths. Under these conditions, codes of practice should focus on providing the basic criteria to calculate the required depth and types of pipe bedding and trench backfilling to take the expected loads over the sewer.

## 11. Manholes

### 11.1 Manhole location

Most of the countries in the region generally specify the installation of manholes at any point where a change in the conditions of a straight sewer line occurs (diameter, direction gradient, material, intersections and start of a line). Also, minimum distances between manholes are given for different pipe sizes. They range from 100 m, for 150mm diameter sewers, to 200-300 m for sewers over 1 000 mm diameter. Considering that the cost of manholes can represent around 40% of the total cost of a sewerage network, it would be desirable to specify manholes only in those places where they are absolutely necessary. Since there is little accumulated experience in this aspect, we will limit ourselves to suggesting some points that should be considered when deciding on new specifications or standards:

- Manholes would not be required at the place of change of the pipe material, as long as watertight joints are obtained and a smooth transition that does not alter the flow régime is ensured. The transition points should be easily identifiable for maintenance purposes.
- It should not be mandatory to install manholes in places where there is a change of direction, diameter or gradient, as long as non-disruption of the flow régime is ensured. The transition point should be easily identifiable for maintenance purposes.

/- The start

- The start of sewer lines should have a manhole, a small inspection chamber, or only a rodding/washing point, according to the sewers' depth and length, and taking into account the available maintenance/cleaning equipment.
- Manholes should be installed in every intersection of two or more sewer lines. Connections for household service pipes should be effected with special fittings or directly joined to the sewer pipe.
- The minimum distance between manholes in uninterrupted sewer lines (without intersections) should be based on the available maintenence/cleaning equipment, and the possibility of direct access to the interior of the sewer line by maintenance staff.

### 11.2 Manhole dimensions

Specified internal diameters of manholes vary from 0.60 m for invert depths up to 1.10 m (Colombia, rural: does not specify pipe diameters), to 1.80 m for sewers up to 1 200 mm diameter (Peru, urban: does not specify invert level). In low-income settlements, where the diameter of sewer pipes would normally not exceed 400 mm, it could be recommended that the internal diameter of manholes should be 0.60 m for invert levels not exceeding 1.20 m below ground level. Manholes for deeper and/or larger mains should be designed according to particular site conditions, keeping economic considerations in the foreground.

## E. Standards

The coverage of current standards for materials and equipment in the region is relatively broad. There are no standards for materials (ductile iron, steel pipes, etc.) and specials (air valves, special fittings, etc.) normally not produced in all the countries of the region, but to cover this eventuality the standards applicable to the country of origin are usually specified.

In this regard, it would be desirable that the countries of the region should carry out more research into appropriate low-cost building materials and fittings, including sanitary fittings allowing efficient use of water (low-volume flush toilets, low-volume shower heads and taps, fittings to allow multiple use of water, etc.).

## F. Solid waste

It was felt that it was not relevant to make further comments in the area of solid waste, considering the extremely limited information available for the study and the also limited availability of information on local experience and practices. Thus, it is hoped that the presentation of current practices in Colombia could serve as a reference for other countries wanting to start developing standards and regulations in this area, and a starting point for further research in the subject.

/Notes

## Notes

1/ Instituto Nacional de Fomento Municipal, Cuestionario sobre normas, códigos y estándares, Colombia, April 1985.

2/ Administración de las Obras Sanitarias del Estado, Cuestionario sobre normas, códigos y estándares, Uruguay, April 1985.

3/ National Water Commission, Questionnaire on regulations, codes and standards, Jamaica, 21 February 1985.

4/ Associaçao Brasileira de Normas Técnicas, Elaboraçao de relatório preliminar de sistemas de esgotos sanitários, P-NB-566, Brazil, 1975.

5/ Associação Brasileira de Normas Técnicas, Elaboração de projetos de redes de esgotos sanitários, P-NB-567, Brazil, 1975.

6/ Associação Brasileira de Normas Técnicas, Elaboração de projetos de interceptores de esgotos sanitários, P-NB-568, Brazil, 1975.

7/ Associação Brasileira de Normas Técnicas, Elaboração de projetos de elevatórias e emissários de esgotos sanitários, P-NB-569, Brazil, 1975.

8/ Associaçao Brasileira de Normas Técnicas, Elaboração de projetos hidráulico-sanitários de sistemas de tratamento de esgotos sanitários, P-NB-570, Brazil, 1975.

9/ Servicio Nacional de Obras Sanitarias, Guía para la elaboración y presentación de proyectos de agua potable y alcantarillado, Chile, March 1979.

10/ Servicio Nacional de Obras Sanitarias, Normas de diseño, Programa Rural, Chile, July 1983.

11/ Instituto Nacional de Normalización, Ingeniería Sanitaria. Presentación y contenido de proyectos de sistemas de agua potable y alcantarillado, NCh1104. Of78, Chile, 11 April 1978.

12/ Instituto Nacional de Normalización, Agua potable - Parte 1: Requisitos, NCh409/1.Of84, Chile, 16 January 1984.

13/ Instituto Nacional de Normalización, Agua potable - Parte 2: Muestreo, NCh409/2.Of84, Chile, 16 January 1984.

14/ Instituto Nacional de Normalización, Agua potable - Fuentes de abastecimiento y obras de captación. Terminología, clasificación y requisitos generales, NCh777.Of71, Chile, 3 November 1971.

15/ Instituto Nacion al de Normalización, Agua potable - Conducción, regulación y distribución, NCh691.Of78, Chile, 11 April 1978.

16/ Servicio Nacional de Obras Sanitarias, Reglamento de instalaciones domiciliarias de agua potable, de alcantarillado y manual de normas técnicas, Chile, 16 September 1980.

17/ 17-A, Facultad de Ciencias Físicas y Matemáticas, Universidad de Chile, Manual del Seminario: Normas de diseño de obras de agua potable y alcantarillado, Chile, 1977.

18/ Ministerio de Salud, República de Colombia, Código Sanitario Nacional, Ley Número 09 de 1979, Colombia, 24 January 1979.

19/ Ministerio de Salud, Decreto Número 1594, Colombia, 26 June 1984 (Usos del agua y residuos líquidos).

20/ Ministerio de Salud, Decreto Número 2104, Colombia, 26 July 1983 (Residuos sólidos).

21/ Ministerio de Salud, Decreto Número 2105, Colombia, 26 July 1983 (Potabilización del agua).

22/ Ministerio de Salud, Manual DISA Número 4: Tanques sépticos.

23/ Instituto Nacional de Salud, Acuerdo Número 014 de 11 de mayo de 1983. Reglamenta la administración de acueductos y alcantarillados rurales, Colombia, 11 May 1983.

24/ Instituto Nacional de Salud, Ministerio de Salud, Resolución N° 001356, Normas de diseño y presentación de proyectos para acueductos rurales, Colombia, 21 September 1971.

25/ Instituto Nacional de Salud, Ministerio de Salud, S.B.R.P. N° 0023-10 Normas de diseño alcantarillados rurales, Colombia, February 1970.

26/ Empresa de Acueducto y Alcantarillado de Bogotá, Procedimiento para la elaboración de proyectos de redes de alcantarillado para urbanizaciones, Colombia, undated.

27/ Instituto Nacional de Fomento Municipal, Ministerio de Salud, Resolución N° 000431. Reglamenta la inscripción, clasificación y calificación de contratistas, Colombia, 10 August 1983.

28/ Instituto Nacional de Fomento Municipal, Ministerio de Salud, Resolución N° 0034. Reglamenta el sistema de inscripción, clasificación y calificación en el registro de consultoría, Colombia, 17 January 1984.

29/ Instituto Nacional de Fomento Municipal, Ministerio de Salud, Decreto 2804 de 1975 (Decreto reglamentario 1157 de 1976). Reorganiza el Instituto Nacional de Fomento Municipal, Colombia, 19 December 1975.

30/ Consejo Nacional de Desarrollo, Normas de equipamiento e infraestructura de los asentamientos rurales del Ecuador (versión preliminar), Ecuador, February 1981.

31/ Instituto Ecuatoriano de Obras Sanitarias, Normas tentativas para el diseño de sistemas de abastecimiento de agua potable y alcantarillado urbanos y rurales (borrador, 1982), Ecuador, December 1982.

32/ Gobierno del Perú, Código Nacional de Construcción, Título II.R.S. N° 146-72-VI-DM, Normas y requisitos para los proyectos de agua potable y alcantarillado destinados a localidades urbanas, Peru, 1972.

33/ Water and Sanitation for Health Project (WASH-USAID), Medidas propuestas para reducir costos en proyectos de infraestructura y urbanizaciones de vivienda mínima, WASH, Informe de Campo N° 46, Washington, D.C., United States, June 1982.

34/ UNCHS-Habitat, Interregional review of technologies for the provision of infrastructure in low-income settlements, Kenya, December 1983.

Annex 1

# QUESTIONNAIRE

1. Definitions: (International Organization for Standardization)

1.1 Regulation: A binding document which contains legislative, regulatory or administrative rules and which is adopted and published by an authority legally vested with the necessary power.

1.2 Code of practice: A rule describing recommended practices for the design, manufacturing, setting up, maintenance or utilization of equipment, installations, structures or products.

1.3 Standard: A technical specification or other rule based on consensus, approved by a recognized standardization body for repeated or continuous application.

2. Notes

2.1 In questions where there are shown several answers mark one or more as appropriate.

2.2 Where descriptions are required please be brief.

2.3 Where YES or NO answers are provided please DELETE THE ONE NOT APPLICABLE.

3. Water supply

3.1 Do you have regulations in the field of water supply? YES NO

3.1.1 If yes:

a) Title ........................................

b) Issuing body ........................................

c) Date of issue ........................................

d) Coverage
- National
- Urban
- Rural
- Others (specify) ........................................

e) Scope
- Domestic
- Industrial
- Others (specify) ........................................

3.2 Do you have codes of practice applicable to water supply? YES NO

3.2.1 If not:

a) Have you adopted for practical purposes codes of practice from another/other country/ies YES NO

Give details:

| | Country I | Country II | Country III |
|---|---|---|---|
| Title | | | |
| Issuing date | | | |
| Issuing body | | | |
| Country | | | |
| Description | | | |

* Use separate page if above space is not enough.

b) If you have not adopted codes of practice from another/other country/ies, indicate which guidelines do you follow for design, construction, etc. (e.g., text books, local empirical practice, non-published codes of practices, etc.). Please describe.

3.2.2 If yes:

Give details:

| | Code I | Code II | Code III |
|---|---|---|---|
| Title | | | |
| Issuing date | | | |
| Issuing body | | | |
| Description | | | |
| Coverage (national, urban, rural, others) | | | |
| Scope (domestic, industrial, others) | | | |

* Use separate page if above space is not enough.

3.3 Standards related to water supply (mark as appropriate the standards currently applied in the country)

| Description | National standard | Foreign standard |
|---|---|---|
| Pipes: P.V.C. | | |
| Asbestos cement | | |
| Ductile/cast iron | | |
| Steel | | |
| Concrete | | |
| Valves: Sluice | | |
| Gate | | |
| Water taps | | |
| Inspection chambers | | |

3.4 Water supply practices

Notes:

- the information required below shall be based on the regulations, codes of practice and standards currently applied by your organization.
- since your organization might be covering only one sector of the national water supply activities (e.g., urban, rural, etc.) you are required to answer only those questions relevant to your activities.

3.4.1 Indicate the design average domestic water consumption in litres per capita per day.

- urban ............................
- rural ............................

3.4.2 Indicate the design daily peak flow factor as a multiplier to the average domestic water consumption.

- urban ............................
- rural ............................

3.4.3 Indicate the maximum instant flow factor as a multiplier to the average domestic water consumption.

- urban ............................
- rural ............................

3.4.4 Indicate the design water storage volume as a fraction of the daily consumption.

- urban ............................
- rural ............................

Do you evaluate water storage requirements based on supply-demand curves? YES NO

3.4.5 Indicate minimum design pressure in distribution mains (bars)

- urban ............................
- rural ............................

3.4.6 Do you have provisions for design of <u>intermitent</u> water supplies?

- urban ............................
- rural ............................

3.4.7 Do you consider fire fighting requirements when designing:

a) Storage reservoirs YES NO
indicate criteria and if it is for rural or urban systems

b) Distribution mains YES NO
indicate criteria and if it is for rural or urban systems

3.4.8 What type of treatment do you specify for surface water:

| Type | Urban | Rural |
|---|---|---|
| Physical/chemical/disinfection as required | | |
| Disinfection only | | |
| None | | |

3.4.9 What type of treatment do you specify for groundwater:

| Type | Urban | Rural |
|---|---|---|
| Physical/chemical/disinfection as required | | |
| Disinfection only | | |
| None | | |

3.4.10 Do you specify water house connections?

| | | |
|---|---|---|
| Urban | YES | NO |
| Rural | YES | NO |

If yes, indicate if you specify use of water meters and payment of tariff.

3.4.11 Do you specify communal water points?

| | | |
|---|---|---|
| Urban | YES | NO |
| Rural | YES | NO |

3.4.12 Details for design of communal water points/wells:

| Description | Urban | Rural |
|---|---|---|
| People served per unit | | |
| Walking distance | | |
| Collection time | | |
| Is there a tariff? | | |

3.4.13 Pipe material:

| Description | Is its use specified | Is it locally manufactured |
|---|---|---|
| u. P.V.C. | | |
| Asbestos cement | | |
| Ductile/cast iron | | |
| Steel | | |
| Concrete | | |

4. Sanitation

4.1 Do you have regulations in the field of sanitation? YES NO

4.1.1 If yes:

a) Title

b) Issuing body

c) Date of issue

d) Coverage

- National
- Urban
- Rural
- Others (specify)

e) Scope

- Domestic
- Industrial
- Others (specify)

4.2 Do you have codes of practice applicable to sanitation? YES NO

4.2.1 If not:

a) Have you adopted for practical purposes sanitation codes of practice from another/ other country/ies YES NO

Give details:

| | Country I | Country II | Country III |
|---|---|---|---|
| Title | | | |
| Issuing date | | | |
| Issuing body | | | |
| Country | | | |

* Use separate page if above space is not enough.

b) If you have not adopted codes of practice from another/other country/ies, indicate which guidelines do you follow for design, construction, etc. (e.g., text books, local empirical practice, non-published codes of practice, etc.). Please describe.

4.2.2 If yes:

Give details

| | Code I | Code II | Code III |
|---|---|---|---|
| Title | | | |
| Issuing date | | | |
| Issuing body | | | |
| Description | | | |
| Coverage (national, urban, rural, others) | | | |
| Scope (domestic, industrial, others) | | | |

* Use separate page if above space is not enough.

4.3 Standards related to sanitation (mark, as appropriate, the standards currently applied in the country)

| Description | National standard | Foreign standard |
|---|---|---|
| Pipes: Concrete | | |
| Clay | | |
| P.V.C. | | |
| Grey iron | | |
| Channels | | |
| Sanitary fittings | | |
| Sanitation units (latrines, septic tanks, soakpits, aqua privy, etc. | | |
| Chambers, manholes | | |
| Wastewater treatment units | | |

## 4.4 Sanitation practices

Notes:

The information required below shall be based on the present practices of your organization.

Since your organization might be covering only one sector of the national sanitation activities (urban or rural), you are required to respond only to those questions relevant to your activities.

4.4.1 Mark below as appropriate which are the norms regulating the implementation (design, construction, operation, etc.) of sanitation projects by your organization in respect of the following systems:

| Description of system | Regulations | | Codes of practice and/or standards | | Local practice (text books, local experience, etc.) | | System is not known or used | |
|---|---|---|---|---|---|---|---|---|
| | Urban | Rural | Urban | Rural | Urban | Rural | Urban | Rural |
| a) On site dry | | | | | | | | |
| Pit latrine-trench overhung | | | | | | | | |
| - Reed odourless earth closet | | | | | | | | |
| - Ventilated improved pit latrine | | | | | | | | |
| - Batch composting latrine | | | | | | | | |
| - Continuous-composting latrine | | | | | | | | |
| b) On site-wet | | | | | | | | |
| Pour flush latrine | | | | | | | | |
| Aqua privy | | | | | | | | |
| Septic tank | | | | | | | | |
| c) Off-site dry | | | | | | | | |
| Vault & vacuum tank | | | | | | | | |
| Vault, manual removal cart or truck | | | | | | | | |
| Bucket latrine | | | | | | | | |
| d) Off-site-wet | | | | | | | | |
| Any of section b) systems plus small bore sewer | | | | | | | | |
| Conventional sewerage | | | | | | | | |